YOFC_10005_WP

Bow-type Optical Cable for FTTx of YOFC

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1. Introduction

Since 2008 "the first year of China's FTTx", domestic operators like China Telecom have given great impetus to "replacement of copper cables with optical cables", and started the large-scale application of domestic FTTx. As the FTTx network technology develops, new optical cable structures for FT-Tx emerge one after another. The bow-type optical cable, also referred to as the indoor optical cable, is the optical cable applicable to FTTx terminal cabling system; and it is now paid much attention in domestic FTTx projects. The performance of bow-type optical cable significantly affects the quality of FTTx project.

1. Introduction to YD/T1997-2009 Standard

To standardize the production and application of bow-type optical cable products, the Ministry of Industry and Information Technology issued the standard *Bow-type Drop Cables for Access Network* (YD/T1997-2009) in December 2009. The standard stipulates that the type of optical fibre used in bow-type optical cable shall be class B6 optical fibre (i.e., G.657 optical fibre) as per YD/T1954-2009 or class B1.3 and class B1.1 optical fibre (i.e., G.652 optical fibre) as per GB/T97H.3 and GB/T9771.1, and also specifies the maximum attenuation value of optical fibre in finished cable as well as the requirements on mechanical performance and environmental performance of bow-type drop cables for access network, together with the test methods thereof. Table 1 gives the maximum attenuation value of optical fibre in finished cable as per standard YD/T 1997-2009.

As the optical cable for indoor use, bow-type optical cable should have excellent bending insensitive; the standard also specifies the minimum allowable bending radius of bow-type optical cable, as shown in Table 2.

Table 1 Maximum Attenuation Value of Optical Fibre in Finished Cable as Per Standard YD/T1997-2009

Type of optical fibre	Wavelength used	Maximum attenuation value (dB/km)
B6a, B1.1 and B1.3	1310	0.40
	1550	0.30
B6b	1310	0.50
	1550	0.40

Table 2 Minimum Bending Radius of Optical Cable

Type of optical fibre	Static (under working)	Dynamic (under installation)
B1.1 and B1.3	30	60
B6a	15	30
B6b	10	25

Meanwhile, the standard further specifies the detailed test methods for mechanical performance and environmental performance of bow-type optical cables. The standard has specified the minimum bending radius of bow-type optical cable, but it does not mention how to measure the minimum bending radius of optical cable; the requirements on bending insensitive and repeated bending are mentioned only in the mechanical performance of optical cable.

3. Technical Feature of YOFC Bow-type Optical Cable

3.1 EasyBand® plus optical cable

YOFC started promoting the research and development of bending insensitive single-mode fibre in 2004, and successfully launched the Easy-Band® series fibre products conforming to ITU-TG.657 standard in 2006. To meet the complex indoor cabling system requirements, such as wall column corners and optical panels, YOFC has used EasyBand® plus optical fibre in all bow-type optical cables; such optical fibre meets the G.657.B requirements in the 2006 recommended edition of ITU-T G.657 standard as well as the G.657.A2 requirements in the 2009 latest revision; it is also fully compatible with G.657.A1 and G.652.D optical fibre; it has 7.5mm minimum allowable bending radius, allowing more convenient optical cable installation and construction. Meanwhile, EasyBand® plus fibre has smaller attenuation characteristics, which are better than class B6, class B1.3 and class B1.1 fibre used in bow-type optical cables as per YD/T1997-2009 standard. Moreover, YOFC strictly controls the production and manufacture process of bow-type optical cables, such that the fibre in finished cables almost have no obvious additional attenuation, and the fibre fully meet and are better than the fibre attenuation characteristic requirements for finished cables as per YD/T1997-2009 standard. In addition, the use of EasyBand® plus fibre having excellent bending insensitive allows the minimum static bending radius of bow-type optical cables manufactured by YOFC to reach 7.5mm, which is better than that of specified in YD/T1997-2009 standard.

Besides, for use in building, the bending additional loss of fibre in finished cable may be affected by the construction and installation pattern. After construction of optical cable, the long-term bending radius should be as big as possible, in order to reduce the macro bending additional loss and the long-term tension that may affect the service life of optical fibre. Therefore, rude and rough installation and construction methods are not recommended for optical cable construction.

3.2 Selection of Reinforcing Components

To better protect optical fibre in optical cable, reinforcing elements are usually arranged in optical cable during the cable forming process, so as to bear the external force in cable laying and use. Common optical cable reinforcing components include metal reinforcement and non-metal reinforcement. Metal reinforcement mainly uses steel wires; and non-metal reinforcement mainly uses fibre reinforced plastic (FRP), which is primarily used in optical cable that has to be insulated.

