Bend insensitive 200 MICRON optical fibre

Bends like Magic

APPLICATION NOTE

AUTHOR
Sudipta Bhaumik

ISSUED
Dec 2018

ABSTRACT
Deployment of optical fibre cable in limited space and in tight bend conditions demands reduced diameter optical fibre and cable with bend insensitive fibre. To address this need, optical fibre with 200 micron outer coating diameter instead of 250 micron for conventional fibre has been developed. This application note outlines various advantages of 200 micron fibre and its backward compatibility with conventional fibre.

Optical fibre is used in all modern optical communications including long-haul, regional, access, and FTTX networks. An optical fibre is made up of three layers, namely, core, cladding, and coating. Light is guided down the centre of the fibre called the "core". The core is surrounded by an optical material called the "cladding" that contains the light in the core using an optical phenomenon called "total internal reflection." The fibre is coated by a buffer layer that protects it from moisture and physical damage. The buffer or "coating" is what one strips off the fibre for termination or splicing. More protection is provided by the cable which has the fibres and strength members inside an outer protective covering called a "jacket" or a "sheath."

The fibre coating is made of a UV curable polymer called acrylate, which acts to protect the inner glass. Dual layered coating structures are generally applied, which use a low-modulus inner or buffer layer to cushion the fibre surrounded by a high-modulus outer coating to increase the flexural rigidity and distribute the lateral external forces.

Glass cladding and outer coating diameter are standardised to 125 μm and 250 μm respectively in various international standards and recommendations. Standardisation of these two critical dimensions of silica glass optical fibre has ensured- compatibility between optical networks across the globe. Currently, single mode optical fibre with a reduced 200 μm coating diameter and 125 μm cladding diameter is commercially available. The 125 μm cladding diameter ensures backward compatibility with existing optical network. Fig. 1 shows a comparison between 250 μm and 200 μm coated fibre. This reduced diameter optical fibre opens up options for producing cable with more compact designs allowing more penetration depth in access and FTTX networks.

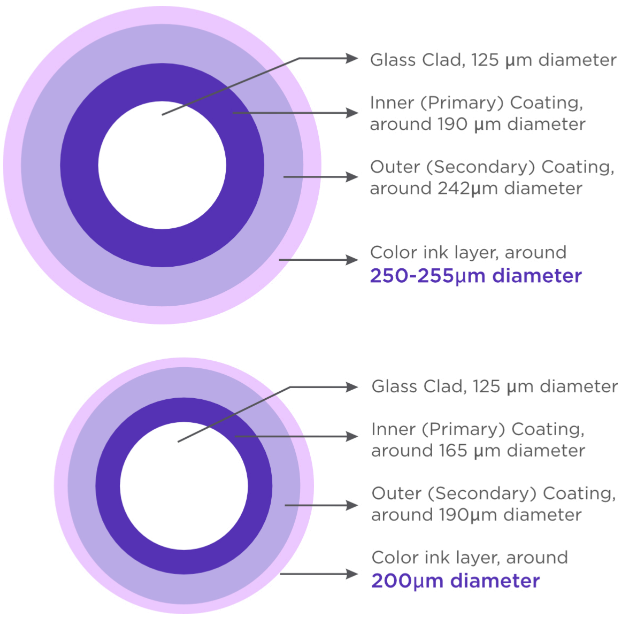


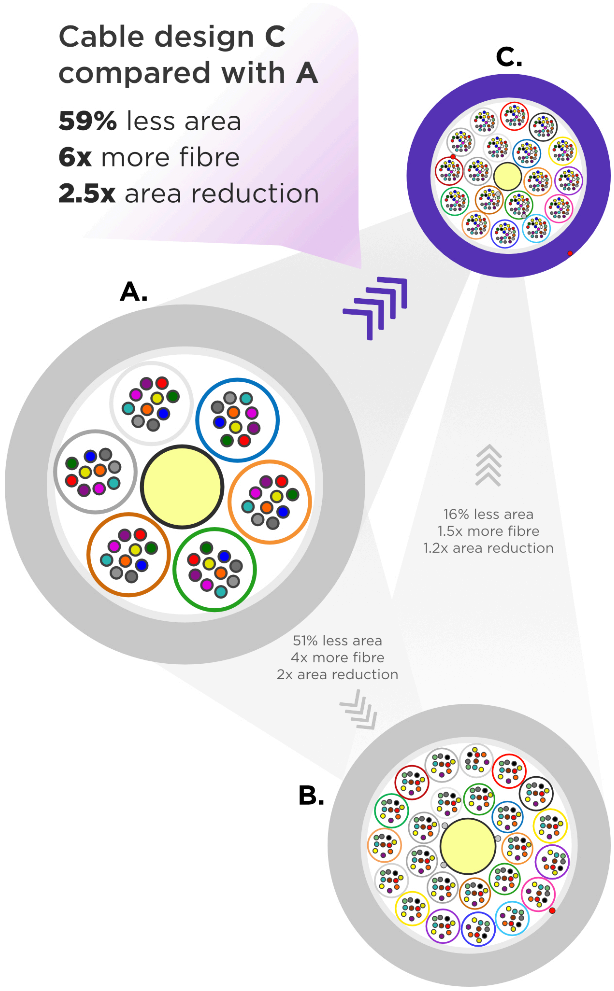
Figure 1: Schematic Cross sectional view of SMF (not to scale)

