New Products

Small-diameter High-strength Optical Drop and Indoor Cables with PBO-FRP Strength Member

1. GENERAL DESCRIPTION

With the growing demand for optical communications, demands for installation of optical fiber cables to subscribers' households are increasing. For such optical cable installations, currently, the fiber element portion of an optical drop cable or optical fiber indoor cables are used. Conventional optical cables using metallic strength member have problems such that although they have sufficient strength they are conductive of lightning currents, and that they are rigid in bending thus leading to difficulty in cabling. On the other hand, non-metallic cables have such advantages as being non-conductive of surge currents and low in bending rigidity, but they are low in tensile strength compared with metallic cables.

Accordingly, we have recently developed optical drop and indoor cables using a new strength member made of poly-paraphenylene-benzobisoxazole (PBO) reinforced FRP. PBO fiber has a tensile strength more than twice that of aramid fiber, and the PBO strength member combines the advantages of both the metallic and non-metallic strength members.

2. FEATURES

2.1 High Strength

PBO fiber is manufactured by the fiber spinning method of liquid crystal polymers, and combines the highest-ranking levels among organic fibers of tensile strength, i.e. more than twice that of aramid fiber, and elastic modulus. The strength member was fabricated by impregnating the PBO fiber with a thermo-setting resin, followed by heating for thermo-setting to make an FRP.

Table 1 compares the size and tensile strength of the new cable using selected sizes of strength members with those of conventional cables. For drop cables, only the fiber element portion is taken into account.

It can be seen that a PBO-FRP of ϕ0.5 mm can achieve, regardless of being non-metallic, an allowable tensile stress comparable to that of a single steel of ϕ0.4 mm. Meanwhile, a PBO-FRP of ϕ0.27 mm can reduce the cable cross-sectional area by half, while obtaining an allowable tensile stress comparable to that of an aramid FRP of ϕ0.5 mm.

Table 1 Size and tensile strength of cables.

Cable type	Strength member size (mm)	Cable size (mm)	Allowable tensile stress of cable (N)
PBO-FRP	ϕ0.5	2×3	130
Single steel wire	ϕ0.4	2×3	150
PBO-FRP	ϕ0.27	1.2×2.4	40
Aramid FRP	ϕ0.5	2×3	35

2.2 Low Bending Rigidity

The cables using PBO-FRP have been successful in lowering their bending rigidity in comparison with conventional cables. Table 2 shows the bending rigidity of the new cable using selected sizes of strength members. For drop cables, only the fiber element portion is taken into account.

It can be seen that the bending rigidity of a cable using a PBO-FRP of ϕ0.5 mm is not more than one half that of a cable using a single steel of ϕ0.4 mm, and that of a flat cable measuring 1.2 x 2.4 mm using a PBO-FRP of ϕ0.27 mm is one third that of a cable using an aramid FRP of ϕ0.5 mm.

Table 2 Size and bending rigidity of cables.

Cable type	Strength member size (mm)	Cable size (mm)	Bending rigidity at D=20 mm (N) *
PBO-FRP	ϕ0.5	2×3	1.5
	ϕ0.27	1.2×2.4	0.48
		ϕ2.4	1.3
Single steel wire	ϕ0.4	2×3	3.5
PBO-FRP	ϕ0.5	2×3	1.5

* Measured in compliance with IEC 60794-1-2 Method E17C.

3. STRUCTURE

Figure 1 shows the cross-sectional structures of the cables. For each type of cable, the FlexiWave fiber that is capable of reducing the conventional allowable bending radius by half, i.e. from 30 mm to 15 mm, has been applied. As for small-diameter types, a round cable has been added to the product lineup in addition to conventional flat type cables.

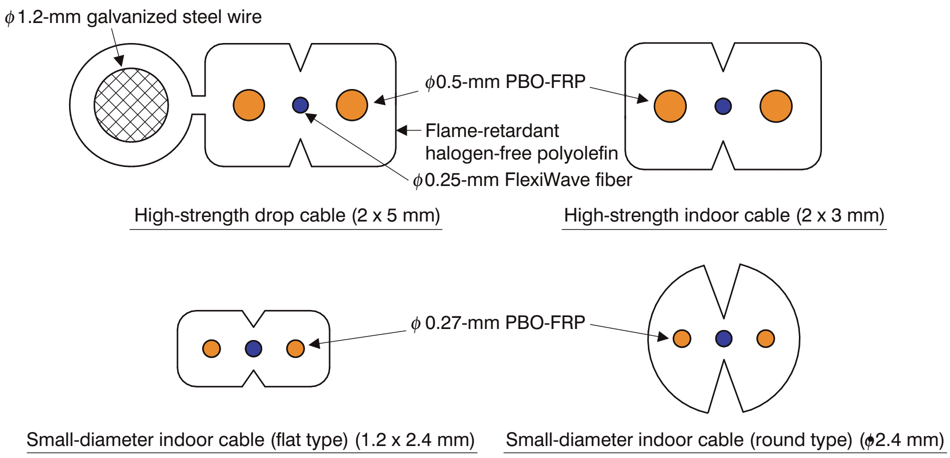

Figure 1　Cross-sectional structures of cables.

Table 3　Cable characteristics.

Test item		Test condition	High-strength drop	High-strength indoor	Small-diameter indoor (flat)	Small-diameter indoor (round)
Transmission characteristics		at 1.31μm, the maximum	0.34 dB/km	0.34 dB/km	0.34 dB/km	0.34 dB/km
		at 1.55μm, the maximum	0.21 dB/km	0.21 dB/km	0.21 dB/km	0.21 dB/km
Mechanical characteristics at λ=1.55μm	Tensile strength (of element portion)	High-strength: 130 N	<0.01 dB	<0.01 dB	<0.01 dB	<0.01 dB
		Indoor: 40 N				
	Squeezing	700 N, R=300 mm, 90°	<0.01 dB	—	—	—
	Reversed bending	R=15 mm x 10 cycles	<0.01 dB	<0.01 dB	<0.01 dB	<0.01 dB
	Winding	R=15 mm x 10 turns	<0.10 dB	<0.10 dB	<0.10 dB	<0.10 dB
	Lateral pressure	1200 N/25 mm x 1 min.	<0.01 dB	<0.01 dB	<0.01 dB	<0.01 dB
	Twist	50 N, ±180°/m x 10 cycles	<0.01 dB	<0.01 dB	<0.01 dB	<0.01 dB
	Impact	0.3 kg x 1-m height	<0.01 dB	<0.01 dB	<0.01 dB	<0.01 dB
Temperature characteristics		Drop: –30~70°C	<±0.02 dB/km	<±0.03 dB/km	<±0.03 dB/km	<±0.03 dB/km
		Indoor: –10~40°C				
Flame resistance		JIS C 3005, slanted	Self-extinguishing	Self-extinguishing	Self-extinguishing	Self-extinguishing

4. CABLE CHARACTERISTICS

Table 3 shows the cable characteristics, which are excellent and are comparable to those of conventional cables.

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