YOFC_10015_WP

Solution to Use Slotted-core Fibre Ribbon Cables in FTTH

Liu Wei

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1. Background

Following the rapid development of communication technology and industry, optical fibre transmission has been developed from medium and long distance transmission gradually to short-distance FTTH. Most of existing FTTH cable laying methods have adopted common stranded loose tube cable and tight buffered cable, where the optical cable has to be cut off for splice, or multiple incoming cables have to be laid, when the FTTH needs to be split but separation window cannot be made. Such design is complex, consuming a large number of optical cables, occupying many pipes during laying, causing crowded cables as well as complicated bifurcation and splice; moreover, the tube filling in common stranded loose tube cable also brings inconvenience in construction. When there is a large quantity of FTTH, the problems above becomes more serious.

Slotted-core fibre ribbon cable is favored by users because of its high optical fibre density, no tube filling, good side pressure resistance, good damp-proof property and convenient splice. On the basis of fully utilizing the advantages of slotted-core fibre ribbon cable, YOFC has proposed the solution to use slotted-core fibre ribbon cable in FTTH: optical fibre in the fibre ribbon cable for leading in are connected from the machine room to several cross-connection cabinets and then connected to each housing unit; the optical fibre ribbons to be connected to the household can be pulled out directly by making several separation windows on the slotted-core fibre ribbon cable, without cutting off the cable as in conventional way. As there is no need for splice and only few cables are required, and the no tube filling feature of slotted-core fibre ribbon cable, the FTTH design and construction becomes very simple and convenient.

2. Brief Description of Solution

Required fibre ribbons are separated at each floor from the slotted-core fibre ribbon cable for shaft corridor access, and the fibre ribbons are converted into pigtail by splice closure for access to the home; as to slotted-core fibre ribbon cable for horizontal pipe access, requirement fibre ribbons can be pulled out by two sections at each point, and converted into pigtail by splice closure for access to two neighboring households; the heads and ends of cables are finally concentrated in the machine room, thereby forming a ring-like FTTH solution which utilizes the fibre in the cable to the greatest extent.

The solutions makes the FTTH design and construction become very simple and convenient; multi-household (e.g., 72 households) FTTH can be realized by only laying one slotted-core fibre ribbon cable with corresponding number of cores; and in large-scale community, the requirement can be satisfied by only few slotted-core fibre ribbon cables; the no tube filling feature gives great convenience to the construction. In a large community where many buildings need to be accessed, use of slotted-core fibre ribbon cable as lead-in cable will highlight its advantages better.

3. Detail Implementation

Opening of separation window in requirement position of slotted-core fibre ribbon cable can easily split the FTTH optical cable; the recommended length of separation window is about 60mm; and housing units of different structures require different access fibre ribbons.

3.1 For apartment building, slotted-core fibre ribbon cable is usually used for cabling in shaft corridor; required fibre ribbons are separated at each floor, converted into pigtail by splice closure for FTTH;

3.2 For office building, slotted-core fibre ribbon cable can also be used for cabling in shaft corridor. However, each floor has a large number of users and the environment is complex, the horizontal FTTH needs indoor cables having good side pressure resistance, good bending insensitive and even good inflaming retarding property;

3.3 For common villa building, required fibre ribbons can be pulled out by two sections at each point from the slotted-core fibre ribbon cable accessed by horizontal pipe, and then respectively converted into pigtail by splice closure for access to two neighboring households; the heads and ends of cable are finally concentrated at the machine room, thereby forming a ring-like cabling system which utilizes the fibre in the cable to the greatest extent;

3.4 For high-grade villa having large interval between households, indoor-outdoor dual-purpose cable is used for FTTH.

Figure 1 is the schematic diagram of slotted-core fibre ribbon cable for shaft corridor access; Figure 2 is the schematic diagram of slotted-core fibre ribbon cable access to villa via horizontal pipe.

