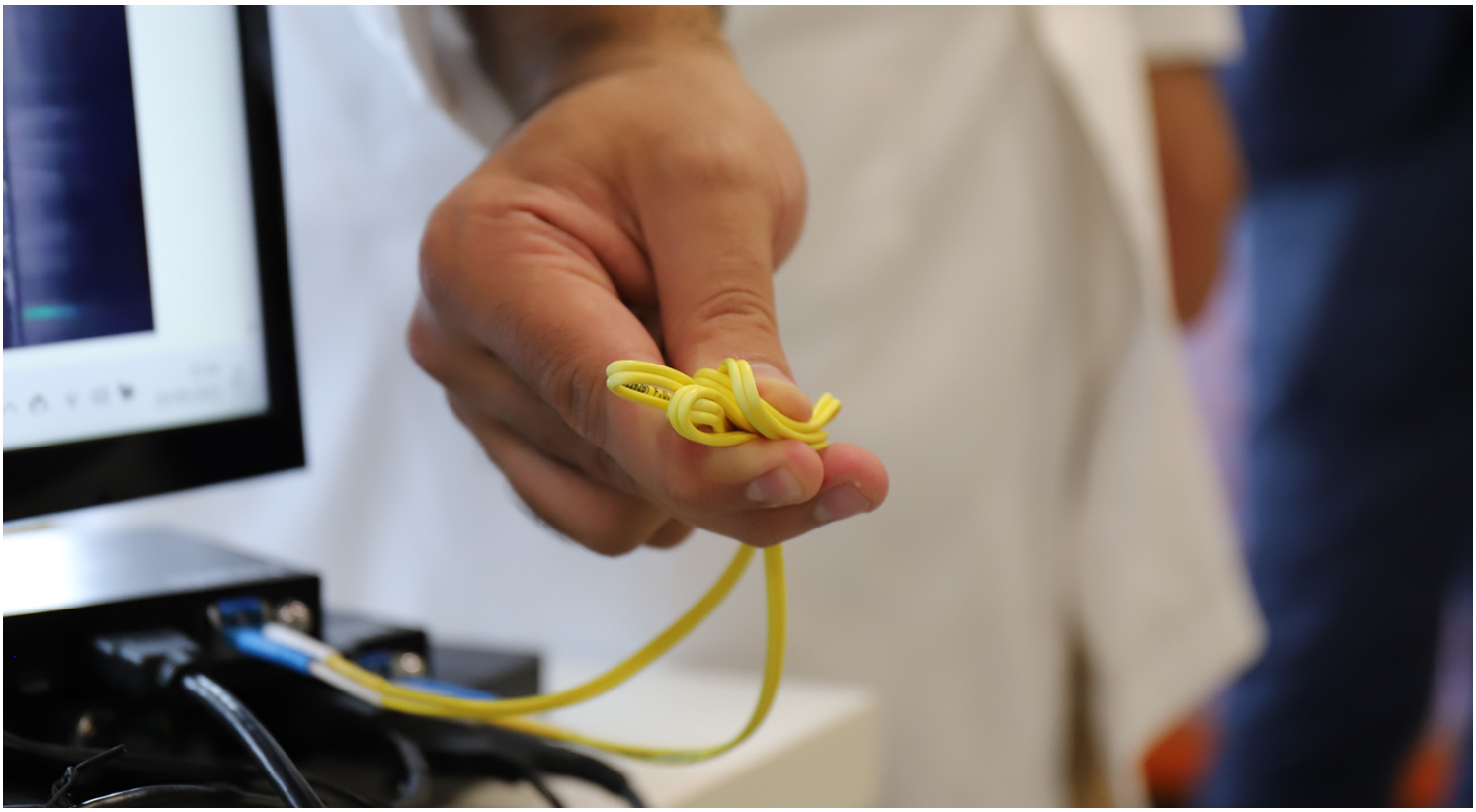
# BEND INSENSITIVE FIBER

*Posted on 18-12-2024 by Leonardo Martínez*

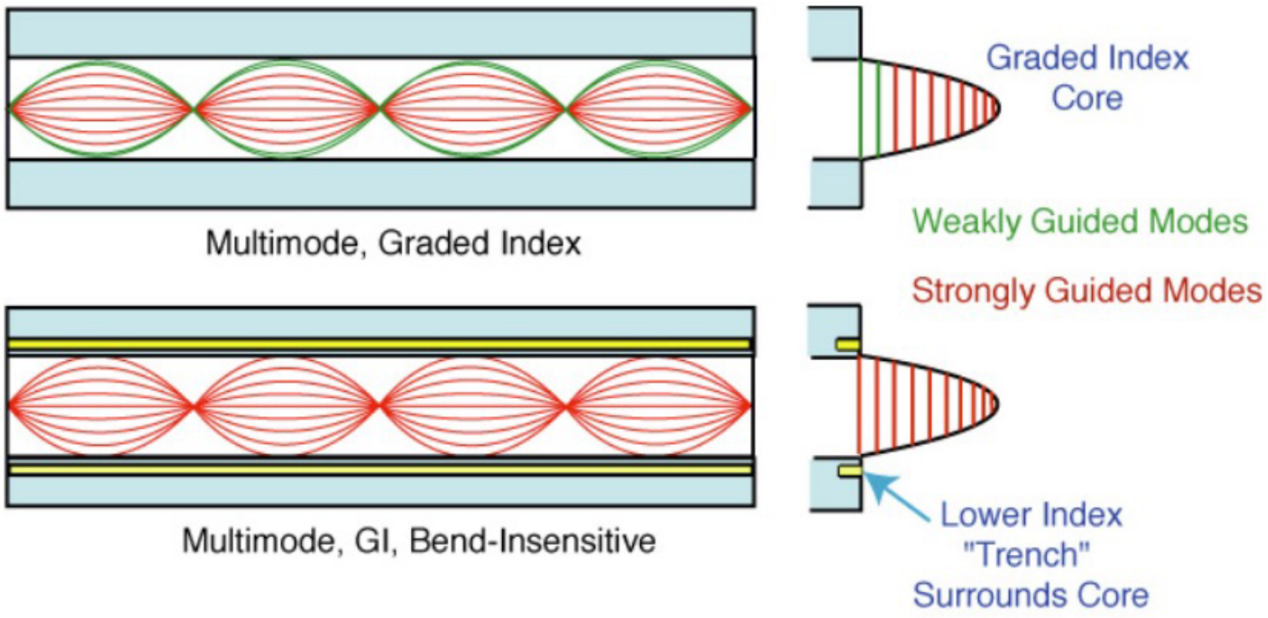


**Category:** Fiber Optic

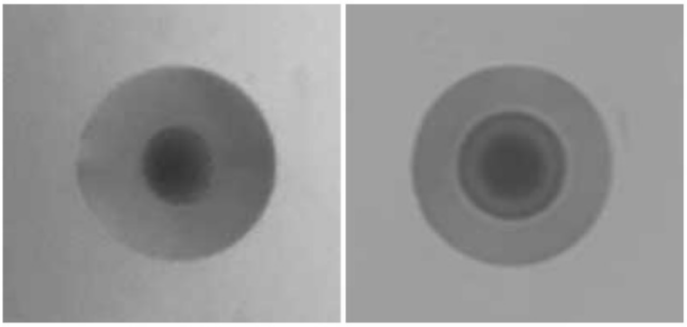
Optical fibers are sensitive to bends that can occur in the cable during installation and during use, this type of bends is called macro bendings. When a fiber optic cable is over-curved, light traveling on the outside of the core can be refracted and disappear into the coating creating an additional attenuation point. In systems with very low attenuation budgets, such as in a Data Center, this can have as a consequence the loss of communication between the active connected equipment.
Excessive bends can occur in trays and pipes, especially when they are very full and architectural obstacles have to be overcome. It is also very common for them to appear in racks and specifically inside the trays and cable guides. The higher the density of the trays and in the cable guides, the easier it is for excessive curvatures to occur and, as a result, an excess of attenuation.

The design of the construction of the coating and sheaths of the cables and fibers is intended to minimize the impact of curvatures, but in the end, it is inherent in the design of the optical fiber itself. Losses caused by curvatures depend on the type of fiber (single-mode or multi-mode), fiber design (core diameter and numerical aperture), operating wavelength (higher wavelengths are more sensitive), and cable design.

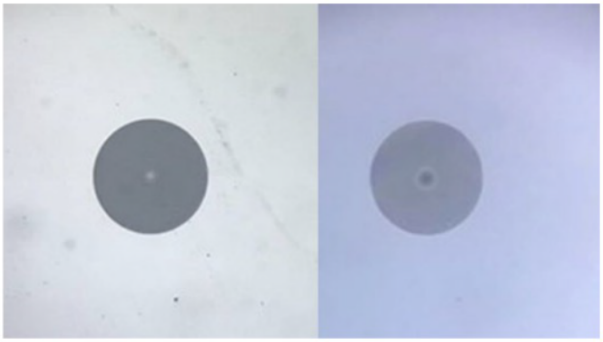
In 2007, single-mode bend insensitivity (BI SMF) fibers were introduced commercially. Multi-mode bend insensitivity (BI MMF) fibers followed shortly thereafter in 2009. These fibers have in common in their construction the presence of a "trench" in the refractive index around the core. This trench reinforces the reflections of the exterior modes which have a weaker guidance than the interior modes and because of that it is easier for them to be refracted in a curvature in the coating. The trench reinforces the guidance of the exterior modes and allows for smaller bending radii.




