

Whitepaper

Cable Jetting:

Is it the Optimal Cable Installation Solution for Ducts?



Table of Contents

Cable Jetting: Is it the Optimal Cable Installation Solution for Ducts?	01
Technical Overview of Cable Jetting	02
Expert Advice for Seamless Cable Installation	03
Necessary Pre-Cable Jetting Tests: Ensuring a Successful Deployment	4-6
Cable Jetting Best Practices for Microduct Cables	7-9
Advantages of Cable Jetting over Traditional Cable Installation Methods	10
Comparison between Cable Pulling and Cable Jetting Methods	11
Cable Jetting Use Cases Across Industries	12-13
Challenges and Limitations of Cable Jetting	14
Anticipated Developments and Innovations on the Horizon	15
Conclusion	16
About HFCL	16

Cable Jetting: Is it the Optimal Cable Installation Solution for Ducts?

The adoption of fiber optic cables is on the rise globally, accounting for approximately 32% of fixed broadband subscriptions in 38 OECD countries. In India, the market for optical fiber and connectivity is projected to experience substantial growth, with an anticipated CAGR of 17.2% from 2019 to 2026, reaching a value of \$1.66 billion. The increasing demand for fiber optic cables is expected to surpass the demand for traditional technologies like copper cables, creating opportunities for equipment such as modern machines for underground cable laying.

In the vast landscape of cable installation methods, choosing the right approach can often feel like navigating through a maze of options. The decision between push, pull, or jet can leave cable or network operators perplexed, wondering which path will lead to optimal results. However, the importance of selecting the right cable installation method cannot be overstated, as it directly impacts the efficiency, cost-effectiveness, and long-term performance of the network infrastructure.

Why is it crucial to choose the right cable installation method? The answer lies in the profound impact it has on project timelines, labor requirements, costs, and network performance.

Among the various options available for installation into ducts, cable jetting emerges as a standout solution that delivers unmatched benefits. With its innovative working principle and specialized equipment, cable jetting revolutionizes cable installation by propelling cables through conduits or pathways using compressed air. This technique eliminates the need for labor-intensive trenching or cumbersome overhead installations, paving the way for faster, more efficient, and cost-effective projects.

Stay tuned as we explore the technical nuances, real-world applications, and transformative potential of cable jetting in the pages that follow.



Cable Jetting Machine

Technical Overview of Cable Jetting

A well-chosen method can streamline the installation process, maximize efficiency, and minimize disruptions to existing infrastructure. On the other hand, a poor choice can result in extensive delays, unnecessary expenses, and compromised network reliability.

Working Principle:

Cable jetting works by feeding cable into a duct or conduit by pushing through a traction mechanism while simultaneously injecting air pressure to carry the cable along. The compressed air creates a force that contributes to the forward cable movement, while a lubricant may be used to reduce friction and facilitate smooth movement. This technique allows for efficient installation even in complex or obstructed environments.

Equipment and Tools:

Cable jetting requires specialized equipment and tools. A typical cable jetting setup includes a jetting machine and air compressor, which generates the necessary pressure to direct the compressed air flow, a lubrication system as needed for applying lubricant to the cable and monitoring devices to ensure proper cable alignment and movement.

Expert Advice for Seamless Cable Installation

Here are a few key parameters to keep in mind for a smooth cable jetting process

Duct Fill Ratio

The duct fill ratio refers to the ratio between the diameter of the cable being jetted and the internal diameter of the duct or conduit. It determines how tightly the cable fits within the duct and affects the ease of cable installation. The optimal duct fill ratio depends on various factors, including the type and size of the cable, the conduit diameter, and the desired cable performance.

In most cable jetting scenarios, a duct fill ratio between 45% and 80% is deemed appropriate. For microducts, the optimal range is 70% to 80%. A ratio exceeding 85% can create excessive friction and installation challenges, limiting installation distance and potentially damaging the cable. Thus, it's crucial to maintain an optimized duct fill ratio.

Cable Stiffness

Cable stiffness refers to the resistance of the cable to bending or flexing. It influences the cable's ability to navigate through bends, turns, and undulations in the duct route during jetting. A cable with higher stiffness may encounter difficulties when passing through tight bends or changes in direction. It can result in increased friction, cable hang-ups, or even cable damage. On the other hand, a more flexible cable with lower stiffness can navigate the duct route more easily, reducing the chances of installation issues. When selecting a cable for jetting, it's important to consider its flexibility, bending radius, and the anticipated duct route to ensure compatibility and smooth installation.

