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Ribbon Fiber Cable
A comparison with Non-Ribbon Cable

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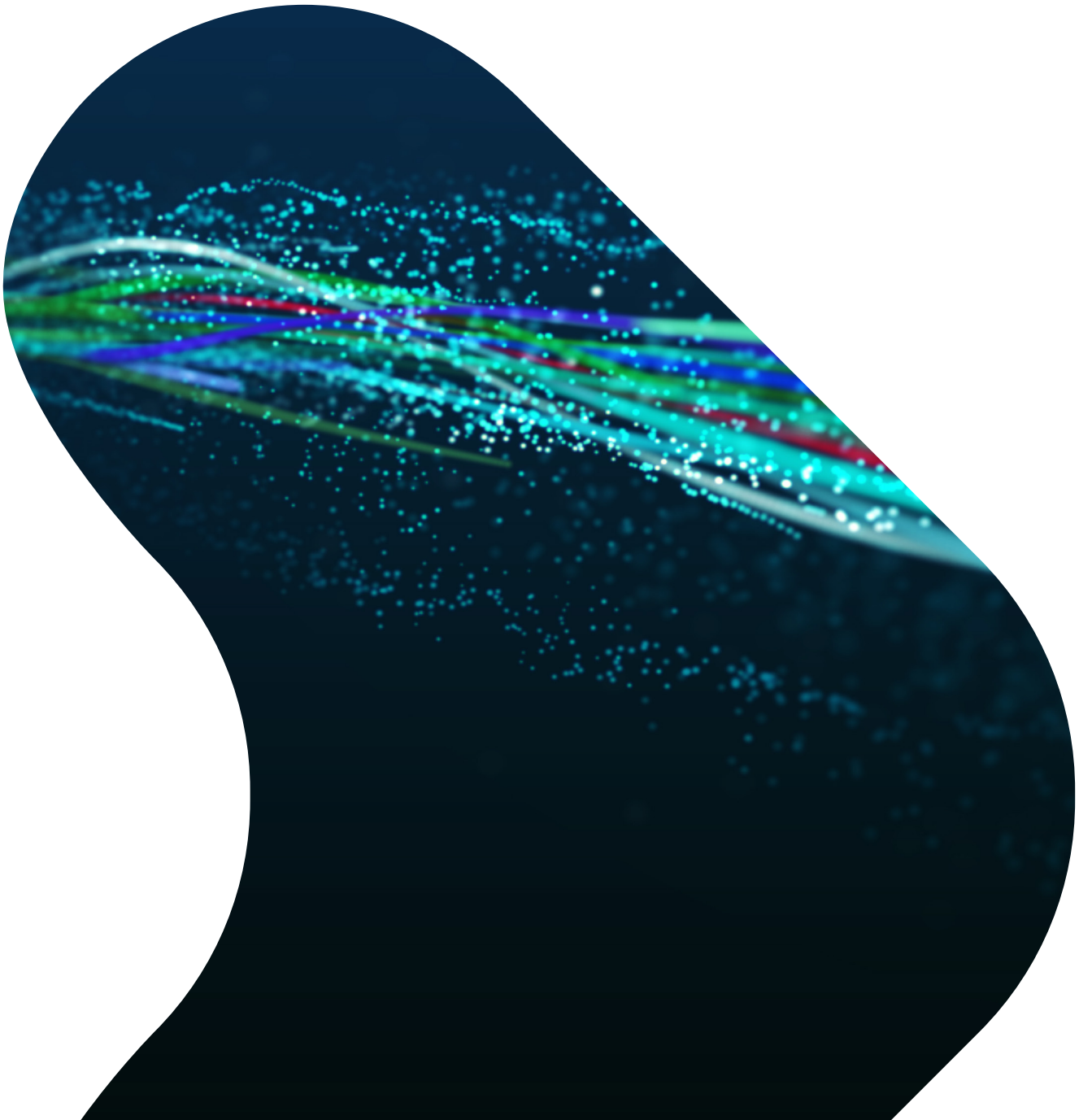


ABSTRACT

Substituting ribbons for individual fibers within an optical cable allows the fiber to be packed more compactly within the cable whether it is a multi-tube or central tube cable. Ribbon cables are smaller in size and weight and generally easier to handle than comparable individual fiber based cables. The net result is ribbon cables are easier for the installation crew to handle and place.

What is a Ribbon Optical Cable?

