Trenchless TECHNOLOGY

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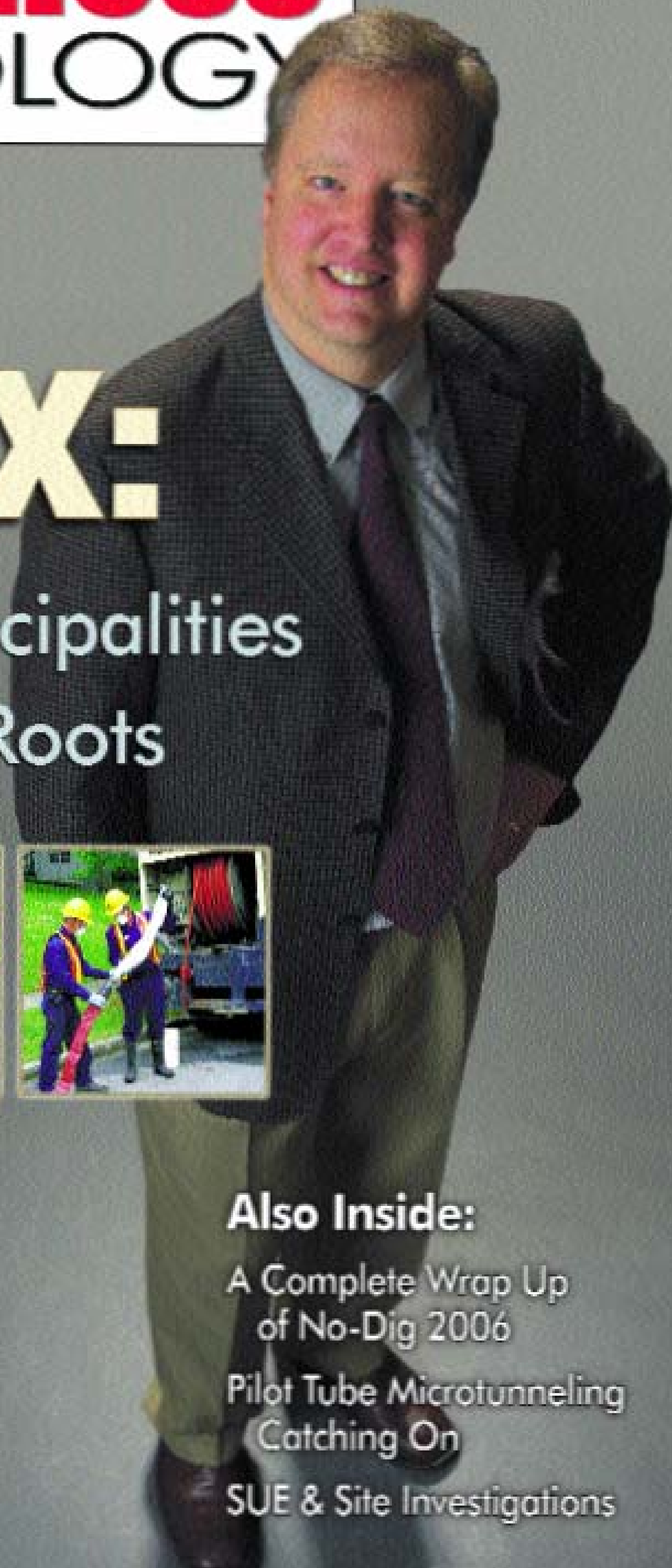

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Pilot Tube Microtunneling Catching On

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Pilot Tube Microtunneling Catching on

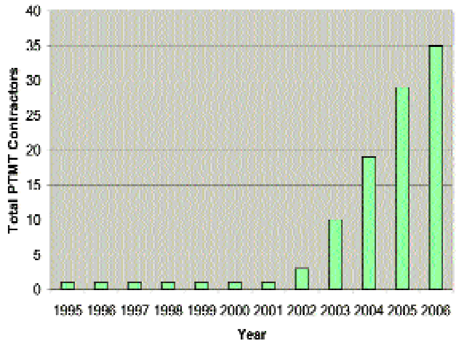
Pilot tube microtunneling (PTMT) has been increasing in popularity year after year since it was first introduced in the United States in 1995. This guided-boring process has grown to become a replacement for the early small diameter auger microtunnel machines.

The PTMT process of installing sewer pipe is essentially a hybrid of three trenchless boring techniques:

1. A slant-faced steering head similar to that of a directional drill
2. The guided accuracy of a conventional microtunnel machine
3. An auger type spoil removal system similar to a horizontal bore

Among the reasons for the popularity of this system are: low equipment costs, relatively small topside footprint and small jacking pits. Each year more contractors are purchasing these inexpensive and easy-to-operate tunneling machines from three equipment manufacturers: Akkerman Inc., BohrTec and Wirth-Soltau.

Initially, pipe sizes ranged from 4 to 12 in., with maximum drive lengths up to 250 ft. The U.S. record for the largest diameter pipe installed with a PTMT machine is 27-in. I.D. VCP. The record for maximum drive length is just more than 400 ft. Larger diameters and longer drive lengths are possible because of the development of better optics with digital monitors in the guidance system and more powerful hydraulics in the compact jacking frame.



Origins

The pilot tube method of microtunneling originated in Europe nearly two decades ago as a way to install 4- and 6-in. house connections using trenchless techniques. Today, this technology has grown to installations with pipe diameters up to 48 in. (in Europe) and drive lengths in the 400-ft range. The primary reason for this growth is the achievement of the same accurate on-line and on-grade installation as conventional microtunneling, but with significantly reduced costs. Projects are often less costly than conventional open-cut methods and solve engineering problems such as utility obstacles, poor soils, deep installations and high groundwater. Costly lift stations and maintenance costs associated with them are also often eliminated from projects. The societal advantages to this trenchless method include the elimination of traffic delays, road closures, street repairs, contaminated soil disposal and citizen complaints.

