

Ice in Conduit

AEN159, Revision 0

Installing fiber optic cables in conduit is a common practice. Conduit allows the use of dielectric cable in an area that would normally require armor, and/or provides more protection for the cable being installed. When using fiber optic cables in an area that can see freezing temperatures, precautions must be taken to provide long term cable and fiber reliability.

Can it destroy my cable?

Outdoor fiber optic cables contain water-blocking components, but this does not prevent water from standing around the outside of the cable jacket. When conduit containing fiber optic cables contain water, and are above the frost line, they can experience ice formation and increased pressure on the cables. This is especially common in conduit paths along bridges. Plastic conduits will expand in size due to the added volume and internal pressure from the ice, but metal conduits typically do not. This in turn leads to additional pressure on the objects within the conduit.

While some fiber optic cables are designed for higher crush performance, most Telcordia rated outdoor cables are designed to handle a short-term compressive load of 125 lbf/in and long-term load of 63 lbf/in¹. Depending on temperature, ice formation can create pressures inside the conduit much higher than either one of these loads.

This additional compressive load, due to ice, can cause macrobends in the fiber and degrade the signal, especially in networks with higher bandwidth requirements. Typically the signal will degrade or “go dark” at night when the temperatures are lowest and return during the warmer part of the day. If the temperatures get low enough, there could lead to permanent cable and fiber damage.

Solutions

Generally, it is recommended practice to install the cable conduits or ducts below the frost line to prevent any water from freezing. However, this is not always possible (ex: ducts under bridges across bodies of water). In these cases, the best results are obtained by reducing the volume of water in the duct in order to diminish ice-freezing effects and reduce potentially harmful crushing forces. Sealing the conduit ends during initial installation will prevent water from entering from the open pipe ends. However, condensation may form and collect in conduits even if the ends are sealed.

The preferred approach to prevent ice-freezing effects is to ensure that all cables are installed inside of a small diameter PE subduct, which in turn is contained in the larger

conduit. Corning recommends a maximum fill ratio for subducts of 65%. That is, the cross-sectional area of all cables inside one subduct should not exceed 65% of the inside cross-sectional area of the subduct. For single cable deployment, a one-inch or 1.25" subduct should be sufficient, if it meets the 65% rule.

The use of a subduct is recommended since it will provide an additional layer of mechanical protection, and isolation, from external effects. Any water that collects in the underground duct system, in all probability, will collect within the larger conduit. The subduct will ensure the cable remains dry and isolated from any ice formation. Should the water in the conduit freeze, compressive forces will be transmitted to the subduct, not to the cable. In addition, since the subduct will occupy more space than the cable does, the total amount of water that can collect (and ice that can form) in the conduit will be reduced significantly.

If it is not possible to retrofit problematic locations with subduct, a second possible solution would be to pump a cable-compatible antifreeze material into the conduit. The gel is pumped in, fully occupying the empty duct space around the cable. If necessary, this material could be placed only in those areas of the duct that are prone to ice formation. Please note, Corning has not performed comprehensive testing on all antifreeze materials and recommends contacting the manufacturer to make sure it is compatible with polyethylene jacket materials.

Use of both a subduct and an antifreeze product should protect cables from freezing. In this situation, the material would be pumped into the subduct, not the conduit.

References

- 1) Telcordia GR-20-CORE, Iss. 4: "Generic Requirements for Optical Fiber and Optical Fiber Cable"