A Multi-Fiber Low Friction Indoor Cable with an Easy Mid-Span Access

1. INTRODUCTION

When a new optical subscriber comes to request in multi dwellings, optical fibers are wired by laying single-core cables for the required subscribers' numbers inside a conduit line connecting a Main Distribution Frame (MDF) and an Intermediate Distribution Frame (IDF) in each floor. However, the condition that empty space in the conduit line is not enough, by existing metallic cables and the other optical cables, was creating difficulty in multiple-line installation for the required number of the optical fibers (Figure 1).

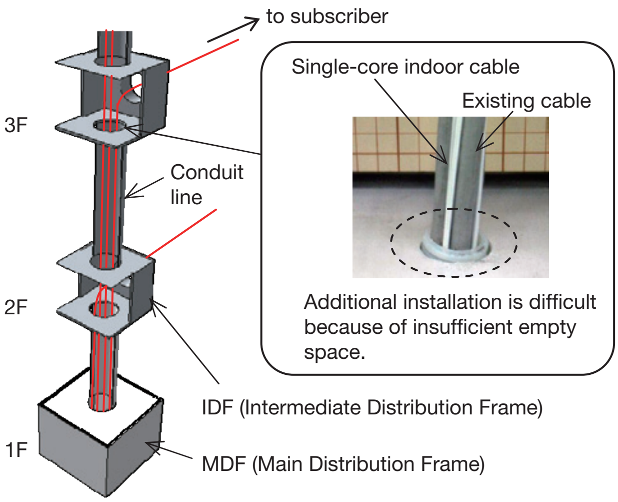

Figure 1 Conventional installation of an optical indoor cable in multi dwellings.

The construction method in Figure 2 has been being proposed as a solution to this problem: Laying a high-density multi-fiber optical cable lengthwise as a trunk line cable in advance. When a new subscriber comes to request, wire an optical fiber to the subscriber's home by performing mid-span branching in an IDF.

We have developed a multi-fiber low friction indoor cable with a multi-fiber structure. It allows a low friction push-in wiring, as well as a conventional thin low friction single-core indoor cable. Also, it allows easy mid-span branching with all-purpose nippers. In addition, we have developed a premises cable combining multiple multi-fiber low friction indoor cables for wiring in large premises.

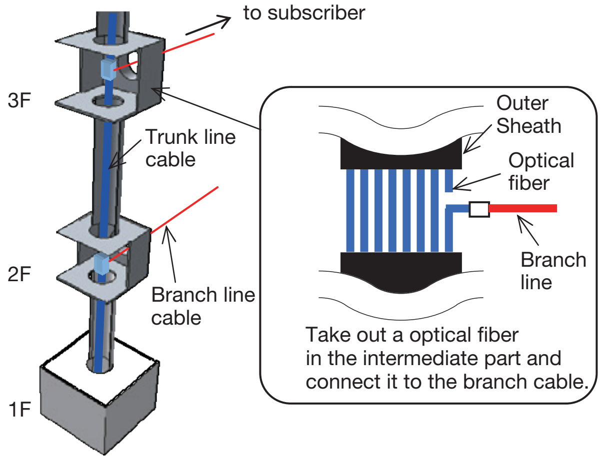

Figure 2 Proposed installation of an optical indoor cable.

2. PROPERTIES OF THE DEVELOPED PRODUCT

2.1. Outer Sheath

When wiring an optical cable into a conduit line by pushing, the optical cable starts buckling when the friction resistance exceeds a certain value. It creates difficulty in applying the pushing force to the whole optical cable, thus cutting off further wiring. To accomplish easy push-in wiring, the outer sheath material of an optical cable requires low friction. In addition, it requires fire retardancy in the vertically laid condition which is provided in JIS C3521 for it is wired lengthwise in premises.

We have adopted a method that blends a lubricant, which also functions as a fire retardancy auxiliary material, with a highly fire retardancy material. By optimizing the blending quantity of the lubricant, we have developed an outer sheath material which meets both properties of low friction and fire retardancy (Table 1).

Table 1 Properties of the developed outer sheath material.

	Highly fire retardancy material	Low friction material	Developed material
Low friction properties	×	○ 1/5, compared with our with our existing products	○ 1/5, compared with our with our existing products
Vertical fire retardancy (JIS C3521)	○	×	○

2.2 Cable

A multi-fiber low friction indoor cable requires the ability to mid-span branching. In other words, an arbitrary optical fiber needs to be able to be taken out after removing the cable outer sheath and the other unnecessary objects without affecting the communication quality of the actually-used optical fiber. The conventional optical cable which can perform mid-span branching generally use an intermediate component which does not adhere to the outer sheath and the optical fiber, and the cable performs mid-span branching by incising toward the intermediate component. However, incising the outer sheath requires specialized tools, and removing the discarded intermediate component was troublesome. To counter these problems, the multi-fiber low friction indoor cable has a newly adopted protuberant structure, thereby enabling mid-span branching with all-purpose tools, such as nippers, not using an intermediate component inside the cable.

