



Yangtze Optical Fibre and Cable Joint Stock Limited Company

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Air-blown Micro Ducts and Micro Cables





Yangtze Optical Fibre and Cable Joint Stock Limited Company (also known as 'YOFC') is established in Wuhan, Hubei Province in May 1988. It's a technologically innovative enterprise specializing in optical fibre preforms, optical fibres, optical fibre cables and integrated solutions. It is also a global leading supplier of optical fibre preforms, optical fibres and optical fibre cables.

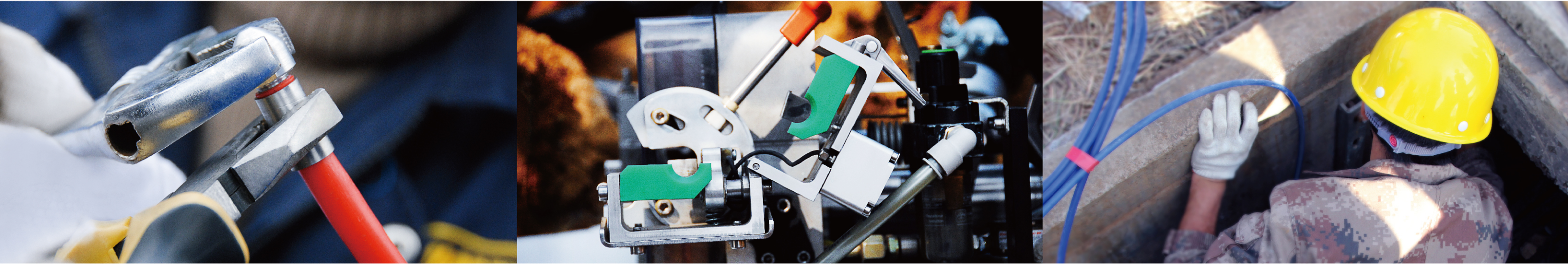
YOFC was listed on the Hong Kong Stock Exchange on December 10, 2014 (Stock Code: 06869.HK), and listed on the Shanghai Stock Exchange on July 20, 2018 (Stock Code: 601869.SH), and is the only A&H shares company in China's optical fibre and cable industry as well as the first one in Hubei Province.

YOFC mainly produces and sells different types of optical fibre preforms, optical fibres and optical fibre cables that widely installed in telecommunications industry, customized specialty optical fibres and optical fibre cables, RF coaxial cables and accessories. YOFC also provides the integrated systems, project design and services. In addition, YOFC is equipped with a full series of optical fibres, optical fibre cables and solutions, providing a variety of different products and solutions for world's telecommunications industry and other industries (e.g. Public utility, Transportation, Oil & Chemistry and Medication etc.) and offering its products and services to over 70 countries and regions around the world.

Through introduction, digestion, absorption and re-innovation since its establishment, YOFC has carried out a way to successfully revitalize national industry. YOFC has mastered 3 types of optical fibre preform manufacturing technology (PCVD/OVD/VAD), and honored many awards & reputations such as National Enterprise Technical Center, National First Batch Intelligent Manufacturing Pilot Enterprise, the Second Class National Science and Technology Progress Award (3 times), the China Quality Award, the European Quality Award, etc. In addition, YOFC has obtained over 400 national-granted patents and several foreign invention patents from Europe, US and Japan, and was nominated the support organization for State Key Laboratory in optical fibre and optical fibre cable manufacture technology. It's also one of the significant members in ITU-T and IEC in setting international standards.

Adhering to the mission of 'Smart Link Better Life', YOFC devotes itself to becoming the leader in information transmission and smart links through its core value 'Client Focus Accountability Innovation Stakeholder Benefits', and builds its strategies in the following 5 aspects: Organic growth strategy of the preform, optical fibre and cable business; Strategy for technological innovation and smart manufacturing; Strategy for internationalization and expansion of business scope; Related diversification strategy; Capital operation strategy for synergy in development.

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Introduction

Since the first R&D of the technology of air-blown micro duct and micro cable by YOFC to China in 2004, after many years of technological innovation, YOFC is capable of designing overall air-blown micro duct and micro cable solutions and providing a full range of products, and has accomplished cases in the construction of long-haul trunk lines, urban loop networks, interoffice relay trunks, duct expansion and FTTx networks, etc.

YOFC possesses professional technicians in air-blown micro ducts and micro cables and can provide complete solutions and technical support services for applications in factories, enterprises, schools, hospitals, public institutions, business centers, subscribers in residential areas and villas. It can also provide complete solutions and designs for transmission lines lack of communication routes, expansion of communication ducts and construction of non-communication ducts.

Being capable of integrating the complete product chain of micro ducts and auxiliary protective products, YOFC provides safe and efficient air-blown micro duct and micro cable solutions. YOFC takes strict measures in quality control and project management to control the quality of various kinds of integrated products, guarantee construction quality and provide customers with satisfactory service.

Advantages of Air-blown Micro Ducts and Micro Cables

The technology of air-blown micro duct and micro cable is a kind of high technique. Compared with optical cables deployed in the traditional ways, air-blown micro cables have the following advantages

Advantages

1. It improves duct utilization and increase fibre density

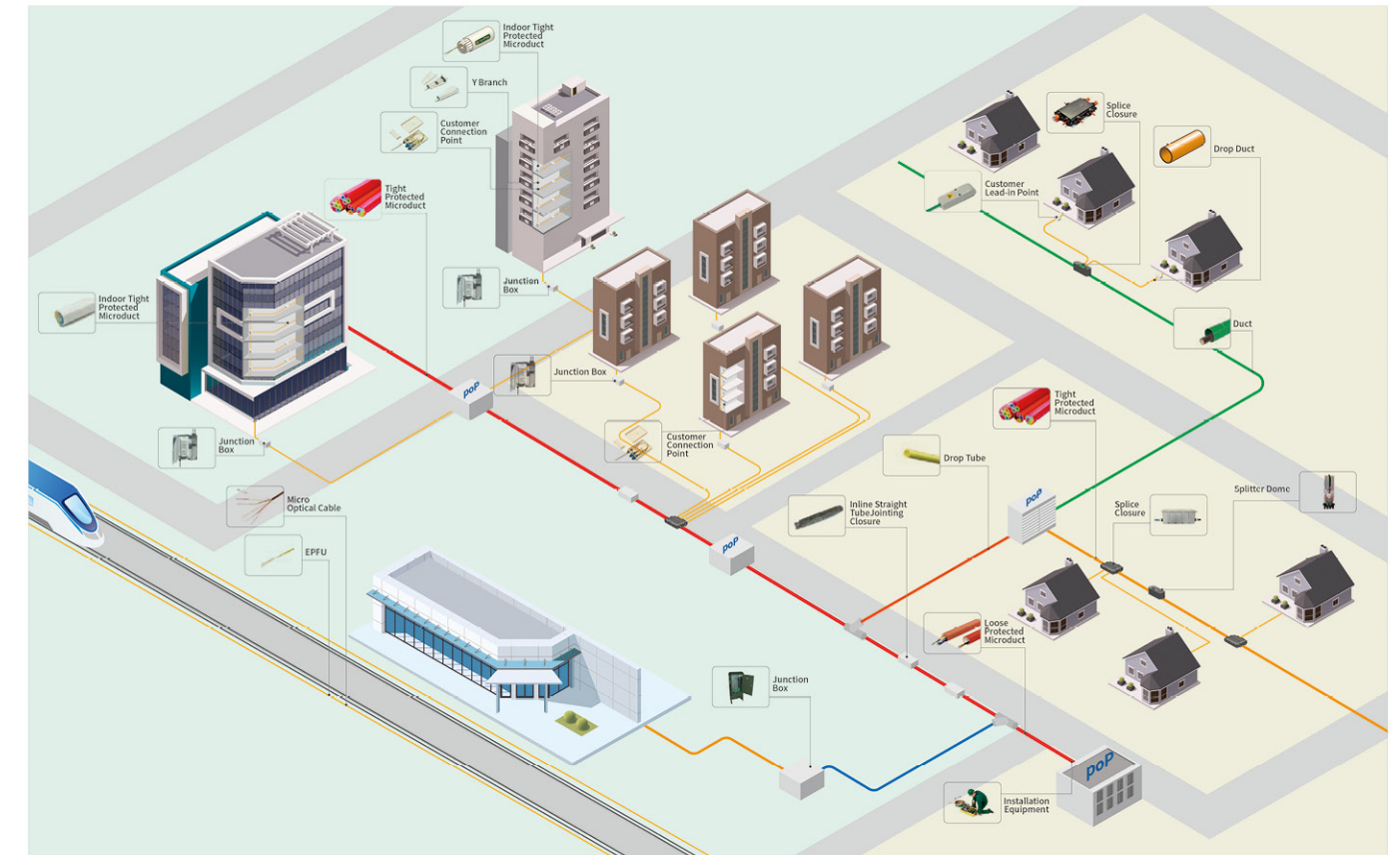
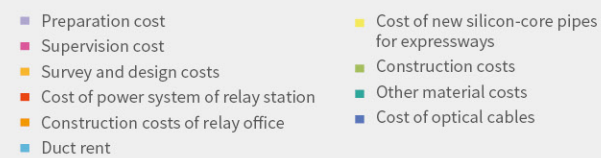
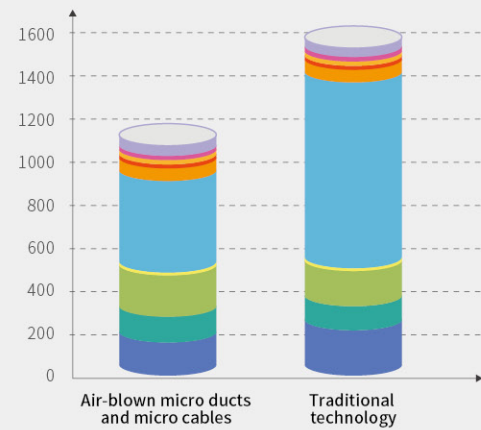
- The technology of air-blown micro duct and micro cable minimizes the sizes of cables, ducts and accessories, which can fully exploit duct space and save construction cost.