Optical fiber ribbons are made up of individual fibers aligned in a single row then impregnated with an acrylate UV curable resin. Multiple individual optical ribbons can be stacked into a bundle with a matrix structure and stored in a central core-tube or in stranded multi-tubes in the cable core to optimize the fiber packing density within the cable.

Fiber ribbon cables are described by several international standards bodies, including the International Electrochemical Commission (IEC) and the Insulated Cable Engineers Association (ICEA). Optical ribbons are specified as part of the IEC 60794-series of specifications and several of the ICEA optical fiber cable documents which are ANSI-recognized U.S. National Standards. ANSI/ICEA S-87-640-2006, the standard for outside plant optical fiber cable and GR-20-CORE, Telcordia Technologies specification for outside plant fiber and fiber optic cable are pertinent to fiber and fiber ribbon, and ribbon cables referenced in this document. Sterlite Technologies ribbon cables described here comply with the requirements and test methods of these standards.

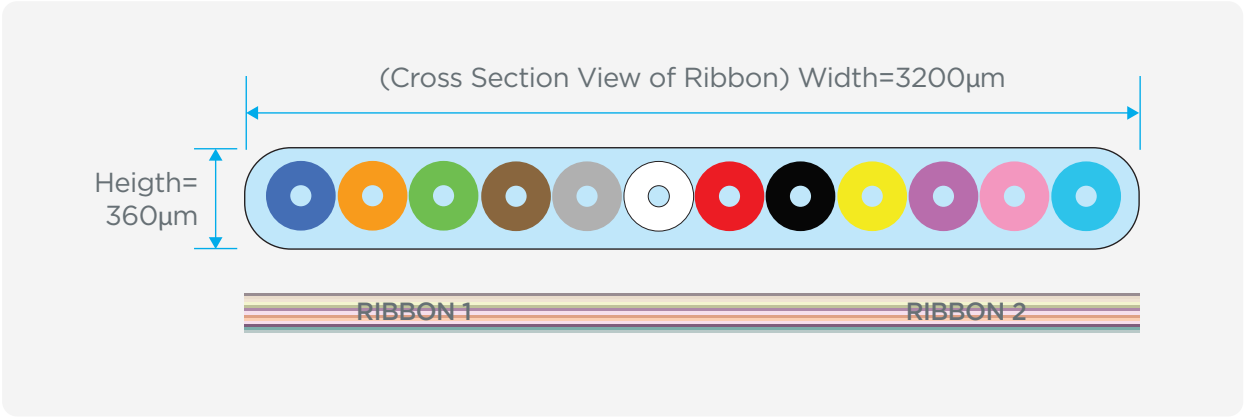
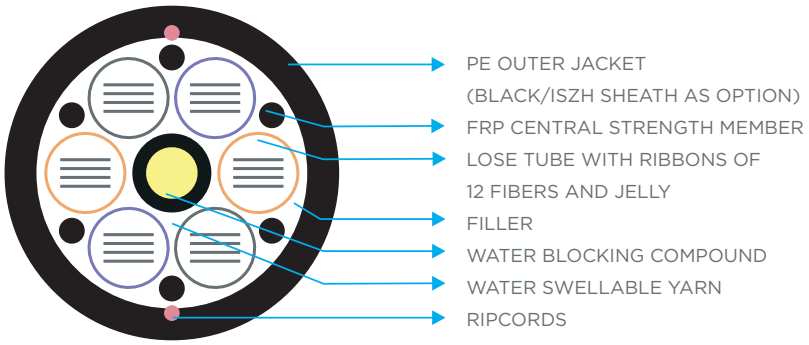


Figure 1- Cross-Sectional View and Plan View of Sterlite 12 Fiber Ribbon

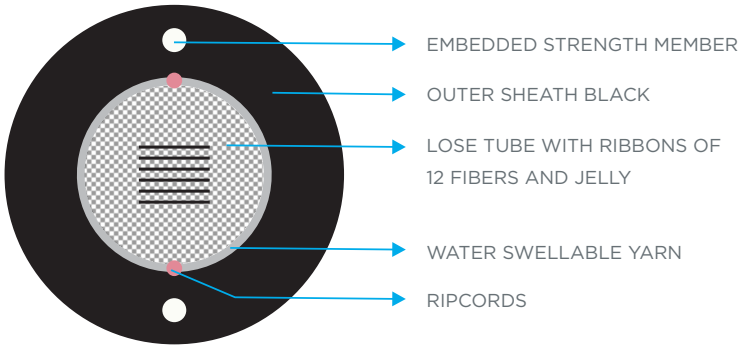
What is the Difference Between Ribbon and Non-Ribbon Fiber Cable?