Figure 3 shows the structure of the developed multi-fiber low friction indoor cable. The cable is made by coating eight single-core optical fiber and two tension members with a low friction fire retardancy material to form a protuberant structure. The cross section of the cable is about twice a thin low friction single-core indoor cable, and the density of the optical fiber optical fiber per unit cross section improved by about four times.

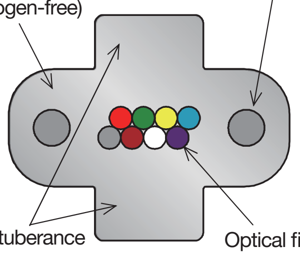

Figure 3 Cable structure of the multi-fiber low friction indoor cable.

The tension member adopts a high-rigidity type so that push-in wiring directly into the conduit line is possible.

Figure 4 shows the procedures of the mid-span branching. First, incise in the position of the protuberance where the sheath material needs to be removed. Then, lightly nip the protuberance in the position and peel the protuberance off the cable part taking care the plier keeps nipping the protuberance. These procedures generate a crack from the base of the protuberance toward the optical fiber, thereby allows the division of both the outer sheath and the protuberance contacting the optical fiber. Perform the line of procedures above on both protuberances to remove the entire outer sheath, and take out the optical fiber in the center part.

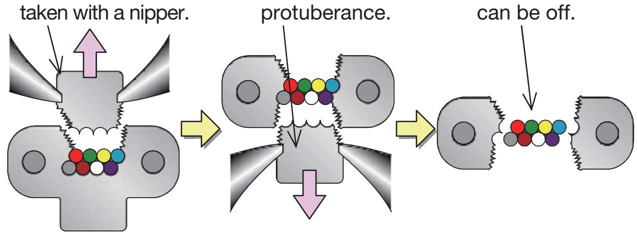

Figure 4 Procedures of the mid-span branching.

In addition, for wiring optical fibers in large-scale premises which require more optical fibers, we have developed 24-fiber and 40-fiber optical premises cables, gathering multi-fiber low friction indoor cables of three strips in the former and five strips in the latter. Figure 5 shows their structures.

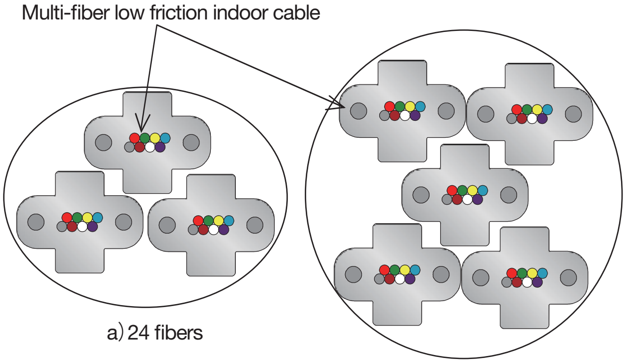

Figure 5 Cable structures of the 24-fiber and the 40-fiber optical premises cables.

2.3 Cable Properties

Table 2 shows the cable properties of the developed multi-fiber low friction indoor cable. This cable shows good performances in the transmission properties, the mechanical properties, the thermal properties, the fire retardancy properties and the mid-span access.

Table 2 Cable properties.

Test item		Test condition	Properties
Transmission loss		Test wave length λ =1.31 μm	< 0.36 dB/km
		Test wave length λ =1.55 μm	< 0.21 dB/km
Mechanical properties	Bend	R = 30 mm × 10 cycles	< 0.1 dB
	Crush	1960 N / 100 mm	< 0.1 dB
	Impact	Mass 2.94 N, Height 1 m	< 0.1 dB
	Twist	± 90℃ /m	< 0.1 dB
Thermal properties		from – 30 to + 60℃	< 0.1 dB/km
Fire retardancy properties		JIS C3521 Vertical combustion test	Damaged length < 1.8 m
Mid-span access workability		Sampling interval 1 msec	Working hours 1 to 2 min Loss fluctuation < 0.5 dB

3. CONCLUSION

We have developed a multi-fiber low friction indoor cable for effectively wiring optical fibers in the conduit lines without having enough empty space for further cables in multi dwellings. In addition, we have developed premises cables which gathered the multi-fiber low friction indoor cables for wiring optical fibers in large-scale premises. These optical cables allow effective wiring of optical fibers to the areas where wiring was difficult with the conventional technologies.

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