Application Notes

Sterlite Tech

Selection of the Correct Optical Cable Core Design for the Application

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Abstract

The cable core provides the organization for the optical fibers inside the cable and impacts the time associated with cable preparation and splicing. The cable core contains the fiber arrangement that also impacts the ease of cable end preparation and mid span access. Various levels of fiber protection are provided for storage in splice closures and in pedestals. Finally, it contains the optical fiber itself, the pathway over which information is carried.

Keywords

Cable sheath, multitube versus unitube design, ribbon versus loose fibers, water blocking gel versus dry water block materials.

Introduction

This Optical Cable Core Design Selection Note is intended to provide the reader with an organized selection methodology when they must select the best suited optical cable core for the specific application. Cable core issues discussed: multitube versus unitube design, ribbon versus loose fibers, and water blocking gel versus dry water block materials.

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A typical cable design has the cable sheath surrounding the cable core. The cable sheath often contains much, if not most of the environmental protection. Cable sheath contains strength members, armoring, and jacketing to provide its abrasion resistance, placing characteristics, and fire retardance if required. The cable core consists of the packaging for the fiber, fiber organization, water protection, and strength elements. The figures below show optical cables with a mutitube and unitube cable core, respectively.

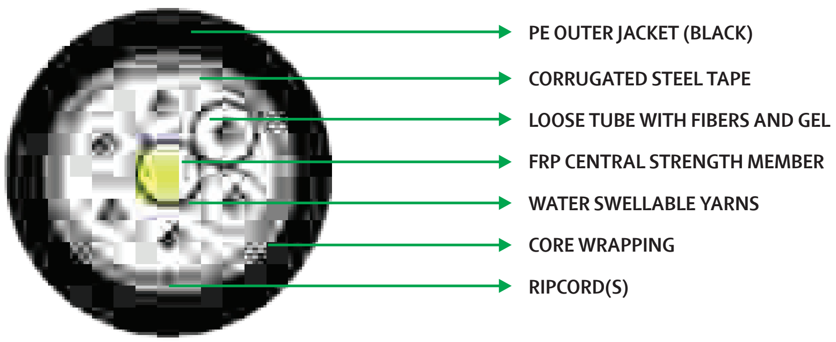


Figure 1- Sterlite® ARMOR-LITE™ Fiber Optic Cable Series
Multitube Single Jacket Steel Tape Armored Gel Free Fiber Optic Cable

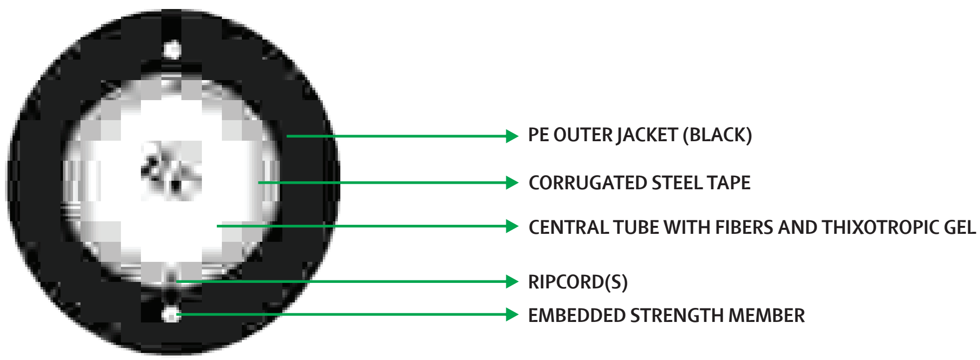


Figure 2– Sterlite® ARMOR-LITE™ Fiber Optic Cable Series
Unitube Single Jacket Steel Tape Armored Fiber Optic Cable

Optical cables are available in a wide variety of cross-sections. They vary from the smallest, simplex or duplex cables used as jumpers and pigtails to large size (up to 864-fiber cable) for long haul transmission. Outside plant cable cores contain either bare fibers (250 µm diameter) or multifiber ribbons placed inside one or more buffer tubes. Some cables in the outside plant, e.g., those that are pre-terminated with optical connectors, and smaller cables used indoors contain bare fibers covered with a 900 µm diameter tight buffer coating. The tight buffer coating provides additional robustness to the fiber for improved individual fiber handling characteristics.

