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Applications
Engineering Note

Considerations for Improved Bend Performance Optical Fibers

AEN 110, Revision 3

This Applications Engineering Note (AE Note) addresses application and selection considerations for improved bend performance optical fibers (IBP fibers).

Application Considerations

IBP fibers offer operational improvements where fibers or cables are subjected to acute bends. Inadvertent tight bends are common in high-density installations and in plants which are frequently reconfigured (e.g. adds, drops and moves). Intentional tight bends are increasingly common to accommodate smaller routing/housing hardware and OEM equipment cases.

Optical Attenuation in Bending

Any all-glass, communication fiber is optically unaffected by bending above some threshold radius. That radius varies according to the particular fiber's design, but historically, most fibers are optically unaffected by bends ≥30 mm radius. As a bend is reduced to a critical value, though, some portion of light traveling at the core/cladding interface cannot be refracted back into the core. This portion of light is stripped out of the fiber and is measured as increased insertion loss (IL). Further reducing the applied bend radius rapidly increases IL (i.e. non-linearly with bend diameter). Likewise, increasing the length of fiber bent below the critical radius increases IL, but more linearly with the number of turns at a given radius.

While IBP fibers can be used in virtually any cable design, they measurably improve system performance only where fibers or light-duty cables will be or might be acutely bent. They add little value in very robust cables which, by design, inherently limit fiber bends (e.g. outside plant cables) or in applications where fiber terminations are well protected and infrequently accessed (e.g. in a splice case).

Mechanical Reliability in Bending

Bending a fiber induces tension on the outside of the bend. Optical fibers are proof-screened to eliminate fiber breaks from loads sustained in normal cable manufacturing and field handling. For example, a 125 micron diameter fiber (glass only) bent to a 32 mm radius induces 20 kpsi maximum tension, well below the industry-typical proof-screening value of 100 kpsi. For detailed information on fiber reliability in bending, see AE Note 21.

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Selection Considerations - General

While application considerations are similar for either single-mode or multimode fibers, selection criteria differ somewhat. Considerations common to MM and SM fibers are below, followed by specific information for each type.

Irrespective of fiber type, Corning jumper cables may be bent to a minimum of 5x the cable outer diameter or the fiber bend limit, whichever is greater (see Table 1)

Jumper Outer Diameter	Minimum Bend Radii (mm)
1.6 mm	8
2.0 mm	10
900 µm (buffered fiber)	5

Table 1

Minimum recommended bend radii for common Corning optical fibers are summarized in Table 2.

Fiber Type	Bend Radius
ClearCurve® SM	5mm
G.657.A/B compliant	7.5mm
SMF-28e® XB	10mm
SMF-28e®	25mm
ClearCurve® MM 50 um	7.5mm
Laser Optimized 50um	25mm
62.5um	25mm

Table 2

Selection Considerations for Multimode Fibers

IBP MM fibers were commercialized in 2009 in response to industry needs. Conventional 50 micron fibers are limited to a 25 mm bend radius. IBP MM fibers improve on this limit considerably. They minimize increased attenuation from tight bends, negating effects of routing errors and reducing size limitations for fiber optic hardware and OEM equipment. Corning's ClearCurve® 50 micron fibers may be bent to a minimum radius of 7.5 mm.

Wavelength (nm)(1)	Induced Attenuation (dB)	Mandrel Radius (mm)	Number of Turns
850	≤ 0.1	15	2
1300	≤ 0.3	15	2
850	≤ 0.2	7.5(2)	2
1300	≤ 0.5	7.5	2

Table 3

Notes: (1) ClearCurve® 50 micron MM fiber is bend optimized at 850 nm, though bend performance is improved vs. conventional 50 micron fiber at both operating wavelengths.

(2) Minimum recommended radius for ClearCurve® 50 micron MM fiber is 7.5 mm

Selection Considerations for Single-mode Fibers

IBP SM fibers have been commercially available for several years. ITU recommendation G.657 (2006) specifies two classes of IBP single-mode fibers.

G.657 Class A fibers are specified for a minimum bend radius of 10 mm, allowing up to 0.75dB increase in one turn. Further, the mode field range is backward compatible with G.652 (single-mode) fibers.

G.657 Class B fibers are specified for a minimum bend radius of 7.5 mm, allowing up to 0.5dB increase in one turn. However, the class allows for a minimum mode field of 6.3 microns. Fibers commercially available at the time of G.657 publication were *not* backward compatible with G.652 fibers. Since that time, fibers meeting the compatibility requirements of G.657A and meeting or exceeding the bend requirements of G.657B have been commercialized. Corning's IBP SM fibers are summarized in Table 4.

Fiber Type	Induced Attenuation @ 1550nm (dB)	Mandrel Radius (mm)	Number of Turns
ClearCurve® SM	≤ 0.1	5(1)	1
ClearCurve® SM	≤ 0.05	7.5	1
G.657.A/B compliant	≤ 0.4	7.5(2)	1
SMF-28e® XB	≤ 0.5	10(3)	1
SMF-28e® XB	≤ 0.05	16	10
SMF-28e®	≤ 0.05	16	1

Table 4

Notes: (1) Minimum recommended radius for ClearCurve® SM fiber is 5 mm
(2) Minimum recommended radius for G.657.A/B is 7.5 mm
(3) Minimum recommended radius for SMR-28e® XB fiber is 10 mm