CURRENT STATE OF THE HORIZONTAL DRILLING TECHNIQUE FOR LONG DRAINAGE BORINGS TO DRAIN SLIDING SLOPES

AKTUELLER STAND DER HORIZONTALBOHRTECHNIK FÜR DRÄNAGELANGBOHRUNGEN ZUR ENTWÄSSERUNG VON KRIECHHÄNGEN

SITUATION ACTUEL DE LA TECHNIQUE DU FORAGE HORIZONTAL POUR DES PERCAGES LONGUES, QUI SERVENT A DRAINER DES PENTES MOBILES

Tobias Bräutigam, Hans Bossenmaier

SUMMARY

In the following summary, long drainage borings will serve as an example in order to show the current state of the nonsteerable and the steerable horizontal earth drilling technique. These drilling methods are used for both: through-borings and bottoming borings. Since recently, one also drills to install horizontal ground heat exchangers.

ZUSAMMENFASSUNG

Es wird der aktuelle Stand der ungesteuerten und der verlaufsgesteuerten Erdbohrtechnik am Anwendungsbeispiel der Herstellung von Dränagelangbohrungen dargestellt. Mit beiden Bohrverfahren können sowohl durchschlägige Bohrungen, als auch Sacklochbohrungen hergestellt werden. Als neues Einsatzgebiet der Verfahren sind Bohrungen für das Einbringen von Erdwärmekollektoren zu nennen.

RESUME

Dans l´exposé suivante, il s´agit des derniers développements en ce qui concerne les techniques conduitable et nonconduitable pour les forages horizontales de la terre à l´example de l´utilisation du forage long pour la drainage. Avec les deux méthodes de forage, il est possible de faire des forages de traverse

et aussi des forages de sac. Une nouvelle application possible, ce sont des forages pour l´installation des exchangers de chaleur de terre horizontale.

KEYWORDS: Horizontal Drilling Technique, Long Drainage Borings

1 GENERAL INFORMATION – GEOTECHNICAL PROBLEMS

Sliding Slopes in geologic formations which vary in their solidity (e. g. Knollenmergel, clay-soils of the dogger-formation) are in a delicate balance with a factor of safety of about 1. As a result, the stability of many traffic lines is no longer sure, in particular in zones of the Swabian Escarpment Land, especially in the zone of the Albtrauf (northern rim of the Swabian Alb, Baden-Württemberg, Germany).

In most cases, retaining constructions stabilizing moving earth masses are too expensive. So the only possibility left is to lower the ground water horizon in the slope. This is aimed at reducing the water the soil contains and at reducing the thrusting forces of this water to have at least a little effect. Consequently, one can stabilize the relevant masses. This stabilization is only a little, but mostly a sufficiant one. The gravity drain would provide a solution for well-aimed borings with slight ascended drilled bottoming borings out of the sloping site into the mountain in order to renovate relevant traffic line sections, if the ground water horizons are known. (Examples for projects the Department of Geotechnic has already suggested, see [1, 2a, 2b, 2d]).

One drills several borings which are arranged fan-shaped in the groundplan, while a water collecting well with a connection to the next canal is positioned at the collective starting point of the borings, in the final state. In spezial cases, drainage borings are radially drilled out of large-calibred wells or tunnels. (Example for a project the Department of Geotechnic has already suggested, see [2c]).

2 DRILLING TECHNOLOGY OF LONG HORIZONTAL BORINGS

Digging wells after the process of boring is finished, is usually too expensive, if the overburden is increasing.

2.1 Nonsteerable Horizontal Drilling Technique

Normally screw-borings are carried out with a length of up to 120 m. In geologic formations with embedded rocks or boulders, one uses a borehole hammer. Even in homogenous formations , the boring tool may drift downwards because of gravity. The deeper the borehole is, the more often the booring tool drifts apart. The phenomenon of drifting may also arise, if hard boulders are slippery cutted.

The vertical position of the boring head can be controlled with the principal of the tube level by using the hollow drill stam. Consequently, the hollow drill stam remains in the borehole as a measuring sonde.

Nonsteerable horizontal borings are approvable, if low standards in the precision of position are sufficient and if there are draining gradient reserves concerning the plan.

