A Small Optical Indoor Cable with PBO-FRPs

1. INTRODUCTION

Recently, demand for leading optical fibers to subscribers' homes has been increasing with the spread of FTTH (Fiber To The Home), and optical indoor cables have been widely used for wiring in subscribers' homes. These indoor cables are used between an outdoor optical distribution cabinet and an optical rosette installed in a wall of the room, and also used between an optical rosette and an ONU (Optical Network Unit) by wiring on a wall or a floor of the room. Therefore, the cables are required to be wired flexibly and practically unnoticeable in a room in order not to disturb its beauty (Figure 1). Existing optical indoor cables have been designed taking these points into account. They are comparatively easy to be wired because they are the smallest, the lightest and the most flexible of all optical cables. Also, they are composed of the coating materials with practically unnoticeable colors such as white and ivory.

On the other hand, to promote leading and wiring optical fibers to subscribers' homes further, optical indoor cables that are easier to be wired and that also are smaller, lighter, and more flexible with the minimum disturbance to the beauty compared to the existing optical indoor cables, are required. However, there were problems with the tension members used in the existing optical indoor cables, such as steel cables and aramid fiber FRPs (Fiber Reinforced Plastics). Because steel cables are heavy, they are comparatively inflexible. Aramid fiber FRPs have difficulty in further downsizing in terms of their allowable tensile force because their tensile elasticity rates are low.

To counter such a situation, we have developed a small optical indoor cable using PBO (Poly-p-phenylenebenzobisoxazole) fiber FRPs. PBO fibers are what we have been considering to implement into practical use. That will be described in the following.

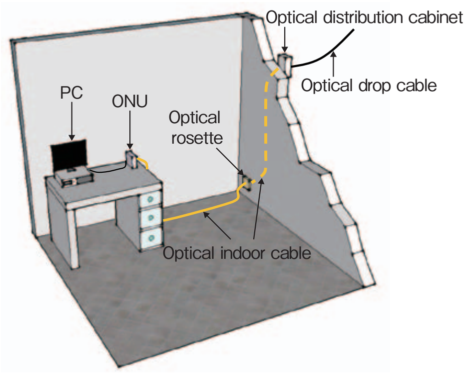

Figure 1 Installation of optical indoor cable.

2. CHARACTERISTICS OF THE DEVELOPED PRODUCT

2.1 Cable Structure

Figure 2 shows the structures of the existing cable and the developed cable. Figure 3 shows the comparison of their appearances. By using PBO fiber FRPs which have a high tensile elasticity rate, the tensile strength is equivalent to the existing aramid fiber FRPs, also the external diameter of the tension member can be smaller. Moreover, we have tried to reduce the diameter of the cable to the extent of holding its mechanical characteristics.

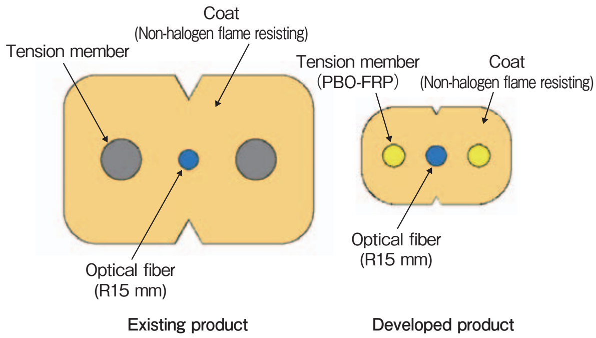

Figure 2 Cable structure.

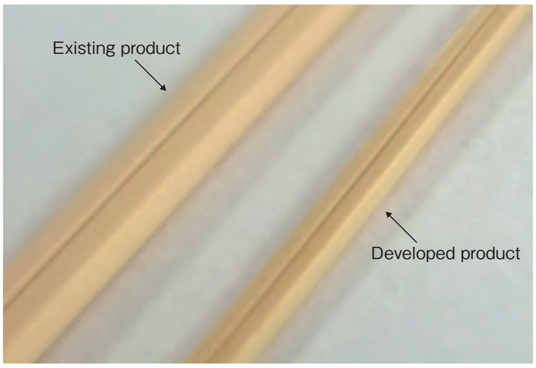

Figure 3 Cable appearance.

