Performance Analysis and Monitoring of Different Designed Optical Fiber Cables

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ABSTRACT

To achieve greater flexibility and commercial performance like minimum laser bandwidth, attenuation, fast Ethernet performance different types of optical fiber cables are used for fiber optic communication channel. These FOC cables maximizes the rapid surface processing as well as very easy to install in a very small space in fiber patch panels with communication closets, medical laser power delivery, outdoor telecommunication networks on trunk or inter-exchange routes, telecommunication networks on high voltage overhead lines, undersea and electro-optical applications. This paper reviews a tabular comparative analysis for different optical fiber cables that utilizes indoor/outdoor and special type cables. Also these fiber optic cable design have attracted for high R & D works due to their different features and wide applications.

Keywords

FOC cable, Loose Tube, Crush resistance, Core diameter.

1. INTRODUCTION

Now-a-days optical fiber cables in the research field are characterized by a low optical loss, high flexibility and commercial cost. From a long history of research optical fiber cables are designed for unprotected environment and data cable in distribution networks. But Now-a-days for commercial point of view optical fiber cables are characterized for a best resource. The selection [12] of a FOC cable is vital in the field of application whether it is useful for low to high fiber count requirements or factory floor automation and harsh environment installation. In this paper representation of ultra high density [4] rollable optical fiber ribbons, stranded tube ribbon cable, single-tube ribbon and single armour optical fiber cable is described. Also the analysid of the structural design of the vital features of Gel-Free, Arid-core , Self-supporting and Drop-type FOC cables are monitored. In this article emphasis is given on different recent and oldest commercial FOC cables according to their fiber counts, advantages and widely used applications for high data transmission. It is impossible to overview the descriptive information in this specific area due to limitation of pages given and also many excellent reviews have already appeared. In this article several available fiber counts and inter-core diameters of different FOC cables are discussed.