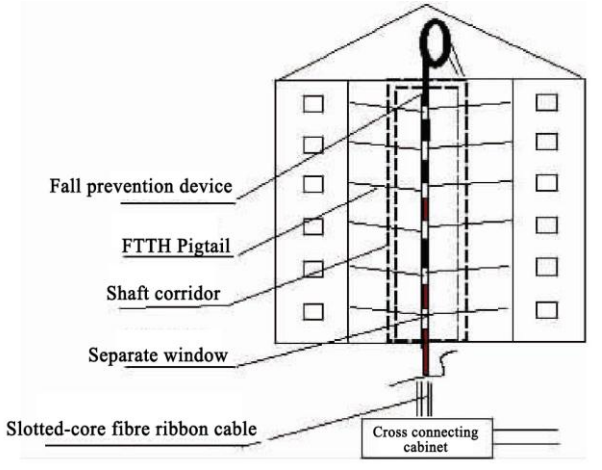

Figure 1 Schematic Diagram of Slotted-core fibre ribbon cable for Shaft Corridor Access

In Figure 1: optical cable is accessed from bottom layer of the corridor; the separation window can be made by stripping the sheath, metal belt and water-blocking tape of the cable. Separation windows are generally opened from top floor to bottom floor; if one fibre ribbon needs to be extracted at certain floor, the fibre ribbon has to be cut off at the separation window of upper floor; the distance between two neighboring windows shall guarantee the sufficient length of the extracted fibre ribbon; and then the fibre ribbon shall be converted into pigtail by splice closure for FTTH. To prevent unconnected fibre ribbons against falling due to gravity, fall prevention device shall be installed on roof of building to wind the cable ends in several turns and fix it.

The number of cores in slotted-core fibre ribbon cable for shaft corridor cabling system can be selected according to the number of floors and the number of households at each floor; for a building which is not higher than six floor and has four households at each floor, 4-core optical fibre ribbon cable of 24 cores can be used; for six households at each floor, 6-core optical fibre ribbon cable of 36 cores can be used. For a building which is not higher than 12 floors and has four households at each floor, 4-core optical fibre ribbon cable of 48 cores can be used; for six households at each floor, 6-core optical fibre ribbon cable of 72 cores can be used. The 4-core optical fibre ribbon cable of 72 cores can be used for a building which is up to 18 floors and has four households at each floor. If there are many floors or many households at each floor, several optical cables can be used.

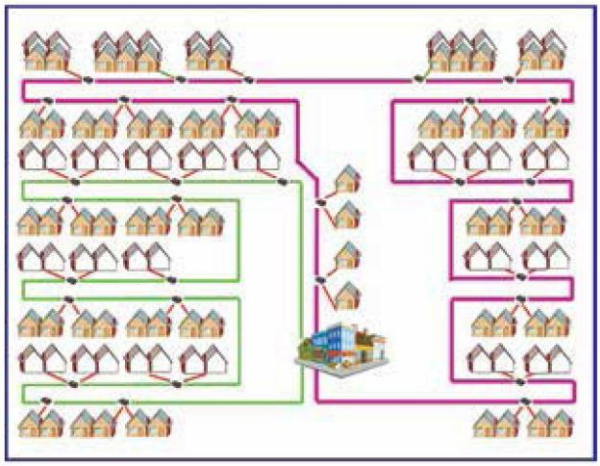

Figure 2 Schematic Diagram of Slotted-core fibre ribbon cable Access to Villa via Horizontal Pipe

4. Structure and Relevant Parameters of Splice Closure Converting Fibre Ribbon into Pigtail

4.1 Dimension and Material

Splice closure is 250mm long, 150mm wide and 50mm high; it shall be fixed on wall and easy to open (it can be provided with special lock or screw to prevent damage by others). The housing can be hard plastic or iron plate; it is required to be free of deformation and breakage within the temperature range of -40℃~70℃; it shall have certain strength and good tightness, in order to prevent water seepage.

4.2 Components in Box

Figure 3 is the splice closure which converts optical fibre ribbon into pigtail; and its components and parts are described as follows:

4.2.1 Sheath Fixer

Function: fix the optical cable, and prevent the sheath against retraction.

4.2.2 Optical Fibre Ribbon Receiving Tray

It is required to have the space for receiving 1.2m optical fibre ribbon (minimum bending radius greater than 37.5mm), with split optical fibre ribbon inlet and fixed place, and optical fibre ribbon heat shrink tube fixer.