Ribbon cables have an array of color coded fibers configured as fiber ribbons housed in loose tubes or in larger central tubes. Non-ribbon fiber cables have individual, color coded fibers in either loose tubes or larger central tubes. More than one ribbon often is housed in each loose tubes or the central tube of an 1 optical cable. Each ribbon can have between 4 and 24 fibers[1]. Fiber ribbons can be separated into subribbons of 2, 4, or 6 fibers using a ribbon splitting tool

[1]Some large fiber count cables have ribbons 24 fibers wide instead of 12 fibers.



Multi-Tube Cross-Section



Uni-Tube Cross-Section

Figure 2- Two Ribbon Fiber Cable Cross-Sections

What cable designs are available with Ribbon Cable?

Ribbon cables are available in both uni-tube and multi-tube designs and are available with a dry core, wet core, or all dry cross-section. These cables are available in both armored and unarmored dielectric designs.

Ribbon cables offer at least a four-point advantage over non-ribbon designs:

1. Ribbon cable can be prepped and spliced much more rapidly than similar sized non-ribbon cables. This advantage translates into less installation time, less installation labor cost, and significantly less emergency restoration time.

2. Ribbon cables result in a smaller footprint for splice closures and in telecommunications rooms.

3. Ribbon cables have a greater fiber packing density than cables with individual fibers. In higher fiber count cables this provides a more efficient use of limited duct space.

4. Ribbon cables are typically cost competitive in fiber counts above 72 to 96.

The first two advantages are the result of mass fusion splicing of individual fiber ribbons. A mass fusion splicer can splice all of the fibers in a ribbon simultaneously. Therefore, if a 12 fiber ribbon is being spliced; all 12 fibers can be quickly spliced in less than a minute and yield an average splice loss of 0.10dB. In contrast, splicing individual fibers in a non-ribbon cable requires each fiber to be spliced individually. In summary, a 144 fiber ribbon cable requires 12 splices to be fully spliced while a 144 fiber non-ribbon cable requires 144 splices to be made. In addition to the time saved during splicing, fewer splices reduce the amount of space required to store and organize these splices within their closure or cabinet. Less splice time reduces the amount of construction disruption at splice locations such as in manholes, cabinets, central offices, and telecommunications rooms.

The cost of mass fusion splicing equipment may have been a concern a few years ago, but the cost difference between single-fiber and mass fusion splicing equipment has decreased dramatically. In the past, ribbon cables were also difficult to clean and therefore a problem to prepare for splicing. Current designs using dry core, all dry construction, and even when their ribbons are encased in a gel filling are very easy to clean up, usually requiring less time than their non-ribbon counter-part with individual fibers. The design of ribbon cables is well suited to use the advantages of all-dry fiber cable technology that will yield substantial reductions in cable prep time. Manufacturers of splicing equipment have developed high quality robust equipment and materials to make mass fusion splicing dependable, easy to accomplish, and more economically attractive.

Figure 3- Modern Mass Fusion Splicers That are Simple to Use and Provide High Levels of Splicing Productivity to the Outside Plant.

Even for low fiber count applications, ribbon cables carry a significant advantage in splicing costs. The commonly used critical point to convert to ribbon cables typically occurs at 72 to 96 fibers depending on the labor rates used for economic modeling. In that range of fiber counts, any incremental cost difference between ribbon and loose fiber cable costs will be offset by savings in splicing costs and installation time For fiber counts equal to and greater than 96, the carrier generally would need a compelling reason to not deploy ribbon cables given the reduced cost of splicing and comparable material costs.

The economics of fiber counts notwithstanding, there are still a few areas where either ribbon or loose-fiber cables are the preferred option. For example, it takes four splices to repair a 48 fiber count ribbon cable compared to 48 splices for the non-fiber equivalent. On certain critical fiber links, it might be desirable to have a lower fiber-count ribbon product just because of the advantages in emergency restoration. Also, ribbon cable products are more compact in size for a given fiber count, which creates some space-saving advantages in conduit. On the other hand, some applications (fiber-to-the-home, for instance) require multiple cable access locations where only a few fibers are “pulled out” from a cable for splicing using midsheath access techniques. In those instances, ribbon can be accessed with new “splittable” ribbon technologies, which might be less practical for some carriers than conventional loose tube cable construction.