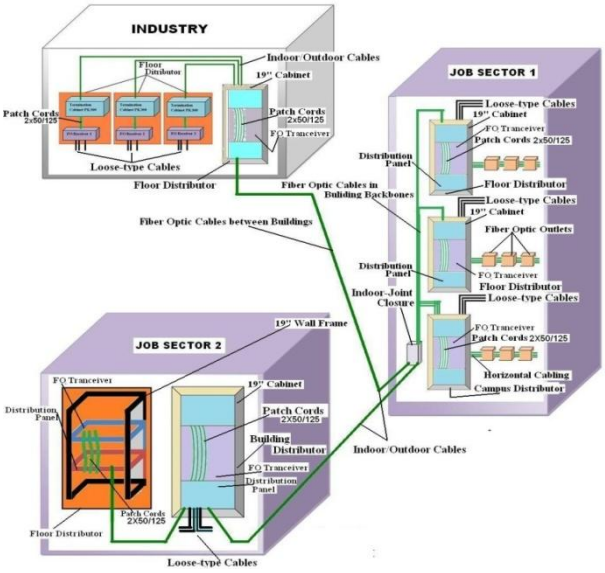


Fig 1: Schematic of FOC cable connection for multiple network applications

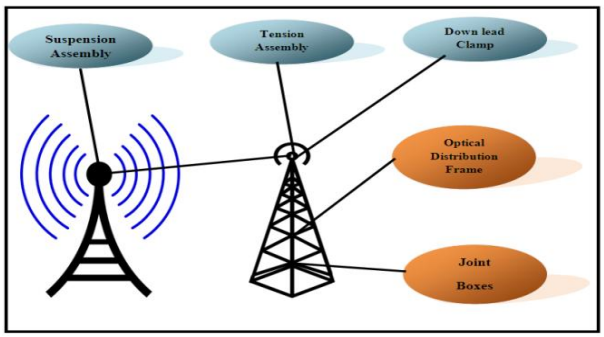


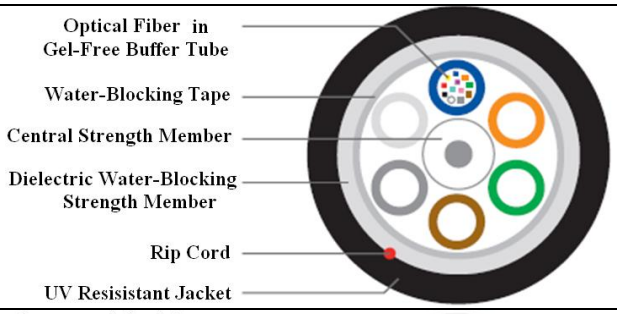
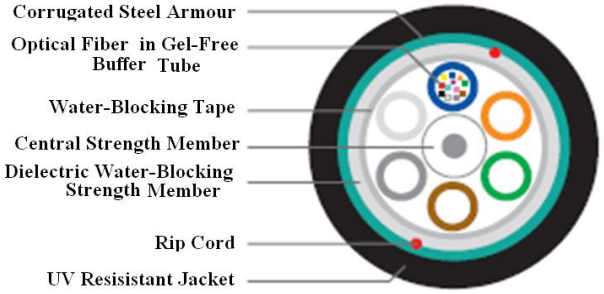
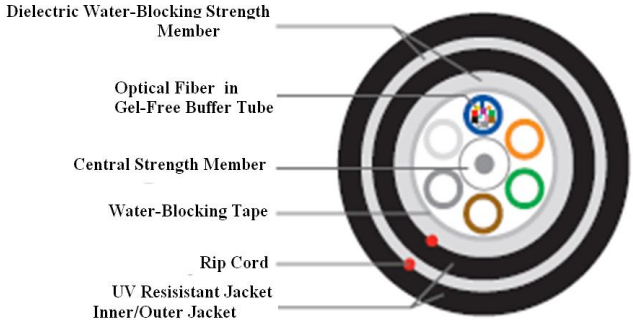
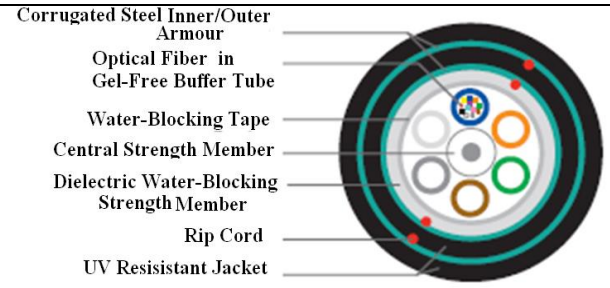
Fig 2: Schematic of FOC cable connection for data distribution applications

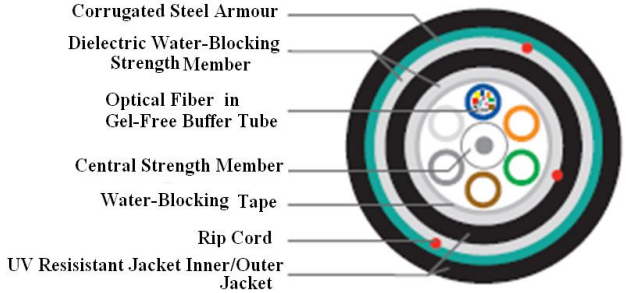
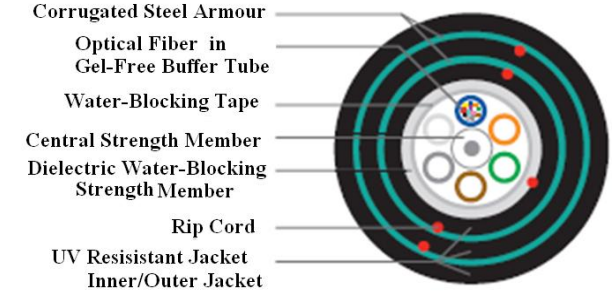
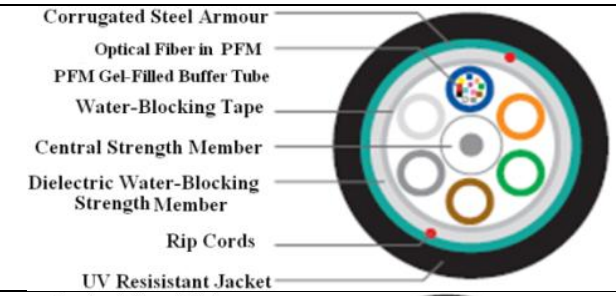
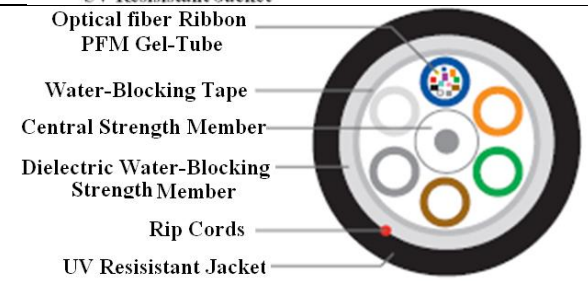
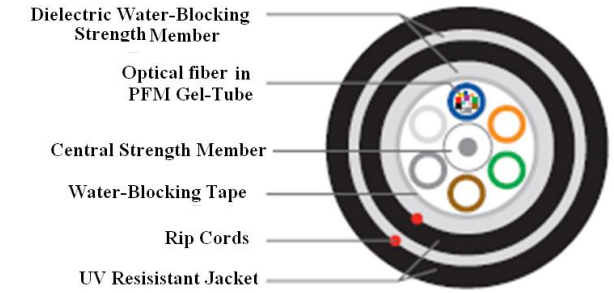
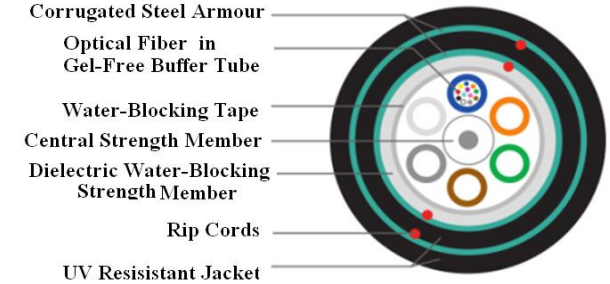
2. DIFFERENT DESIGNED OPTICAL FIBER CABLES (AVAILABLE FIBER COUNTS)

