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Selection of FTTH Optical Cable

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Abstract: This paper introduces the characteristics and main technical parameters of several kinds of optical cables suitable for FTTH use, including the general bow-type optical cable, small size and low friction bow-type optical cable, round drop optical cable and FTTH air blown optical cable, and gives some suggestions on the application of these optical cables.

Key words: FTTH, bow-type optical cable, low friction, round drop optical cable, air blown FTTH

I. Introduction

FTTH (Fibre To The Home) refers to the access mode that connects the communication central office and the home only by optical fibre medium. The FTTH drop optical cable refers to the optical cable led from the optical cable distribution box to the in-house optical cable terminal facilities that is exclusively owned by a single household. The FTTH optical cable route consists of indoor optical cable, optical cable terminal facilities and auxiliary facilities for indoor optical cable laying, such as PVC conduits.

In the recently issued two national standards of *Code for Design of Communication Engineering for Fibre To The Home in Residential Districts and Residential Buildings* and *Code for Construction and Acceptance of Communication Engineering for Fibre To The Home in Residential Districts and Residential Buildings*, mandatory provisions on the implementation of Fibre To The Home are made for the first time. The implementation of these national mandatory standards will further promote the construction of China's Fibre To The Home Project, and will bring tremendous business opportunities to the manufacturers of communication infrastructure.

As an important route product in the construction of FTTH network, the FTTH optical fibre is always valued by many optical cable manufacturers. After years of development, at present, there are many kinds of optical cables suitable for FTTH engineering construction in the market. They have their own advantages and disadvantages, and different applicable scenarios. For most of the time, due to wrong optical cable type selection for different laying scenarios, communication operators encounter many problems in the use of these FTTH optical cables, which brings greater risks for the future stable operation of the network. From the perspective of application, this paper introduces the performance characteristics and application scenarios of several widely used optical cables in the market, in order to promote the standardized application of FTTH optical cables and better serve the construction of the FTTH Project.

II. Features and Application of FTTH Bow-Type Optical Cable

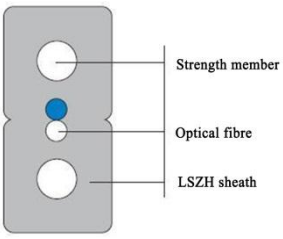
2.1 Introduction to FTTH Bow-Type Optical Cable

FTTH bow-type optical fibre cable (commonly known as rubber covered optical cable). The bow-type optical cable for FTTH users usually contains 1~4

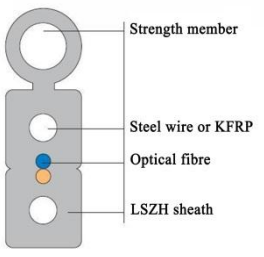
coated silica optical fibres of ITU-T G.657(B6). The coating of the optical fibres can be colored and the color of the colored coating can be blue, orange, green, brown, gray, white, red, black, yellow, purple, pink or aqua that conform to the regulations of GB 6995.2. The single-core optical cable can be its natural color.

The strength member in the optical cable can be metal strength members of high strength stainless steel wire or phosphatized steel wire, or non-metal composite strength members. There are two strength members in the optical cable, which are placed in parallel and symmetrically in the optical cable sheath.

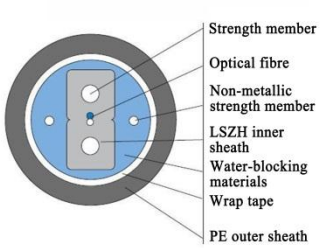
Low smoke zero halogen materials shall be used for the sheath of the indoor bow-type optical cable to meet the indoor cabling requirements of environment protection and flame-retardant. The FTTH bow-type optical cable for outdoor use shall meet the requirements of water-blocking for total cross-section of the optical cable, and the structural drawings of several typical FTTH bow-type optical cables are shown in Figure 1



a. Indoor cabling type



b. Self-supporting aerial type



c. Underground duct burial type

Figure 1: Structural Drawings of Several Typical FTTH Bow-type Optical Cables

2.2 Suggestions on the Application of Bow-Type Optical Cable

The bow-type optical cable is mainly used for cabling and connecting the multimedia information box to corridor transition box, optical cable splice closure and telecommunication optical cable cross connecting cabinet. The bow-type optical cable is divided into three types for indoor, self-supporting aerial and underground duct burial deployment, the prices of the three products are quite different. At present, the price of buried type is about twice the price of indoor type. In general, only in some special application scenarios such as villas without pre-embedded pull boxes during the construction period, can we consider adopting the underground duct burial bow-type optical cable.

