A Comparative Study Between Horizontal Directional Drilling (HDD) And Microtunneling

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Abstract **- Two of the most used trenchless techniques for installing underground pipes are microtunnelling and horizontal directional drilling (HDD). Both approaches are appropriate for various applications since they both have their own benefits and drawbacks. By comparing and contrasting the advantages of Microtunneling and HDD, this comparison aims to provide an insight of both techniques. The study will first describe each method's typical uses before introducing its fundamental concepts and methods. Then, it will assess and analyse their benefits and drawbacks in terms of cost, effectiveness, accuracy, safety, and environmental impact. The results of this study will help engineers, contractors etc. choose the most suitable and efficient techniques for trenchless laying of pipelines.**

Index Terms: **Horizontal Directional Drilling (HDD), Microtunneling, Trenchless pipeline construction, Trenchless technology, Underground pipelines.**

I.INTRODUCTION

The installation of underground pipelines and utility lines is a crucial aspect of modern infrastructure development. It ensures efficient and safe transport of resources such as water, gas, and electricity. Traditional excavation techniques for installing pipelines can result in severe surface disruption, environmental degradation, and increased risks for both public and worker safety. As a result, trenchless methods such as horizontal directional drilling (HDD) and microtunneling have gained popularity due to their advantages over traditional excavation methods. These methods involve the installation of pipelines underground without the need for large-scale excavation, which reduces surface disruption and environmental impact. However, there are significant differences between these two methods in terms of their equipment, installation process, and cost. Therefore, a comparative study between HDD and microtunneling is necessary to understand the strengths and weaknesses of each method and determine which is best suited for a particular project. The comparative study may involve factors such as site conditions, pipe material, installation depth, length of the installation, and the presence of any obstacles or utilities. The study will help identify the best method for a particular project based on its requirements. For example, HDD may be the better option for long-distance installations, while microtunneling may be the more appropriate method for installations in metropolitan areas. Several factors may influence the selection of the most appropriate method for a particular project. The pipe material, for instance, may dictate the choice of method, as some materials such as ductile iron may require a more delicate installation process. The installation depth may also influence the choice of method since HDD may not be suitable for installations at depths greater than 50 meters. Additionally, the presence of any underground utilities or obstacles may dictate the choice of method since microtunneling can cause damage to existing utilities.

This paper aims to provide a comprehensive review of the literature related to HDD and microtunneling, highlight the differences between these two methods, and identify the factors that influence the selection of the most appropriate method for a particular project. The paper will also present case studies of projects that have used HDD and microtunneling and compare their results to determine the advantages and disadvantages of each method.

Introduction to HDD:

Horizontal directional drilling (HDD) is a trenchless underground drilling method used for installing of underground pipes, cables, and utilities. This method involves drilling a small diameter hole called ‘Pilot hole’ at a shallow angle beneath the ground surface. The drill bit is then guided to the desired location using a directional drilling system and a digital tracker, which allows the drill operator to steer the drill in the desired direction.

Introduction to Microtunneling:

Microtunneling is a trenchless method of installing underground pipes and utilities using a remotely controlled boring machine known as 'Microtunneling Machine'. This method involves excavating a tunnel using a boring machine that is guided by laser or other guidance systems. The tunnel is excavated using a slurry system that supports the tunnel walls and removes the excavated soil.

II.OBJECTIVES OF THE PROJECT

- To identify benefits and drawbacks of using Horizontal directional drilling (HDD) and microtunneling for laying of underground pipelines.
- To compare the two methods in terms of cost, efficiency, environmental impact etc.

This project compares HDD (horizontal directional drilling) and microtunneling, two different trenchless tunnelling techniques which makes it possible to underground pipeline construction more efficient, cost effective, environmental friendly and have a number of benefits overtraditional trenching methods.