Table 1. IEEE standards defined for various data rate(Mbps) w.r.t maximum distance(km)

Cable Type	Standard	Data Rate	IEEE Standard Max. Distance
Multi-mode: 850 nm; 50/125µm or 62.5/125µm 2 km	10Base-FL	10 Mbps	2 km
Multi-mode: 1300 nm; 50/125µm or 62.5/125µm 2 km	100Base-FX	100 Mbps	2 km
Multi-mode: 850 nm; 50/125µm or 62.5/125µm	100Base-SX	100 Mbps	300m
Single-mode: 1310nm, 1550nm, 9/125µm	100Base-LX	100 Mbps	100 km
Multi-mode: 850 nm; 62.5/125µm, 50/125µm	1000Base-SX	1000 Mbps	220 m, 550 m
Multi-mode: 1300 nm; 50/125µm or 62.5/125µm Single-mode; 1310 nm; 9/125µm	1000Base-LX	1000 Mbps	550 m 2 km
Single-mode: 1550 nm; 9/125µm	1000Base-LH	1000 Mbps	70km

Table 2. Performance Analysis of different designed FOC cables (6 > 100 < 300 available fiber counts)

FOC Cable (Fiber counts/ Internal Core diameters)	Cross-Sectional view	Advantages	Applications
1.Dri –Lite Loose-Tube Single Jacket All Dielectric Optical Fiber Cable (12fiber/10.9, 288fiber/20.5)		•It reduces cable preparation & Installation time. •High fiber density. •Multiple network applications.	•Local loop, metro, long-haul & broadband network. •Underground duct & lashed aerial antenna. •Trunk, distribution & feeder cable.
2.Dri –Lite Loose-Tube Single Jacket Single Armor Optical Fiber Cable (12fiber/12.2, 288fiber/22.7)		•Multiple network applications. •Improves compressive strength & rodent protection. •High fiber density.	•Trunk, distribution & feeder cable. •Local loop, metro, long-haul & broadband network. •Direct bury , underground duct & lashed aerial.
3.Dri –Lite Loose-Tube Double Jacket Non-Armor Optical Fiber Cable (12fiber/13.5, 288fiber/22.9)		•It reduces cable preparation & installation time •High fiber density. •Metallic option offers ease of location, dielectric design eliminates grounding issues.	•Local loop, metro, long-haul & broadband network. •Underground duct & lashed aerial antenna. •Trunk, distribution & feeder cable.
4.Dri –Lite Loose-Tube Double Jacket Double Armor Optical Fiber Cable (12fiber/17.5, 216fiber/25.6)		•Reduces the number of tools required. •Improves compressive strength & rodent protection.	•Local loop, metro, long-haul & broadband network. •Underground duct & lashed aerial antenna. •Trunk, distribution & feeder cable.

5.Dri –Lite Loose-Tube Double Jacket Single Armor Optical Fiber Cable (12fiber/14.5 288fiber/25)		•Reduces the number of tools required. •It reduces cable preparation & installation time. •Multiple network applications.	•Local loop, metro, long-haul & broadband network. •Underground duct & lashed aerial antenna. •Trunk, distribution & feeder cable.
6.Dri –Lite Loose-Tube Triple Jacket Double Armor Optical Fiber Cable (12fiber/20.3, 216fiber/27)		•Speeds fiber access & cleanup •Improves compressive strength & rodent. •Multiple network applications.	•Local loop, metro, long-haul & broadband network. •Underground duct & lashed aerial antenna. •Trunk, distribution & feeder cable.
7.Loose-Tube Single Jacket Single Armor Optical Fiber Cable (6fiber/12.2, 288fibe/22.7)		•Non-sticky gel speeds fiber. access & clean up •Multiple network application. •Reduces the number of tools required.	•Local loop, metro, long-haul & broadband network. •Underground duct & lashed aerial antenna. •Trunk, distribution & feeder cable.
8.Loose-Tube Single Jacket All dielectric Optical Fiber Cable (6fiber/10.3, 288fiber/18.9)		•Non-sticky gel speeds fiber access & clean up. •Metallic option offers ease of location, and dielectric design.	•Local loop, metro, long-haul & broadband network. •Underground duct & lashed aerial antenna. •Trunk, distribution & feeder cable.
9.Loose-Tube Double Jacket Non-Armor Optical Fiber Cable (6fiber/10.3, 288fiber/18.9)		•Non-sticky gel speeds fiber. access & clean up •High fiber density. •Multiple network applications.	•Local loop, metro, long-haul & broadband network. •Underground duct & lashed aerial antenna. •Trunk, distribution & feeder cable.
10. Loose Tube Double Jacket Double armor Optical Fiber Cable (6fiber/17.5, 216fiber/25.6)		•Used as data cable in distribution networks. •Used for high safety requirements in case of fire.	•Low smoke, halogen free and self-extinguishing. •Easy stripping and no need for cleaning the fibers.