Challenges in cable deployment in optical networks

There are two major challenges in cable deployment in high capacity optical networks – limited space in distribution network and tighter bends in subscriber loop. To provide service to large number of subscribers, high fibre count optical fibre cables which can carry large volume of information is necessary in distribution network. Currently optical fibre cable is available with over 1000 fibres in a single cable.

Although high fibre count cable is a solution to handle large volume of information, this option is not always suitable due to limited space in installed ducts as higher fibre counts generally increase the cable diameter. Installation of new ducts is an expensive & time consuming operation due to the large amount of civil work needed, and the need to get right of way approval from the government & other local bodies. At present, successful penetration of optical fibres into the local distribution networks depends on the development of small, flexible, lightweight and cost effective cables. In addition, cable blowing distances can be vastly increased using smaller and lightweight cables reducing deployment costs. Therefore, reduced diameter cables called 'micro cables' have become popular during duct and cable installation. To increase fibre count further in micro cables and to reduce cable diameter further such that micro-ducts can be used, a compact cable design is necessary. Compact cable design can be achieved by increasing fibre packing density, and reducing size of the cable elements and fibre. Tighter packing density and reduced size cable elements need fibre with less micro-bend sensitivity. Additionally, fibre with improved macro-bend sensitivity is essential to limit increase in optical power loss due to tighter bends in subscriber loop. Bend sensitivity improved ITU-T G.657 category single mode optical fibre (SMF) with reduced coating diameter is therefore the solution for compact cable design.

A significant improvement in fibre density in optical fibre cables can be achieved by using bend insensitive 200 micron optical fibres. Figure 2 illustrates how compact cable design is achieved with 200 micron fibre. Diameter of a 72 fibre conventional cable with 250μm fibre is around 13.5 mm. In Micro cables, the diameter was reduced to around 9.4 mm for 288 fibre. With 200 micron fibre, 432 fibre cable can be produced with 8.6 mm outer cable diameter. Reduction in fibre cross-sectional area enables higher fibre count cables with smaller cable outer diameter. In 432 fibre micro cable, 24 fibres instead of 12 can be placed in a similarly sized loose tube. Although this type of design has higher packing density, it can result in higher optical loss due to micro-bending effect. Use of bend improved ITU-T G. 657 category fibres with micro-bend resistant coating reduces micro-bend loss and helps to achieve targeted cable attenuation.



A. Conventional cable with **72 fibre (250 micron)** with **~13.5 mm diameter**

B. Micro cable with **288 fibre (250 micron)** with **~9.4 mm diameter**

C. Micro cable with **432 fibre (200 micron)** with **~8.6 mm diameter**

Figure 2: Schematic Cross sectional view of various cable designs

In IEC 60793-2-50 (Edition 6) single mode fibre specification, 200 micron fibre was included as an alternative coating diameter option [1]. As shown in Fig. 1, in the 200 micron fibre, diameter of the coating layers are reduced in comparison to conventional fibre whereas diameter and other characteristics of glass cladding remain same. In the field, 200 micron fibre works well with the existing tools and practices during stripping and splicing. Once coating is stripped out, cladding diameter is 125 micron which is same as conventional 250 micron SMF; therefore cleaving and fusion splicing can be performed with the same tools. Figure 3 and 4 shows splice loss distribution of 200 micron v/s conventional SMF (Sterlite's MICRO BOW