2.2 Cross Sectional Areas of the Cable

Table 1 shows the cross sectional areas of the existing product and of the developed product. The cross sectional area of the developed product is 1.9 mm^2, which is reduced to 30% of the existing product. Consequently, it brings advantages that not only cables are practically unnoticeable in a room but also lightweight and flexible.

Table 1 Cross sectional area.

	Existing product	Developed product
Cross sectional area (mm^2)	6.2	1.9
Relative value of cross sectional area	1.0	0.3

2.3. Cable Weight

Table 2 shows the weights of the existing cables and of the developed cable. The weight of the developed product per unit length is 3 g/m, which is lightweight to a great extent. Compared with the existing product made of a steel cable, it accomplished the reduction of about 70% of the weight. Compared with the existing product made of an aramid fiber FRP, it accomplished the reduction of about 60% of the weight.

Table 2 Cable weight per unit length.

	Existing product	Developed product
Weight (g/m)	10 *1 8 *2	3

*1 : The tension member is a steel cable.
*2 : The tension member is an aramid fiber FRP.

2.4. Flexibility (Bend Restitution)

Table 3 shows the bend restitutions of the existing products and of the developed product. When bent to 15 mm radius, the existing product made of a steel cable showed the bend restitution of 1.9 N, and the existing product made of an aramid fiber FRP showed the bend restitution of 1.3 N. On the other hand, the bend restitution of the developed product showed 0.15 N, which is low. With this low bend restitution, wiring with small radius bending inside an optical rosette and an optical distribution cabinet, and wiring along the corners of walls and desks become easy.

Table 3 Bend restitution.

	Existing product	Developed product
Bend restitution (N) IEC60794-1-2 compliant Bend radius 15 mm	1.9 *1 1.3 *2	0.15

*1 : The tension member is a steel cable.
*2 : The tension member is an aramid fiber FRP.

2.5. Cable Characteristics

Table 4 shows the cable characteristics of the small optical indoor cable. This cable has good transmission, mechanical, temperature and flame resisting characteristics.

Table 4 Cable characteristics.

Test item	Test condition	Characteristic
Transmission loss	Test wavelength λ=1.31 μm	Less or equal to 0.35 dB/km
	Test wavelength λ=1.55 μm	Less or equal to 0.21 dB/km
Tensile	150 N	Less or equal to 0.1 dB
Bending	R = 15 mm × 10 cycles	Less or equal to 0.1 dB
Crush	1200 N/25 mm	Less or equal to 0.1 dB
Impact	Weight 2.94 N, Height 1 m	Less or equal to 0.1 dB
Temperature characteristic	−30 to +70℃	Less or equal to 0.05 dB/km
Flame resisting	JIS C3005 inclination	Self inflammation

※Test wavelength of mechanical test and temperature test: λ = 1.55 μm
※The characteristic values in the table are the representative values, not guaranteed values.

2.6. Wiring Example

Figure 4 shows the statuses that the existing product and the developed product are wired along the wall starting from an optical rosette. Compared with the existing product, the developed product can be wired easily along a wall and the cable itself is practically unnoticeable because of its thinness and flexibility. In addition, it is easy to handle because of its lightweight. Consequently, it contributes to the facilitation of the installation work.

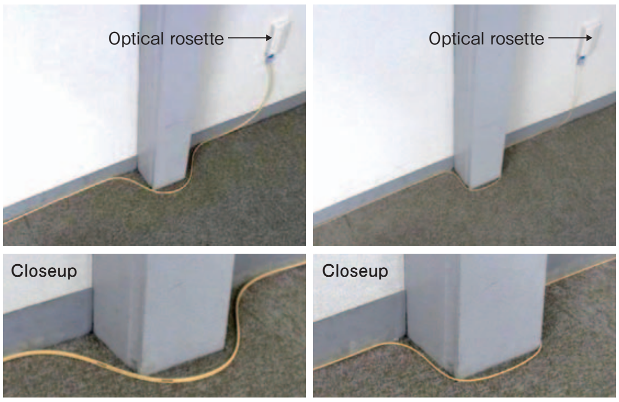

Figure 4 Wiring example.

3. CONCLUSION

We have developed a small optical indoor cable using PBO fiber FRPs. This cable enables easy wiring inside a home because it is small, lightweight and flexible. Moreover, because it is practically unnoticeable, optical fibers can be wired without disturbing the beauty of a room.

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