Merits of Ribbon versus Loose Tube Optical Cable in Aerial and Underground Applications

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By Guy Swindell

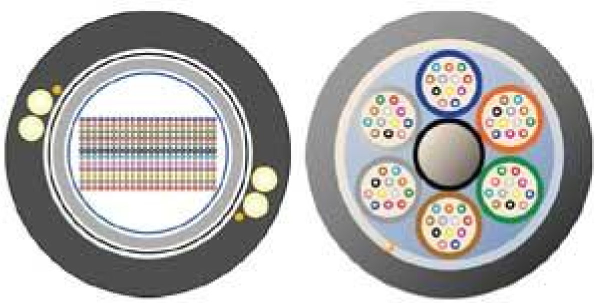
The electric utility industry is increasingly reliant on high speed optical networks to support daily operations. For over two decades, utilities have used fiber optic media to support their own internal applications. In more recent years, public power companies and an occasional electric cooperative have ventured into fiber-based networking for the benefit of their customers and the generation of additional revenue streams. In the future, new construction and smart grid initiatives promise to expand fiber's role even farther into electric utility operations. The last point is quite a statement considering that fiber is already found on transmission lines and distribution lines, in generating stations, and even in substations.

All-dry optical cables can reduce preparation and installation times.

So, if it is a given that optical fiber is a reality of the electric utility industry, then it is important for those with responsibility for the management of utility assets to understand some of the basic categories of optical cable products and where those products best fit in the electric grid. Since most of the fiber used by utilities is deployed in the outside-plant, some of the most common questions center around the selection of ribbon versus conventional loose tube cable designs and where one solution might be more economically viable than the other.

Outside plant cables, either aerial or underground, get closer to the home.

Both ribbon cables and conventional loose tube cables are staples of the telecommunications industry and have been around for decades. Both products perform well in harsh outdoor environments, and both are available in a multitude of configurations, including: all-dielectric, armored, aerial self-supporting, etc. The chief distinction between these two product families is the manner in which the individual fibers themselves are packaged and managed within the cable. A ribbon cable has the individual fibers precisely bonded together in a matrix that might encompass as few as four or as many as 24 fibers. Typically, however, these matrixes, or “ribbons” are bonded together in a group of 12 and placed inside a tube that holds multiple ribbons. In contrast, a loose tube cable design has between 2 to 24 individual fibers housed in multiple buffer tubes with each fiber detached from the other.



Just about anyone in the electric utility industry with any level of exposure to optical fiber products will be familiar with the basic structure of loose tube cable. Ribbon cables, on the other hand, have enjoyed widespread adoption among regional and long-haul telephony providers but might still be unfamiliar to some in the electric utility space. This unfamiliarity carries a price since ribbon products can offer a four-fold advantage over loose tube designs in many applications:

1. Ribbon cable can be prepped and spliced much more rapidly than loose tube cables. This advantage translates into less installation time, less installation labor cost, and significantly less emergency restoration time.
2. Ribbon cables enable a smaller footprint in splice closures and telecommunications room fiber management.
3. Ribbon cables offer greater packing density in higher fiber counts which enables more efficient use of limited duct space.
4. Ribbon cables are typically very cost competitive in counts above 96 fibers.

The first two advantages listed above are byproducts of the mass fusion splicing technology enabled by ribbon cable. A mass fusion splicer can splice all of the fibers in a ribbon matrix simultaneously. Thus, if a 12 fiber ribbon is used, all of those fibers can be spliced in about 12 seconds with average splice losses of 0.05 dB. In contrast, the conventional loose tube cable requires each fiber to be spliced individually. So, by way of comparison, a 144 fiber count ribbon cable requires 12 splices in order to be fully spliced while a 144 fiber count loose tube cable requires a full 144 splices. In addition to the time savings, a decreased total number of splices also yields a decrease in the amount of space needed for splicing. Hence, there is an associated decrease in the amount of space needed to support splicing in closures and in telecommunications room fiber management.