Figure 4- Two Examples of Commercially Available Ribbon Splitting Tools

Feeder cables in FTTX networks usually have a considerably smaller fiber count than their distribution cables. Feeder cables are point-to-point from the CO to the fiber distribution hub (FDH) and may be best served in many cases with ribbon type central tube cables. Since distribution cables connect the FDH to the customer, they may have considerable points where several fibers are dropped off to a cluster of customers using mid-span access techniques. Individual fiber cables may provide the best service for this type of an application. It is important to examine each application with respect to its service distribution demands and geography to determine the most cost effective cable cross-section to use.

The gel-free, all-dry, technology found in both ribbon and loose-tube cables is a huge labor savings feature. The all-dry cross-section is generally available for all OSP applications, including ADSS cable. Sterlite's all-dry cables should provide a lifetime of trouble-free service. Conventional flooding gel is no longer a product that must be included in the design of an optical cable.

In summary, there is not a single network design that fits all applications, and not a single cable that fits all network designs. However, knowing the options and knowing where they fit can significantly impact installation time, labor costs, and emergency restoration time.The performances of Sterlite's ribbon cables are field proven and have been successfully used for years.Service providers can leverage the advantages of these cables just by considering the options available, and applying a little basic math to compare cable costs, splicing costs, and labor hours.

Construction Issues

Since both ribbon and individual fiber optical cables are quite similar in outward appearance and both exhibit similar handling characteristics and have the same type mechanical and optical limitations, both types of cables are placed using very similar procedures. Both Sterlite cable types are entirely suitable for use in the outside plant in underground (ducts), buried (trenched or plowed) or aerial applications. Indoor versions of each cable type are also available.

Substituting ribbons for individual fibers within an optical cable allows the fiber to be packed more compactly within the cable whether it is a multi-tube or central tube cable. Ribbon cables are smaller in size and weight and generally easier to handle than comparable individual fiber based cables. The net result is ribbon cables are easier for the installation crew to handle and place. Three possible conclusions result ribbon cables can be placed in slightly longer lengths, they occupy available duct space more efficiently, and they can be designed to accommodate higher fiber counts.

Both ribbon and individual fiber cables are available in armored and all dielectric cables. As described in the economics of fiber splicing, ribbon cable is easier to prepare for splicing.

Splicing Issues

Fusion splicing has become the defacto standard for quality splicing for permanent fiber connections on all types of fiber applications from long haul point to point networks to FTTX networks. The history of fusion splicing has been influenced by the development of high tech, reliable tools that are now available to produce high quality splices (single fiber and ribbon splices). As fusion splicing has matured, the cost of this equipment has become more affordable, splice quality has reached its highest levels (less than 0.05 to 0.10 dB per fiber), and splicing production has improved. In the last decade, fusion splicing ribbon cable has become a standard operating procedure for most telecommunications companies.

Mass fusion splicing ribbon cable has caused the redevelopment of all the materials used to splice individual fibers. The following new equipment was developed: Ribbon matrix strippers, ribbon positioning blocks for the fusion splices, mass fusion splices, ribbon splice protectors, splice protector heaters, splice organizers, and splice closures. This equipment has been available for the last decade and has evolved into nearly trouble free operation at a cost quite competitive with single fiber splicing systems.

Figure 5- Ribbon Holding Block, Used to Position Ribbons during Cleaving and Splicing. Different Blocks are Available for 12 and 24 Fiber Ribbons.

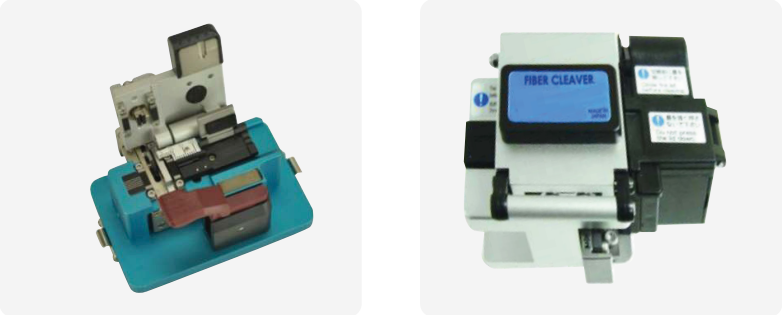


Figure 6- Typical Modern Ribbon Fiber Cleavers Designed to Use the Same Ribbon Holding Block Used with the Fusion Splicer.