4.2.3 Optical Fibre Receiving Tray

It is required to have 12-core optical fibre heat shrink tube fixer, with space for receiving 1.2m optical fibre (minimum bending radius greater than 37.5mm), and multiple bifurcation tight tube jumper fixing slots. 4.2.4 Inlet and outlet openings are about 24mm, provided with dust-proof sealing member

4.2.5 When the optical cable has to be cut off, strength member fixer shall be installed, in order to prevent the optical cable against sliding.

Figure 3 Splice Closure Converting Optical Fibre Ribbon into Pigtail

5. Slotted-core Fibre Ribbon Cable with Small Fibre Counts for FTTH Access

5.1 Small-fibre-count Slotted-core 6-Fibre Ribbon Cable Series

In general, slotted-core fibre ribbon cable has more than 72 cores; because of the large number of cores, the optical cable is relatively thick, and not as flexible as the indoor tight buffered optical cables. The core number of optical cable required for FTTH access is not big, but the lead-in environment is fairly complex, especially in the established community. Therefore, the lead-in cable shall not only adapt to tubed overhead laying and directly shallow trench burying (to cross roads in community), but also adapt to the small bending radius in corridor and even the inflaming retarding and ratproof requirements. YOFC has specially developed the flexible, small-diameter 72-core and below slotted-core four/six-fibre ribbon cables for FTTH access. To meet the construction requirement of branch lead-in environment, YOFC has employed the cable structure of smaller central strength member and thinner sheath (as shown in Figure 4), and adopted reasonable process control to guarantee that the product performance, especially the mechanical performance, conforms to the standard requirements.

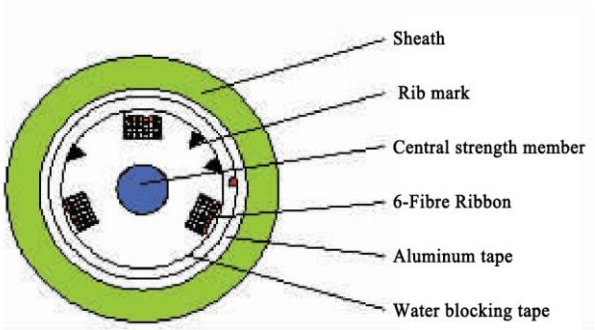

Figure 4 Small-fibre-count Slotted-core fibre ribbon cable Structure

See Table 1 for the structural parameters of the small-fibre-count slotted-core 6-fibre ribbon cable developed by YOFC.

Table 1 Structural Parameters of Small-fibre-count Slotted-core fibre ribbon cable for FTTH

Model GYDGA	Number of slots	Layer number of each slot	Diameter of strength member	Slotted-core diameter	Outer diameter of optical cable	Cable weight (for reference)
36-6F	3	2		φ6.0mm	φ10.5mm	90kg/km
54-6F	3	3		φ6.5mm	φ11mm	100kg/km
72-6F	3	4	φ1.6mm	φ8.5mm	φ13mm	140kg/km
24-4F	3	2		φ6.0mm	φ10.5mm	90kg/km
48-4F	3	4		φ6.3mm	φ11mm	100kg/km
72-4F	6	3		φ7.5mm	φ2.5mm	130kg/km

5.2 Performance of Small-fibre-count Slotted-core fibre ribbon cable

5.2.1 Temperature Performance

The attenuation value of optical fibre in small-fibre-count slotted-core fibre ribbon cable is 1310nm at normal temperature; 0.36dB/km; 1550nm; ≤0.23dB/km, in -40℃~+60℃ temperature cycle, the additional attenuation is not greater than 0.05dB/km; the diagram below is the 1550nm attenuation variation curve within the temperature cycle, where the pink curve means the maximum attenuation value, the blue curve means the average attenuation value, and the orange curve means the minimum attenuation value.

