

A New Drop Cable for FTTH

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Abstract

With the development of optical communication technology, FTTH (fiber to the home) has become a mainstream trend. Drop cable has also been widely used in many complex environment. However, the drop cable is more easily to be damaged by wild creatures, which is becoming more and more frequently in recent years. Especially in areas where the cicadas appear frequently, the drop cable is more easily to be damaged by cicadas. In this paper, according to the habits of cicadas and the mechanisms of their damage on cable, we develop three kinds of drop cables to resist cicada damage:

- 1). the drop cable contains two-tier jacket: the inner jacket is low smoke zero halogen and the outer jacket is nylon.
- 2). the drop cable contains two-tier jacket: the inner jacket is nylon and the outer jacket is low smoke zero halogen.
- 3). the drop cable designed unsymmetrical notches to increase the thickness of the jacket around fiber.

The first and second kinds of drop cable can resist cicada damage by hard jacket. The third kind of drop cable can protect the optical fiber by thick jacket around the optical fiber.

Keywords: FTTH; drop cable; cicada proof; material; structure; temperature characteristics; mechanical characteristics.

1. Introduction

According to MIIT (Ministry of Industry and Information Technology), compared with 2014, the fixed line Internet service of China increased by 12.888 million users (to a total of 213 million) in 2015. The new addition of household by FTTH(X) increased by 51.408 million (to a total of 120 million) [1]. It is expected that FTTH will increase rapidly over the coming years in the country towns of China.

However, the optical fiber cable's demand which is designed for country town is different from that for city. First, the country town covers large population, but the population density is relatively low than that in city. The houses of country usually bungalows, and therefore the quantity is large but distribution is dispersion. Second, there are various kinds of animals in country towns and the drop cable sometimes would be damaged by tiny animals. For example, female cicadas bore their sharp ovipositor into branches when they lay their eggs. However, cicadas sometimes lay their eggs into the drop cable instead of branch.

Above all, drop cable used for country town should designed for tiny animal proof, especially cicada resistant and UV resistant. Moreover, the drop cable should be easy to install and low cost and environment friendly.

2. Conventional Cicada Proof Drop Cable

In order to split the drop cable and release fiber easily, the drop cable is usually designed notches which distribute symmetrically on the two side of the drop cable. The distance between the bottle of notch and optical fiber is of minimum thickness (Figure 1) [2]. Sometimes, female cicadas penetrate their ovipositors into the notch when they lay eggs which would case the breakage of optical fiber in the drop cable.

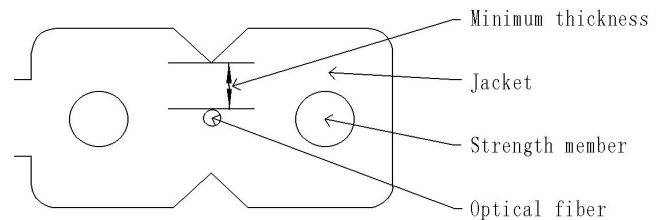


Figure 1. Minimum thickness

In generally, in order to protect the optical fiber, the cicada proof drop cable is designed by adopting special jacket material, increasing the minimum thickness of jacket or installing a protector around the optical fiber.

2.1 Jacket material

Many companies developed variety of cable jacket materials to protect drop cable from being attacked by cicadas.

Fujikura developed a new flame retardant hard material for the drop cable. They confirmed that their newly drop cable has not only the excellent cicada proof but also the work ability for cable installation and the compatibility with the current devices.[3]

Sumitomo applied new materials to the aerial drop cable which have low friction and a high abrasion-resistant feature.[2]

Hitachi developed a new drop cable with hard jacket, lower friction. It is an effective defense over the cicada egg-laying as well. In addition, it is easy to release fiber in it.[4]

2.2 Cable structure

Two types of conventional cicada proof drop cable are shown in Figure 2 and Figure 3, respectively.[5]

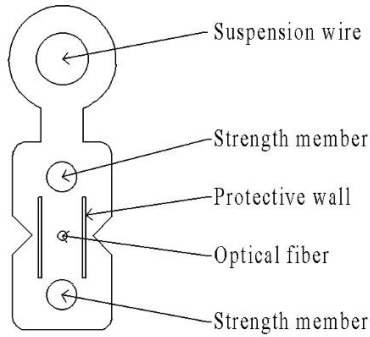


Figure 2. Conventional cicada proof drop cable with protective walls

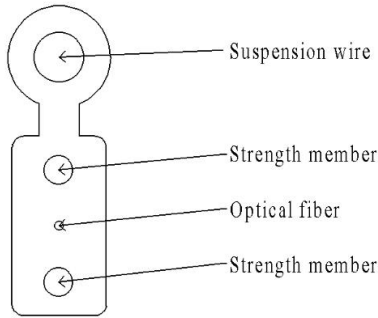


Figure 3. Conventional cicada proof drop cable without notches

In Figure 2, protective walls are parallel to the optical fiber and they are hard enough to protect the optical fiber from being damaged by cicadas. In Figure 3, this kind of drop cable increases the minimum thickness by removing notches and resists cicada's ovipositor boring into cable jacket.