Coefficient of Friction

The coefficient of friction refers to the measure of the resistance between the outer surface of the cable and the inner wall of the duct. It plays a crucial role in determining the force required for cable jetting and affects the smooth movement of the cable through the conduit. A lower coefficient of friction indicates less resistance and facilitates easier cable installation.

To achieve optimal results, it's advisable to maintain a coefficient of friction value below 0.1. Several factors impact this value, including the materials of the cable jacket and the inner conduit wall. To minimize friction, lubricants or cable lubrication gels are frequently applied to the cable before jetting. This reduces resistance and facilitates smoother cable movement within the duct, reducing the coefficient of friction to nearly 0.1, typically ranging from 0.07 to 0.08. This improvement can increase the blowing length by at least 25% compared to jetting without lubrication.

Necessary Pre-Cable Jetting Tests: Ensuring a Successful Deployment

Cable Crash Test

The cable crash test is conducted to assess the cable's ability to withstand impact or collision during the jetting process. It involves subjecting the cable to controlled impacts or collisions to ensure that it can withstand potential external forces without damage or performance degradation.

- Before starting cable installation, it's advisable to conduct a crash test to determine the maximum allowable pushing force, ensuring optimal results and cable safety.
- This test aims to find the right balance between pushing force and radial pressure on the cable.
- The pushing force is controlled by regulating the machine's pushing mechanism, while the clamping unit adjusts the radial pressure.
- Excessive clamping leading to high radial pressure can negatively impact cable laying performance by increasing power dissipation in the drive system.
- Conversely, insufficient clamping with low radial pressure can also have adverse effects, increasing the risk of cable slipping between the belts.

Duct End Cap



Cable Crash Test – Setup



Crash Test Procedure

- 1 Insert a duct length of 4 to 5 meters into the duct insert, blocking one end with an end stopper/duct end cap.
- 2 Set up the cable in the machine for laying and allow it to enter the duct by a few centimeters.
- 3 Apply slight radial pressure to clamp the cable and gently pull its end. If it slips between the belts, increase the radial pressure. If the belts turn without cable slippage during a manual pull, proceed.
- 4 Start the blowing machine motor and feed the cable until it encounters the blockage in the duct. Avoid pressurizing the blocked duct during this test.
- 5 If the drive pulley halts when the cable reaches the blockage without buckling, repeat the crash test with increased air pressure in the motor circuit.
- 6 If, in these tests, the belts continue running despite cable blockage, indicating slippage, further increase the clamping force.
- 7 Continue crash tests until the cable buckles within the duct. If this occurs, the adjustment is too strong.
- 8 Return to the previous air pressure setting in the motor circuit, where the cable remained straight.
- 9 You have now determined the maximum allowable pushing force for cable laying. Note this value for future reference.

Cable Drum Pay-Off

The cable drum pay-off test is performed to ensure that the cable unwinds smoothly from the cable drum during installation. It checks for any issues such as tangles, snags, or excessive tension that could hinder the cable's proper feeding into the jetting equipment.

Duct Integrity Test (DIT)

The duct integrity test involves several sub-tests to evaluate the integrity and suitability of the conduit or duct system for cable jetting. These four tests help ensure that the cable is capable of withstanding potential impacts. Conducting these tests before installation minimizes the risk of cable damage or installation issues, and ensures a successful cable jetting process.

1. Duct Continuity Test

A constant flow of air pressure is passed through the duct route to check that the proper flow is received at the other end. This will ensure that the duct route or pathways are free from any disconnect or major leakage.

2. Sponge Test

A sponge is blown through the conduit to clean for any obstructions or debris that could impede cable jetting, ensuring a clear pathway.

3. Shuttle Test

A shuttle or mandrel is inserted into the conduit to verify its inner dimensions, identify any blockages, or assess any irregularities that could affect the cable's smooth movement.

4. Air Pressure Test

This test assesses the airtightness of the duct by applying air pressure and monitoring for any pressure drops, indicating potential leaks or weaknesses.

Cable Jetting Best Practices for Microduct Cables

Effective End Sealing of the Cable

Crimp the cable end with a cable cap to prevent fiber exposure during duct installation.