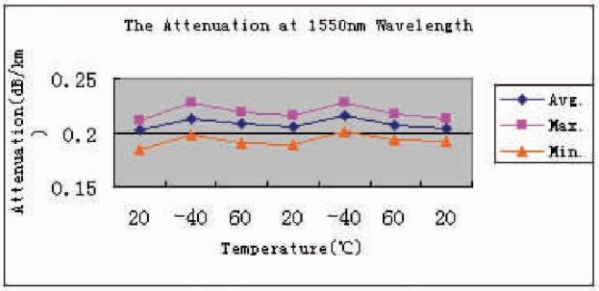

Figure 5 Attenuation Variation of Small-fibre-count Slotted-core fibre ribbon cable at 1550nm in Temperature Cycle

5.2.2 Tensile Property

Length of branch lead-in cable is generally not greater than 1km; and it is only two or three hundred meters in most cases. The stress on cable is not great during construction. YOFC has used smaller steel wires and thinner sheath in the small-fibre-count slotted-core fibre ribbon cable for FTTH, but the tensile strength of the cable is able to meet the standard requirements; the short-term tensile strength of such cable can be up to 2000N and more. The cable is under small tension force in short-distance construction; and the abrasion to sheath is generally small; therefore the thinner sheath will be enough to protect the fibre in cable from damage.

5.2.3 Bending Property

FTTH branch lead-in cable needs excellent bending property; it has to be as flexible as normal electrical cable, for easier construction in corridor and fixation along the wall. To validate the bending property of small-fibre-count slotted-core fibre ribbon cable, GYDGA-72B1-6F cable has been subjected to dynamic and static bending property test as per requirements higher than the standard.

According to the standard, the static bending radius of sheath A cable shall be greater than 10 times of the cable diameter, and the dynamic bending radius shall be 20 times thereof. A small ring is made in the middle of GYDGA-72B1-6F cable (13mm diameter) for static bending property test; the diameter of the small ring is gradually reduced; and OTDR is used to monitor the OTDR curve of the bending part at the cable end, as well as the fibre attenuation variation of the whole section. Test results indicate that even the diameter of small ring is reduced to 45mm, i.e., the static bending radius of cable is 1.73 times of cable diameter, the OTDR curve has no stage and the attenuation does not change. Bending radius equivalent to 4 times of cable diameter is adopted for repeated bending test; and the optical power does not change after 30 times of tests.

The test proves that the small-fibre-count slotted-core fibre ribbon cable has excellent dynamic and static bending properties, and that the cable is applicable for small bending radius construction in corridor.

5.2.4 Shock Resistance and Side Pressure Resistance

The unique structure of slotted-core cable provides the excellent side pressure resistance. The cable is tested under triple tube cable side pressure specified in the standard; and test shows that the optical fibre attenuation has no obvious variation, and that the sheath has no breakage.

Considering that FTTH branch lead-in cable may need to cross roads in community, trench shall be directly made in roads for shallow burying. This brings higher requirement on shock resistance and side pressure resistance to lead-in cable. Therefore, shock resistance test and ultimate side pressure resistance test have been made on GYDGA-72B1-6F cable as per the direct burial cable standard. Test results indicate that the optical power does not change under impact of 1000g heavy object. The tested ultimate side pressure resistance is up to 7900N, which is much higher that the side pressure resistance requirement (5000N) of 2T steel wire armored cable.

The test indicates that: the small-fibre-count slotted-core fibre ribbon cable of YOFC is applicable to not only tube and overhead laying, but also applicable to shallow burying in roads; therefore, it is convenient to lead in FTTH branch to the greatest extent.

6. Conclusion

The solution has fully utilized the inherent advantages of slotted-core fibre ribbon cables; optical cables of corresponding structures can be selected for different building structures; and the FTTH fibre ribbons can be directly extracted from the slotted-core fibre ribbon cable by making separation windows; therefore, there is no need for splice, and only few cables are required; moreover, the cable features, such as flexible, easy to bend, no tube filling, good tensile strength and good pressure resistance, make the FTTH design and construction very simple and convenient, and are advantageous for implementation and promotion of FTTH.

Yangtze Optical Fibre and Cable Joint Stock Limited Company

Stock code: 601869.SH 06869.HK

Address: No. 9 Optics Valley Avenue, Wuhan, China (postcode: 430073)

Tel: 027-67887650

Email: sales_spu@yofc.com

Web: www.yofc.com