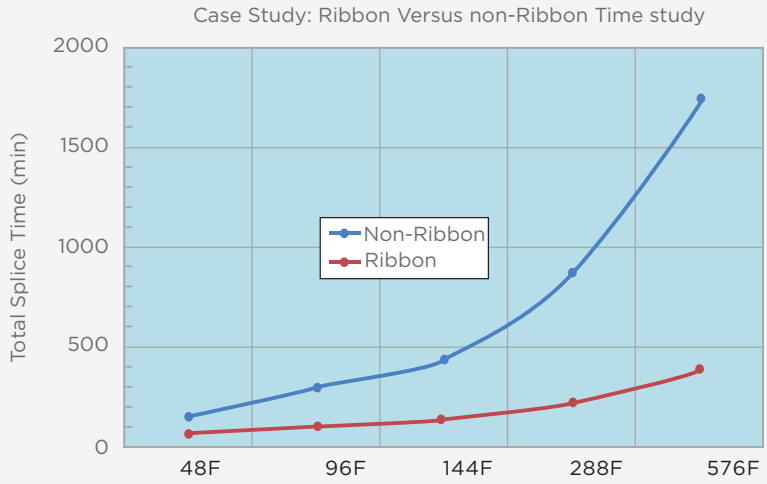
Figure 7- Special Ancillary Equipment for Ribbon Cable: (L-R) Ribbon Fiber Stripper; Splice Protector for Ribbon; Protected Ribbon Splice.

The development of support materials has enabled the preparation of ribbon cables to be competitive with non-ribbon cables. In fact in most cases, ribbon cables can be prepared with less effort and cost than similar non-ribbon cables. New, safer, more effective cleaning materials have been developed, as have more effective preparation and stripping tools. Both ribbon and non-ribbon type cables manufactured by Sterlite can support end-to-end splicing and mid-span access.

Cost of Splicing

STL has conducted a study that compares the cost of splicing two ribbon cables end-to-end versus the cost to splice two similar sized non-ribbon cables. The study included the time required to prepare the two mated cables and the time required to perform the fusion splice. Because labor rates are quite variable, time was chosen as the measured dependent variable. If time found in the study is multiplied by the local labor rate, the labor costs for the cable splicing can be determined. If the time required to splice similar ribbon and non-ribbon cables is compared, the ratio is similar to the ratio of cost to make each splice independent of labor costs. For example, if the ribbon cable is two times less labor intensive, that ratio holds for both time and costs, and the cost to make a ribbon splice is two times less than a similar size non-ribbon splice.

A Comparison of Cable Preparation and Splicing Cost For Ribbon and Non-Ribbon Cable Based on Minutes Required



Graph interpretation:

Graph clearly shows as fiber count gets larger, the time advantage and resulting cost advantage of the Ribbon fiber cable increases over the Non- Ribbon cables.

Ribbon Cable and Ribbon Splice Reliability

Physical plant performance

Ribbonized fibers and individual fibers within non-ribbon type cables are expected to perform similarly. The two types of cables are designed to withstand the same mechanical, environmental, reliability, and optical requirements. Most splicers find organizing ribbons in splice closures simpler than individual fibers. If individual fiber connectors are required, a ribbon can be spliced to a fiber “fan out,” such as might be used at a FTTX FDH connection to the back plane of the fiber distribution panel.

Conclusions

To conclude, the use of ribbon cable is more cost-effective for higher fiber count cables and longer cable link lengths as compared to the use of non-ribbon cables on similar applications. Ribbon cable is lighter, more compact and easier to handle and splice. For example, 8 ribbons are less expensive to prepare and splice than 96 fibers.

Summary of benefits of ribbon cable compared to non–ribbon cables

- Can be prepared and spliced much more rapidly than individual fiber cables.
- Less installation time and significantly less emergency restoration time result in lower labor content and o place cable, make splices, and maintain the network
- Requires a smaller footprint in splice closures and telecommunications rooms.
- Mid-span assessable , similar to conventional to non-ribbon cables.
- Individual fibers within a ribbon can be accessed using “ribbon splitting” tools and technologies for applications like FTTX, etc.
- 2 Provides a faster restoration of large fiber count cables(lower MTTR[2]).
- Provides for better cable management and handling capabilities.
- Yields better network uptime, more revenue, and better customer satisfaction.
- Typically material cost of ribbon cable is competitive with non-ribbon cable for fiber counts of 96 and above.

[2]MTTR is mean time to repair.

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