The reader with experience using ribbon cable might offer two objections at this point. The first objection would be the cost of mass fusion splicing equipment, and the second objection would be the painful and messy process of prepping large fiber count unitube ribbon cables. The first objection is easily overcome just by looking at the current prices of mass fusion splicers. Over the past few years, the cost difference between single-fiber and ribbon-fiber splicing equipment has decreased dramatically. The second objection has been overcome through the introduction of all-dry optical cable products. Older ribbon cable products were painful to prep because of the infamous “icky-pick” gel used to provide water-blocking. The unitube design of many ribbon cable products translated into an excess of gel and a general mess for the splicing technician. However, new technologies allow both conventional loose tube and ribbon products to meet stringent water-blocking standards with no gels whatsoever. This dramatically reduces the cable prep time when splicing for both product families. However, the basic design of ribbon cables means that the advantages of all-dry technology yield even more substantial reductions in cable prep time.

Even for low fiber count applications, ribbon cables carry a significant advantage in splicing costs. The best point for conversion to ribbon cables typically occurs at 96 to 144 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 configurations will be offset by savings in splicing costs and installation time. For fiber counts equal to and greater than 144, the carrier would need a compelling reason to not deploy ribbon cables given the reduced cost of splicing and very comparable material costs.

Splicing costs vary tremendously based on the local labor market. Typically, however, single-fiber fusion splicing costs are somewhere between $23 and $35 per-splice on a national level for standard outside-plant cable. For cost comparison purposes, we will split the difference and assume that we must pay $28 per-splice if we sub-contract or outsource single-fiber splicing. If we outsource ribbon-fiber splicing, we will assume that each 12 fiber ribbon splice costs us $120. Ribbon-splicing costs also vary tremendously depending on the local labor market, but the $120 number is probably in the high-average range.

So, based upon those assumed splice costs, a standard loose-tube cable splice will cost us $4,032.00 at the 144 fiber count (144 single fibers x $28 per-splice) whereas the comparable ribbon cable splicing costs will be $1,440.00 (twelve 12-fiber ribbons x $120 per-splice). This gives us a total savings of $2,592.00 in splicing costs at each splice location. If the 144 fiber ribbon cable costs the same or less than the comparable loose-tube cable, then the case for ribbon at that fiber count and higher is the proverbial “no-brainer.” When a ribbon cable is available that will do the job in this scenario, there is little reason to consider the alternative.

The case for ribbon versus loose-tube optical cable is less compelling at lower fiber counts. For example, when using those same per-splice costs in a 96 fiber count scenario, the ribbon cable saves us $1,728.00 at each splice location. However, the financial benefit afforded by the splicing may be offset by higher cable price. Additionally, the number of splice locations can vary greatly from one application to the next. In a typical utility application, however, 96 fiber configurations represent the point where cable costs and splicing costs tend to break even when comparing ribbon to loose tube.

The economics of fiber counts notwithstanding, there are still a few areas where either ribbon or loose-tube is the preferred option. For example, it takes four splices to repair a 48 fiber count ribbon cable compared to 48 splices for the loose-tube equivalent. On certain critical circuits, therefore, 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 generally smaller 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 we pull out only two to eight fibers from a cable for splicing using mid-sheath access techniques. In those instances, ribbon can be viable with new “splittable” ribbon technologies, but might be less practical for some carriers than conventional loose tube. However, the gel-free technology found in both ribbon and loose-tube is a huge labor savings feature in those circumstances. Aerial self-supporting cables (ADSS) still require the use of some gels, but any utility company installing fiber optic cable in any other application should be leaving the gel-remover back in the shop. “Icky-pick” in conventional ribbon and loose-tube cables is a relic of the 90’s and an addition to labor hours which can be easily avoided.

To sum it up, 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. All of the options are field-proven and have been around for years. Utilities can leverage the advantages of these different solutions just by remembering what is available, and applying a little basic math to compare cable costs, splicing costs, and labor hours.

About the Author:
Guy Swindell manages applications engineering for OFS in the Eastern Region of North America. He has authored numerous published white papers, articles and reports on the subjects of fiber-to-the-home, optical fiber cables, and cable applications. Swindell has been in the fiber optics industry since 1998, and has held positions in field engineering, applications engineering, installation project management, and business development. He is a graduate of the U.S. Coast Guard Academy.

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