3. New Cable Design

Cicada proof drop cable is designed to meet the following characteristics:

- Easy to manufacture
- Light weight
- Conventional size as the drop cable
- Easy to stall and saving the construction time
- Hard jacket or special structure to protect from being damaged by cicadas.

3.1 Material

We had developed a newly nylon which is flame-retardants for cable jacket and it is hard enough to avoid cicadas from boring their sharp ovipositors into it. In the following, we present two different kinds of drop cables which adopt newly nylon.

3.1.1 Nylon outer jacket drop cable

Figure 4 shows the cross-section of the nylon outer jacket cicada proof drop cable. Table 1 shows the structure of this kind of drop cable.

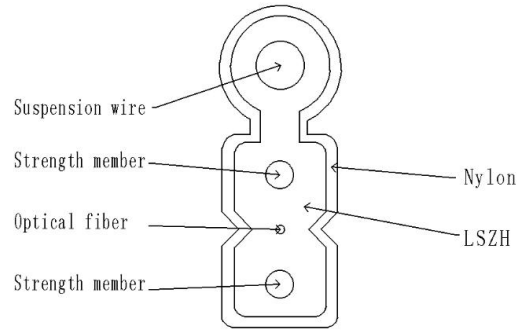


Figure 4. Nylon outer jacket drop cable

Table 1. Structure of nylon outer jacket drop cable

Item		
Dimension (mm)	cable	2.0×5.2
	Suspension wire	1.0
	Strength member	0.45
Thickness of nylon(mm)		0.30
Weight of cable(kg/m)		0.02

3.1.2 Nylon inner jacket drop cable

Figure 5 shows the cross-section of the nylon inner jacket cicada proof drop cable. Table 2 shows the structure of this kind of drop cable.

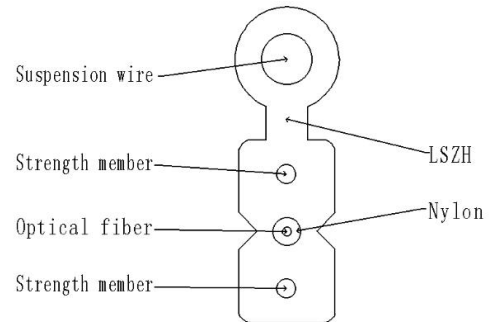


Figure 5. Nylon inner jacket drop cable

Table 2. Structure of nylon inner jacket drop cable

Item		
Dimension (mm)	Cable	2.0×5.2
	Suspension wire	1.0
	Strength member	0.45
Thickness of nylon(mm)		0.30
Weight of cable(kg/m)		0.02

3.2 Structure

3.2.1 'V' notch drop cable

We have developed 'V' notch drop cable in which notches are unsymmetrical between two sides of drop cable. In this way, the ovipositor of cicada would slip to the deep of notch and miss fiber. Figure 6 shows the cross-section of the 'V' notch cicada proof drop cable. Table 3 shows the structure of this kind of drop cable.

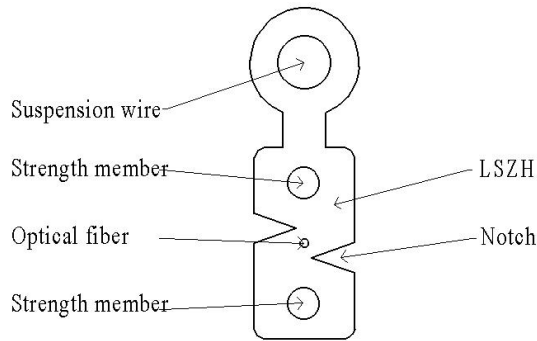


Figure 6. 'V' notch drop cable

Table 3. Structure of 'V' notch drop cable

Item		
Dimension (mm)	cable	2.0×5.2
	Suspension wire	1.0
	Strength member	0.45
Weight of cable(kg/m)		0.02

4. Cable Characteristics

The cable characteristics of three kinds of drop cable above are shown as following.

4.1 Transmission Characteristics

The transmission characteristics of the three kinds of newly developed drop cables are shown in Table 4.

Table 4. Transmission characteristics

Wave	Attenuation
1310nm	<0.38dB/km
1550nm	<0.25dB/km

4.2 Temperature Characteristics

The additional attenuation (1550nm) of nylon inner jacket drop cable changes with temperature, which is shown in Figure 7.

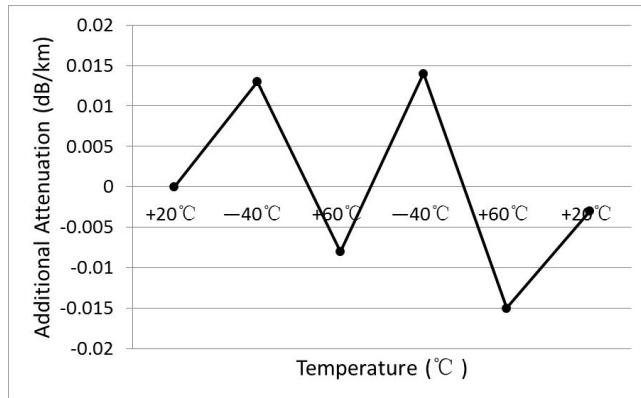


Figure 7. Temperature characteristic

In the picture, Maximum attenuation change of optical fiber is less than 0.015dB/km in the range of -40 °C to +60 °C . The additional attenuation of other newly developed drop cables in temperature test are also less than 0.015dB/km.