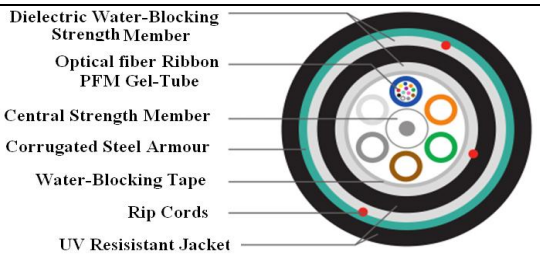
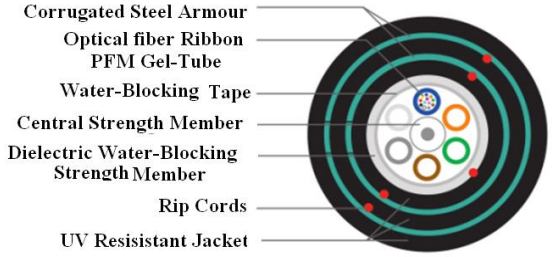
11. Loose Tube Double Jacket Single Armor Optical Fiber Cable (6fiber/14.1, 288fiber/22.9)		•No need for fiber cleaning. •Low smoke, halogen free and self-extinguishing.	•Used for installation in cable ducts and high fire safety. •Used as data cable in distribution networks.
12. Loose Tube Triple Jacket Double Armor Optical Fiber Cable (6fiber/20.3, 216fiber/27)		•Halogen free and non-corrosive fire gases. •Longitudinal and transversal watertight cable.	•Used for installation in indoor and outdoor areas. •Ideal for high safety requirements in case of fire.

Table 3. Performance Analysis of different designed Ribbon-type FOC cables (12 – 1008 available fiber counts)

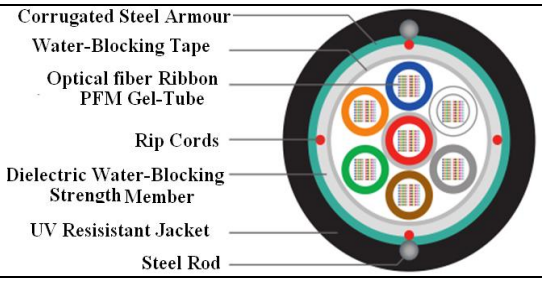
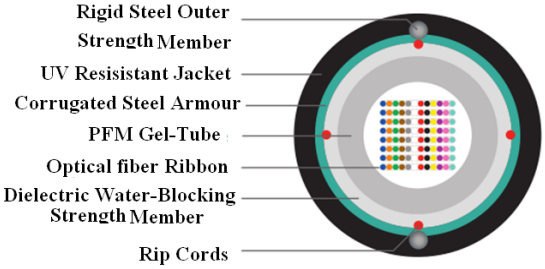
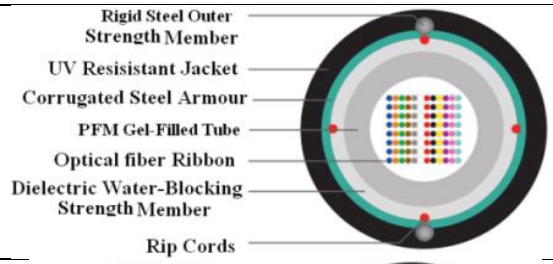
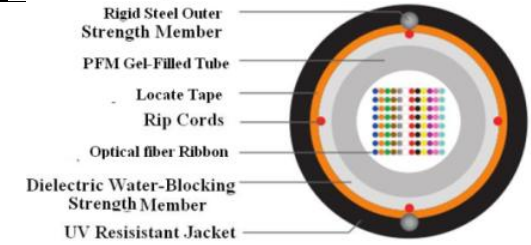
FOC Cable (Available fiber counts/ Internal Core diameters)	OFC Cable Name	Advantages	Applications
1.Stranded Tube Ribbon Single Armor Optical Fiber Cable (360fiber/31.8, 1008fiber/31.8)		•It has high fiber density and individual tube access. •It has compressive strength, rodent protection and ease of location.	•Used as trunk distribution and feeder cables. •Specifically applicable for direct bury installations.
2.Single Tube Ribbon Optical Fiber Cable (12fiber/12, 864fiber/24.4)		•Its dielectric design eliminates grounding issues. •Its non-sticky gell allows easier and faster clean up.	•Designed for outside plant direct bury installations. •Used as lashed aerial and underground duct.
3.Single Tube Ribbon Single Armor Optical Fiber Cable (12fiber/13, 432fiber/21)		•Multiple network applications •Easier handling and reduced loss.	•Specifically used for lashed aerial and underground duct. •Used for broadband.
4.Ribbon Locate Optical Fiber Cable (60fiber/13, 216fiber/17)		•Reduces preparation time and labour cost. •It has small outer diameter and high flexible tube.	•Used as lashed aerial and underground duct. •Specifically used for broadband networks.