By looking at this type of fibers through an optical microscope we can easily differentiate the ring between the core and the coating as shown in the following images:



50/125 MMF, regular (L) and bend-insensitive (R)



SMF, regular (L) and bend-insensitive (R)

Bend insensitivity fibers are completely compatible with conventional fibers. Within the same link we can mix the two types without any negative consequences. We can choose the most convenient type of fibers for each part of the infrastructure.

Bend insensitivity fibers are widely used in FTTH installations in drop cables. In this case they are single-mode fibers that comply with the G657.A2 standard.

Bend insensitivity fibers have many advantages. We can increase the number of fibers we install in a single tray. They allow to have smaller distribution boxes, install fiber cables in cable trays with high occupancy, install cables in existing conduits in residential buildings, install cables around moldings in walls and ceilings. They reduce the possibility of excessive attenuation in any type of installation. They reduce the number of communication failures and this will have as a consequence a time and cost reduction to solve failures since they are avoided from the beginning.

The purchase cost of bend insensitive fibers is somewhat higher than traditional fibers. This higher cost is largely compensated by the reduction of possible failures that may appear in installations with traditional fibers and their associated costs to their resolution.

Bend insensitive fibers have so many benefits that they allow us to improve the performance of the links when density and construction conditions require it or make it advisable. The cost of cables, patch cords and pigtails made with these fibers is slightly higher, but it more than compensates by saving the costs of solving problems that can arise if we use conventional fibers. Getting it right the first time always reduces installation and maintenance costs.