Pilot tube microtunneling has been used successfully in weak soils where other methods such as open-cut and auger boring failed. This system works well in weak soils where sewer lines can be installed in zero blow count conditions (See Table 1). Consultants and owners are quite impressed with the rifle-barrel-straight installations that result from this installation method.

The Process

The installation begins with the excavation and construction of jacking and receiving shafts. Most shafts are 6.5- to 8-ft diameter round shafts that cause little surface disruption and fit a compact jacking frame. This frame accepts pilot tubes, auger flights and final carrier pipe — all of which have a 1-m length. PTMT machines are gaining popularity when used in conjunction with auger boring-type equipment. The results are increased power and productivity, which allow the installation of longer pipe sections of larger diameter. The larger shafts for this setup have typically been square or rectangular to accommodate these longer frame machines and 2-m product pipe.

Once the shaft is in place, the PTMT machine is then set to the desired height, grade and line from control points established using conventional surveying techniques. The guidance system consists of a digital theodolite with an integrated camera, independent of the jacking frame and a monitor screen. The theodolite is also adjusted for height, grade and line. Since the accuracy of the completed sewer depends on the theodolite, prudent setup is required.

The first step in the PTMT method is the precise installation of the pilot tube on line and on grade (1/4-in. accuracy up to 300 lf). During the installation process, the spoil is displaced by the slant-faced steering head. The pilot tube is then directed on line and on grade by rotation during advancement. The hollow stem of the pilot tube provides an optical path for the camera to view the LED target in the steering head displaying the head position and steering orientation. This step establishes the centerline of the new installation; the remaining steps will follow this path of the pilot tube. Once the pilot tubes reach the reception shaft, the theodolite, video camera and monitor guidance system are no longer needed and may be removed from the jacking pit.

The second step is to follow the path of the pilot tube with a reaming head, which is slightly larger in diameter than the product pipe being installed. The front of the reaming head fastens to the last pilot tube in the same manner in which the pilot tubes fasten to each other. Following the reaming head are auger casings of the same diameter, which transport the spoil to the jacking shaft

By Jeff Boschert, P.E.

in the United States

Pilot tube microtunneling has been increasing in popularity in the United States since first introduced in 1995. The method originated in Europe nearly 20 years ago.

for removal. The spoil may be removed by a muck bucket or vacuum truck, depending on the soil type. This step is complete when the reamer and auger casings reach the reception shaft and all spoil is removed.

The third step is to install product pipe, which replaces the auger casings. The product pipes push the auger casings into the reception shaft, where they are removed one by one with the addition of each section of product pipe. There is no spoil to be removed in this step since the product pipe has the same outside diameter as the auger casings.

An alternative method has been used, which combines steps two and three listed above. In this method, a reaming head funnels the excavated material into auger casings, which are coupled together inside the product pipe. Once the product pipe is installed, these auger casings are then retracted from the inside of the product pipe via the jacking shaft or possibly the reception shaft. This method allows contractors to install multiple sizes of sewer lines while utilizing the same set of auger casings. However, as pipe diameters increase, a larger amount of soil must be transported via these casings. PTMT equipment manufacturers can help determine which system is best suited to varying project conditions.

Table 1

Applicability of Pilot Tube Microtunneling for Different Soil Conditions

Type of Soil	Applicability
Soft to very soft clays, silt and organic deposits	Yes
Medium to very stiff clays and silts	Yes
Hard clays and highly weathered shales	Yes
Very loose to loose sands (above water table)	Yes (w/lubricant)
Medium to dense sands (below the water table)	Yes (to 10 ft head) Marginal (over 10 ft)
Medium to dense sands (above the water table)	Yes
Gravels and cobbles less than 2 to 4 in. in diameter	Yes
Soils with significant cobbles, boulders and obstructions larger than 4 to 6 in. diameter	Marginal
Weathered rocks, marls, chalks and firmly cemented soils	Yes (w/ air hammer)
Significantly weathered to unweathered rocks	Yes (w/ air hammer)

Applicable Soils

The pilot tube system can be used in a variety of soft and displaceable soil conditions. Large cobbles and boulders can cause some challenges during construction. Recent developments such as lubricants for loose sands, water control reaming heads for wet sands and air hammers for solid rock have increased the possibilities for soil conditions that were once considered impossible. As with any type of tunneling, a good soils investigation is crucial to the final success of the project.

Vitrified Clay Jacking Pipe

Vitrified clay jacking pipe has been the predominant pipe material used in the PTMT process due to its high compressive strength (18,000 psi average), low-profile zero-leakage joint, affordability in the typical 1- or 2-m pipe lengths and elimination of an external casing pipe. With the guided accuracy of this system, there is no need for the typical larger diameter steel casing and the grade-adjusted inner carrier pipe as is necessary with a non-guided boring technique. This saves the additional cost of excavation, transportation and removal of spoil and the purchase of two separate conduits, thus resulting in a lower overall project cost.

The chemical resistance of VCP is unsurpassed, making it an ideal choice in industrial/commercial applications. The nature of the ceramic material prevents it from changing properties with age, compared to limited life products which experience degradation over time.

Every city in the United States that is more than 100 years old probably has VCP sewer lines in their infrastructure still in service today. These pipelines have lasted, despite having been made with 100-year and older technology and having been installed with outdated construction practices. With today's high-tech vitrified clay jacking pipe and with newer constructions practices, engineers are realizing the possibilities for centuries of service life.

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