Table 4. Schematic of different designed optical fiber cables having Rollable Ribbons.

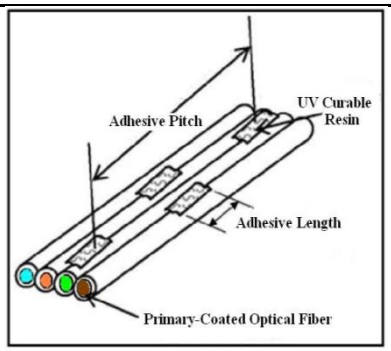


Fig 3: Schematic of Unrolled 4-fiber Ribbons

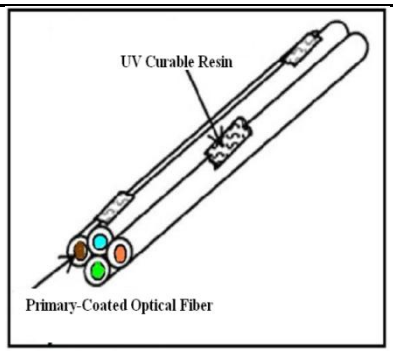


Fig 4: Schematic of Rolled 4-fiber Ribbon

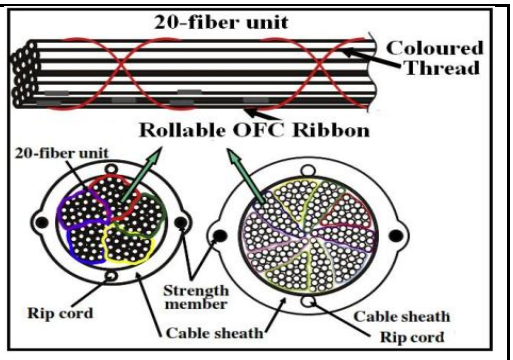


Fig 5: 100 & 200-fiber Ribbon FOC cable design

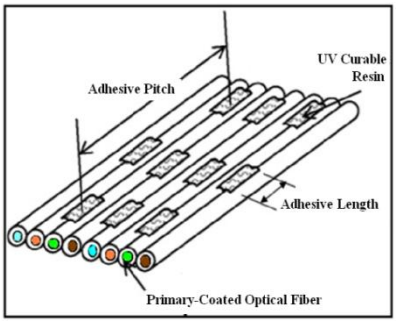


Fig 6: Schematic of Unrolled 8-fiber Ribbons

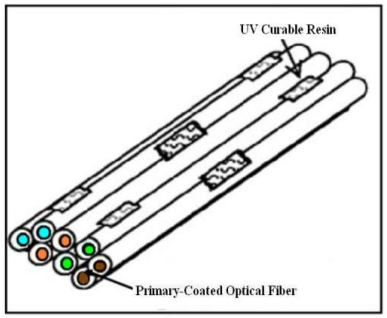


Fig 7: Schematic of Rolled 8-fiber Ribbon

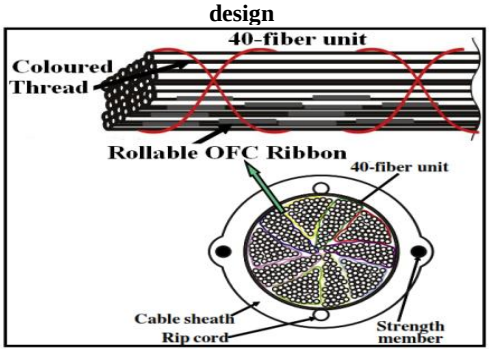


Fig 8: 400-fiber Ribbon FOC cable design

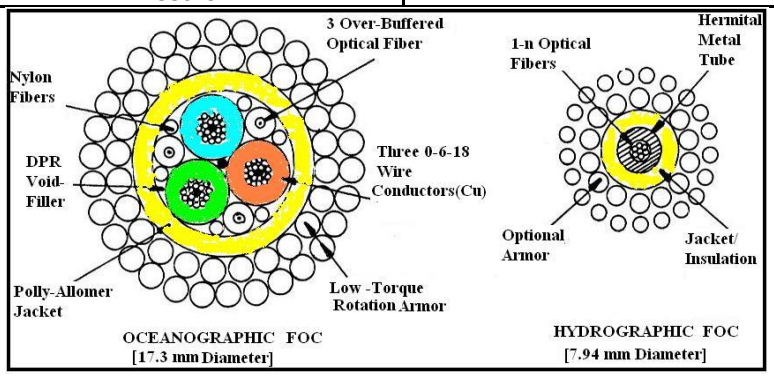


Fig 9: Schematic of Oceanographic and hydrographic FOC cable having 17.3 mm and 7.94 mm diameter respectively