2. It reduces construction costs and thus increases economic benefits

- Compared with the traditional ways of deploying cables, construction cost with this technology is low. Thus duct rent can be reduced remarkably and the management interface can be defined clearly. It is the best technology for collaborative construction and sharing of resources.

3. It allows more flexible network construction

- Air-blown micro duct and micro cable are applicable to the whole FTTx network. They require only one-time installation in the feeder segment and can be branched at the drop section on customers' demands. Complex procedures like splicing of traditional cables are avoided, thus allowing much more flexible network construction.



Advantages of YOFC's Air-blown Micro Duct and Micro Cable Solutions

Advantages

- YOFC is capable of the design and construction the technical support for air-blown solutions for all-optical networks. It has Class B qualification for system integration of communication information network.
- YOFC can provide the full range of micro ducts and micro cables (2~576F)
- YOFC can provide construction equipment and relevant accessories for air-blown micro ducts and micro cables
- YOFC can provide customized products
- YOFC has rich engineering experience in many successful cases
- YOFC is able to conduct comprehensive performance tests and trainings on air-blown micro ducts and micro cables

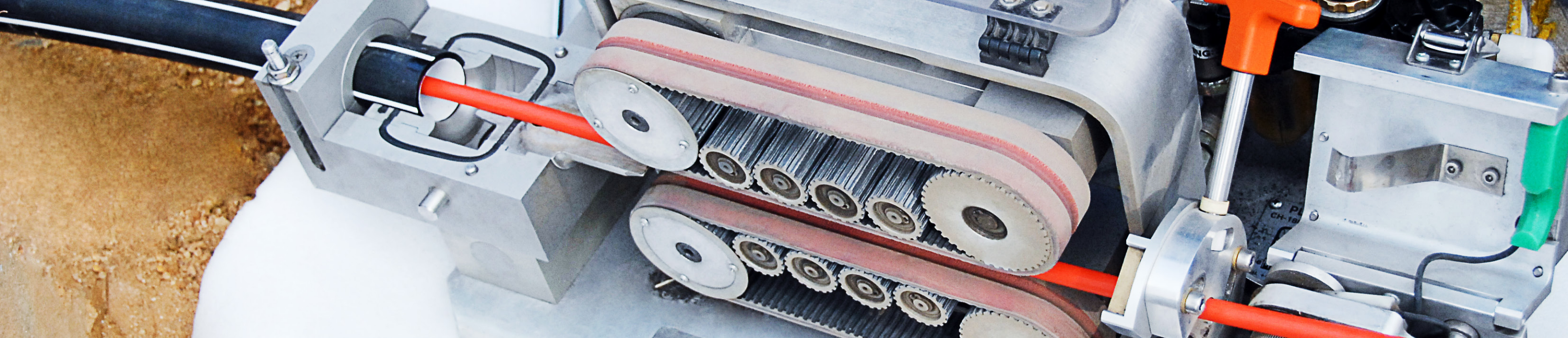
Abilities of Design and Construction and Construction Qualification

- The company is qualified for business activities including the planning and design of master plans of communication information network construction, provision of and selection of models of equipment, software development, implementation of project and guarantee for operation at the later stage of project, etc.
- The company is capable of undertaking the projects of system integration of telecommunication networks and supporting networks of communication around the world, with the investment amount of no more than RMB 20 million Yuan for each
- The company has comprehensive abilities of the design and construction of air-blowing solutions for backbone network (BN), metropolitan area network (MAN), access network (AN) and special applications



Full Range of Micro Ducts and Micro Cables

- The company has production lines of micro ducts and micro cables, which are completely imported with high precision
- The company has carried out deep study on mass production technology and product structure of micro ducts and micro cables for many years
- Micro cables have been certified by Telcordia
- Full range of micro ducts and micro cables are available
 - Enhanced Performance Fibre Units (EPFU)
 - Uni-tube Micro-duct Air-blown Cable (GCYXFTY)
 - Stranded Loose Tube Micro-duct Air-blown Cable (GCYFY)
 - Down Sized Stranded Loose Tube Micro-duct Air-blown Cable
 - Air-blown micro ducts
 - Air-blown bundled micro ducts
 - Auxiliary tools for air blowing
- The company cooperates with the first-class international partners including HAWE, Dueland[dura·line], Plumett



Strong Construction Ability

- The company has rich construction experience and excellent performance in air-blown micro ducts and micro cables
- The company possesses professional technicians and complete air-blowing equipments
- The company provides comprehensive technical service and training for air-blown micro ducts and micro cables

Numerous Successful Cases

- Broadband project in New Zealand
- Domestic partners: China Telecom, China Mobile, China Unicom
- International customers all over the world: Singapore, Indonesia, Malaysia, South Korea, Philippines, Denmark, Africa, South America, etc.

Comprehensive Performance Tests and Trainings

- It is a partner of China Telecommunication Technology Labs
- It is able to conduct comprehensive performance tests required by IEC and YD/T

Air-blowing Sites Meeting Different Standards

- It is a partner of China Telecommunication Technology Labs
- It is able to conduct comprehensive performance tests required by IEC and YD/T



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Product Series – Air-blown Micro Cables

Enhanced Performance Fibre Units (EPFU)

Optical fibres and filler elements are arranged in a certain configuration in UV-curable resin covered by an extruded special low friction sheath.

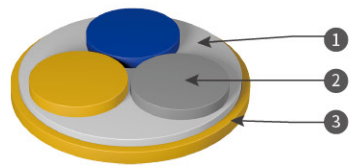
Characteristics

- Easy to install, and compatible with standard air-blowing equipments
- Using bending insensitive fibres, suitable for indoor deployment small bending radius
- Unique sheath design, ensuring good air blowing performance
- Small diameter and light weight, suitable for FTTx

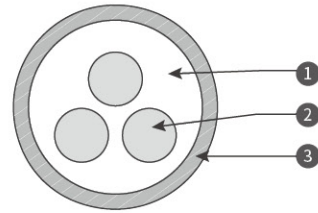
Applications

- In a FTTH network, it can be used as drop optical cable that is air blown with a handheld jetting machine from indoor distribution box to access point for subscriber.

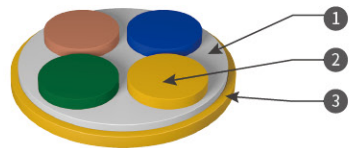
- ① Resin
- ② Optical Fibre
- ③ Low Friction Sheath



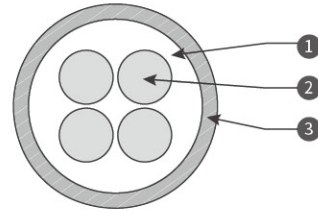
EPFU-2B6a2



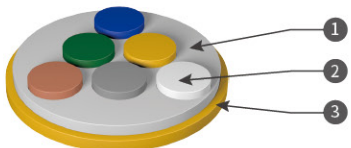
- ① Resin
- ② Optical Fibre
- ③ Low Friction Sheath



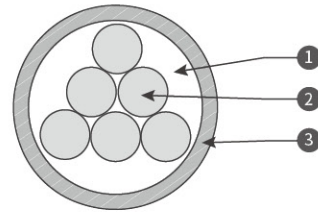
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- ① Resin
- ② Optical Fibre
- ③ Low Friction Sheath



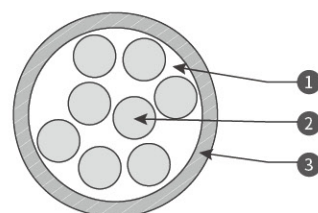
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- ① Resin
- ② Optical Fibre
- ③ Low Friction Sheath



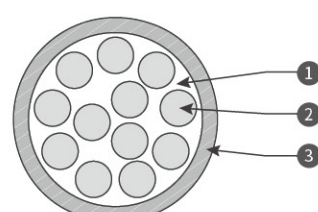
EPFU-8B6a2



- ① Resin
- ② Optical Fibre
- ③ Low Friction Sheath



EPFU-12B6a2



Technical Characteristics

Type	2F	4F	6F	8F	12F
O.D. of cable (mm)	1.1	1.1	1.3	1.5	1.6
Cable weight (Kg/km)	1.0	1.0	1.3	1.8	2.0
Tensile strength (N) Long/short term	0.3G/1G				
Crush resistance (N/100mm) Long/short term	50/100				
Applicable to micro ducts(mm)	5.0/3.5				
Typical blowing distance (m)	800				
Transport/storage/use temperature	-40°C ~ +70°C				
Installation temperature	-5°C ~ +50°C				

Note: G is the weight of optical cable per km.

