Under Water Highway And Tunneling

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Abstract- *With the urban population increasing, traffic jam happens everywhere. In this case, utilization of underground and underwater space has become an effective way to undertake this problem. tunnel construction important infrastructure projects, which is vital for enhancing the transportation network, in specially in congested cities. the reviw project presents the frame work for the selecting the appropriate tunneling method and transportation network with respect to the induce ground surface settlement when completed, this water tunnel will served as a tool for classroom, and laboratory demonstration in undergraduate level courses related to flued mechanics.*

Keywords- Tunnel, Microtunneling, Core, Jacketing

I. INTRODUCTION

Originally microtunneling was defined by tunneling techniques and activities used in the formation of underground pipelines of 900 mm or less in diameter. Now microtunneling is generally understood to be any remote controlled excavation method that installs the pipe behind the shield by jacking. The machines have cutting heads at the front of a train of pipes being advanced into the earth. To counterbalance the external pressures, they can have either slurry or earth pressure balance chambers. In a slurry machine the soil is brought to the surface by the return slurry line where it is separated out and the cleaned bentonite slurry returned into the system.

The first slurry pressure-balance microtunneling machines were introduced in 1979. Japanese manufacturers produced hundreds of pressure balance machines of all sizes. It was estimated that there were over 3,000 machines in Japan in the eighties. However, after the big sewer projects were completed, the demand for new machines slowed down.

II. LITERATURE SURVEY

Rashid Rehan & Dr. Mark Knight – The preliminary analysis found that the use of trenchless construction methods can result in 78-100% lower greenhouse gas emission than open cut pipeline installation method. It can be achieved mainly due to its shorter job duration using less construction equipments and limited or no disruption to traffic flow. The report concludes by identifying further research needs that will expand further trenchless technology greenhouse gas emission saving and the applicability of greenhouse gas calculation methodology

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Trung Thanh Dang - Microtunneling operations involve a complex interaction of processes that require a variety of supporting equipment and personal experience. Furthermore, different construction processes such as supply chain management for the machine or for material handling must be integrated. Breakdowns of critical processes will directly affect the performance of the construction, with impacts on extended construction time, increased cost as well as reduced productivity of the microtunneling project. If the construction process is reasonably planned, the construction operations may be controlled and adjusted more efficiently. The use of operational process simulation can be a benefit for planning and operating a microtunneling project. Thereby, problems at different construction phases can be anticipated and analyzed. Moreover, it has potential to optimize usage of resources, to develop better project plans, to minimize costs or project duration, to improve overall construction project management and to avoid costly mistakes.

Dr. Ingenleur – this thesis presents an approach for analyzing construction operations with micro tunnel bore machines (MTBT) utilizing process simulation. The goal is to develop an appropriate and adaptable simulation module for microtunneling construction operations, it helps to analyze the processes and to identify the factors, which influences the operation productivity of the construction process essentially. Author also discusses on microtunneling operation involve a complex interaction of processes that require a variety of

supporting equipments and personal experiences. Furthermore different construction processes such as supply chain management for the machine or for material handling must be integrated. Further, the impact of varying resources on the MTBM advance rate is studied in a sensitivity analysis.

Jacobs Associates – this paper describes why contingency planning is an essential activity on any microtunneling and other trenchless construction projects then summarize what engineers, owner and contractor need to consider in developing contingency plans. This paper is intended to help demonstrate why developing contingency plan for microtunneling project is not a waste of time, but a useful and necessary activity due to nature of microtunneling work. It also describes common consideration for microtunneling contingency plan, these helps to designer owner, contractor get a cost and time effective start on contingency planning of microtunneling.

Dietrich stein – designed as a fundamental source of information on installation and renewal of non-man size supply and sewage lines by trenchless construction method, this book describes non-steerable microtunneling system., tables and charts, in depth knowledge is given on the subject of design and operation of different types of soil removal system measuring and steering techniques, construction of starting and target pits as well as obstruction removal. Moreover, it provides detailed information regarding the relevant stress and strain analysis.

III. METHODOLOGY

Microtunneling is a technique for directly installing pipelines using a steerable jacking method. This can take the form of Auger, slurry, EPB and "Pilot Pipe" techniques described as follows.

3.1 Auger Microtunneling

The microtunneling techniques of remote controlled pipe installation originated in Japan in the early 1980's for sewer installation and installation tolerances are +/- 25 mm on line and grade.

