Microtunneling

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Abstract— This project report on MICROTUNNELING is intended to provide information regarding the use of Microtunneling in today's world. Significant technical advances and increases in the utilization of Microtunneling have occurred in the World in the past few years permitting the installation underground of pipes in all ground conditions with the minimum of surface disturbance. Microtunneling techniques are providing wide range of diameter and applications. Many problems of large diameter tunnels and technically demanding tunnels are incorporated due to Microtunneling. This project is specifically tailored for those interested in Microtunneling and describes the technique in depth together with comparisons with other trenchless techniques. The project provides an in-depth review of Microtunneling including all its aspects.

Key words: Pipe Jacking, Equipments of Microtunneling, Curved Microtunneling

I. INTRODUCTION

Microtunneling is a process that uses a remotely controlled Micro Tunnel Boring Machine (MTBM). In order to directly install product pipelines underground in a single pass Microtunneling is usually combined with the Pipe Jacking method.

It is a trenchless method of pipe installation where a pipe is jacked behind a Micro tunnel Boring Machine which is shoved forward as the pipe is installed by avoiding man entry. Generally guided by a laser and most often used for the installation of gravity flow systems. For example sewer and storm water or for other services where high accuracy is required.

The need of providing long stretches of open trench for pipe laying can be avoided by Microtunneling as they cause extreme disturbance to the community.

In the U.S., Microtunneling has been used to install pipe from 0.3 m to 3.7 m in diameter.

Microtunneling is currently the most accurate pipeline installation method. Line and grade tolerances of 2.5 cm are the Microtunneling industry standard. This can be significantly useful where a large maze of pipelines exists underground.

II. HISTORY OF MICROTUNNELING

The origins of Microtunneling go way back into the early 1970's where it was developed by the Japanese in order to replace open sewers with underground gravity sewers in urban areas. South Florida in 1984 was the first location in the United States where Microtunneling work was initiated. This tunnel project spanned over 182 meters while having a pipe diameter of 1.82 meters. Originally Microtunneling projects were only designed for construction of gravity sewers, but with passing time they are now also used for underground crossings of highways, railroads, runways, etc.

III. PIPE JACKING

Pipe jacking is supplementary method used along with micro tunneling so as to push the sections of the concrete pipes into tunnel drilled by micro tunneling boring machine.

A. Procedure of Pipe Jacking

1) Excavate and prepare the driving shaft.
2) Set up the jacking frame and the hydraulic jacks to adjust to the proposed design line and grade by providing a simple track to guide the pipe sections.
3) Install laser guidance system in the driving shaft which is fixed in the back of the hydraulic jack pad to guide the operator to jack the pipe in proper alignment and slope
4) Lower the boring machine into the driving shaft and set it by using an Auger machine.
5) Mate the jacking push plate to the shield or the tunnel boring machine.
6) Advance the shield or the TBM through the prepared opening in the forward shaft support structure. The movement of the jacking machine is controlled by the control panel outside of boring machine, whereas the drilling operation is controlled by the control levers inside the boring machine.
7) Retract the jacks and push plate to provide a space for the pipe segment.
8) Place the first pipe segment on the jacking tracks.
9) Mate the push plate to the pipe and pipe to the shield or the TBM.
10) Initiate forward advancement, excavation, and spoil removal.
11) Repeat pipe jacking cycles until the complete line is installed. The next section of pipe is lowered into the pit and the above steps repeated.
12) Remove the shield or the TBM from reception shaft.
13) Remove the jacking equipment, IJS and the tracks from drive shaft.
14) Restore the site as required.

B. Scope of Pipe Jacking

Pipe jacking is used to install conduits below ground for a variety of applications including:

- Sewerage pipelines
- Storm water pipelines
- Road and rail culverts

C. Benefits of Pipe Jacking

- Inherent strength of lining.
- Smooth internal finish giving good flow characteristics.
- No requirement for secondary lining.
- Considerably less joints than a segmental tunnel.
- Prevention of ground water ingress by use of pipes with sealed flexible joints.

– Invert channels can be provided in larger pipes to contain the dry weather flow of a sewer in a combined system.

IV. CONSTRUCTION PROCEDURE

Microtunnelling, being a modern method of laying of pipes, has fine and systematic construction procedure leading to great accuracy and clean, tidy site. The method can be explained through the points stated below:

1) Excavation for commencement shaft and Transportation of different units and plants to the site.
2) Construction of thrust wall in the direction of progress of work and Installation of hydraulic jacking frame facing it.
3) Setting of slurry separation tank, Bentonite and slurry pumps, slurry lines, controlling container and Positioning of cranes, Backhoes, Pipes etc.
4) Fixing Laser guidance system, followed by Lowering of Micro Tunneling Boring Machine (MTBM) with suitable cutting head on the launch skid.
5) Connecting all of the slurry lines and cables with appropriate connections of MTBM.
6) Setting and matching the coordinates of MTBM with those in controlling cabin with the help of Laser guidance system as per desired alignment of work. Starting up of the MTBM.
7) Lowering of first pipe section on launching skid and jacking it into the drilled tunnel following MTBM.
8) Disconnecting the cables and slurry lines indicating cessation of first section of pipe. Lowering of succeeding section of pipe.