Color arrangement of fibres

Color arrangement of fibres	1	2	3	4	5	6	7	8	9	10	11	12
	Blue	Orange	Green	Brown	Grey	White	Red	Black	Yellow	Violet	Pink	Aqua

Filler elements should be in natural color. Color arrangement can be customized.

Delivery Length

- Recommended length: 1/2/3km; other lengths are also available on customers' demands.

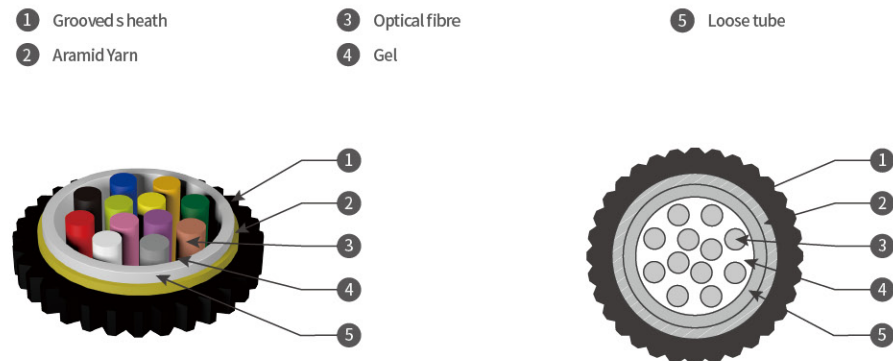
Uni-tube Micro-duct Air-blown Cables (GCYFXTY)



Optical fibres are contained in a loose tube made of high-modulus material. The tube is filled with non-toxic, water-blocking compound, wrapped with aramid yarns as needed, and finally covered by an extruded sheath with low friction coefficient.

Characteristics

- Small size, light weight, proper rigidity, easy to be bent during air blowing, easy for operation
- Totally non-metallic structure, no need to be earthed
- Optical cables can be blown by phases as communication demands rise, allowing investment step by step and reducing initial investment
- Micro cables can be blown out and replaced with new types of optical cables, to keep technical superiority
- Suitable for construction in crowded MAN ducts, destructive excavation avoided
- No need to determine positions of cable joint boxes and terminal boxes in advance. The outer protective duct and micro ducts contained in it can be cut anywhere anytime for cable branching without impact on other optical cables, reducing the number of manholes, hand holes and joints and thus reducing overall cost.



Technical Characteristics

Type	2F	4F	6F	8F	12F	24F
O.D. of cable (mm)	2.3	2.3	2.3	2.3	2.3	2.6
Cable weight (Kg/km)	4.5	4.5	4.5	4.5	4.5	6
Tensile strength (N) Long/short term	0.15G/0.5G					
Crush resistance (N/100mm) Long/short term	150/450					
Applicable to micro ducts(mm)	5/3.5					
Typical blowing distance (m)	≥1000					
Transport/storage/use temperature	-20°C ~ +70°C					
Installation temperature	-5°C ~ +50°C					

Note: G is the weight of optical cable per km.

Color arrangement of fibres

Color arrangement of fibres	1	2	3	4	5	6	7	8	9	10	11	12
	Blue	Orange	Green	Brown	Grey	White	Red	Black	Yellow	Violet	Pink	Aqua

Filler elements should be in natural color. Color arrangement can be customized.

Applications

- In a FTTH network, it can be used as optical cable air blown to connect cable branching point with access point for subscriber in the distribution segment. It can also be used in BN, MAN and AN.

Delivery Length

- Recommended length: 1/2/3km; other lengths are also available on customers' demands.

Stranded Loose Tube Micro-duct Air-blown Micro Cables (GCYFY)



A non-metallic central strength member is adopted without any armor. This kind of micro cable may be deployed by pulling or air blowing a micro duct in an existing outer protective duct and then air blowing the micro cable into the micro duct. It breaks the limitation of the existing duct cable installation techniques, improved duct utilization, and makes capacity expansion easy.

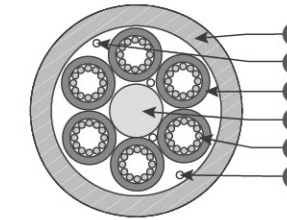
Characteristics

- Small size, light weight, proper rigidity, easy to be bent during air blowing, easy for operation
- Totally non-metallic structure, no need to be earthed; the low friction sheath material and proper structural design allow a long air blowing distance
- Allowing full use of duct resources; fast speed of air-blowing deployment; long blowing distance
- Optical cables can be blown by phases as communication demands rise, allowing investment step by step and reducing initial investment
- Micro cables can be blown out and replaced with new types of optical cables, to keep technical superiority
- Suitable for construction in crowded MAN ducts, destructive excavation avoided
- No need to determine positions of cable joint boxes and terminal boxes in advance. The outer protective duct and micro ducts contained in it can be cut anywhere anytime for cable branching without impact on other optical cables, reducing the number of manholes, hand holes and joints and thus reducing overall cost.
- Suitable for BN, MAN and AN

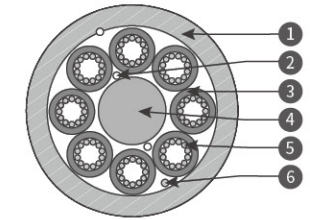
- 1 PE Outer Sheath
- 2 Water Blocking Yarn

- 3 Loose Tube
- 4 Central Strength Member

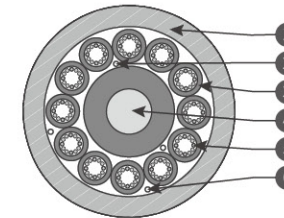
- 5 Fibre and Filling Compound
- 6 Ripcord



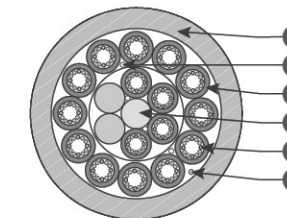
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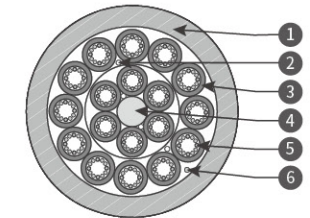
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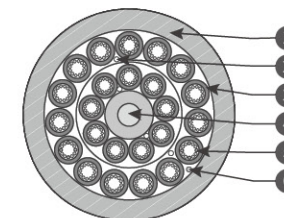
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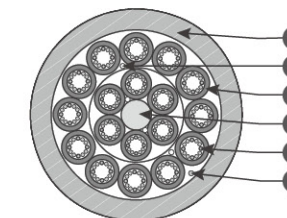
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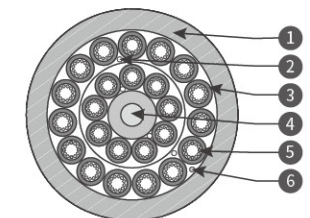
GCFY-216B1.3



GCFY-288B1.3



GCFY-432B1.3-24F/T



GCFY-576B1.3-24F/T

Technical Characteristics

Type	12/24/36	24/48/72	96	144	192	216	288	144	192	288	432	576
Fibre count per tube	6	12	12	12	12	12	12	24	24	24	24	24
Number of tubes	2/4/6	2/4/6	8	12	16	18	24	6	8	12	18	24
O.D. of cable (mm)	4.5	5.4	6.1	7.9	7.9	7.9	9.3	7.3	8.8	11.4	11.4	13.4
Cable weight (Kg/km)	16	26	36/29	52	52	52	80	42	76	110	105	140
Max. tensile force (N)	200	600	800	800	600	600	1000	800	1000	1200	800	1200
Tensile strength (N) Long/short term	0.3G/1.0G											
(N/100mm) Crush resistance (N/100mm) Long/short term	150/500											
Applicable to micro ducts(mm)	6/8	8/12	8/12	10/14	10/14	10/14	12/14	10/14	12/16	14/16	14/16	16/20
Typical blowing distance (m)	≥1200											
Transport/storage/use temperature	-40°C ~ +70°C											
Installation temperature	-5°C ~ +50°C											

Note: G is the weight of optical cable per km.