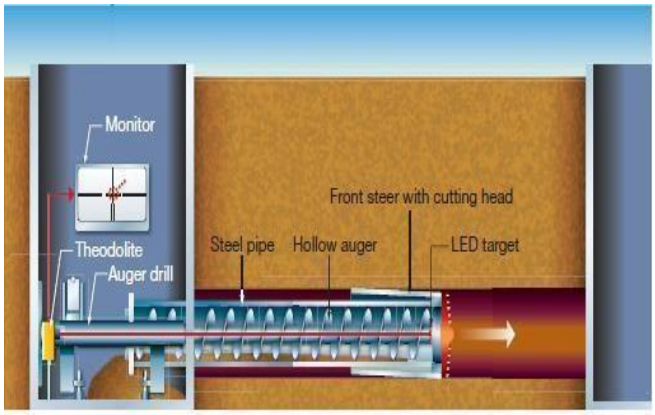


Fig. 3.1 Schematic Section of Auger Microtunneling

Internationally the installation of pipes using remote control techniques up to 900 mm dia. is called microtunneling though in the US this description is more widely used where techniques using slurry, EPB techniques, as described later, up to diameters of 3.5 m, are termed microtunneling. The first three are similar techniques, and the distinction between them relates principally to the excavation ability of the tunnel shield being used to provide a pressurized excavation at the face (slurry and EPB) and also the ability to accurately directly install small diameter pipes by remote control.

3.2 Slurry Tunneling Systems:

This is shown in Fig 3.4 and again is typically a pipe jacking technique and can be briefly described as a closed face tunneling system that provides a water tight bulkhead in the front of the machine to prevent the ingress of groundwater and soil, whilst tunneling. In front of this bulkhead, is a chamber called the plenum chamber which is filled with pressurized slurry when operating. This pressurized slurry counterbalances both the groundwater and the soil pressures (the "earth pressure" in front of the bulkhead in the machine) thereby closely controlling soil movement and settlement.

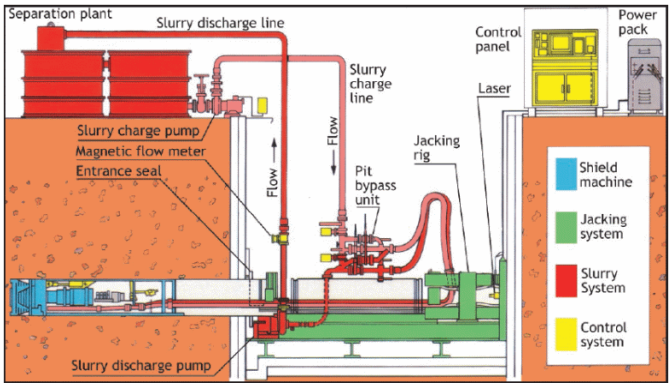


Fig. 3.2 Schematic Slurry Tunneling System Section

3.3 EPB Microtunneling:

This is shown in Fig 3.6 and again is typically a pipe jacking technique.

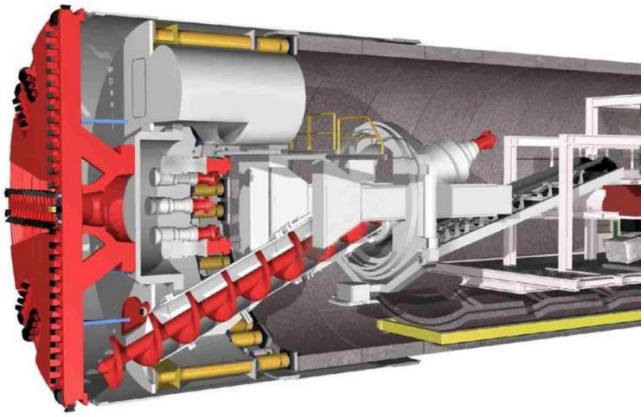


Fig. 3.3 EPB Microtunneling

It is similar to the slurry machine in that it is a closed tunneling system with a water tight bulkhead in the front of the machine to prevent the ingress of groundwater and soil. The plenum chamber in this case is retained full of the excavated material under pressure when operating and this pressurized excavated material counterbalances any groundwater and the soil pressures in front of the bulkhead.

IV. GUIDELINES FOR THE USE OF MICROTUNNELING

4.1 Geotechnical considerations

A thorough subsurface investigation is required during the design phase to identify the geological conditions. In order to select the appropriate microtunneling machine for each project, physical properties such as moisture content, strength grain size, plasticity, compressibility, and permeability of the soil should be carefully investigated. The level of ground water should be determined because of its significant influence on ground behavior and loss of ground support. Hydraulic conductivity should be estimated by using pumping test to determine whether dewatering will be required.