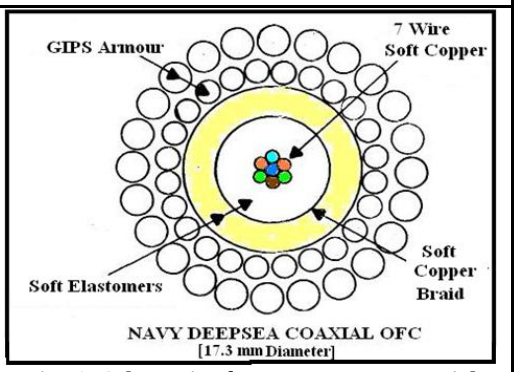
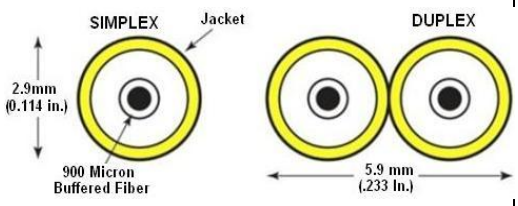
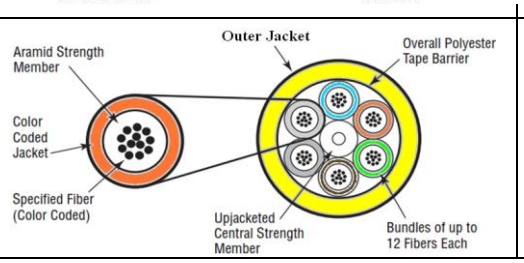
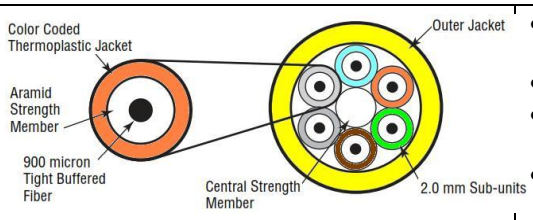
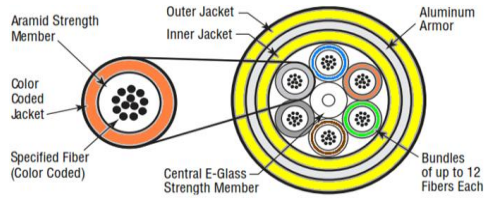
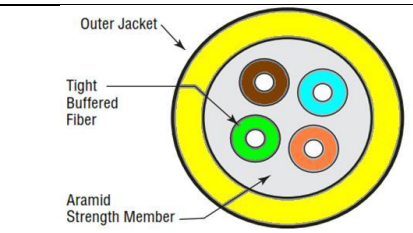
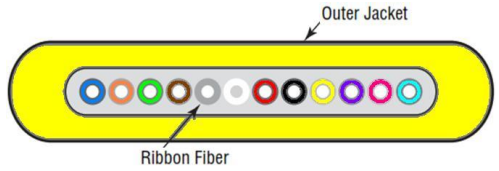
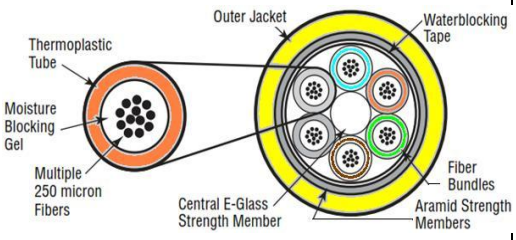
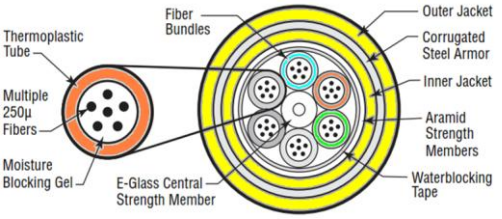
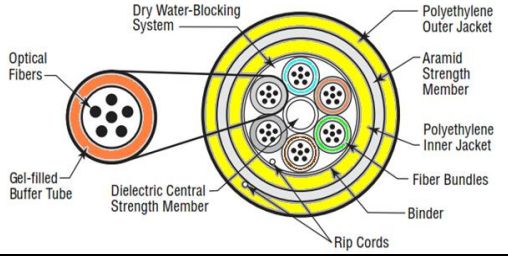
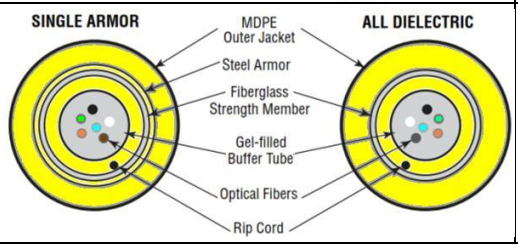


Fig 10: Schematic of Navy Deep-sea co-axial FOC cable having 17.3 mm diameter

Table 5. Selection Analysis of different designed FOC cables

Optical fiber cable Types	Fiber Bundle	Parameters	Applications
1.Interconnect Cable		•Operating Temperature Range : -20 to +70°C •Crush Resistance : 200 N/cm •Impact Resistance : 20 Impacts @ 1.0 N-m •Cyclic Flexing : 2000 cycles, min.	•Patch panels. •Workstation equipment connections. •Horizontal distribution in open office environments.
2.Distribution Cable		•Operating Temperature Range : -20 to +70°C •Crush Resistance : 2000 N/cm •Impact Resistance : 2000 Impacts @ 1.6 N-m •Cyclic Flexing : 2000 cycles, min.	•Low to high fiber count requirements. •In-building backbone •Fiber-to-the-desk applications. •Computer room.

