

Trenchless Replacement of Buried Cable Lines

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Bezvýkopové technológie ukladania káblov

An enormous amount of underground electricity and telecommunication cables have been worn over the time with technical defects or need capacity increases. Thus, new lines need to be installed. In urban areas, even in smaller communities and in natural reserves, open trenching is difficult and often not permitted.

In response, new patented methods of trenchless cable replacement using the HDD equipment have been developed by the TT Group. The new technology is called "Wash-over-cable-replacement" and applies specially designed drill heads, cutting around the old cable string in various configurations (completely closed, U-shape or S-shape embracing), depending to the coating type of the old cable. This special cable replacement drill head separates the cable from the surrounding adhesive soil or the sand bedding by creating a very small annular space around the cable thus enabling the pulling or dragging out of the old cable section between the start and the exit pit. After the old cable has been loosened from the surrounding soil by means of the wash over process and pulled out, the new cable can be smoothly pulled into the void using the drill rods and embedding the new cable in a rich bed of Bentonite.

The wash-over drill heads are slim and have inner and outer nozzles for Bentonite and bits to handle roots, pebbles, gravel and the like. These drill heads perform very quickly (up to 3 meters per minute) to effectively wash over existing cables without damaging the cable coating and prepare the ground for a fast new laying of a new cable in the existing line. Network owners also benefit from the fact that new geodetic or topographic surveys and documentations of the new cable are not necessary. Only the documents, remarks, technical codes and existing geodetic data need to be updated.

The paper will outline the technological background and include several practical job examples.

Key words: *Trenchless Replacement, cable*

Introduction

We are quite familiar with trenchless line replacement methods for several years by now, mainly for house connections and network lines and within the area of water, natural gas and sewerage. These replacement methods often involve splitting or cutting off, bursting or crushing of the old line; sections of the defective line are pulled, torn or pushed out continuously or segment-wise, or they are disintegrated or split up in small parts which remain in the soil. Except for the pipe bursting method and the steel pipe propulsion by means of earth piercing devices, all the methods mentioned above suffer from disadvantages like the time and cost expenditure. The environmental and economical attitude of energy suppliers, particularly of the electric power suppliers, is to be closely scrutinized in these days, innovative, and ecofriendly and cost effective installation methods are usually favoured.

A retrospective view of the development

A demand for the trenchless power cable replacement methods has been going strong for a while within the area of underground cable installation, especially because a vast number of cables with defective coatings from the 1960s and 1970s are urgently awaiting a replacement. The cables with an insulation damage show a tendency towards short circuits, and their replacement is inevitable.

Six different over-boring methods were developed for the trenchless defective cable and line replacement. In the 1990s, FlowTex developed an wash over method in co-operation with ABB in Mannheim, and so has the Leonhard Weiss company in Göppingen. With the FlowTex/ABB method, very scattered cable tracks were washed over and replaced; however, due to confined technical limits of many cable beddings, but also because of the installation in certain soils or the extent of cable damage, the application of the method never became a routine.

The Tracto-Technik company has developed four wash over methods in the past years, they are all patent protected, including the machinery belonging to the methods. The latest TT development in the wash over methods received best results on the trial jobsite. Meanwhile, the TT wash over method has become a routine application on other jobsites. As usual, the know-how can be found in the details of the construction and the accomplished handling of the wash over tools and the wash over process. The wash over heads developed by Tracto-Technik differ greatly from their precursors of the 90s, they can not be compared neither in the construction nor in their way of action. The latest wash over heads have an extremely slim design, they are armed with an assortment of cutting and jetting facilities, the geometry of their internal

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and external set-up is completely different; they have open or closed guidance structures, are made of highly flexible special alloys and equipped with deflectors to prevent a contact with the cable coating of the old cable. Also, roots are separated from the old cables or other kinds of lines with very high working speed.

Meanwhile, a variety of wash over head types are available for different kinds of bedding and dimensions of the old cable. At present, over-boring of old cables is chiefly executed with slight reciprocating motions of the wash over head.

Therefore, the drilling rods need a particularly tight connection. At present, wash over lengths up to approx. 180 m are feasible: 10 kV, 20 kV and 60 kV cables have been replaced.

The Latest State of Development

The process method for the trenchless earth cable replacement has meanwhile matured to a practically applicable degree. Using the wash over method, long, economical sections of old cables can be bored free, pulled and replaced by installing a new cable in the void left by the removed old cable.