4.2 Microtunneling Machine Considerations

Special Microtunneling boring machines (MTBM) are used to install pipelines in difficult and variable ground conditions. Among the microtunneling methods slurry type machines can be used regardless of the groundwater level. Auger type machines are mainly limited to more than 3 m below the ground level. Thus, slurry type machines are preferable when the groundwater exists above the pipeline installation depth. However, for pipeline installation above the groundwater table, auger types may have higher productivity and lower cost. Some machines are capable of crushing boulders and also boring through hard rock.

4.3 Alignment consideration

With a marginal increase in construction cost, pipelines can be installed at deeper locations by microtunneling methods. Straight alignment are more preferable for microtunneling projects because they facilitate more accurate control of line and grade and more uniform distribution of force at pipe joints. The location of jacking and receiving pits should be determined by the maximum jacking distance ofmicrotunneling techniques. For slurry type machines, the maximum jacking distance without the intermediate jacking station typically ranges from 700 to 800 feet (210 to 240 m).

4.4 Economic Feasibility

Generally, microtunneling is economical when the invert of the pipe is 20feet (6 m) deep or more due to the fact that the traditional dig and fill method would require trench shoring and considerations of confined space entry which slows down productivity and adds to cost. A minimum of 5feet (1.5 m) of cover is usually recommended for microtunneling to avoid settlement of surface. When the average depth to pipe invert exceeds 6 m, comparison is made the of cover or the ratio of cover to diameter with minimum height of cover (1.5 m) or cover to diameter ratio (3:1) respectively. If these conditions are met, microtunneling is technically feasible.

4.5 Selection of Recommended Method

In auger type microtunneling machines, the diameter of pipe installed is usually less than 120 cm. On the other hand, slurry type machines are available for wider range of the pipe diameter. With an auger type, maximum lengths of drives are around 105 m. longer drives can be achievable in a slurry type. A slurry type can be used regardless of the ground water level. Whereas, an auger type is limited to less than 3 m below groundwater level. For cohesive soils, auger type is better suited for granular soils. If boulders are present, an auger type MTBM may be preferred as it allows access to the face to break up the boulder.

4.6 Selection of pipe

For the selection of pipes in microtunneling operation, the size of the pipe and its material are the main factors. Parallel to this the selection is also depends on the

pipelines final use, soil conditions, and compatibility of the material with the microtunneling method. Pipes should also designed to withstand the axial forces applied to the pipe during installation.

V. COMPONENTS OF MICROTUNNELING

Microtunneling is a method of installing pipes below the ground, by jacking the pipe behind a remotely-controlled, steerable, guided, articulated microtunnel boring machine. Microtunneling can be 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 operation of the micro tunneling boring machine take place inside a control room located on the ground service.

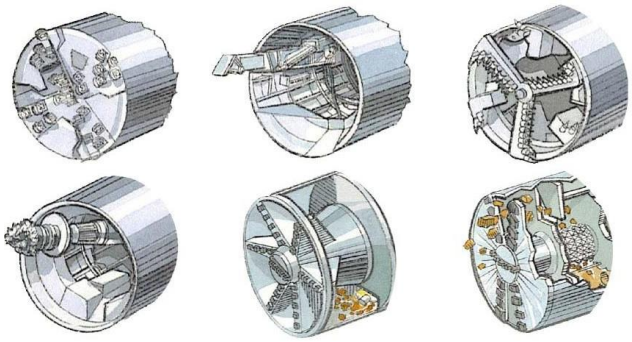
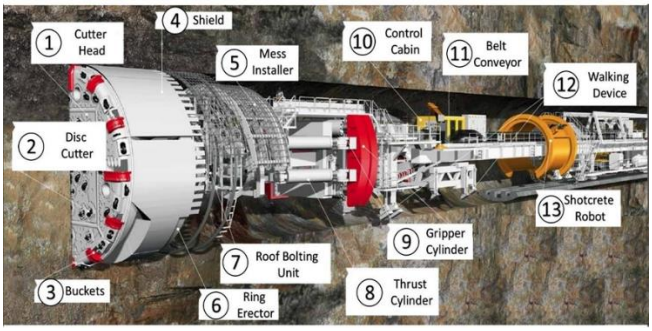


Fig. 5.1 Different Types of Cutter Head

The system simultaneously installs pipe as spoil is excavated and transferred to the ground service via the slurry excavation system. Personnel entry is required only for working inside the shaft. Laser guidance system is commonly used for straight line alignment and gyro system for curved alignments.