As the bow-type optical fibre swerving with small bending radius always occurs in the laying environment, in order to reduce the additional bending loss caused by the small bending radius of the bow-type optical cable and to lower the risk of optical fibre breakage (i.e. to improve the mechanical reliability of the optical fibre) in the bending state for

long time, the G.657.A2 optical fibre should be used in the bow-type optical cable. The bending radii of the indoor bow-type optical cable using different optical fibres are shown in Table 1.

Table 1 Minimum Bending Radius of Optical Cable

Optical fibre type	Static (under working)	Dynamic (under installation)
B1.1 and B1.3	30mm	60mm
B6A1	15mm	30mm
B6A2	10mm	25mm

The FTTH bow-type optical cable has two forms of the non-metallic strength member and the metallic strength member. Considering lightning protection and high voltage interference protection, the bow-type optical cable with the non-metallic strength member should be adopted for indoor use. The non-metallic strength member is made of FRP (fibre glass) and KFRP (aramid fibre), which are mostly used for indoor cabling. The bow-type optical cable of the fibreglass has good rigidity and is suitable for in-conduit tubes, and the bow-type optical cable of the aramid fibre is suitable for the scenario where indoor open wires to be laid along right-angle turning positions such as wall corners. The metallic strength member is generally made of steel wire, and is mostly used for outdoor cabling. The self-supporting bow-type optical cable with the metallic strength member is generally introduced from the outdoor optical cable distribution box to the indoor side. After it is introduced for indoor laying, the metal part of suspension wires shall be removed to prevent outdoor lightning from being led in.

As that space in the user multimedia information box is small, general optical cables are relatively hard, so it is hard to bend, fix, and coil them, and the end part is easy to break after spliced, which brings difficulties to the follow-up maintenance and installation work. Therefore, in the network circuit design, the general optical cables are not allowed to be directly laid into the box and terminated. However, the bow-type optical cable has the characteristics of light weight, good bending insensitive performance and easy fixation, easy termination in 86 terminal box, so the indoor bow-type optical cable should be selected for indoor use.

At present, that indoor bow-type optical cable has types of 1-core, 2-core, 3-core, 4-core, etc. and the single-core cable should be selected for the residential users' access of the FTTH bow-type optical cable; the 2-core-4-core cables should be selected for the business users' access of the FTTH bow-type optical cable.

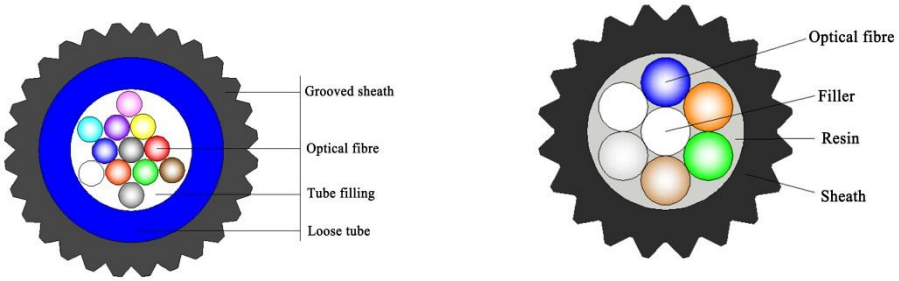
The unique 8-shaped structure of the bow-type optical cable can realize field formation in the shortest time. At present, the 2.0mm × 3.1mm standard size bow-type optical cable can adapt to various field connectors manufactured by Corning, 3M and Fujikura, and can be widely used in the world.

III. New Types of FTTH Optical Cables

3.1 FTTH Air Blown Optical Cable

The optical cable route from the ODN network into the house is deployed at both the indoor side and outdoor side, and the optical cable application scenarios and laying methods are not the same. For areas with a low broadband subscription rate, placing fibre optic cables in place at one time in places where there are potential demands will clearly result in waste and overstock of funds. The air-blown micro duct and micro cable technology can effectively solve this problem, it only needs laying the corresponding air-blown micro duct system in the network in advance, and laying the optical cable with appropriate capacity in the initial stage. Then the optical cable can be blown into the micro duct of the built-up protection duct in batches according to the development demands, thus saving the initial stage investment and avoiding a large number of idle optical fibres; optical cable bifurcations can be added at any time according to service needs, and the Y-connector can be used to reduce the optical cable joints. At present, the air-blown micro duct and micro cable technology has been used in FTTH network works abroad in large

scale, and many domestic optical cable enterprises have developed a variety of air blown micro cable suitable for FTTH, and carried out FTTH air blown optical fibre FTTH project trials combined with air blown equipment and cooperating with network construction organizations. Two types of FTTH air blown optical cables developed by Yangtze Optical Fibre and Cable Joint Stock Limited Company are shown in Figure 2.