Color arrangement of fibres

Color arrangement of fibres	1	2	3	4	5	6	7	8	9	10	11	12
		Blue	Orange	Green	Brown	Slate	White	Red	Black	Yellow	Purple	Pink
Color arrangement of tubes	13	14	15	16	17	18	19	20	21	22	23	24
		Blue with black ring	Orange with black ring	Green with black ring	Brown with black ring	Slate with black ring	White	Red with black ring	White with black ring	Yellow with black ring	Purple with black ring	Pink with black ring

Color arrangement can be customized.

Applications

- In a FTTH network, it can be used as drop optical cable air blown to connect cable branching point with access point for subscriber in the feeder segment. It can also be used in BN, MAN and AN.

Delivery Length

- Recommended length: 1/2/3km; other lengths are also available on customers' demands.

Down Sized Stranded Loose Tube Micro-duct Air-blown Optical Cable (with YOFC's EasyBand® Plus-Mini Fibre)

The same structure as stranded loose tube air-blown micro cables is adopted. EasyBand® Plus-Mini 200µm fibres are used, which are bending insensitive. Thus the cable diameter is smaller and the fibre density is higher, compared with stranded loose tube air-blown micro cables with same fibre counts.

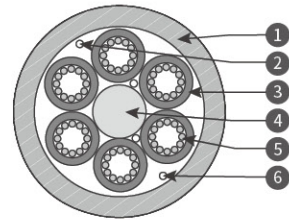
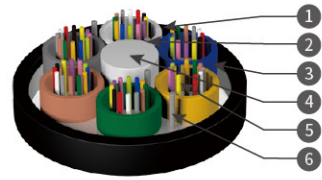
Characteristics

- Small size, light weight; smaller cable diameter and higher fibre density, compared with stranded loose tube air-blown micro cables with same fibre counts
- Totally non-metallic structure, no need to be earthed
- Allowing full use of duct resources; fast speed of air-blowing deployment; long blowing distance
- Optical cables can be blown by phases as communication demands rise, allowing investment step by step and reducing initial investment
- Micro cables can be blown out and replaced with new types of optical cables, to keep technical superiority
- Suitable for construction in crowded MAN ducts, destructive excavation avoided
- No need to determine positions of cable joint boxes and terminal boxes in advance. The outer protective duct and micro ducts contained in it can be cut anywhere anytime for cable branching without impact on other optical cables, reducing the number of manholes, hand holes and joints and thus reducing overall cost.
- Suitable for BN, MAN and AN

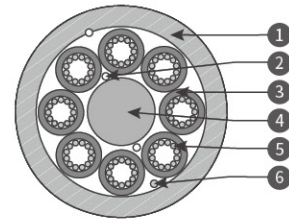
- 1 PE Outer Sheath
- 2 Water Blocking Yarn

- 3 Loose Tube
- 4 Central Strength Member

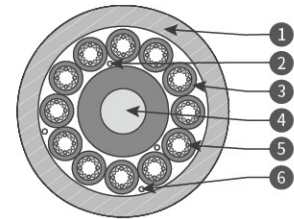
- 5 Fibre and Filling Compound
- 6 Ripcord



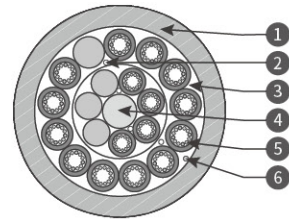
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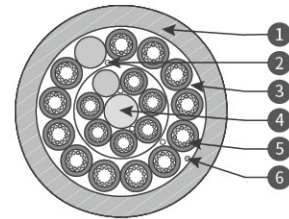
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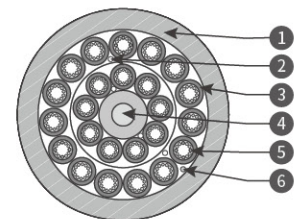
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GCFY-288B1.3



GCFY-432B1.3-24F/T



GCFY-576B1.3-24F/T

Technical Characteristics

Type	24	48	72	96	144	192	216	240	288	144	192	240	288	432	576
Fibre count per tube	12	12	12	12	12	12	12	12	12	24	24	24	24	24	24
Number of tubes	2	4	6	8	12	16	18	20	24	6	8	10	12	18	24
O.D. of cable (mm)	4.5	4.5	4.5	5.6	7.2	7.8	7.8	7.8	8.1	6.2	7.2	8.1	9.3	9.6	11.2
Cable weight (Kg/km)	16	16	16	26	43	48	48	48	58	32	48	58	80	78	110
Max. tensile force (N)	200	200	200	800	800	800	800	800	800	800	1000	800	1000	800	1200
Tensile strength (N) Long/short term	0.3G/1.0G														
(N/100mm) Crush resistance (N/100mm) Long/short term	150/500														
Applicable to micro ducts(mm)	6/8	6/8	6/8	8/10	10/14	10/14	10/14	10/14	10/14	8/14	10/14	10/14	12/16	12/16	14/16
Typical blowing distance (m)	≥1200														
Transport/storage/use temperature	-40°C ~ +70°C														
Installation temperature	-5°C ~ +50°C														

Note: G is the weight of optical cable per km.

Color arrangement of fibres

Color arrangement of fibres	1	2	3	4	5	6	7	8	9	10	11	12
	1	Blue	Orange	Green	Brown	Slate	White	Red	Black	Yellow	Purple	Pink
Color arrangement of tubes	13	14	15	16	17	18	19	20	21	22	23	24
	Blue with black ring	Orange with black ring	Green with black ring	Brown with black ring	Slate with black ring	White	Red with black ring	White with black ring	Yellow with black ring	Purple with black ring	Pink with black ring	Aqua with black ring
Color arrangement of tubes	1	2	3	4	5	6	7	8	9	10	11	12
	Blue	Orange	Green	Brown	Slate	White	Red	Black	Yellow	Purple	Pink	Aqua

Color arrangement can be customized.

Applications

- In a FTTH network, it can be used as drop optical cable air blown to connect cable branching point with access point for subscriber in the feeder segment. It can also be used in BN, MAN and AN.

Delivery Length

- Recommended length: 1/2/3km; other lengths are also available on customers' demands.



Product Series – Air-blown Micro Ducts

Air-blown Micro Ducts

Micro ducts are an important part of air-blown micro duct and micro cable systems. The air-blowing process is to manually pull or air blow micro ducts into an outer protective duct and then to air blow micro cables into the micro ducts. This method can improve duct utilization remarkably and allows more flexible deployment ducts. Micro cables may be not installed in the initial phase but be deployed before use with the proper fibre counts as needed, thus reducing initial investment and improving network structures as needed. Micro ducts can provide protection for micro cable network systems from backbone lines to subscribers. The outer layer of a micro duct is made of HDPE while its inner layer is made of low friction silicon material. The inner walls of micro ducts are of two kinds, i.e., the wall with smooth surface and the wall with guide grooves.

Characteristics

- Small size, outer diameter of 5mm~16mm; existing ducts containing cables may be used
- At most 576F micro cable may be installed in a single micro duct, thus reducing cost and time of duct construction
- Waterproof feature allows quick cleaning of dirt in micro ducts, facilitating air blowing of micro cables
- Made of elastic HDPE, micro ducts could be bent without special tools. Continuous routing reduces losses at joints
- Excellent low-temperature performance allows installation at low temperatures and provides protection for micro cables in a long distance in outdoor environment
- Persistent route is available, making the maintenance and upgrading of micro cables easy in the future

Technical Characteristics

Type	5/3.5	7/3.5	7/5.5	8/6	10/8	12/8	12/10	14/10	14/12	16/14
O.D. (mm)	5.0	7.0	7.0	8.0	10.0	12.0	12.0	14.0	14.0	16.0
Min. I.D. (mm)	3.4	3.4	5.4	5.9	7.9	7.9	9.9	9.9	11.9	13.9
Min. wall thickness (mm)	0.65	1.65	0.65	0.9	0.9	1.9	0.9	1.9	0.9	0.9
Allowable internal pressure	1.2MPa									
Friction coefficient of inner wall	≤0.1									
Transport/storage temperature	-20°C ~ +60°C									

Air-blown Bundled Micro Ducts

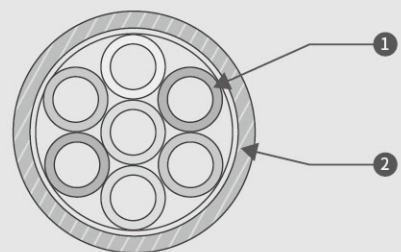
Bundled micro ducts are a bundle of micro ducts assembled together in an outer protective duct, providing multiple routes. Micro cables can be blown into or out of any individual micro duct for network upgrading without any additional routing cost. It can increase the number of micro ducts contained in each protective duct and maximize the fibre count in the limited space. After bundled micro ducts are directly buried in or blown/pulled into the protective duct, micro cables could be blown into each micro duct as needed. Bundled micro cables are widely used in FTTx, MAN and BN.

