PILOT TUBE MICROTUNNELING: INSTALLATION OF NEW PIPELINES IN HEAVILY DEVELOPED ENVIRONMENTS

By H. Robin Losh

For over three decades America has been facing the challenges of expanding utility infrastructure to accommodate both growing populations and demand. Much of this expansion has been in the form of placing larger transmission/collection lines in highly developed urban settings, where open trench installation was neither cost effective nor friendly to the public in their daily travels. What was needed was an installation procedure that was less damaging to existing improvements and less disruptive of the public's daily routine.

In answering this need, the engineering and contracting communities from around the world began developing trenchless installation methods for pipelines. One of the earlier installation methods was the conventional Jack and Bore Method. This method employs a tunneling technique where steel casing segments are pushed from a jacking pit at the beginning of the installation, through the earth, to a receiving pit located at the termination of the installation. A cutting head attached to augers inside the casing segments removes the soil from the leading edge of the first casing segment. The augers then transport the soil through the casing and discharge it into the jacking pit for disposal. This effectively produces a tunnel through which the casing can be pushed to its terminal point. Once the casing is in place, a carrier pipe is inserted through the casing to convey the intended product. This process has been used extensively for installations that are under 200 feet long, and where slope or grade does not need to be maintained.

While conventional jack and bore installations can be cost effective for shorter trenchless installations, construction in an increasing number of highly developed areas signaled the need for added length and accuracy for the bores. This need was addressed by two totally different guided bore installation methods, each having a specific application and both eliminating the requirement for a casing. One of these methods is Horizontal Directional Drilling (HDD). HDD is a method that initially bores a small diameter tunnel from a launch site at the ground's surface, angling downward to a predetermined depth, then turning upward to a terminal site with the bore exiting again at the ground surface. To bore this initial tunnel, HDD utilizes a guided steering head with a drilling fluid delivery system that flushes the spoil back to the launch site for removal. Once complete, the initial tunnel is then expanded by pulling a reamer back through the tunnel with a jointless product carrier pipe attached. The HDD process has been successful in the installation of long runs; some several thousand feet in length. It also allows for an installation with accurate horizontal alignment, but does not allow for an installation with an accurate slope on grade.

To address the need for accurate slope to provide for gravity flow pipeline installations, the Microtunneling Method was developed. Microtunneling combines the jacking technique used in the conventional Jack and Bore Method with the spoil removal technique of HDD. To maintain an accurate horizontal and vertical alignment, a laser and target are carefully set to line and grade at the centerline of the product pipeline being installed. The target is monitored remotely at the control center by the drill operator who makes necessary corrections at the steering head to keep the bore on alignment. The Microtunneling Method is very accurate but requires highly sophisticated equipment, a large jacking pit with stable walls and floor, and a large topside footprint for the equipment and control center. These requirements tend to make this method very expensive, thus limiting its application to only the more difficult installations. Microtunneling also is typically limited to carrier pipes 12 inches in diameter and larger.

In 1995, the Pilot Tube Microtunneling (PTMT) Method of trenchless construction was introduced in the United States as a cost effective method of installing small diameter (4- to 12-inch) gravity sewer lines to accurate line and grade for distances up to 250 feet. Since the introduction of PTMT, this installation method has increased in popularity primarily due to reduced costs when compared to conventional microtunneling. Lower equipment costs, a smaller topside footprint and small, less complex jacking pits all contribute to the lower installation costs associated with PTMT.

The PTMT Method of installation employs trenchless boring techniques from the three methods previously discussed. Each method contributes the following concepts:

- Conventional Jack and Bore – auger-type spoil removal system
- Horizontal Directional Drill – slant-faced steering head
- Microtunneling – laser-type guidance system

The PTMT Method process, in detail, is as follows:

Preliminary Setup:

1. Excavate and prepare jacking and receiving pits. Small bore jacking pits can be as small as 8 feet in diameter.
2. Set up guided bore machine (GBM) to elevation, line and grade. Set up guidance system for monitoring bore position.

Bore Process:

1. Install small diameter pilot tubes on line and grade. Steering is accomplished with a rotating slant-faced steering head, advanced by pushing with a hydraulic jacking frame. Pilot tubes are hollow to provide an optical path for the guidance system and double walled to provide a channel for lubricating fluid transfer to the steering head. Once the pilot tubes reach the receiving pit, the guidance system is no longer required.
2. Attach reamer that matches the outside diameter of the product pipe to the last pilot tube. As the reamer advances, auger casings with internal augers are attached which transport the spoil material to the jacking pit for disposal. Once the reamer reaches the receiving pit, it is removed and spoil material is removed from the casing.
3. Once the spoil material is cleared from the casings, the product pipe is attached to the last casing with an adapter. The casings are pushed into the receiving pit by the product pipe for removal of each section. Once the product pipe reaches the receiving pit, the process is complete.

While initially PTMT was limited to 12-inch and smaller pipe installation, the demand for larger pipe diameters and longer installation lengths began to grow. Industry responded to these demands by developing better optics with digital monitors in the guidance systems, more powerful hydraulics in the jacking frame and combining PTMT guided bore machines with auger boring equipment. This combination of equipment results in increased power and productivity allowing longer installations of larger diameter pipes. Today, PTMT has the capacity to install up to 48-inch diameter pipe and drive lengths up to 400 feet. When properly employed, Pilot Tube Microtunneling is a cost effective method to meet the growing need for accurate trenchless installation of gravity flow pipelines in highly developed construction work zones.

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