Optimal Duct Lubrication Procedure

- Lubricate the duct before commencing cable blowing for extended blowing length.
- Choose an appropriately sized foam plug for effective lubrication according to the duct's size.

Duct Internal Diameter	Foam Plug Size (Ø x H)
5 - 7 mm	12 x 42 mm
7 - 9 mm	16 x 42 mm
9 - 12 mm	20 x 42 mm
12 – 16 mm	25 x 42 mm

- Before introducing lubricant into the microduct, use a slightly lubricated foam plug to clean and verify the duct's cleanliness and absence of water.
- After cleaning the microduct, insert the slightly lubricated foam plug and use a thin rod to push it into the duct. Refer to the table below for the specific penetration length based on the duct's ID.



Duct Lubrication Process

Internal Diameter	Penetration Length
5 mm	40 cm
6 mm	33 cm
8 mm	25 cm
10 mm	20 cm
12 mm	17 cm
13 mm	16 cm
14 mm	14 cm
15 mm	13 cm

- Place the next foam plug 5 cm from the duct's end.
- Adjust the inlet pressure to approximately 4 - 5 bar to propel the foam plug, ensuring proper setup to capture the sponge at the other end.
- Record and take note of the foam plug's travel time.
- In a clean and unobstructed duct route, the approximate travel times per 1 km are the following:
 - 5 mm ID microduct → 4 – 8 minutes
 - 6 mm ID microduct ID → 2 – 4 minutes
- If the specified time elapses, increase the pressure to 6 – 8 bar, and wait for the indicated duration. If it still hasn't reached the destination, an obstacle may be present. Remove the obstacle and then proceed.



Wet sponge inserted initially



Inserting the sponge up to desired depth using a rod



Suggested lube quantity poured



Advantages of Cable Jetting over Traditional Cable Installation Methods

Compared to traditional methods like trenching, cable pulling, cable jetting offers several advantages:

Optimized Workload with Minimal Manpower

This cable installation method significantly reduces the need for manual labor, as it eliminates or minimizes the requirement for extensive digging for cable installation.

Navigating Complex Pathways

It allows cables to be routed through existing conduits, even when they contain bends, obstacles, or multiple branches.

Substantial Savings

This process results in reduced material expenses, labor costs, and project delays, emphasizing the economic viability and return on investment of cable jetting.

Increased Cable Capacity

Cable jetting enables the installation of multiple cables within a single conduit. This optimizes the use of available space and increases cable capacity, allowing for future expansion and minimizing the need for additional infrastructure.

Faster Installation

Cable jetting enables faster installation, as the cables can be propelled quickly through the conduits or pathways, without the need for extensive trenching.

Minimal Disruption

By avoiding extensive excavation, cable jetting minimizes disruption to existing infrastructure, reduces road closures, and mitigates impact on traffic flow and public services.

Potential for Reduced Materials Consumption

Installation of microcable in microduct reduces the amount of raw materials used per unit length of cable, minimizing plastic consumption and increasing sustainability.

Comparison between Cable Pulling and Cable Jetting Methods

Aspect	Cable Pulling	Cable Jetting
Installation Process	Physically pulling the cable through the conduit	Propelling the cable using compressed air with simultaneous application of pushing
Conduit Size	Typically limited by the cable and conduit size	Can accommodate high density optical fiber cable in smaller conduits
Installation Speed	Relatively slower	Faster installation process
Installation Length	Suitable for shorter distances (few 100 m)	Suitable for longer distances (over 1 km in a single go)
Bend Radius	May encounter challenges in tight bends	More flexible and can navigate tighter bends
Cable Protection	Requires additional pulling grips for protection	Reduced risk of cable damage during installation
Labor Requirement	Requires manual pulling force	Requires fewer labor resources
Cable Types	Suitable for a wide range of cable types	Suitable for specific cable types (e.g., fiber)
Equipment Complexity	Requires pulling equipment (winch, capstan, etc.)	Requires only a jetting machine and compressor
Common Applications	Electrical power cables, medium-sized conduits	Fiber optic cables, long-distance installations
Cable Size/Weight	Higher weight and diameter designs required to protect fibers from high pulling forces	Lower weight and diameter allowed due to relatively low pushing force from jetting machine + air pressure

Cable Jetting Use Cases Across Industries

Connecting the World: Telecommunications Industry

Cable jetting in telecommunications is used to install high-capacity fiber optic cables across a city, enabling faster internet speeds and supporting the deployment of advanced services like video streaming, cloud computing, and 5G connectivity. It enables the efficient deployment of cables in urban areas over long distances and through existing conduits or ducts, thus, reducing disruption to existing infrastructure.