Characteristics

Conventional bundled micro ducts

- Bundled micro cables are covered with PE outer sheath when being delivered from the factory. Typical configurations include 7 holes, 4 holes, 3 holes and 2 holes, etc.
- Multiple routes can be installed once and for all, reducing installation cost
- Transportation on standard reels available
- Bundled micro ducts are installed with the same equipment and tools as those used for traditional ducts. without special requirements
- Multiple routes are available for capacity expansion in the future

1 Micro duct 2 Outer sheath



Flame-retardant bundled micro ducts

- Flame-retardant LSZH is used
- Available from 1.91 to 7.62cm
- Flame-retardant (UL94 V-0)
- Low smoke generation improves visibility during fire
- No halogen, safe for use
- Acid resistant and oxidation resistant, reducing safety hazards for equipment and people



Flat-shape bundled micro ducts

- Multiple micro ducts lined up and covered with a thin HDPE layer. It is easy to separate each micro duct. Typical configurations include 6 holes, 4 holes and 2 holes
- The flat shape makes installation easy in narrow slots. This product can also be deployed by means of trending, burying and shallow horizontal trenches
- The transport volume of excavated earth is reduced, good for recovery of traffic interruption
- The same equipment and tools as those used for traditional ducts are used without special tools



Conventional bundled micro ducts

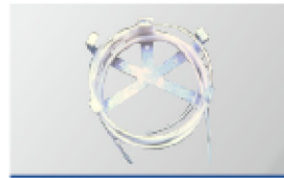
Technical Characteristics

Type	2×5/3.5	2×10/8	4×5/3.5	4×7/3.5	4×10/8	4×12/10	7×5/3.5	7×7/3.5	7×10/8	7×12/10	7×14/10	12×5/3.5	12×7/3.5	19×5/3.5	24×5/3.5	24×7/3.5
O.D. (mm)	12	22×12	12×12	16×16	22×22	32×26	17	23	32	42	42	28×26	29.6×26.8	27	30	42
Min. wall thickness (mm)	1.0	1.0	1.0	1.0	1.0	4.0	1.0	1.0	1.0	3.0	3.0	4.0	1.0	1.0	1.0	1.0
Min. wall thickness (mm)	240	440	240	320	440	840	340	460	640	840	840	266	592	540	600	800
Allowable internal pressure	1.38Mpa															
Friction coefficient of inner wall	≤0.1															

Product Series – Auxiliary Tools for Air-blowing



Adjustable hose



Trestle for micro duct reservation



Branching support



Air-blown micro duct



Micro duct holder



Puller



Micro duct bending holder



Splice closure



Water block connector



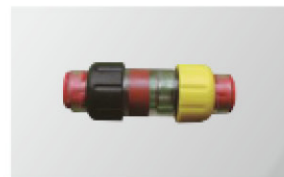
End cap



Reducer



Straight connector



Water block connector A



Gas block connector

Product Series – Construction Equipment for Air-blowing

Road Trencher – Model 1

- Road trenchers are mainly used to dig trenches on the surface of asphalt roads, cement roads and large-area sites.

Item	Fuel tank	Trenching width	Trenching depth	Cutter assembly
Parameters	25L	0.8~5cm	5cm at the maximum	30.5cm, equipped with 6 hardalloy cutters



Road Trencher – Model 2

Type	Trencher	Engine model	KOHLER CH730S
Rated power	25HP	Rated speed	3600r/min
Machine weight	260kg	Dimensions	1800×850×960mm



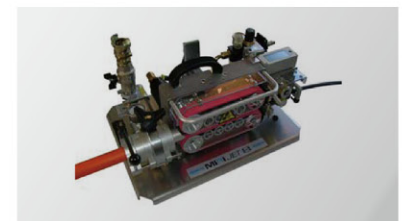
Jetting machine for micro ducts

- Cables can be blown inside of the HDPE micro ducts with long distance and a speed if 40m/min.

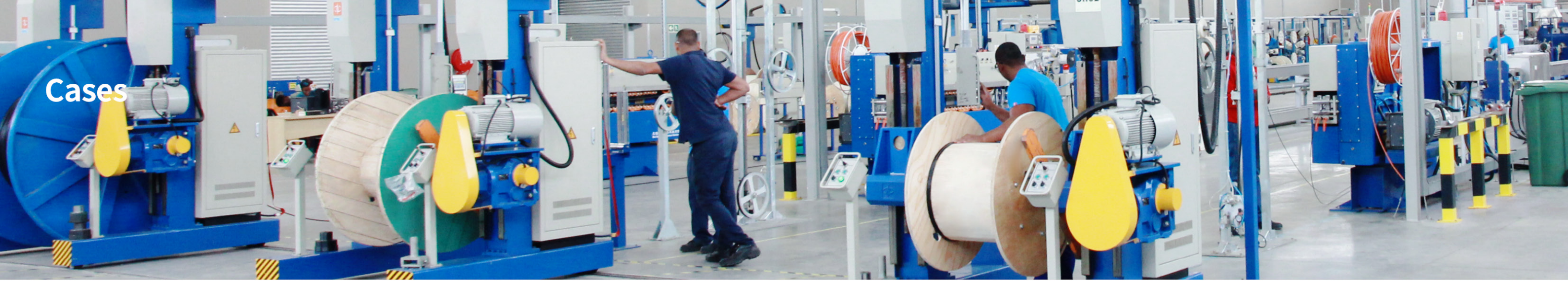


Jetting machine for micro cables

- Air blowing 288F micro cables into 14/12mm micro ducts
- Air blowing 216F micro cables into 12/10mm micro ducts
- Blowing speed can reach 100m/min at the maximum



Cases



Case of backbone network

- Background: The project is on a highway, with the total length of 206km.
- Implementation method: First, two $\phi 10/8$ micro ducts are air blown into a $\phi 40/33$ silicon duct. Then, a 96F stranded loose tube micro-duct cable and a 48F stranded loose tube micro-duct cable are air blown into the micro ducts respectively.
- Achievements: Multiple optical cables, in the trunk line, have shared one silicon core duct, improving duct utilization and saving construction and operation cost. The success of this case not only provides a solution to meet the demands of existing business, but also proves the feasibility of the micro duct and micro cable technology used for secondary trunk lines.

Case of MAN

- Background: The project is located in an old urban area, where there is a shortage of duct resources.
- Implementation method: First, three $\phi 10/8$ micro ducts are deployed in a $\phi 30/25$ PE duct through manual pulling. Then, a 48F stranded loose tube air-blown cable is air blown into one of the micro ducts.
- Achievements: A solution has been provided to meet the demands of the existing lines for optical fibres in the old urban area, and the space has been reserved for future expansion. Duct utilization has been improved remarkably.

Case of Application on Bridge in MAN

- Background: This project runs across a bridge, with the total length of 3.7km. The distance as long as 1.7km is required for one blowing.
- Implementation method: The length of micro cable per reel used for this project is 4km, to reduce losses at joints. Reservation boxes for micro ducts and micro cables are used, which effectively protect the micro ducts reserved for this project.
- Achievements: The duct construction cost has been reduced remarkably, with increased construction speed, and it is convenient for operators and customers to use the duct resources in the future.

Case of Application for FTTB in access network

- Background: This project is in an old residential area, where the optical cables are required to pass through underground PVC ducts (O.D.: 110mm) and vertical PVC ducts (O.D.: 30mm) going into buildings. Optical cables have already been deployed in some of the ducts, with some right angles and bends.
- Implementation method: Micro ducts with the diameter of 10/8mm are installed in ducts by means of manual pulling directly from 1-3# cross connecting cabinets to the distribution box for each building, and then 12F stranded loose tube air-blown micro cables are blown into the micro ducts. Micro ducts with the diameter of 5/3.5mm are installed in ducts by means of manual pulling directly from other cross connecting cabinets to the distribution box for each building, and then 2F EPFUs are blown into the micro ducts.
- Achievements: Difficulties in the installation have been solved.

Case of Application for FTTH in access network

- Background: This project is a Fibre-To-The-Home project for new residential areas, where the highest building has 15 storeys.
- Implementation method: A 40/33mm silicon core duct is installed by burying from the central office to each building. Eight micro ducts in red and eight in blue with the diameter of 5/3.5mm are pulled manually into the silicon core ducts. After entering the basement of each building, the micro ducts are pulled through the vertical shaft to each storey. Protected with corrugated tubes, the micro ducts are directly led into indoor distribution boxes at homes. The entire work of air blowing is completed in the central office. 1F EPFUs are blown into 5/3.5mm micro ducts.
- Achievements: The FTTH project has been accomplished safely and efficiently.