4.3 Mechanical Characteristics

4.3.1 Split force

In order to take out the fiber conveniently and efficiency, the split force at the notch (Figure 8) of drop cable should not be too large.

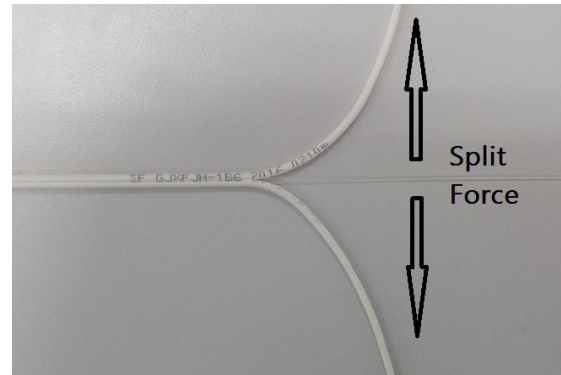


Figure 8. Split force

In the test of split force, the suspension wire should be removed in advance and the split force should be tested by special instrument. The split forces of the newly developed drop cables are shown in Table 5.

Table 5. Split force

	Split force (relative)
Conventional drop cable	1.0
Nylon outer jacket drop cable	4.3
Nylon inner jacket drop cable	1.3
'V' notch drop cable	1.0

In table 5, the split force of nylon inner jacket drop cable and 'V' notch drop cable are respectively in comparison with the conventional drop cable. However, the split force of nylon outer jacket drop cable is four times stronger than the conventional drop cable.

In split test, we should split the nylon outer jacket of nylon outer jacket drop cable, and the split force of nylon is stronger than LSZH, so compare with the nylon inner jacket drop cable, the nylon outer jacket drop cable need more split force than nylon inner jacket drop cable.

For the nylon inner jacket drop cable, the nylon is not split in the split test and it would be take out by special instrument.

4.3.2 Tension

The new developed three kinds of cicada proof drop cable are all self-supporting, their tensile performances have been verified and the characteristic of 'V' notch drop cable is the worst. The tensile characteristic of 'V' notch drop cable is shown2 in Figure 9 and the others are shown in Table 6.

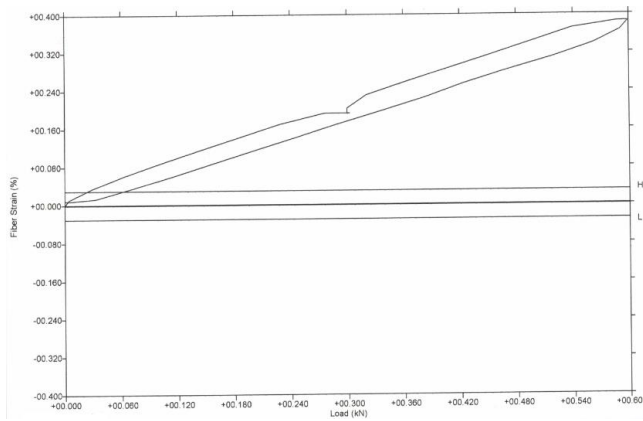


Figure 9. Tensile characteristics (600N)

In Figure 9, the maximum fiber strain is 0.4% for a 600N load dwell. In addition, the additional attenuation (1550nm) is less than 0.03dB and the outer jacket is not damaged.

Table 6. Tensile characteristics(600N)

	Maximum fiber strain	Additional attenuation
Conventional drop cable	<0.4%	<0.03dB
Nylon outer jacket drop cable	<0.3%	<0.03dB
Nylon inner jacket drop cable	<0.3%	<0.03dB
'V' notch drop cable	<0.4%	<0.03dB

4.3.3 Others mechanical characteristics

The other mechanical characteristics of newly developed cicada proof drop cables are shown in Table 7.

Table 7. Others mechanical characteristics

Test Item	Condition	Additional attenuation (1550nm)
Torsion(扭转)	-180° ~ +180° 1m(length) 20cycles	<0.01dB
Crush (压扁)	2200N 1min	<0.03dB
	1000N 1min	<0.01dB
Repeated bend(反复弯曲)	60mm 20N 300cycles	<0.01dB
Impact (冲击)	1N 1m(height)	<0.02dB

* Test result is the worst result of three kinds newly development cicada proof drop cable.

5. Conclusions

In this paper, we present three kinds of cicada proof drop cable to meet the requirement of country town market. The cables above have been confirmed for environment characteristics and mechanical characteristics. We believe that those three kinds of cicada proof cable could give clients a more choice for FTTH application.

6. References

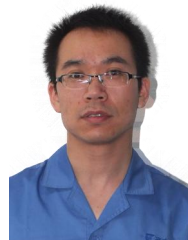
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