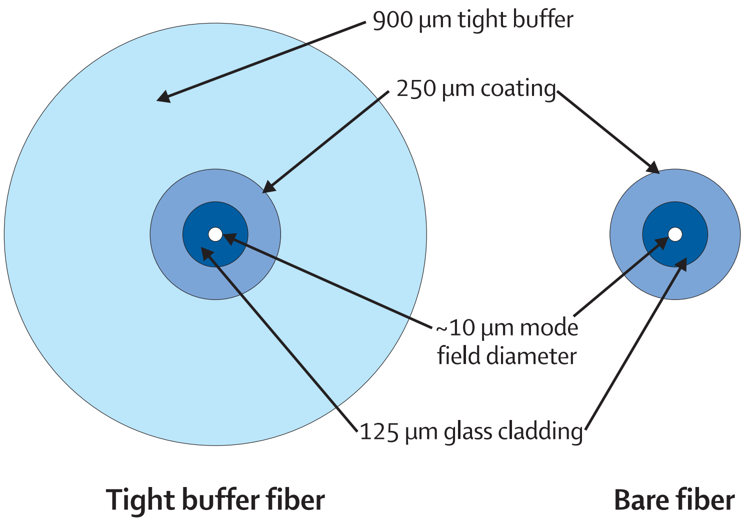


Figure 3– Sterlite's Tight Buffered fiber and Bare Fiber

Sterlite optical cables all are compliant with the following international specifications:

- Meets or exceeds Telcordia GR-20-CORE and GR-409-CORE.
- Meets or exceeds IEC 60793 and IEC 60794 and other industry standards.
- Compliant with EU's RoHS (Restriction of the use of Certain Hazardous Substances Directive).
- Fibers meet ITU-T G.650 series for singlemode and multimode fibers.

Multitube versus central tube

Multitube Design

The loose buffered tubes form a modular cable that is useful in providing a protected system that allows groups of fibers to be dropped off at key midspan branching points along its length.

Multitube cables are designed with fiber filled buffer tubes stranded around a central strength member (CSM). Each buffer tube contains 6-24 color coded individual fibers, with 12 individual fibers as the most common. Multitube cables may also contain up to 12-fiber coded ribbons per tube. For Loose Tube cables, the buffer tubes are of small diameter, color coded plastic tubes. Normally, the diameter of buffer tubes for loose individual fibers ranges from 1.9 to 3 mm.

Buffer tubes are stranded during manufacture to have a reverse oscillating lay around the CSM called S-Z stranding. This provides some slack within the cable core to relieve strain during cable loading and also to provide some slack for cable repairs and in-line, mid-span access to specific tubes and fibers. The tubes of the optical fiber cables are stranded in concentric layers around the CSM to reach high fiber counts. As a result of the S-Z stranding, the length of the fibers is slightly longer than the length of the cable sheath. As load or thermal changes occur on the cable, the fibers adjust their position within their buffer tubes.

The buffer tubes are useful in providing protection to fiber as they enter, leave, or are expressed through a splice closure or pedestal. The buffer tubes provide organization within in splice closures and pedestals. They also enable technicians to confidently identify individual fibers within large cables.

The buffer tubes, fibers, and fiber ribbons are color coded to help the splicing technician identify individual fibers within the cable. In North America, TIA-598 fiber identification coding is normally followed.

Table 1- TIA 598 Color Coding for Fiber and Buffer Tubes

Fiber Number	Color Code	Color	Fiber Number	Color Code w. black tracer	Color w. black tracer
1	Blue		13	Blue	
2	Orange		14	Orange	
3	Green		15	Green	
4	Brown		16	Brown	
5	Slate		17	Slate	
6	White		18	White	
7	Red		19	Red	
8	Black		20	Black[1]	
9	Yellow		21	Yellow	
10	Violet		22	Violet	
11	Rose		23	Rose	
12	Aqua		24	Aqua	

[1] Fiber 20 is color coded black with a yellow tracer.

Unitube Design

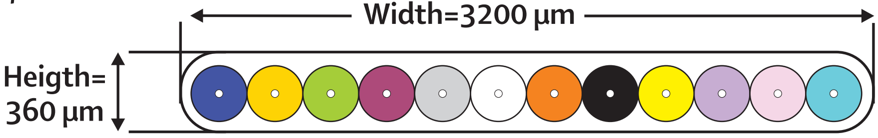
A second core design found in some optical cables is the central core tube or unitube design. The unitube cable has only one tube that is concentric with the center of the cable. The large central tube at its core contains loose individual fibers, loose fibers arranged in binder groups, or in ribbons.

The unitube cable often provides the most compact fiber arrangement, thus keeping the cable size to a minimum. Fiber within the center tube can be packaged either bundled in 12 fiber color coded wrapped bundles or in 12-fiber ribbons, some unitube designs contain 24-fiber ribbons.