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This datasheet can only be a reference, but not a supplement to the contract. Please contact our sales people for more detailed information

Annex 1 – FAQ and Solutions



FAQ	Solution
Blocking of outer protective duct	<ul style="list-style-type: none"> • Clean the outer protective duct. For instance, blow sponge balls into the duct, which move along the duct to clear water and dust; detect blocking position and eliminate the blocking.
Unable to blow micro duct	<ul style="list-style-type: none"> • Check whether the jetting machine works normally. • Check whether the accessories of the jetting machine for micro ducts fit the outer protective duct and the micro duct in dimensions and fit the micro duct in quantity.
Insufficient blowing distance	<ul style="list-style-type: none"> • Check whether the outer protective duct is pre-lubricated. • Check whether the outer protective duct is damaged. • Check whether the outer protective duct is clear and clean. • Check whether the micro duct is well sealed. • Check whether the micro duct and the outer protective duct fit each other in dimensions. • Check whether the blowing site is proper. • Check whether the blowing mode is correct.
Slow blowing speed	<ul style="list-style-type: none"> • Check whether the outer protective duct is pre-lubricated. • Check whether the micro duct is well sealed. • Check whether the micro duct and the outer protective duct fit each other in dimensions.
Damage to micro duct during installation	<ul style="list-style-type: none"> • Check whether the route for deployment is correct. • Check whether the operating pressure of the jetting machine is normal. • Check whether the inner pressure of the micro duct is maintained all the time during the blowing process. • Check whether the pushing force of the equipment exceeds the designed tensile strength of the micro duct.

FAQ	Solution
Unable to blow micro cable	<ul style="list-style-type: none"> • Check whether the jetting machine works normally. • Check whether the accessories of the jetting machine for micro ducts fit the micro cable.
Insufficient blowing distance of micro cable	<ul style="list-style-type: none"> • Check whether the micro duct has been subjected to passing-through check and treatment. • Check whether the micro duct is well sealed. • Check whether the micro cable fits the micro duct in dimensions. • Check whether the blowing site is proper. • Check whether the blowing mode is correct.
Slow blowing speed of micro cable	<ul style="list-style-type: none"> • Check whether the micro duct is well sealed. • Check whether the micro cable fits the micro duct in dimensions. • Check whether the jetting machine works normally. • Check whether the micro cable is well sealed at both ends.
Damage to micro cable during installation	<ul style="list-style-type: none"> • Check whether the route for deployment is correct. • Check whether the operating pressure of the jetting machine is normal. • Check whether the pushing force of the equipment exceeds the designed tensile strength of the micro cable.
Signal problems of micro cable	<ul style="list-style-type: none"> • Check whether on-the-reel testing of micro cables has been conducted before installation. • Check whether the micro cable has been damaged during installation. • Check whether the bending radius of the micro cable during the installation is correct. • Check the splicing and branching of the micro cable and the protection for the optical fibres.

Annex 2 – Use of Special Tools



Tools and accessories

- The following tools and accessories may be used for the installation of product series of micro ducts and bundled micro ducts.



Duct cutter



Wheel duct cutter



Micro duct cutter



Longitudinal ripper



Connector for micro duct



Connector for bundled micro duct(long, black)



Connector for bundled micro duct(2)



Connector for bundled micro duct(split connector)

Connection method for micro ducts

Two micro ducts may be connected by the following steps:

- Cut off the excessive length with a micro duct cutter. The end should be perpendicular and neat, without plastic debris.
- Insert one micro duct into one end of a connector for micro ducts. Try to pull it to make sure will not loose off.
- Insert another micro duct into the connector in the same way.



Connection method for bundled micro ducts

1. Peel off the outer sheath of the bundled micro ducts by following the steps below, to reveal the micro ducts in it.

- Cut the outer sheath with a wheel duct cutter.
- Cut the outer sheath with a longitudinal ripper.

Note: Cutting should be carefully conducted to a proper depth that does not damage the micro ducts in it!

Note: The sheath should be ripped longitudinally along the gap between two micro ducts to avoid any damage to the micro ducts. Ripping the sheath twice symmetrically will make it easier to remove the sheath.

- Pull off the outer sheath to reveal the micro ducts.



2.Connect each micro duct as per the steps mentioned in the previous section.

3.Remove screws on the connector and disassemble it.

4.Place the connected micro ducts in the connector, as shown in Figure A. The connections of the micro ducts may be staggered if necessary.

Note: Gaskets should be placed at the positions and in the order as shown in Figure B when connecting.

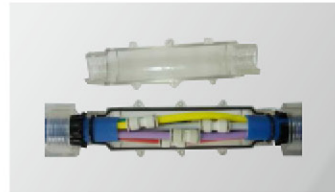


Figure A

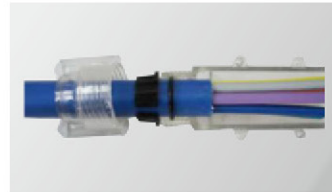
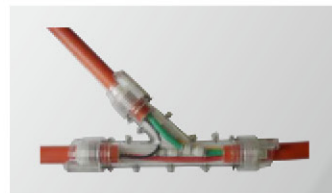


Figure B

5.Mount the screws and nuts to complete the connection.

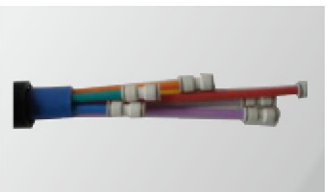
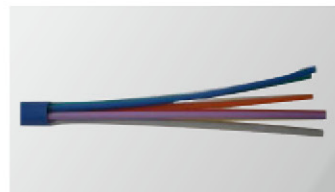
6.Split connectors may be used for branching and connection of micro ducts to meet certain demands. The connection should follow the aforesaid steps.



7.Use of long, black connector

- Remove the outer sheath of the bundled micro ducts with a cutter and a longitudinal ripper.
- Adjust the exposed length of each micro duct, in order to make staggered connections.

- Connect the micro ducts.
- Place the connected micro ducts into the connector.
- Tighten the nuts at the two ends of the connector to finish the connection.



Annex 3 – Instructions for Air-blowing Construction

Preparation requirements

1.Administrative filing and approval for construction

- Relevant filing and approval formalities should be completed in advance according to relevant local laws, regulations and requirements.

2.Construction scheme

- Construction environment and details of landform exploration
- Selection of blowing mode and blowing site in accordance with construction drawings
- Requirements for equipment and materials, and list of items to be prepared
- Working instructions

- Safety measures and emergency plans
- Environmental protection measures and environmental restoration plans
- Transportation specifications and safety measures for equipment and materials

3.Construction materials

- Materials mainly include micro ducts and micro cables. Requirements in the construction scheme should be followed.
- Auxiliary materials: various kinds of connectors and end caps for outer protective ducts and micro ducts; various kinds of splice closures for

micro ducts and micro cables, trestles for duct reservation, labels, blowing lubricant, bottled nitrogen, corrugated tubes and T35 sponge balls, etc.

4.Construction equipment

- Construction equipment mainly include power generator, air compressor, cooler, water separator, jetting machine for micro ducts, jetting machine for micro cables, chemical agent detector, air blower, micro cable storage device, micro duct and micro cable racks, fibre fusion splicer, passing-through device, duct fault detector, steel balls, sponge balls, duct cutters, duct repair clamps, and communication equipment for field construction, such as walkie-talkie, etc.
- Measurement instruments include optical time domain reflectometer, distance meter, caliper, measuring tape and other conventional dimension measurement instruments, etc.

- Safety items include warning signs and fire-fighting equipment on the construction site, etc., personal safety protection articles
- Vehicles and transportation tools used for construction include transportation vehicles for equipment and materials, transportation tools on the site, such as cable trailer and trolley

5. Construction plan, staff allocation and training

- A detailed construction plan and a staff list should be developed.
- Requirements for staff allocation include a clear and effective organization structure, clear division of duties, provision of full-time QC and safety officers, and qualification for special operations.
- All the engineering personnel should read and get familiar with relevant operation instructions and construction plans and be trained

6. Blowing mode

- A proper blowing mode should be selected based on the type of the optical cable/duct to be deployed, the construction environment and the landform.
- Relay mode
 - Multiple jetting machines are placed one after another along the duct, to cover a long distance blowing at one time.
- Intermediate mode
 - Blow to both ends of the route with one jetting machine placed in the middle of the route
 - After blowing the micro cable to one end, use the jetting machine to blow the remaining micro cable from the reel to the cable storage device
 - Find out the inner end of the micro cable and blow it to the other end