Energizing Connectivity in the Energy Sector

In the energy sector, cable jetting is employed in various applications. For instance, in offshore wind farm projects, cable jetting has proven valuable in the installation of power cables, allowing for efficient transmission of electricity from wind turbines to onshore facilities. Similarly, in underground transmission line projects, cable jetting has minimized the need for extensive trenching and reduced the environmental impact of cable installation.

Powering Smart Cities with High-Speed Data

In the development of smart cities, cable jetting is employed to install cables for various smart infrastructure components. This includes communication networks, sensors, surveillance systems, and street lighting, enabling efficient data collection, analysis, and management.

Fuelling Connectivity in Transportation Infrastructure

Cable jetting is extensively used in transportation infrastructure projects, including the construction of highways, railways, and airports. It facilitates the installation of power and communication cables along tracks, within terminal buildings, and under roads, ensuring efficient operation of signaling, lighting, communication, and traffic management systems.

Providing Connectivity beneath the Surface-Underground Utilities

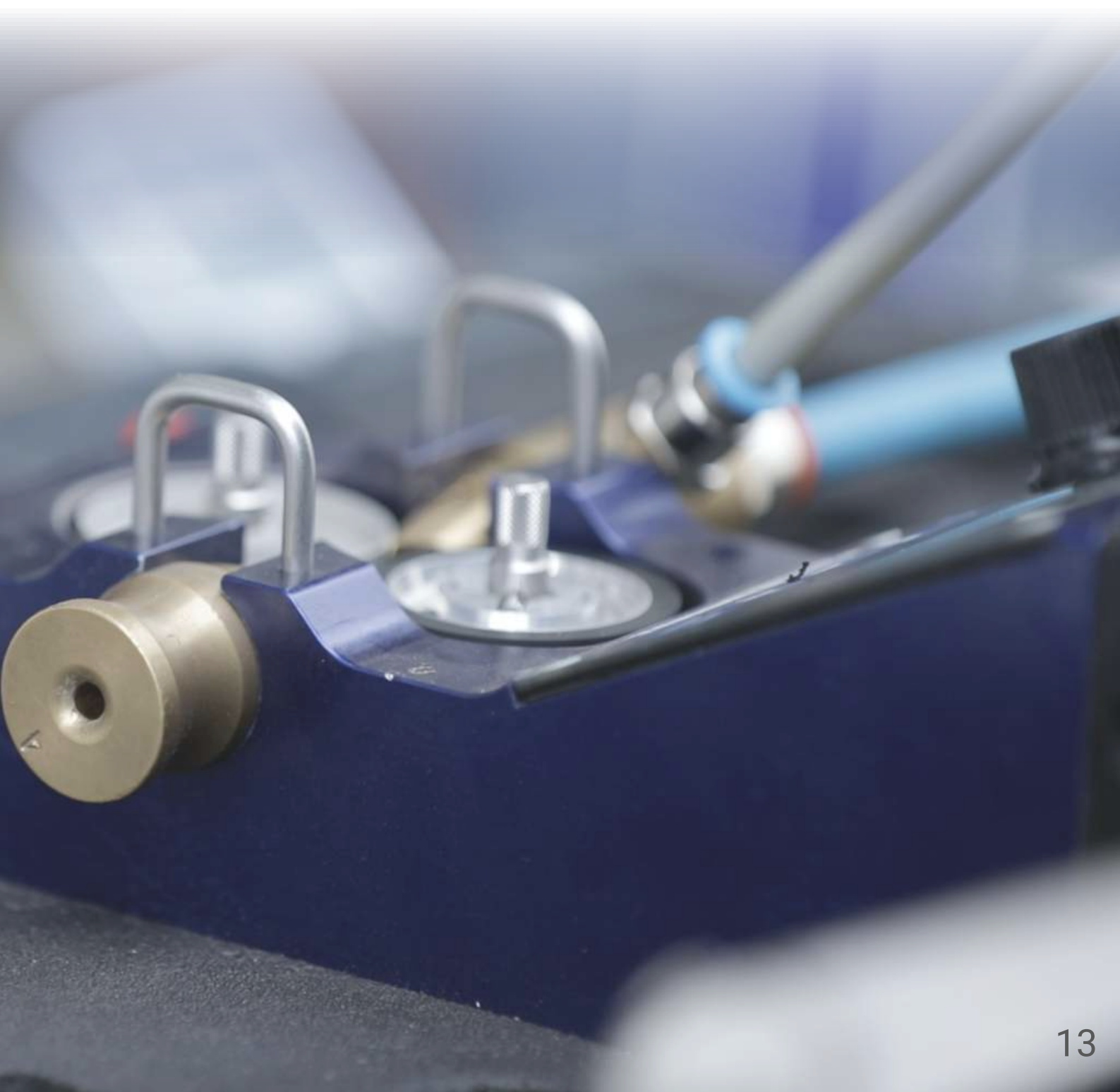
Cable jetting is a preferred method for installing underground utility cables, such as power, water, gas, and telecommunications lines. It minimizes disruption to existing infrastructure, reduces excavation needs, and provides a faster and more cost-effective installation process.