5.2 Components of MTBM

VI. CASE STUDY

"Microtunneling for Relience 4G Telecom Networking at Sangli City"

We have visited one ongoing microtunneling project nearby our city. The microtunneling work is carried out for laying of 4G optic fiber cable of Reliance telecom network provider company. This project's tender is given to Creative Telematics named company, which is Sangli based company and work started in October 2018. The company office situated in timber area in Sangli. This company is established 15 years before and they dealing with microtunneling projects since 3 years.

This whole project is laying 4G optic fiber cable of Reliance Telecom by microtunneling. The area of this project is Sangli-Miraj-Kupwad city and from Sangli city to Pune-Bangalore NH4 highway where they connects this cable containing pipeline to Kolhapur city.

They have already completed 180kms of microtunneling in Sangli-Miraj- Kupwad intracity and started second phase of their project which is microtunneling from Sangli city to NH4

6.1 Microtunneling Bore Machine 'Vermier series 48'

For this project, they using microtunneling bore machine named as 'Vermier series 48' as shown in figure 7.4. This is slurry tunneling type microtunneling bore machine. The machine cost is 3.2 crore. And other required special instruments such as infrared tracker and monitor, chinese finger, rimmer costs upto 4.5 lakhs. There is only 5 skilled labours required to operate this machine. The machine run of this MTBM has 150m. Length of single pipe inserted is 3m. machine's cutter head which is also called as pilot requires maintained temperature between 28ºC to 30 ºC. If, cutter head temperature goes above the limits, then cutter head may be stopped working and hangs up. So, it needs to cool down the cutter head by stopping boring and increase of water blowing.

Fig. 6.2 Digitrax Sound Tracker Instrument

In this project, they making bore of 50mm size at the 1.2m below the ground level. The distance between thrust chamber to reception chamber is 150m. First of all, they dig the thrust shaft by using excavator. No trenching is required due to less depth of operation. Then reception chamber is dug by excavator. Then cutter head which is loaded with infrared sensor, starts boring at thrust chamber. One labour with sound tracker machine which tracks underground infrared sensor (fig. 7.6). That shows on tracking monitor, so we can know, whether cutter head is going in right direction or not. That tracking instrument called as sound tracker. In this project, they using sound tracker of Digitrax Company, as shown in figure 7.5. After ending of each pipe of 3m length, new pipe is attached to boring machines drill. After reaching the cutter head successfully to reception chamber, cutter head is removed and cable pipe are attached at the place of cutter head with help of chinese finger, as shown in figure 7.5

Fig. 6.3 Chinese Finger, Pilot, Infrared Sensor, Tracking Monitor

The completion of this project is expected in September 2021. By using microtunneling for telecom network system in Sangli city, time consumed is less as compared to open digging for 3G network system. For laying 3G optic fiber cables needed 2 years and 8 months in Sangli city, but by microtunneling same project only requires less than a year.

VII. CONCLUSION

1. Microtunneling is very efficient, fast, time saving and also cost efficient technique for underground network system.
2. It is very effective in areas such as heavy traffic, across waterways and bridge, under already situated localities.
3. We recommended this technique in India for water supply networks, sewerage networks, telecom networks and gas transmission and distribution networks in metropolitan cities where gas distributed by pipeline.
4. This techniques requires skilled labours, skilled supervision and also requires various machinery which is all expensive than open digging method, but if we calculated as per required time and accuracy of microtunneling technique, the cost of project is approximately nearby traditional open digging method project cost., because cost is saved due to less numbers of labour required, period of completion of project is less than open digging for same project and very less chances to disturb already installed underground network systems..

VIII. ACKNOLEDGEMENT

We express our deep sense of admiration and gratitude to our project guide Prof. Priyanka P. Kavathekar, Lecturer in Department if Civil Engineering, Zeal Polytechnic, Narhe, Pune, for his invaluable encouragement, helpful suggestions and supervision throughout the course of this work. His willingness, patience and optimistic attitude could lead to completion of this research work. We are also thankful to Prof.Prashant L. Jadhav (H.O.D, Civil Engineering Department) for his moral support.

I also express my thankfulness to the encouragement from Prof. A. A. Tamboli (Principal, Zeal Polytechnic, Narhe, Pune faculty members of Zeal Polytechnic, Narhe, Pune , for their valuable suggestions from time to time.

I am thankful to the Liberians of Zeal Polytechnic, Narhe, Pune for their cooperation in the initial phase of our project. Among the supporters, and all teaching and non-teaching staff deserves special thanks. The experimental work would not have been possible without their kind cooperation.

Lastly but not the least, I do acknowledge the loving support, cooperation that came from family members, relatives to see the completion of this work.

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