V. EQUIPMENTS

Capital equipments used in microtunnelling process are:

A. Micro Tunneling Boring Machine

MTBM is a powerful tunnel boring machine used for drilling underground tunnel of desired diameter, with hydraulic, pneumatic or auger spoil removal system. As per different conditions of underground soil strata, different cutter heads are chosen. (i.e. specially designed for clay, silt, sand, rock). Machine consists of two parts namely shield and can. It houses cutter head, conical crusher, hydraulic motors and receiver of the laser. The machine operates on the diesel generator. Its cost varies from Rs 1 crore to 20 crore.

B. Excavator and Crane

For excavation of the commencement shaft, intermediate shaft and receiving shaft the excavator is used. Depending upon the depth of excavation and groundwater table, suitable type of excavator is used. The crane, preferably of compact size and capable of lifting and lowering the concrete pipe sections and MTBM is used. The crane is desired to be able to carry the controlling container and slurry separation tank in case of emergency.

C. Controlling container

It is the most important unit of process. Different controlling computers, GPS, controls of Laser, slurry and bentonite cables controller, pressure sensor are housed into it. The progress of MTBM is measured by observing the X and Y coordinates obtained through Laser guidance system. By adjusting them, the machine can be given desired upward or downward deviation in path.

D. Diesel Generator and Slurry Separation Tank

Diesel generator supplies power to whole microtunnelling process. The slurry separation tank consists of two units. In first one the slurry is screened and in later one it is kept still so that the debris is settled and water is reused. The settled debris is either dumped or used for leveling low lying areas.

E. Other Miscellaneous Units

The shafts of higher depth are Shortcreted from inside for preventing collapse. A meter gauge is installed at thrust wall for measuring the progress of work. Loaders and trucks are used for hauling the excavated soil and screenings. Bentonite is injected throughout the process for lubricating the machine.

VI. CURVED MICOTUNNELING

For curved micro tunneling Laser Total System or a Gyro Navigation System is used for guidance while introducing the pipe in a curve. This system is created for the guiding long distance and curved pipe jacking applications for pipe diameters of more than 1m.

A servo motorized Laser Total Station which is mounted inside the tunnel on a special bracket is the main component of the system and it moves along together with the pipeline.

The known as-built position of the already installed pipes helps in continuously determining the actual position of the laser total station

The company named Huxted Tunneling LLC recently completed a 480 foot long, 84” Reinforced Concrete Pipe micro tunnel drive with a 700 foot radius horizontal curve which was accomplished using 10 foot long pipe segments.

VII. MAINTENANCE

Various cleaning methods include:

A. Flushing

Flushing is efficient & effectual process of cleaning main. Corrosive materials are easily flushed away during the process throughout the main. Sediment, gelatinous material and stagnant water are also flushed during flushing. Flushing is most effective with flow of six feet per second.

B. Drag Cleaning

This cleaning method is carried out by a pig liner both discharge & receiver point. Cables attached devices are pulled at D/S side for removing heavy encrustation from inside pipe.

C. Hydraulic Jet Devices

This device is used to dislodge and remove obstruction by using high pressure jets of water. This method generates more amount of waste water which is to be disposed off in a suitable manner.

D. Chemical cleaning

Acids are used for cleaning mineral deposits within the pipeline. It requires special handling & skilled labour. After the completion of process, flushing should take to neutralize the acidic reaction.

E. Air cleaning

This method is used for small diameter pipes in which high air pressure is injected with small amount of water to remove scale and deposits inside wall of pipe. Air velocity and cleaning efficiency gets reduced due to valves, bends & appurtenances.

VIII. APPLICATIONS AND BENEFITS

A. Applications

Microtunneling method is efficiently used by pipe jacking and includes installation of new drainage construction, telecommunication cable, oil pipelines, culverts etc. MTBM is suitable for mixed face, soft soil & rock tunneling. It is easily operate able below 3 bar pressure water table.

MTBM technique is for rehabilitation of existing sewer structures. Replacing the old sewer pipeline with the new one can be easily done by trenchless techniques.

B. Benefits

1) It creates very less pollution
2) IT can be used in difficult geological situations
3) This technique is environmentally sound technology
4) Speed of construction is also fast due to skilled labour & easy machineries.
5) It can be also be used in congested areas likes roads, highways, buildings, railway lines.

IX. CONCLUSION

The demand for utilities provision is directly proportional to the population in urban areas. Our paper concludes that for constructing any underground pipeline projects such as oil pipeline, gas pipeline, water mains, sewer etc. in a densely congested area the best and most efficient method is Microtunneling. With respect to development in construction industry today and a big sum of amount is granted in the budget of India for the infrastructural development

Thus the Microtunneling process shall be used in future so that we can save space, money, time and make use of most of the urban area available.

X. FUTURE SCOPE

Microtunneling is recently adopted construction technique. Thus it has high potential of development in the future. In future, there will be scarcity of open spaces in urban areas and thus underground construction will be only possible option for further fulfillment of demand of infrastructure utilities for the population of urban areas.

Thus the project report gives the basis for future development of the Microtunneling construction process.

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