From Manufacturing to Warehouses: Industrial Applications

This cable installation method also finds applications in industrial settings, such as manufacturing plants, warehouses, and distribution centers. It allows for the efficient installation of power cables, control systems, and communication networks, supporting the smooth operation of machinery, equipment, and automated systems.

Providing Seamless Internet Access to Residential and Commercial Buildings

Cable jetting is utilized in the construction and renovation of residential and commercial buildings for the installation of electrical wiring, internet connections, and other communication cables. It offers a faster and less invasive alternative to traditional cable-pulling methods.



Challenges and Limitations of Cable Jetting



Environmental Considerations- Because there's no Planet B

While cable jetting offers significant advantages, it is important to address environmental considerations. These include the disposal of lubricants and the need for eco-friendly practices during cable installation. Organizations should ensure compliance with environmental regulations and adopt sustainable approaches to mitigate potential environmental impacts.

Compatibility and Adaptability- A Crucial Factor

Cable jetting techniques may have limitations based on the types of cables, conduit materials, and installation scenarios. Compatibility and adaptability considerations should be taken into account to ensure successful cable jetting operations. Organizations need to assess the feasibility of cable jetting in specific projects and make appropriate adaptations or alternate choices when necessary.



Anticipated Developments and Innovations on the Horizon

The integration of cable jetting with fiber optic technology holds promise for future network infrastructure. By leveraging cable jetting techniques, high-capacity fiber cables can be efficiently installed, enabling faster data transmission, increased bandwidth, and supporting the demands of emerging technologies like 5G, Internet of Things (IoT), and smart cities.

HFCL's optical fiber microcables offer high scalability, allowing for easy expansion or upgrades of the fiber network without significant infrastructure modifications.

The flexibility and high fiber packing density of our microcables enables them to be deployed in various network architectures, including point-to-point and point-to-multipoint configurations.

Advanced Monitoring and Maintenance

Emerging technologies such as remote diagnostics, predictive analytics, and self-healing capabilities can enhance cable jetting systems' monitoring and maintenance. These advancements can improve the overall reliability and lifespan of cables installed through cable jetting, ensuring optimal network performance and minimizing downtime.

Conclusion

As the demand for faster data transmission and expanding networks continues to grow, cable jetting will play a crucial role in meeting these evolving needs. Embracing cable jetting technology ensures a future of faster, more reliable, and scalable cable installations, paving the way for seamless connectivity in a digitally connected world.

About HFCL

At HFCL, we are a trailblazing global technology company dedicated to connecting billions of people, devices, and systems. With a strong focus on innovation, we design, develop, and manufacture cutting-edge telecommunications equipment, fiber-optic cables, and other related electronics. Our commitment to technological advancement and quality has positioned us as a leading player in the industry. With a rich legacy and a global presence, we are driven by our passion to empower networks and revolutionize the way people communicate. By leveraging our expertise and innovative solutions, we enable seamless connectivity and enhanced reliability, shaping the future of digital and telecommunications. If you have any specific requirements related to advanced networks, optical fiber products, or other telecommunication products, feel free to reach out at +91 124 4310000 or +91 124 4310050.