a. Central tube

b. optical fibre unit

Figure 2 Typical Structure of FTTH Air Blown Optical Cable

Cooperating with China Mobile, Yangtze Optical Fibre and Cable Joint Stock Limited Company carried out a trail project of adding optical cable lines in the existing duct using the air-blown micro duct and micro cable technology in a residential quarter which is composed of 101 apartment buildings. There are 4 optical cable cross connecting cabinets in the residential quarter, and ducts of 110mm outer diameter laid underground. The duct using conventional common optical cable installation in conduit was laid by China Mobile in the way of FTTB+LAN. There are many optical cable reservations in the outdoor optical cable cross connecting cabinets and apartment buildings, and the duct hole resources are very limited. PVC ducts with an outer diameter of 30mm are introduced into the apartment buildings. There are at least two right-angle bends from the manhole of the building to the distribution box on the third floor. The manhole space is small, and there are other cables laid in the first and second floor, as shown in Figure 3.

a. Handhole on first floor corridor

b. Distribution box on the third floor

Figure 3 Line Environment of Construction Site

To add optical cable routing in the scenario of scarce conduit resources and complex construction

environment, we adopt the construction scheme of manual pulling of the micro duct with addition of air blowing of the micro cable and the optical fibre unit. The manual pulling of the 7/3.5 micro duct is used for the 288-core 1-3# optical cable cross connecting cabinets, directly from the cable cross connecting cabinets to the distribution box in the each apartment building on the third floor, and then blowing the 12-core central tube air-blow micro cable into the 7/3.5mm micro duct; manual pulling 5/3 micro duct from the 576-core optical cable cross connecting cabinet to the distribution box in the each apartment building on the third floor, and then blowing the 2-core optical fibre unit into the 5/3.5mm micro duct.

Because the optical fibres need to be repeatedly bent or even at right-angle bend when they are placed between buildings or inside buildings, the transmission attenuation will be increased and the optical fibres will be at risk of fracture if general optical fibres at present are used, which cannot meet the requirements of signal transmission. The bending-insensitive single-mode fibre G.657.A2 is adopted in this pilot project. The use of bottled compressed gas as the power of the air blower greatly reduces the construction noise and the cost of air blowing. The picture of air blowing construction site is shown in Figure 4.

a. Air blowing optical fibre units

b. Using bottled compressed gas as power for air blowers

Figure 4 Air Blowing Construction Site

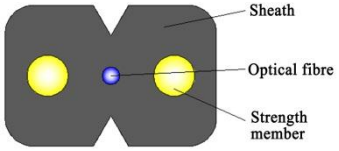
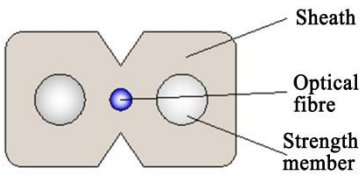
The air-blown optical fibre system provides a new idea for the FTTH line construction mode. As long as that micro tube are pre-deployed in the built residence, the optical fibre units can be blown in batches according to the broadband access demands. Moreover, the optical fibres can be replaced at any time, and the cables are only subjected to a small stress in the construction process, so the probability of failure in the optical cable construction process is greatly reduced. The initial investment cost of this system is low, and the air blowing installation speed is fast. Therefore, this scheme will be the best choice for the future communication operators to deploy the FTTx network.

3.2 FTTH Bow-Type Optical Cable with Small Size and Low Friction Coefficient

There are many kinds of construction modes of the FTTH network, and the routing of optical cable laying varies according to different conditions. For the transformation of the old residential quarters, in many cases, optical cable lines need to be added to the existing multi-dwelling units (MDU). Adopting the scheme of adding new conduit lines will inevitably increase the cost of construction, so existing cable conduits are generally used for additional optical cable laying, and the laying generally adopts the pulling installation method. This installation method requires a lot of time and it is difficult to realize the installation of additional optical cables in the existing conduits.

Therefore, a Japanese optical cable manufacturers took the lead in developing a small-size and low-friction coefficient bow-type optical cable suitable for installation in the existing conduits, as shown in Table 3, which shows the structural comparison between the general bow-type optical cable and the low-friction bow-type optical cable.