III.LITERATURE REVIEW

- Llozumba E. *et al.* (2022) proposed a novel mitigation technique in this paper to effectively improve the safety and integrity of buried pipelines subjected to ground deformation and to mitigate the detrimental effects of ground deformation on the pipe. In this technique, special geomaterial blocks (SGBs) are installed adjacent to the pipes.
- Raymond S. (2020) provides a comprehensive literature review of recent developments and research in the field of pipe jacking and microtunneling. The paper highlights the advantages of these trenchless methods for pipeline installation, including reduced surface disruption, minimal environmental impact, and improved safety compared to traditional excavation methods. The paper discusses recent technological advancements, such as computer-controlled jacking systems and real-time monitoring systems, which have improved the accuracy and efficiency of the construction process. Also, the paper identifies several areas for future research, including the development of new materials for pipes, the optimization of the installation process, and the investigation of the behavior of different types of soils during installation. The study concludes that pipe jacking and microtunneling have significant potential for pipeline construction in challenging terrains and urban areas and that continued research and development will further improve their effectiveness and cost-effectiveness.
- Muhammad A. *et. al.* (2020) presents a case study of the installation of sewerage pipes using pipe jacking and micro-tunnelling boring machines (MTBM) in Ipoh, Malaysia. The paper discusses the advantages of these trenchless methods over traditional open-cut excavation methods, including reduced surface disruption, improved safety, and minimal environmental impact. The study provides detailed descriptions of the equipment and materials used in the installation process and highlights the importance of proper planning and risk assessment. It also discusses the challenges faced during the installation, such as the presence of existing underground utilities and the need for soil stabilization. The study concludes that pipe jacking and micro-tunnelling are effective methods for sewerage pipe installation in urban areas, and their use can result in significant cost savings and reduced construction time.
- Nishith A. Kakadiya *et al.* (2017) found that the direct cost of open excavation method is less compared to trenchless method, but due to the benefits of trenchless method it is more economical and durable in the long run. For the area selected for this research i.e. Mota Varachha, Surat, the duration for open cut laying of pipe was found to be 1 month compared to trenchless laying method which took only 5 days.
- Patel H. *et al.* (2014) suggested that, work should be undertaken for crossings under roads, national highways, railways, canals etc. and all renovations of sewerage systems in metropolitan cities using trenchless technologies.
- Namli M. *et al.* (2011) suggested that the use of slurry type machines prevents the environmental impact, such as lowering of the underground water level. This study was conducted for Istanbul city.
- Curran B. and Bryan A. (2010) examined the potential of microtunnelling as a viable alternative to traditional pipeline construction methods. The paper presents a literature review of several case

studies and projects where microtunnelling was used to install pipelines, it highlighting its advantages such as reduced surface disruption, improved safety, and higher accuracy compared to conventional excavation methods. The paper also discusses the technical considerations for microtunnelling, including the selection of suitable equipment and materials, and the importance of proper planning and risk assessment. The study concludes that microtunnelling has the potential to be a viable option for pipeline construction in urban areas and challenging terrains, and further research is needed to optimize the process and improve its cost-effectiveness.


I. CASE STUDY

1. Sewerage pipeline installation using Microtunneling methods in Mumbai.

The project is undertaken by Bombay Municipal Corporation (BMC) to connect various suburban areas of Mumbai to the sewerage system. The project cost is approximately Rs 1,000 crore and is aimed to install 1200mm and 1800mm diameter sewerage pipeline along the route of Dahisar, Borivali, Jogeshwari, Powai, and Kurla. The depth of the pipes was set at 7 meters, pits of 5m x 6m and 6m x 6m are being excavated as per the requirement or conditions. Concrete lining was used for the installation. The use of microtunneling technology for the installation of the sewerage pipeline allowed for a faster and more efficient installation process with less disruption to the surrounding areas.

One of the main challenges faced during the project was the need to maintain traffic flow on the busy roads in the surrounding areas. Additionally, the contractor had to




ensure that the installation did not damage any existing utilities, such as water and gas pipelines, or cause any harm to nearby structures. We also learned that MTBM cannot be used under Bridges, therefore, pipeline under bridges were being installed manually trough manual excavation. This situation was faced in Kurla.

2. Telecom pipeline installation using HDD methods in Mira-Bhayander.

The project involves laying Airtel telecom cables in Mira-Bhayander, Thane, Maharashtra using Horizontal Directional Drilling (HDD). The project is contracted to ‘Super Drilling Solutions’. This project is 50km in length stretching from Kashimira to Golden Nest and throughout Mira- Bhayander. The client for the project is Bharti Airtel Limited. 2 ducts for 3” cable pipes in each duct are being used installed. The depth of the drilling is 7m below the surface. The HDD machine used in the project is a DL200A model manufactured by Jiangsu Dilong Heavy

Machinery Co. LTD. The machine had a weight of 7.5 ton, with a drill rod length of 3 meters and a pilot diameter of 4 inches. The machine is equipped with an Underground Magnetics Mag 3s digital tracker.
Due to the use of trenchless method for construction i.e. HDD method in this case, no disturbances is occurring on the surface except at the entry and exits of the pipeline and there is no disruption to the traffic.