Figure 1: Nonsteerable horizontal screw-boring for the installation of 3´´-steel-pipes. The slope-draining project at the Thanheimer Steige, L 360, Baden-Württemberg, May 2006. Company: Plereiter GmbH, Innzell

Figure 2: Installation of 3´´-steel-pipes in a horizontal borehole with a length of 85 m in the middle jurassic formation at the Thanheimer Steige (L 360). May 2006

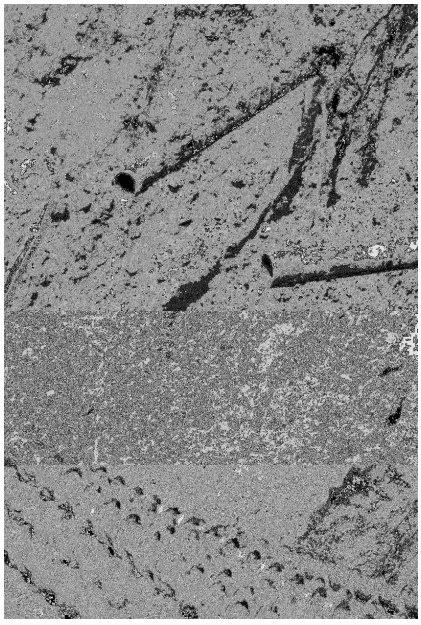

Figure 3: Ground water pours down shortly after the installation of the steel-pipes.

2.2 Steerable Horizontal Drilling Technique

The technology applicated in Germany since the earlier 1990th is also known as Horizontal Directional Drilling (HDD).

The spool-drilling-method in soft soils which are soluble in water and the mud-motor-method in geologic formations with embedded rocks or boulders are often used. The possible length of horizontal borings depends on the maximal torque and the pull of the rope of the machine and can reach up to several hundred metres [4].

But for drainage as a rule, there are shorter borings, often arranged like a galery [1], more usefull and less problematic to drill.

In contrast to that, geologic formations with several changes of soft rock and hard rock layers, as well as sliding soft masses, which are interspersed with

rockbars are difficult to drill. These ones have gradually been remobilized many times and such masses have often moved hundreds of meters.

The borehole course can be controlled with a radio-detection system, consisting of a transmitter, situated in the drilling head and a hand-hold receiver at the top of any actual position of the drilling head. The results of the measurement are analyzed and used to correct the drilling course, if necessary.

Two aspects are the most important ones concerning the results of measurement: the vertical angle of the drilling head and how deep its position is under the top of the terrain.

The steered horizontal drilling technique is often used in order to make boring routes which have to be horizontal or slight ascended and only very little deviation can be tolerated (for example : exact drilling between solitary large concrete piles, after a drilling distance of more than some decametres).

The Horizontal Directional Bottoming Drilling method enables the engineer to carry out borings which are curved according to plan.

The *Tracto-Technik* Company, Lennestadt, presently conducts experiments with flexible pipes which are put in long bottoming boreholes, that are made in order to install borehole heat exchangers [3].

Figure 4: One example of Horizontal Directional Drilling equipment for small drilling diametres up to 110 mm (with a reamer up to 150 mm) and drilling distances up to 50 m (Tracto-Technik Comp., frame rig, syst. Grundopit).
Drilling tests in Stuttgart-Vaihingen, July 2006

3 BOREHOLE EXTENSION

Drain-pipes are put into the boreholes to make them more stable. They are usually out of steel, but it is also possible to use pipes out of PE-HD or PE-X. Sections of massive drain-pipes out of steel (1,5´´ up to 3´´), crude or galvanized and zinc-coated, or more flexible drain-pipes out of some sorts of polyetylene as above, are installed in borings. Before that, they are pushed into the borehole step by step with the boring carriage. This method only works, if being inter-

rupted regularly, because one has to realize the pipe joint at the starting point of the borehole by hand.

Producing joints for steel pipes made of fittings as srew sleeves is the easiest way. In most cases, pipe joints out of plastic pipes are more expensive. They are joint by E-welding-sleeves respective by stump joints [5]. For these, a special construction equipment and a specific knowledge are necessary.

The fact that the properties of the material are depending on time and the kind of deformability of plastic pipes is important. These facts should be taken into consideration when choosing the kind of plastic [7].

Figure 5: Digging for a spool-drilling head in a manhole at the ending-point of a steered horizontal boring. (Tracto-Technik Company, System Grundopit). Drilling tests in Gleierbrück, July 2006

4 PREVIOUS EXPERIENCES

Before planning drain borings, one has to find out the hydrogeological situation. This is prerequisite to the success of a draining project. Nevertheless not each borehole for drainage reaches as much ground water as suspected.
Some reasons:

- Ground water aquifers in slopes are often veined.
- Aquifers can be interrupted by geological disturbances.
- Some drainage borings are only successful if the ground water level has reached a fixed point. At this point, there is some kind of overflow.
- Drainage borings, which are next to each other, are collecting the water deposit.

Many drainage borings have been going on to drain a slope and to stabilize it for decades.

Our experiences concerning long drain borings are, that in most cases, the calcareous precipitations out of the drainage water and the corrosive wear of the inside wall of the pipes are low. That indicates, that only little oxygen comes through.

To sum it up, both methods are well-established. Carrying out bottoming borings is possible because of the HDD-technology. So one is able to drain, even under geometric difficult conditions.
Furthermore, the HDD-technology offers various additional opportunities, i. e. the trenchless installation of horizontal ground water exchangers (horizontal loops) in the shallow underground.

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