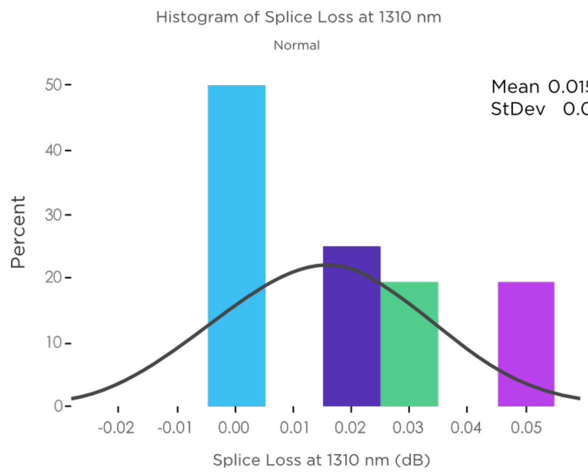


Figure 3: Splice loss between 200 micron and conventional SMF at 1310 nm

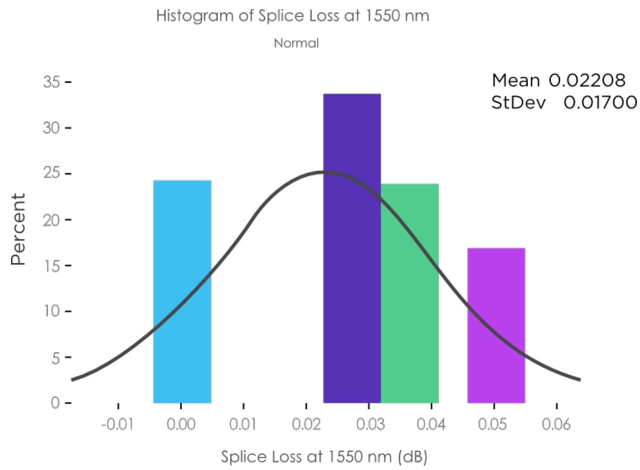


Figure 4: Splice loss between 200 micron and conventional SMF at 1550 nm

LITE™ vs BOW LITE™) at 1310 nm and 1550 nm respectively. The measured mean splice loss is 0.016 dB with standard deviation (SD) of 0.018 dB at 1310 nm, while at 1550 nm, the mean splice loss and SD are 0.022 dB and 0.017 dB respectively. According to ITU-T G.982 recommendation by extrapolating from the Gaussian fit, the worst case (mean + 3 x SD) splice losses are 0.07 dB and 0.073 dB at 1310 and 1550 nm respectively, which less than the ITU requirement of maximum splice loss of 0.1 dB [2].

Similarly, 200 micron fibre has little impact on single fibre connectors as fibre is up- jacketed before connecterisation. However, use of 200 micron fibre in ribbon structure is currently under study. Outer coating diameter decides spacing between two adjacent fibres in a ribbon structure and thus effectiveness of mass fusion splicing. Therefore, if splicing to existing 250 micron ribbon cables is a requirement, the ribbon structure of 200 micron fibre with the spacing equal to 250 micron ribbon is needed.

Sterlite's 200 micron fibre are fully backward compatible with existing fibres, and other reliability parameters controlling fibre life time like proof-test level, dynamic fatigue (N_d), tensile strength of both un-aged & aged fibres, change in attenuation due to environmental aging etc meet the requirement of IEC 60793-2-50 standard.

Use of next generation coating provides the same reliability level even after reduction in coating diameter.

Conclusion

Bend improved single mode optical fibre with reduced coating diameter of 200 micron fibre is compatible with existing 250 micron fibre in optical networks and provides substantially reduced cross-section area allowing more compact micro cable designs.

Sterlite's MICRO BOW-LITE™ and MICRO BOW-LITE™ (E) are 200 micron ITU-T G.657.A1 and G. 657.A2 category fibre respectively and provide a novel and reliable solution to tighter bends and limited duct space frequently encountered in real-life network deployments.

Using optical fibre cables with 200 micro fibre can dramatically reduce the total cost of ownership of a network while limiting the environmental impact of its deployment. Reduction of civil works, possibility to reuse existing ducts, lower costs of pathways fees etc. are some benefits which can be immediately realised.

References

1. IEC 60793-2-50 ed6.0, Optical fibres - Part 2-50: Product specifications - Sectional specification for class B single- mode fibres.

2. ITU-T G.982, Optical access networks to support services up to the ISDN primary rate or equivalent bit rates (1996).