7. Selection of blowing site

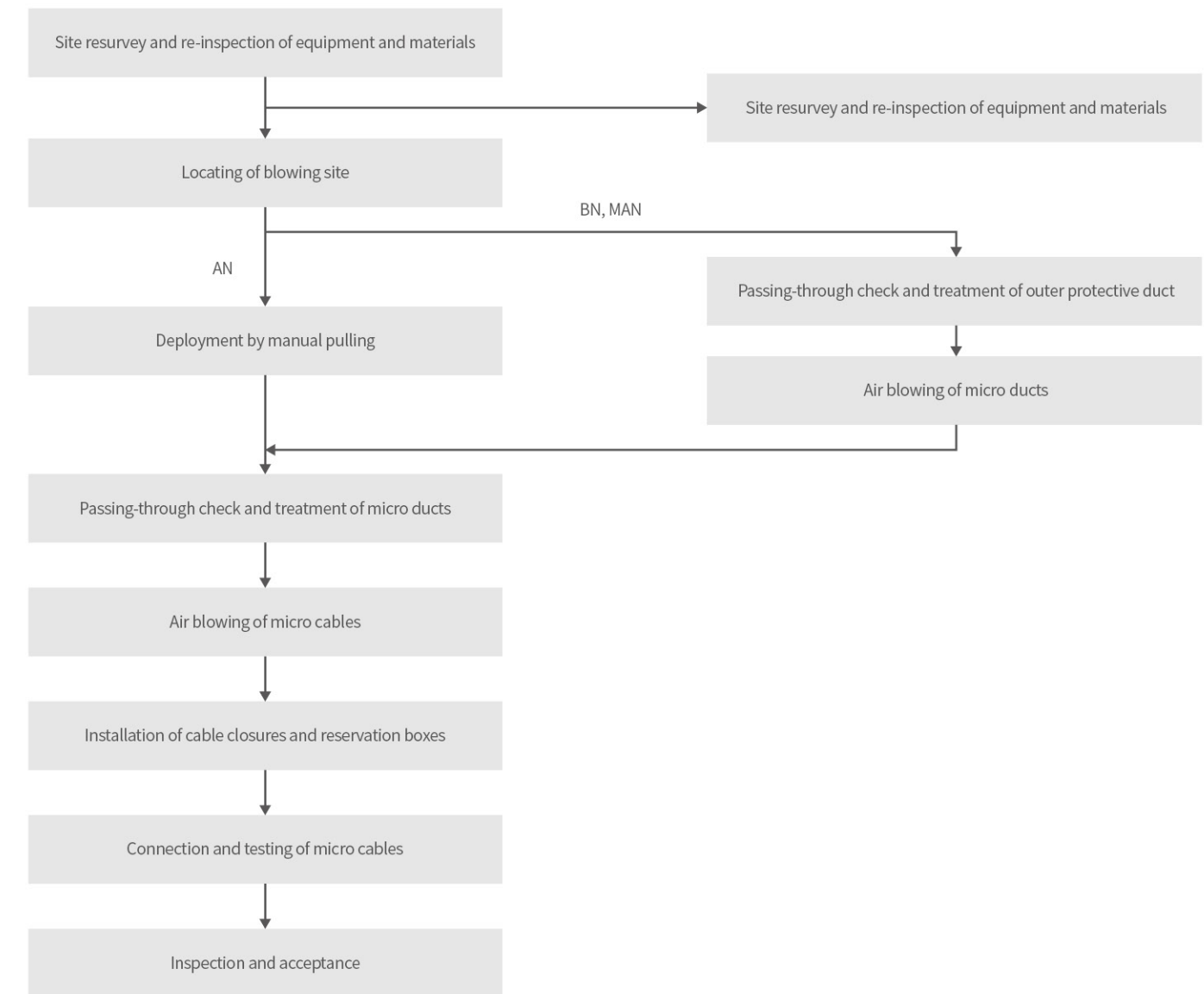
- The selection of the blowing site has direct influence on the feasibility, efficiency and distance of blowing. Factors to be considered include the route situation, duct joints, bends, undulations, the blowing capacity of equipment and deployment conditions.
 - The more bends the duct has, the shorter the max blowing distance is at one time. The blowing site should be close to the bends as much as possible
 - The smaller the bending radius is, the shorter the max. blowing distance is at one time. The blowing site should be close to these with smaller bending radius as much as possible
 - Where the ground elevation varies violently, the jetting machine should be placed at the higher position, so that the cable is blown from the high position to the low position. When the relay mode is adopted, jetting machines should be placed at the position with the intermediate elevation

- before construction when necessary, to make sure they know their jobs well and meet construction requirements.
- Safety training and on-site emergency drills should be carried out in order to guarantee construction safety.

- Leapfrog mode
 - Micro cable is deployed section by section with a jetting machine and a cable storage device, to cover a long distance accumulatively
 - Install the cable storage device downstream to the blowing site, and blow the micro cable directly from the blowing site to the cable storage device
 - Open the cable storage device and take out the micro cable after blowing of the first section
 - Find out the inner end of the micro cable and move the jetting machine to the position where the cable storage device is placed for the first section
 - Put the cable storage device downstream to the next section; start blowing of the next section
 - Repeat the steps above until the deployment of micro cable is finished

- The blowing site should be close to the air compressor, in order to reduce the air loss during transmission.

Workflow



Site resurvey and re-inspection of equipment and materials

1. Site resurvey

- Verify the routes and deployment positions of optical cables on the site according to the construction drawings
- Verify and measure the length of the route
- Verify the length of micro duct/cable per reel and the transportation route
- Verify the blowing site and the positions of jetting machine
- Determine positions of other areas to be constructed on the site
- Modify, adjust and supplement construction drawings according to results of the site resurvey

2. Re-inspection of equipment and materials

- Test run of jetting machine should be conducted to verify its state and functions
- Materials being accepted on the site should meet the requirements of construction design

Inspection of single reel of optical cables

- Open the reel, test fiber attenuation and length with OTDR, fill in testing records and assign a reel number for future use
- Testing data should be checked against the report delivered along with the reel by the manufacturer, and be handed over to the Employer and the Supervision Company for approving with signature
- Testing records and the manufacturer's report should be archived
- The optical cable with proper length should be determined

Locating of blowing site

- Locate and mark the blowing site as per the construction drawings
- Warning signs should be set up on the construction site
- Perform construction according to the requirements of the duct drawings, and clean the site to guarantee the compliance with the blowing requirements

Deployment by manual pulling

- Manual pulling is recommended for the deployment of micro ducts in access network
- Manual pulling imposes relatively small tensile force on the micro duct. The max tension resulting from rapid rotation of the micro duct on the reel and the max tension resulting from the micro duct passing through the outer protective duct should not exceed the tensile strength of the micro duct
- An even pulling speed should be maintained, communication and unified command should be followed, and the operation of the entire team should be in harmony, to avoid excessive tension for the micro duct during pulling
- The speed of the micro duct unloaded from the reel should be in harmony with the speed of manual pulling, to reduce the tension for the microduct

Passing-through check and treatment of outer protective duct

1.Outer protective ducts should be subjected to passing-through check and treatment when micro ducts are deployed by air blowing

3.Cleaning of outer protective duct

- Cleaning of outer protective duct: Blow a sponge ball into the duct to clear water and dust along the duct
- If the sponge ball brings out too much water, it indicates there is water in the duct. Blow the sponge ball repeatedly until water in the duct is fully removed
- If it is unable to blow the sponge ball out, and the pressure on the air filling side is lower than normal air pressure and the air flow at the duct end is small, it indicates severe leak(s) in the duct. First, inspect the sealing of connectors and reconnect

4.Passing-through check of outer protective duct

- The check should be performed to guarantee that the quality of connection and the state of the duct (twisting, blocking and sharp bends, etc.) meet construction requirements of air blowing
- The method is to blow a testing rod (or wooden plug) into the duct by high-pressure air flow with a passing-through device

2.Air tightness testing of outer protective duct

- Where the inner air pressure of the duct reaches 5.5~6.9bar, the pressure drop should be no more than 1.38bar within 2min

the connectors. If the problem is not solved, it indicates damage(s) of the duct. The duct may be repaired as per relevant specifications for silicon core ducts

- If it is unable to blow the sponge ball out and the pressure on the air filling side is higher than normal air pressure, it indicates blocking in the duct or deformation of the duct like crushing. The procedures of passing-through check and treatment should be followed

- If the rod (or plug) is blown out of the duct, it indicates the duct is clear and suitable for air blowing
- If the rod (or plug) is not blown out of the duct and the air flow at the duct end is rather small, it indicates blocking in the duct. The blocking should be located with a duct fault detector and then eliminated

5.Pre-lubrication of the outer protective duct

- Put a sponge ball, with the diameter of which is twice the duct diameter, into the duct
- Inject special lubricant for air blowing in outer protective ducts
- Put another sponge ball of the same size into the duct
- Blow the sponge balls and the lubricant with high-pressure air flow until the sponge balls both come out from the other end of the duct

Air blowing of micro ducts

1.Air blowing should be employed for the deployment of micro ducts in backbone networks and metropolitan area networks