3.Breakout Style Cable		•Operating Temperature :Range : -20 to +70°C •Crush Resistance : 2000 N/cm •Impact Resistance : 2000 Impacts @ 1.6 N-m •Cyclic Flexing: 2000 cycles, min.	•Low to medium fiber count requirements. •In-building backbone or horizontal deployment.
4.Industrial Armored Cable		•Operating Temperature Range: -20 to +70°C •Crush Resistance : 2000 N/cm •Impact Resistance : 2000 Impacts @ 3.0 N-m	•Industrial environments and rugged installations. •Manufacturing plants. •Telecommunications and data trunk.
5.Tactical Cable		•Operating Temperature Range: -55 to +85°C •Crush Resistance : 440 N/cm •Impact Resistance : 200 Impacts @ 2.2 N-m •Cyclic Flexing: 2000 cycles, min.	•ENG vehicles. •Outdoor news, sporting or other events. •Military communications. •Re-deployable communications.
6.Ribbon Cable		•Operating Temperature Range: -20 to +70°C •Crush Resistance : -2000 N/cm •Impact Resistance : 2000 Impacts @ 1.6 N-m	•Inter-equipment connections. •NEBS applications.
7.Single Jacket, All Dielectric Cable		•Operating Temperature Range (Outdoor Series): -40 to +70°C •Crush Resistance : 2000 N/cm •Impact Resistance : 2000 Impacts @ 1.6 N-m	•Medium to high fiber count requirements. •Inter-building duct installations. •Lashed aerial. •Indoor/outdoor. •Industrial outside plant.
8.Double Jacket, Armored Cable		•Operating Temperature Range : (Outdoor) -40 to +70°C •Crush Resistance : 2000 N/cm •Impact Resistance : 2000 Impacts @ 1.6 N-m	•Direct burial. •Low to high fiber count requirements. •Inter-building duct installations. •Indoor/outdoor. •Industrial outside plant.
9.Double Jacket, Heavy-Duty Cable		•Operating Temperature Range : -40 to +70°C •Crush Resistance : 2000 N/cm •Impact Resistance : 2000 Impacts @ 1.6 N-m	•Direct burial. •Harsh environments. •Applications requiring good ozone-, moisture- and weather-resistance.
10. Central Tube Cable		•Operating Temperature Range : -40 to +70°C •Crush Resistance : 2000 N/cm •Impact Resistance : 2000 Impacts @ 1.6 N-m	•Campus OSP backbones drop cable. •Telecommunications and data trunk. •Direct burial (armored only). •Lashed aerial.

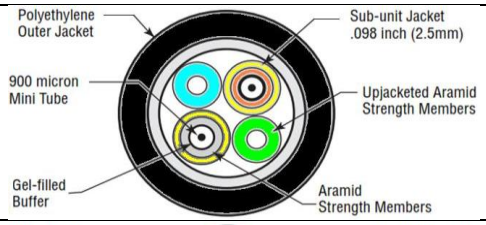
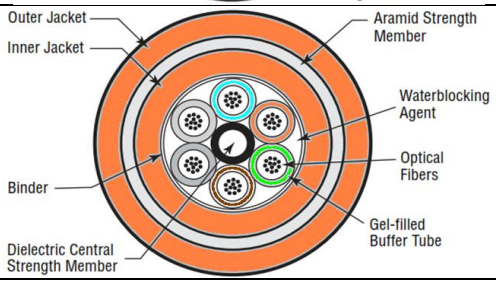
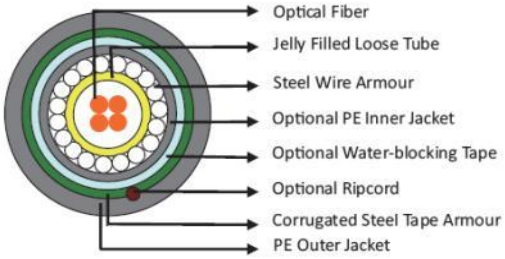
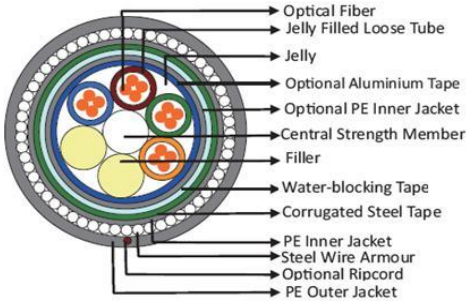
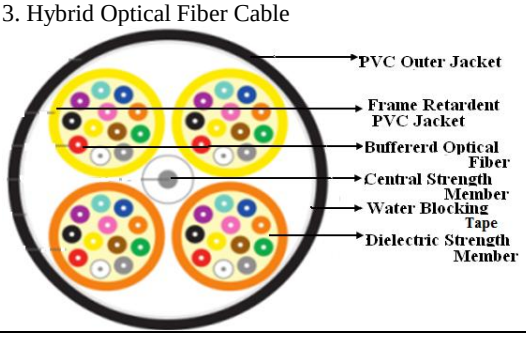
11. Micro Loose Tube Breakout Style Cable		•Operating Temperature Range : -20 to +70°C •Crush Resistance : -600 N/cm •Impact Resistance : 20 Impacts @ 1.0 N-m	•Ducts between buildings (above or below frost lines). •Lashed aerial. •Telecommunications and data trunk.
12. TrayOptic Heavy- All Dielectric Cable		•Operating Temperature Range : -40 to +70°C •Crush Resistance : 2000 N/cm •Impact Resistance : 2000 impacts@ 1.6N-m •Cyclic Flexing : 25 cycles, 12 lbs.	•Industrial and other harsh environment applications. •Factory automation. •Direct burial.