II. COMPARISON BETWEEN HDD AND MICROTUNNELING

i. Comparison Of Cost:
HDD can be less expensive than microtunneling for installations that are less than 300 feet in length. For installations that are longer than 300 feet, microtunneling can be more cost-effective due to its ability to drill longer distances. Microtunneling is also more expensive than HDD for smaller diameter installations. Overall, the cost of each method depends on several factors, including the length of the installation, the diameter of the pipe, and the soil conditions.

ii. Comparison for Accuracy:
Compared to HDD, microtunneling is more accurate, which allows for precise installation and reduces the risk of damage to existing infrastructure. Although HDD allows for directional control, it is not as accurate as microtunneling.

iii. Comparison for Flexibility:
HDD is more flexible than microtunneling and can be used in a wider range of soil conditions, including rock and cobble. Microtunneling is typically used for installations at deeper depths and requires more area for its setup as compared to HDD.

iv. Comparison of Environmental Impact:
Both HDD and microtunneling have minimal environmental impact compared to traditional open trenching methods. However, due to its capacity to reduce soil disturbance and disruption of already-existing ecosystems, microtunneling may be more appropriate for environmentally sensitive areas.

v. Comparison of Installation Speed:
HDD is typically faster than microtunneling, as it requires less setup time and can drill at faster rates. Microtunneling requires more setup time and is typically slower than HDD.

vi. Advantages:
a. Advantages of Microtunneling:
Microtunneling offers a number of advantages over traditional open trenching methods and HDD, such as:

- High accuracy: Microtunneling is guided by a laser or other guidance system, which allows for high accuracy in excavation.
- Long drilling distances: Microtunneling can be used for longer installations, with some machines capable of drilling distances of up to 1,000 feet.
- Large drilling diameter: Microtunneling can be used for larger diameter installations, with some machines capable of drilling diameters of up to 144 inches.
- Minimal surface disruption: Microtunneling requires only a small entry and exit point, which minimizes disruption to the surface area.
- Minimal environmental impact: Microtunneling is a trenchless method, which means there is no need to excavate large amounts of soil or disrupt existing ecosystems which reduces the environmental impact of activities involved such as reconstructing the road and also reduces the CO2 emission from vehicles by not disrupting the traffic.

b. Advantages of HDD:
HDD offers a number of advantages over traditional open trenching methods, such as follows:

- Minimal disruption to the surface area:

As HDD requires only a small entry and exit point, there is minimal disturbance to the surface area. This is especially important in urban areas where open trenching can disrupt traffic and cause other disruptions.

- Minimal environmental impact:

HDD is a trenchless method, which means there is no need to excavate large amounts of soil or disrupt existing ecosystems. This is particularly important in environmentally sensitive areas. Also, there is no need to reconstruct a large area of road, minimizing the negative impact of road construction on the environment.

- Reduced cost:

Although the initial cost of HDD equipment is higher than that of open trenching equipment, the overall cost of a project can be reduced due to the reduced labour and material costs associated with HDD.

- Flexibility:

HDD can be used in a wide range of soil conditions and can be used to install pipes and utilities at shallow or deep depths.

vii. Limitations:

a. Limitations of Microtunneling:

Despite its advantages, microtunneling has some limitations, such as:

- Higher cost:

Microtunneling can be more expensive than HDD and traditional open trenching methods due to the specialized equipment and skilled labour required.

- Limited flexibility:

Microtunneling may not be suitable for all soil conditions, and is typically used for installations at deeper depths.

- Longer setup time:

Microtunneling requires more setup time than HDD, as it need a pit to be excavated to place the tunnelling machine. This can increase the overall project duration and also affect the cost.

b. Limitations of HDD:

Despite its advantages, HDD also has some limitations, such as:

- Limited drilling distance:

The maximum drilling distance for HDD is typically limited to several hundred feet. Therefore, HDD is suitable for longer installations.

- Limited drilling diameter:

The maximum diameter that can be drilled using HDD is typically limited to 48 inches. Due to this limitation, larger diameter installations require another method of trenchless drilling. Also, the risk involved in HDD is directly proportional to the diameter of drilling.

- Limited accuracy:

Although HDD allows for directional control, it is not as accurate as microtunneling, which can make it difficult to drill at specific locations precisely.

III. CONCLUSION

In conclusion, our comparative study between horizontal directional drilling (HDD) and microtunneling has highlighted the advantages and disadvantages of both trenchless drilling methods. Horizontal directional drilling (HDD) is a well-established method and is suitable for a wide range of soil conditions. It takes less installation time and is generally less expensive than microtunneling. Contrary to this, microtunneling offers high precision and accuracy, making it ideal for projects that require more precision. It is also less disruptive to the surface and can be used in congested urban areas where HDD may not be feasible. Ultimately, the choice between HDD and microtunneling will depend on various factors such as the project's scope, drilling diameter, length of drilling, soil conditions, environmental conditions, availability of equipments and specialized labours, and also budget. A thorough analysis of these factors can help project owners and contractors make decision on which technique to use to ensure a successful and efficient installation of pipelines.

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