ENVIRONMENTAL FRIENDLY EQUIPMENT AND TECHNOLOGY FOR UNDERGROUND CIVIL EXCAVATIONS

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Abstract: The increase in urban development is accompanied by large scale civil works for infrastructure to support it. A major portion of such infrastructure comprises of subsurface utilities networks. Such utilities networks like water supply lines, sewage disposal networks, gas supply & cable systems for power & communications are the backbone of the urban development. Trenchless technology is more and more widely used in urban areas due to increasing amounts of investment in underground infrastructures that can be new, deteriorating, or under capacity. Different trenchless technologies are used worldwide; the terminology is not in all cases the same. The paper deals mainly with two new technologies, which are very close one to other, i.e. pipe jacking and microtunneling. These two technologies are quite similar in the final result and the purpose of the utility resulted, some detail aspects can be identified to make the difference. As worldwide the trenchless technology is promoted and widely used, in Romania only a few works were performed, mainly by foreign companies. Some lack of expertise and knowledge can be observed among Romanian civil work companies and urban utility management bodies, as in the training of skilled specialists. The paper intends to make a review of the state of the art of this new and booming technology.

Keywords: trenchless technology, microtunneling, pipejacking, urban subsurface

1. INTRODUCTION

When we talk about trenchless technology, two main items are used, i.e. microtunneling and pipe jacking. They have a common aim, or final result, a small diameter tubular underground supported long excavation, mainly in urban areas, to held inside pipes, cables, wires a.s.o., called microtunnel. When microtunneling describes a technique, pipe jacking can be understood as a process or a technique.

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2. PIPE JACKING

With pipe jacking, utility lines and pipes are driven underground in segments from a starting shaft, using hydraulic jacks. After the starting and target shafts designed to absorb the jacking forces have been constructed, the face is cut with a cutting shoe or under the protection of a shield tunneling machine. With each successive pipe, the cutting shield is advanced, the hydraulic jacks bearing against the reinforced wall of the shaft. In this way, each individual pipe is lowered into the shaft, joined to the previous one and then jacked forward. The overcut produced by the cutting shoe is grouted with cement through openings in the pipes. Intermediate jacking stations are used to reduce the jacking pressures and facilitate curve drives. With longer tunnels, there are intermediate shafts which may be crossed by the pipe section.

The pipes are usually made of high-strength concrete to withstand the high jacking forces. They form driving elements and permanent supports at the same time. Their wall thickness and weight are determined by the maximum compression forces occurring. They can be up to 40 cm thick and weigh more than 50 tones, and they are made on or off site.

The term pipe jacking can be used to describe a specific installation technique as well as a process applicable to other trenchless technology method: When refers to a process it implies a tunneling operation with use of thrust boring and pushing pipe with hydraulic jacking force. This concept of jacking system is adopted by many trenchless technologies including auger boring and microtunneling. However, in the literature the term pipe jacking is regarded rather as an installation technique.

Pipe jacking is a trenchless technology method for installing a prefabricated pipe through the ground from a drive shaft to a reception shaft. In the pipe jacking operation, jacks located in the drive shaft propel the pipe. The jacking force is transmitted through the pipe-to-pipe interaction, to the excavating face. When the excavation is accomplished, the spoil is transported through the jacking pipe in the drive shaft by manual or mechanical means. Both excavation and spoil removal processes requires workers to be inside the pipe during the jacking operation.

This is essentially what separates pipe jacking from microtunneling. Although it is theoretically possible for a person to enter a 36-in diameter pipe the minimum recommended diameter for pipe installed by pipe jacking is 42 in.

3. MICROTUNNELING

Microtunneling (Fig. 1) is a high-performance and environmentally friendly alternative to pipeline construction with trenches; it can also be used in the most demanding of circumstances: ground water and difficult geologies are no problem for microtunneling, and it has proven to be a very good method of avoiding obstructions in city centers.

Microtunneling is a method of installing pipes below the ground, by jacking
the pipe behind a remotely-controlled, steerable, guided, articulated microtunnelling boring machine (MTBM). The MTBM, which is connected to and followed by the pipe being installed, ensures that soils being excavated are fully controlled with the rate of advancement of the machine at all times. According to American Society of Civil Engineers standards, MT is defined as a remotely controlled, guided, pipe jacking technique that provides continuous support to the excavation face and does not require personnel entry into the tunnel. The system simultaneously installs pipe as spoil is excavated and removed.

Microtunnels are defined as cavities of up to four meters in diameter. The technology is essentially no different from the tunneling methods used for larger diameters, using adequate tunnel boring machines.

In the figure 2, an example of cutterhead, so called MTBM (Micro Tunnel Boring Machine) is presented, as used in the technology shown in figure 1.

The cutter head (1) removes with its tools – cutters, knives, chisels or discs – the surrounding soil. This is taken to the crusher chamber (2). This is where any stones are crushed (3). Water is initially pumped into the crusher chamber in a closed circuit, is mixed with the soil there and then pumped back out of the drill hole.

The separating system then separates the water from the soil. The soil is disposed of and the water is pumped back into the crusher chamber. The pipe is pushed into the soil using the hydraulic cylinders in the jacking frame. A laser beam dictates the location of the pipe axis.

The target board (4) reports the position of the laser point to the machine operator in the control container. Hydraulic cylinders (12) mean that the cutter head
can be angled, thus correcting the position. The operator controls the entire system from the control container. Many kind of cutting machines can be used for excavation, as shown in figure 3.

Fig. 2. MTBM used in microtunneling for soil removal and hauling

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Fig. 3. Different kind of mechanical excavating tools used in microtunneling
4. HORIZONTAL DIRECTIONAL DRILLING

Horizontal directional drilling (HDD) is a popular way of laying pipelines or other utility lines up to 1.5 m in diameter under rivers and in other inaccessible locations. It is rather a drilling method than a tunneling method, but the result is a small diameter tunnel. A pilot borehole (Fig. 4.a) is successively enlarged (Fig. 4.b) until the desired product pipe can be drawn into the cavity (Fig. 4.c). The traction to be applied reaches magnitudes that can border on the limits of the materials. Once a traction device disintegrates, it can only be retrieved at great expense.

![Fig. 4. Stages of HDD technology:](image)

- a) pilot hole drilling;
- b) enlargement of pilot hole;
- c) traction of pipe elements
REFERENCES