2.Preparation of micro ducts

- Check whether the number of the micro ducts to be blown is in line with the design and the colors meet the identification requirements
- Check whether the inner ends of the micro ducts have been taken out and damaged
- Check whether the length of micro duct per reel meets the requirement of blowing distance
- Check whether there is air pressure in the micro ducts if the micro ducts are delivered in pressurized state
- The micro duct reel should be put close to the blowing site, along a straight line towards the inlet of the jetting machine
- Check whether the accessories of the jetting machine for micro ducts fit the outer protective duct and the micro ducts in outer diameter and fit the micro ducts in quantity
- Check whether the reel stand has been fixed
- Put the micro ducts through the guide of the jetting machine
- Check whether the air filling assembly and air filling valve for micro duct are complete
- Mount sealing end caps at the ends of the micro ducts
- Turn on the air compressor to pump air into the micro ducts; adjust the pressure regulating valve of the air filling assembly to make inner pressure of micro ducts reach 4-6 bars; the air pressure should be distributed over the inner wall of each micro duct evenly; inspect and remove any micro duct with leaks
- After air filling, check the sealing end caps with leak detection fluid (or soap water). If any leak is detected, the end caps should be sealed again
- Arrange the micro ducts in order by length; put the micro ducts into the outer protective duct, with the distance between the ends of every two micro ducts of 30~50cm
- Close the sealing cabin of the jetting machine
- Install a counter and make it zero

3.Basic requirements for air blowing of micro ducts

- In the whole air blowing process, in no case should the pushing force designed exceed the designed tensile strength of the micro ducts
- The inner pressure of the micro ducts should be maintained all the time in the blowing process, to provide resistance to outer pressure
- The micro duct should be pulled out from the top of the reel and a loose curve should be kept without twisting
- An air cooler and a water separator should be used behind the air compressor to keep the air dry and cool when entering the duct
- The blowing speed should be above 30m/min within 1km of blowing distance and no less than 10m/min beyond 1km
- After the deployment of the micro ducts, check whether the micro ducts are deformed. End stop connectors should be installed at the exits of the duct, in accordance with the number of micro ducts. The ends of the micro ducts should also be sealed to avoid water penetration

4.Steps of air blowing of micro ducts

- Inform personnel at the end site of air blowing that the deployment is to be performed; evacuate irrelevant personnel on the site
- Close the air out let valve of the air compressor and the air in let valve of the jetting machine; turn on the air compressor
- Turn on the jetting machine ; adjust the operating pressure of the jetting machine until the micro ducts start to move steadily
- Turn on the air out let valve of the air compressor, and turn on the air inlet valve of the jetting machine slightly, to maintain the air supply pressure at 3~4Bars; observe the moving speed of the micro ducts and the operating pressure of the jetting machine in the blowing process
- The micro ducts in the jetting machine should be in a loose state. Check at any time whether the inner pressure of the micro ducts has dropped
- When the micro ducts are about to reach the end, inform the personnel at that end and lower the blowing speed
- When all the micro ducts come out of the end of the duct with enough length, the personnel at the end should inform the personnel at the blowing site to stop the blowing

Passing-through check and treatment of micro ducts

- Blow a sponge ball into a micro duct to clean it. If the ball is not blown out, it indicates blocking in the duct or deformation of the duct like crushing. Unacceptable micro ducts should be replaced
- Put a steel ball through the micro duct to see if the micro duct deforms during blowing. The diameter of the ball should be 80% of the inner diameter of the micro duct. If the ball cannot run through the micro duct successfully, the micro duct should be replaced
- Put a sponge ball into the micro duct, inject special lubricant for air blowing, and then put another sponge ball into the duct. Blow the balls and the lubricant with high-pressure air flows until the balls come out from the other end of the micro duct

Air blowing of micro cables

1. Basic requirements for air blowing of micro cables

- Static bending radius of a micro cable should be no less than 10 times its O.D. Its dynamic bending radius should be no less than 20 times its O.D. during blowing
- Before air blowing of micro cables, the tensile strength of the micro cables should be figured out through blowing impact test
- In the whole air blowing process, in no case should the pushing force exceed the tensile strength of the micro cables
- The micro cable should be pulled out from the top of the reel and a loose curve should be kept without twisting
- An air cooler and a water separator should be used behind the air compressor to keep the air dry and cool when entering the duct
- After the deployment of the micro cables, check whether the optical fibres are working. The ends of the micro cables should also be subjected to sealing and damp-proof treatment to avoid water penetration

2. Steps of air blowing of micro cables

- Install end caps of micro cables
- Install cable reel (stand with fixing clamps is preferred)
- Proper accessories of the jetting machine should be selected based on the diameters of micro cables and micro ducts
- Check the airflow output and output pressure of the air compressor
- Insert the micro cable into the micro duct; close the sealing cabin of the jetting machine; make the counter zero
- Close the air out valve of the air compressor and the air in valve of the jetting machine

3. Running back of micro cables during air blowing

- Where the length of micro cable per reel exceeds the blowing distance, or the intermediate mode or leapfrog mode is adopted, the micro cable should run back at the blowing site or from a position downstream to the blowing site
- Since there is no enough protection for micro cables, which are softer and thinner than conventional optical cables, the

- running back of micro cables should be carefully handled to avoid damages
- Safety and the quality of the running back operation should be strictly controlled. A special micro cable storage device should be used for the running back of micro cables

Auxiliary protection for micro ducts, micro cables and splice closures

1. Protection for micro ducts and micro cables

- After the deployment of micro ducts and micro cables, effective protection should be provided for the connections in manholes (hand holes)
- To provide protection for connections in a manhole, the reserved length of micro cable at the inlet and that at the outlet should be in line with design specifications. When such protection is needed in a hand hole, the micro cable should be reserved according to design specifications
- The reserved micro ducts and micro cables should be coiled up and hung on the inner wall of the manhole properly, to avoid water and steps
- All the micro ducts and micro cables that pass through connections in a manhole must not be exposed in the manhole. Overall protection with corrugated tubes is recommended

2. Installation of corrugated tubes

- If corrugated tubes are to be installed on the wall of a manhole (hand hole), the wall should be levelled appropriately
- Screws used to fix corrugated tubes should be spaced no more than 500mm apart from each other
- Corrugated tubes should be closely connected to the outer protective duct for waterproof purpose in handhole

3. Installation of splice closures for micro cables

- Micro ducts and micro cables should be connected to splice closures respectively
- Micro ducts and micro cables should be sealed against each other, to avoid the flowing of muddy water from any broken micro ducts into the splice closure

4. Installation of protection boxes for micro ducts and micro cables

- Protection boxes should be used to protect the reserved micro cables in manholes/hand holes in an access network or a MAN
- Protection boxes installed in manholes/hand holes should be integrated with the ducts, to reduce the space used for micro cables
- Safety of the line and convenient maintenance should be guaranteed. The chance of damaging micro cables when operators are doing work in manholes again should be reduced

5. Installation of protection cabinets for micro ducts and micro cables

- Protection cabinets should be used to protect connections of micro cables and reserved micro cables in manholes
- Outer protective ducts should be fixed with the connecting parts at the inlet and the outlet of a protection cabinet and should be integrated into the duct system

6. Installation of reservation boxes for micro cables

- Connection of micro ducts should be carried out in the reservation boxes for micro cables
- The reserved length of micro cable in a reservation box should meet future requirements

Connectors and protection of micro ducts

- The connectors are plug type used to connect micro ducts. Typical types include reducing connectors and straight connectors
- Check whether the connections of micro ducts are smooth before operation. Cut the micro ducts neatly with special cutting tools
- When a micro duct is being plugged straight into a connector, the micro duct should be parallel to the end of the connector, and installed properly
- After the installation of micro ducts, the micro ducts should be blocked up with end stop connectors to keep dirty water way
- After the blowing of micro cables, the micro ducts should be blocked up with end caps

Connection and testing of micro cables

- Connection and branching of micro cables and protection of optical fibre connections should be performed in splice closures for micro ducts and micro cables
- Micro cables should be deployed to planned connecting positions with the specifications, routing and ends in line with design requirements
- Micro cables should be reserved at connecting positions as per design specifications
- Before the connection of micro cables, water block connectors should be installed properly and be sealed and tightened
-Refer to design specifications

Provisions on construction safety

- Construction safety measures as required in the construction plan should be strictly followed
- Safety supervisors should intensify patrol in the construction process in order to detect potential safety hazards in time and should take corrective measures promptly
- Warning lines should be set up in construction areas, where persons who are not professional construction personnel should not enter without permit
- Maintenance of equipment should be performed strictly in accordance with requirements to guarantee the safety and reliability of their working conditions. The requirements and procedures in operation instructions should be strictly followed
- Warning cones should be placed around the air compressor to warn those vehicles passing by
- Warning cones should be used before the operation pit is backfilled
- No body is allowed to stand at the end of a duct and the personnel on duty should keep a certain distance from the end when air blowing is being conducted
- When a jetting machine is working, hands should be away from the driving part
- When an air compressor is being used, it should be placed far away from any manholes
- Before the pressure disappears, it is not allowed to open any connectors and passing-through devices
- In the construction, operators should wear personal safety articles, such as helmets, safety gloves, safety shoes and goggles, etc.