The technique of over-boring in combination with loosening of adherent soil and deflecting possible approximation elements (i.e. cable-covering stones) has found its solution in a special geometry of the bore head, the material and motional technique and the determined arrangement of jets, as well as in the cable bedding of the new cable in the wash over hole. The Bentonite of the drilling fluid is used as a bedding medium for the new cable in the old bore hole.

Bentonite, a clay with a swelling capacity, has many advantages for the cable bedding:

- good heat discharging properties,
- very soft and gentle bedding, due to the extremely fine and plane particle structure of the clay,
- very obvious friction reduction (sand is quite rough-grained and sharp-edged in contrast to Bentonite),
- frictional connection of the bedding due to the subsequent swelling of the Bentonite, therefore a gentle bonding effect on the complete bedding surroundings is built up.

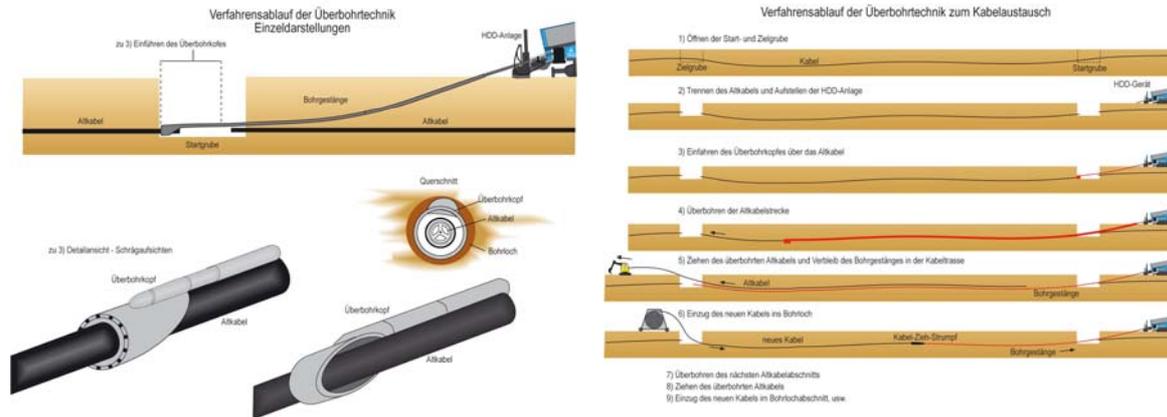
Measurements have proven that the tensile stress at the while pulling in the new cable reaches its peak in the instant, when the cable is rolled off the drum, while the traction forces are much smaller during continuous pulling in the bore hole, they only require quite a small fraction of the limiting value.

Application Fields

The application of the wash over method also serves other purposes besides the replacing of earth cables. Over-aged steel lines (i.e. for gas and water), mainly straight leaden lines, old telephone lines in a string shape and linear metal elements (cable bolts) can also be washed over and loosened from their bond with soil by using the same method proceedings and application techniques, which are also suitable for retrieving the ground locked drill rods.

Cable replacement

Defective, cleared old cables are separated in two places in pits and a section of each is cut out. The wash over head, screwed to the drill rods on the side of the HDD machine, is very flatly driven over the old cable on an overdriving level and parallel to its position. After this action, the old cable, overdriven by approx. 30 cm, is tightly connected to the fixing device by means of a wire stocking grip or a cable connection. Then the wash over head is driven over the old cable in swaying motions to the left and right. This swaying motion allows the drill rods, which are very tightly connected, to drive over the old cable in a speed of approx. one to two metres per minute. The TT wash over head is designed to trace the winding course of old cables. The old cable presents a restricted guidance for the wash over head which cuts the adhering sand bedding or soil free in a uniform distance and a very close annulus. After driving over the track of the defective cable, the wash over head is screwed off the drill stems while a wire stocking grip or a cable lug is prepared for pulling in the new cable. In the meantime, the old cable, now having been bored free, can be pulled out from the launch side with a cable winch or other building machines (i.e. excavators). With the drill rods resting inside the bore hole, the new cable can then be pulled exactly into the old position which has been evacuated by the old cable. Inventory plans need not to be dimensioned anew, only a note concerning the new cable is added. The high replacement speed (approx. 120 m over-boring of a cable in one to two hours) as well as the saved dimensioning costs are features which make this method so economical.



Figs. 1 and 2: Process sequence and schematic diagram of the wash over technique

Steel line replacement

Welded steel pipes, even their connecting bulbs, can also be washed over and freed of their bedding bond in a way similar to the cable replacement method. If these lines are weakened by corrosion, it is possible to drive a thin drill rod string through the inner old line, then the old line can be pulled completely and wreck-free via these internal rods.