FRP means fibre reinforced plastic. It is a composite material using various fibre and products thereof (glass cloth, ribbon, felt, yarn, etc.) as reinforcing materials and synthetic resin as substrate. FRP mainly comprises glass fibre reinforced composite (GFRP), carbon fibre reinforced composite (CFRP), Kevlar fibre reinforced plastic (KFRP) and boron fibre reinforced composite. The relative density of FRP is between 1.5 and 2.0, which is only 1/4~1/5 of carbon steel; but its tensile strength is close to or even higher than that of carbon steel; and its specific strength is comparable to that of high-grade alloy steel. The tensile strength, bending and compression strength of certain epoxy FRP can be up to 400Mpa or more; in addition, FRP has excellent electric insulation and corrosion resistance; and it is now the widely used material for non-metal reinforcement of optical cable.

The non-metal reinforcement in bow-type optical cable of YOFC employs Kevlar fibre reinforced plastic (KFRP). Comparing to the glass fibre reinforced composite (GFRP) that is commonly used in optical cables, KFRP has higher tensile strength and smaller bending radius, which is able to fully exert the bending characteristics of EasyBand® plus fibre, and meet the small bending radius service condition when laying optical cables indoor. Table 4 gives the comparison of technical indexes between GFRP and KFRP.

Table 4 Comparison of Technical Indexes Between GFRP and KFRP

Feature	Technical index	
	GFRP (φ0.5mm)	KFRP (φ0.5mm)

Tensile strength (Mpa)	≥1100	≥1700
Modulus of elasticity for tension (GPa)	≥15	≥50
Elongation at break (%)	≤4.0	≤3.0
Minimum bending radius (mm)	≤ 20	≤7.5

From Table 4, it can be observed that KFRP has better tensile strength and smaller bending radius on condition of same diameter, as compared with GFRP. Taking KFRP of φ0.5mm as an example, its minimum bending radius can be 7.5mm or even smaller; the bow-type optical cable with excellent bending insensitive can be produced by using it in combination with the EasyBand® plus bending insensitive fibre of YOFC, which is more suitable for indoor terminal cabling system of FTTx project.

In YD/T1997-2009 standard, the requirement on reinforcing component of bow-type optical cable is that: "the reinforcement component can be made of either metal or non-metal materials. For self-supporting bow-type drop cables, strengthening members shall be arranged in the cables in addition to the reinforcing components. The strengthening member of optical fibre shall be preferably suspension wire, which bears most of the tension force in case of overhead laying. The suspension wire is usually a single steel wire or a strand of multiple metal wires; FRP round bars can also be used".

It should be emphasized that, especially in areas where lightning hazards usually happen, if reinforced metal suspension wire is used in optical cable, when the sheath is broken down, electric current will be led indoor along the suspension wire or the metal reinforcement and cause danger; therefore, we believe that metal reinforcement should not be used in indoor-outdoor dual-purpose bow-type drop cables; and we recommend non-metal reinforcement for the sake of safety.

3.3 LSZH Sheath Material

According to statistical data from fire department, about half of the fire accidents happened in our country is caused by electrical problems; and among electrical fire accidents, fires caused by aged and overloaded electric wires and cables due to inadequate inflaming retarding ability have occupied a fairly large proportion. In case of fire, the heavy smoke hinders the victims from clearly identifying directions, extends the retention time in fire, and hinders the firefighters from giving help. Therefore, YD/T1997-2009 standard further specifies that the sheath material of bow-type drop cables shall be low-smoke zero-halogen inflaming retarding polyolefin or polyvinyl chloride.

All FTTx bow-type cables of YOFC have adopted the low-smoke halogen-free inflaming retarding sheath material as specified in YD/T 1113 standard, so as to meet the safety requirements of indoor optical cables.

4. Conclusion

YOFC always devotes itself in providing customers with FTTx optical fibre and cable products having the best cost performance and best service performance and solutions, and uses the Easy-Band® plus optical fibre conforming to the ITU-T G.657.A2 standard in the produced FTTx bow-type optical cables. The minimum bending radius of the optical fibre can reach 7.5mm; the optical fibre is fully compatible with G.652.D and G.657.A1 fibre, and is more suitable for indoor laying; the cable sheath is made of low-smoke halogen-free inflaming retarding (LSZH) material, in order to meet the safety requirement of indoor optical cable; in indoor-outdoor dual-purpose optical cable, only FRP is used as the reinforcement of bow-type optical fibre, in order to avoid leading electric indoor from outside, and to guarantee the safety; and the material for reinforcement in optical cable is KFRP. At present, the FRP materials mainly comprise GFRP and KFRP; the KFRP material has better bending property, which is able to fully exert the bending insensitive feature of EasyBand® plus fibre, and satisfy the use of optical cable under small bending radius.

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