Ribbons versus individual fiber bundling

Cable designers place individual fibers in bundles in gel filled buffer tubes or a gel filled central tube or multi-tube ribbons also stored in gel filled buffer tubes or a central tube within the cable core. The gel filling is used as a water blocking material to prevent water infiltrating through the cable. An alternate water blocking material, embedded in yarns or tapes can be used as a light weight, less messy substitute for gel filling. Both fibers and fiber ribbons are coded for identification to TIA 568. Fibers and fiber ribbons are normally used in similar cable designs; however, since ribbons are somewhat larger than individual fibers, they need to be protected in larger diameter tubes than individual fibers.

Figure 4- Sterlite's Optical Ribbon



The following table provides a listing of the advantages and disadvantages of loose buffered fiber cables as compared to using ribbon type cables.

Table 2- Comparisons of the Strengths of Individual Buffered Fibers and Ribbonized Fibers

Loose Buffered Fibers	Ribbonized Fibers
• Easy access to individual fibers	• High fiber counts (Up to 864) available.
• Reverse Oscillation Lay (ROL) buffer tube stranding technique facilitates mid-span entry.	• Ribbon provides somewhat more robust package
• Meets Telcordia GR-20 and IEC 60793.	• Meets Telcordia GR-20 and IEC 60793.
• Compliant with RoHS.	• Compliant with RoHS.
• Splicing technicians are familiar with this type of fiber.	• Mass fusion splicing enables significant time reduction for high fiber count cables.
• Minimal fiber strain on optical fibers.	• Ribbon splicing can save considerable time and money when compared to splicing individual fibers.
• No offset breaks during accidental dig ups resulting in minimum repair length requirements.	• Ribbon cable is typically cost competitive in counts of 96 fibers and above.
• Provides a organized system to break out individual fibers or groups of fibers from a cable.	• Produces a more compact and organized fusion splice that uses less space.
	• Provides easier, mid-span access than conventional loose tube cables.

Given the various tradeoffs, ribbon cores, either stranded tube or central tube, are typically chosen for high fiber count cable applications. Whereas multiple stranded buffer tubes are selected for mid fiber count cables, and central tube core designs are selected for low fiber count cables.

WATER BLOCKING GEL VERSUS DRY BLOCK

Water blocking materials are placed inside the cable core inside and outside of the buffer tubes to prevent water migration down the optical cable. While optical fibers are extremely resistant to water, it is generally not a good idea to allow water to migrate lengthwise inside the cable, particularly near a splice closure. Water blocking technology comes in two forms: greases & gels, or super absorbent, water swell-able materials.

What is "wet core" Cable?

Wet core is often used to describe grease and gel-filled cables. For wet core cables the buffer tubes are filled with a thixotropic gel, called filling compound, which protects the fibers and prevents water migration inside the tubes. After the tubes are stranded together, a thick sticky grease material, called flooding compound is forced into the spaces and voids between the tubes to prevent water migration down the core of the cable. For a wet core cable, water blocking gels inside the fiber buffer tubes and water blocking flooding compounds throughout the cable core prevent water migration and offer mechanical protection to the optical fibers inside the buffer tubes.

What is Dry Block?

For most cable designs the original sticky greases or flooding compound are no longer used outside of the buffer tubes, rather tapes and yarns impregnated with the same super absorbent water swell-able materials used in disposable diapers are used to capture water and prevent it from migrating down the outside of the tubes.

Cables with dry block materials in the core, and gel filling compound inside the tubes are still widely used in various markets and applications. For fully "dry" loose tube cables, one or more water swellable yarn(s) are placed inside the buffer tubes along with the loose optical fibers. For fully "dry" ribbon cables, water swellable tape(s) wrap around the ribbon stack inside the tube. In each case, the water block materials absorbs any water that enters the tubes, causing it to swell forming a physical barrier to block further water migration along the cable.

Dry block cables are somewhat lighter in weight than wet core cables of similar size and intended use. As a result, they will be easier to handle and can be placed in longer lengths in underground ducts. Most fiber technicians find working with dry block cables, easier, faster, and less costly.

Table 3- Comparison of Wet Core to Dry Block

Cable Element Receiving Water Protection	Wet Core	Mixed Dry Core Gel Filled	Dry Block
Fiber Buffer Tubes	Filling Gel	Filling Gel	Water Blocking Yarns
Spaces within Core	Flooding Gel	Water Blocking Tape & Yarns	Water Blocking Tape & Yarns
Core Wrapping	Polyester Tape	Water Blocking Tape	Water Blocking Tape

Both Wet and Dry core cables not only meet the water penetration requirements of fiber optic cable specifications, they also are compatible with all other requirements of the testing, i.e. temperature cycling, hot and cold bending, impact, crush, tensile strength, material compatibility, and many more. Sterlite Technologies has determined that both types of cables perform similarly when tested to international cable specifications.

Additional Information

If there are additional questions on this topic or other fiber optic issues, please contact:

Contact Information

telecom.sales@sterlite.com

www.sterlitetechnologies.com