Boring free ground locked drill rods

Besides the cable and pipe line replacement, the HDD wash over method can also be used when the drill rods are wedged in the underground, due to soil or other external difficulties, during a trenchless new installation with the HDD bore measures. These can be bored free with the TT wash over method in a most simple way by using the clamp rods as guidance, allowing the drilling project to be continued quickly.

If the line gets jammed when the pipe is being pulled in, maybe due to wood inclusions or other debris, it can be “freed” with the help of the wash over technique. Of course this should be followed by driving out, checking and line replacement, if needed.

Line re-bedding

Many lines show signs of a bedding damage after several years, which is often caused by silting and the unequal compactness of the soil. The sand grains of the line bed and fine soil particles from the sides of the former line trench may migrate and be displaced underground, leading to a deficiency space in the immediate area of the line bedding.

The lines can sink, take different tensions and thereby receive unbalanced points of load. Voids may be generated in the outer area of the line, creating problem zones for the pressure lines. Because the TT wash over method causes no damage to existing lines, these can be washed over and re-bedded conclusively and efficiently in the reverse gear with a purposeful emanation of subsequently binding Bentonite drilling fluid.

Description of Application Examples

The jobsite photos show the cable replacement projects in a timbered landscape protection area near Baltmannsweiler, the administrative district of Esslingen and beneath a pedestrian connection path in the housing development Buchhalde in Dettingen/Erms, the administrative district of Reutlingen. Defective 10 kV earth cables from the 1970s had to be replaced in both cases. The grundodrill 13 X drill rigs were used for both jobs; they were equipped with the TT wash over heads with short, counter-acting, sharp-edged TCI cutting bits mounted to exchangeable front disks with internal fleeting rings. The replacement path near Baltmannsweiler was approx. 550 m long, the stairway track near Dettingen/Erms extended to 125 m. The 550 m long track was divided into 3 drilling sections, the longest of these covering a distance of 180 m.

Other jobsite photos show an example of application in Uelzen / Lunenburg Heath. Here, an old oil-cooled 60kV cable had to be removed from the underground to be replaced by an empty pipe for taking up a 1 kV cable and several communication lines, which was to be pulled exactly into the old cable path. The old line was situated 1.20 m deep beneath an alley of trees between a road and a pavement, making the open-trench replacement impossible for reasons of tree protection. The complete repair track of the old cable amounted to more than 1250 m, the section pictured here has the length of 275 m. All the wash over

lengths had 100 to 120 m each, every 30 m, and an intermediate pit for removing pieces of the old cable was established. These short removal distances were chosen because of the great weight of the cable (34 kg/m) and the thin cable coating (risk of oil emerging due to overstraining of the coating). The defective cable was removed from the complete track without any damage and could be collected in large containers for recycling. The customer and commissioned company were extremely pleased with the applied method, and the department of the environmental protection was also very satisfied with the results.



Fig. 3. Old cable replacement project in Uelzen. The cable path is situated beneath the alley of trees.



Fig. 4. Grundodrill 13 X over-boring a 60 kV cable.



Fig. 5. Threading the bore head into a new wash over section.



Fig. 6. The recovered old 60 kV cable inside the transport container.

Conclusion: Advantages of the New Operation Technique

An application potential can be found in the wash over method. Previously, drilling speeds up to 3 metres per minute were achievable. The increased lengths and larger diameters are the aim, as also is the over-boring of clay pipe, cast iron and the ceramic lines and their replacement. The wash over methods utilise the layout of the old line, they require no further underground space, are cost-saving, recover the old line completely and provide an optimal line bedding in the old and, at the same time, new pipe course, thanks to Bentonite and other soft filling materials.

Trenchless cable replacement requires a minimum of jobsite set-up, because only a selective intervention of the old line is necessary. The number of machines and devices to hold ready is also very small.

The wash over technique allows a very eco-friendly and complete cable replacement; trees (roadside trees, alleys, protected forests, parks), green areas, street and pavement surfaces are maintained and remain almost untouched. The work is carried out rapidly, inconspicuously and with a low noise level.

Because of the restricted guidance of the old cable, a new path is not needed.

The old cable is recovered completely and can be passed on to a recycling company.

The new cable and possible additional data lines require no new survey documentation, the entry of the new line name(s) in the already existing maps is sufficient. The new cables can be installed directly in the soil of the old path, but also in protection pipes or perforated protection pipes.

The wash over techniques of Tracto-Technik are patent-protected several times over.

Anyone who has ever experienced the Tracto-Technik cable replacement method will be particularly impressed by the great replacement speed and the inconspicuousness of the process.

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