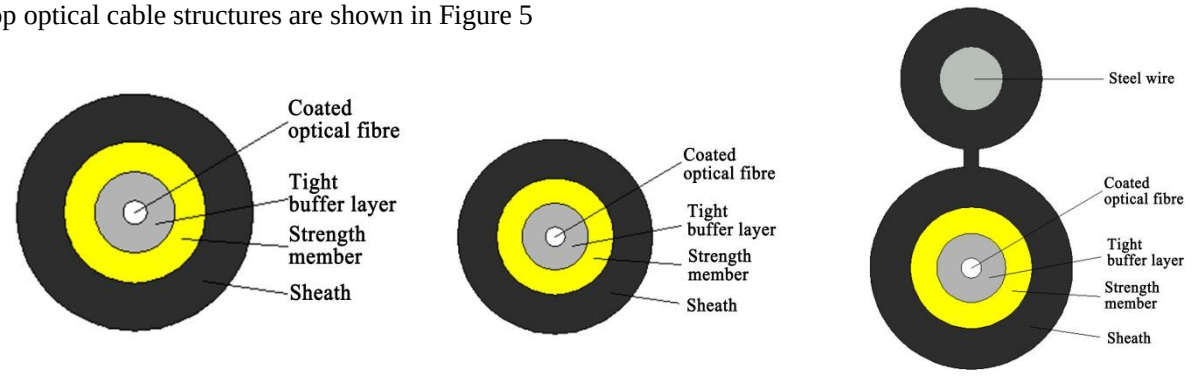
Table 3 Structural Comparison of Two Types of Optical Cable

Item	General bow-type optical cable	Low-friction bow-type optical cable
Optical cable structure		
Dimensions (mm)	2.0 ×3.1	1.6 ×2.0
Strength core	Non-metallic FRP	Metallic
Sheath	Flame-retardant	Low friction, wear-resistance and flame-retardant
Maximum tension (N)	80	200
Optical cable cross-sectional area (mm^2)	6.2	3.8
Friction coefficient (relative)	1	0.2
Installation tension (relative)	1	0.15

Low friction and good rigidity of the sheath materials are the key technologies of this type of optical cable, and it also has the advantages of small size and high hardness. It can also be able to pass the friction coefficient test between the optical cables and the in-conduit optical cable pushing test (in a 20m in-conduit tube with 5 right-angle bends, at least 8 low-friction optical cables shall pass through at a time). These two key performances ensure that the low-friction bow-type optical cable can be pushed directly into the conduit unit without pulling in the narrow conduit space, thus greatly reducing the laying time and cost.

3.3 Round Drop Optical Cable

The traditional bow-type drop cable has defects in the cable structure. When the cable is laid horizontally, it is easy to accumulate water and freeze, which leads to the increase of optical fibre attenuation. Moreover, due to the flat structure characteristics of the cable, it is easy to twist and break the optical fibre when the number of twisting turns is too much. For this reason, many domestic manufacturers have developed the round drop optical cable in recent years, which can make up for the structural defects and improve the construction convenience. The circular drop optical cable is similar to the conventional single-core indoor tightly buffered optical cable in structure, which has the advantages of torsion resistance, bending insensitive performance, good tensile performance, good environmental protection and flame retardance effect, wide applicable temperature range, and it is structured without groove to reduce optical fibre attenuation increasing probability; with all-dielectric structure, good lightning protection, high voltage invasion protection, anti-rust characteristics. Three typical round drop optical cable structures are shown in Figure 5



a. Indoor type (GJFJH) b. Indoor and outdoor type (GJYFJH) c. Self-supporting aerial type (GJYFJCH)

Figure 5 Structural Drawings of Typical Round Drop Optical Cable

In order to adapt to the usage environment of FTTx project construction, the round drop optical cable also adopts the bending-insensitive optical fibre G.657.A2, which endows the round drop optical cable with excellent performance. See Table 4 for the main performance parameters of the round drop optical cable

Table 4 Main Performance Parameters of Round Drop Optical Cable

Model and specification	Outer diameter (mm)	Short-term tensile resistance (N)	Optical cable weight (kg/km)	Environmental resistance (℃)
GJFJH-1B6a2	2.5	150	6.5	-40~+60
GJYFJH-1B6a2	3.0	500	9.5	-40~+60
GJYFJCH-1B6a2	5.0*3.0	600	20	-40~+60

The LSZH materials are generally used as the tight cladding and sheath of the round drop optical cable, which allows the optical cable good environmental protection and flame retardance. At the same time, the aramid yarn strength member adopted allows the optical cable softness, small bending radius and good tensile performance. In addition, the round drop cable has mature pre-formation technology and matching fast connector technology, which make it more suitable for indoor and outdoor drop scenarios. However, due to the softness of the round drop optical cable, the cable is only suitable for the pulling construction method with the messager wire. When the conduit is deformed or blocked, if the constructors

pull the cable forcibly, the cable is likely to break, which brings certain hidden troubles to the construction process.

5. Conclusion

With the comprehensive development of the FTTH project in China, there are more and more kinds of optical cables used in the FTTH network. This paper introduces several kinds of optical cables suitable for the use in the FTTH network, including the general bow-type optical cable, small-size and low-friction bow-type optical cable, round drop optical cable and air-blown drop optical cable, and introduces their product characteristics, applicable scenarios and application characteristics. In order to give certain guidance to the vast number of fibre optic cable users, and better serve for China's FTTH network construction.

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