Table 6. Performance Analysis of Special types of different designed FOC cables

Cross-sectional View	Application	Advantages	Properties
1. Central Loose Tube Under Water Cable 	•It is used for long haul communication system in under water condition. •Junction communication system in under water condition.	• Loose tube jelly filled for superior fiber protection. • High tensile strength design. • Superior mechanical and environmental performance.	•Available Fiber Count: 2-12. •Operating Temperature Range : -40°C to +70°C). •Crush Resistance: 263 N/cm. •Maximum Compressive Load: 3000 N.
2. Multi Loose Tube Under Water Cable 	•It is used for long haul communication system in under water condition. •Junction communication system in under water condition.	• Superior fiber protection. •Colored coded fibers and binders for quick and easy identification during installation. •High tensile strength design.	•Available Fiber Count: 2-12, 26-36, 38-72. •Operating Temperature Range: -40°C to +70°C. •Crush Resistance:220 N/cm. •Maximum Compressive Load: 4000 N.
3. Hybrid Optical Fiber Cable 	•Most cost-effective cables for the varied applications. •Eliminates the need for additional pathway space for different cable types. •Assures compliance for all current networking.	•Intra-building backbones and Inter-building backbone. •Service entrance to communication closets.	•Available Fiber Counts:4-72. •Flexible tight buffer material extruded over the fiber to a diameter of 900 µm for use with standard connectors. •Operating Temperature Range: -40°C to +75°C •Storage Temperature Range: 40°C to +75°C

3. ENVIRONMENTAL EFFECTS AND THEIR SOLUTIONS

Table 7. Effects and their solutions adopted for different operating environments of optical fiber cables.

Handling Environments	Effect on fiber optic cables	Necessary Steps used
Working in ice, temperature and wind.	Attenuation increased or fiber optic cable breakage due to compression or expansion.	Loose fiber protection with excellent control of fiber extra length allowing elongation or compression of the cable.
When hydrogen is generated in metal structure	Attenuation increased because FOC cable absorbs hydrogen.	Hydrogen-absorbent gel filled within core of the cable.
Within Moisture and Rain.	Attenuation increased.	Sealing gel filled within core of the cable.
The impact of lightning.	Cable wire may breakdown.	Select Aluminum Alloy wires for Thermal protection.
The line short-circuits.	Sttenuation increased.	To design core with high Aluminum material.
Condition of corrosion.	Cable wire breaks and attenuation increased.	To use AA and AS wires for highly corrosive areas.

4. CONCLUSION

In this article, representation of different designed fiber optic cables for excellent applications is discussed. Analysis of different aspects of designed FOC cables on the basis of their available fiber counts, internal core diameter, benefits with respect to their applications is also clearly stated. The design of FOC cables would benefit in cable handling and should occur primarily as response to new operational capabilities offered by the fiber or to new requirements that the fiber brings with it in the future. These future scopes include the efficiency of these designed FOC cables that show their adaptability to exposure for different operating environments. The fiber cables discussed in section 2[1, 7] clearly show the application and various advantages for fiber counts less than 300. For Ribbon type FOC cables there is a vast variation of fiber counts ranging from twelve to three hundred. This tabular comparison can be extended to FOC cables of general type (not Ribbon type) beyond three hundred counts on which investigation is being carried out. From the available sources [4, 7] the schematics of ribbon FOC cables are displayed in Table 4. On the basis of available facts [12, 13] selection analysis of various FOC cables are described in tabular form in Tables 5 and 6 respectively. It is hoped that this investigation would help readers in getting a fair idea about FOC cable interior design.

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