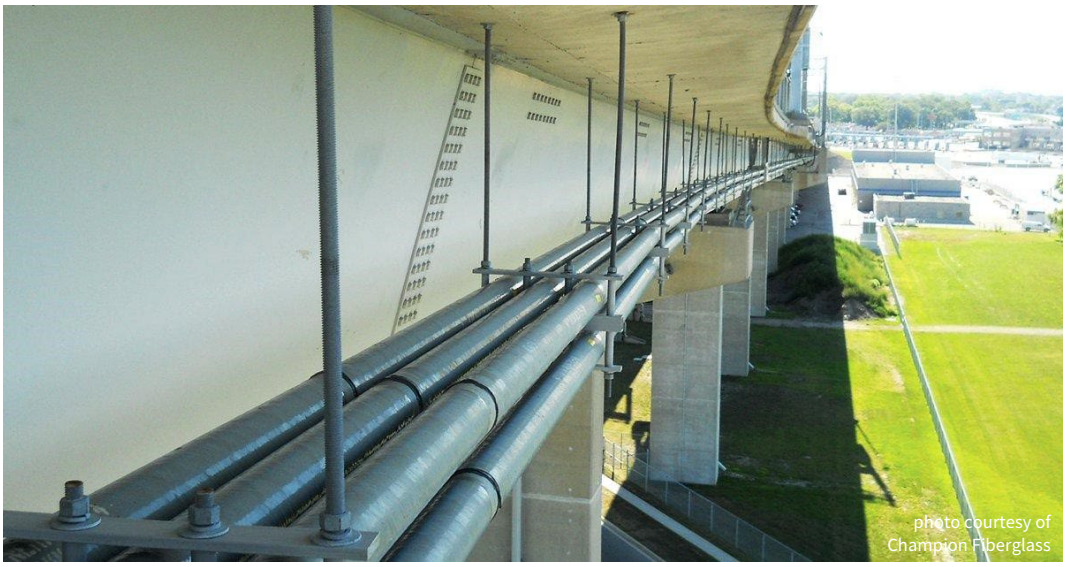
When Winter Freezes Fiber Transmission

Fiber optic cable in duct is susceptible to ice damage



Overview

Copper cable is routinely replaced with fiber optics for high-speed transmission. With improved quality, however, comes unanticipated maintenance problems.

For years, installed fiber cables mysteriously failed for no apparent reason, often recovering to full speed later. Since failures tend to happen in winter, weather was suspected. We now know that these failures result from water freezing in the conduit**.**

Water in Ducts

When conduits are placed above the frost line, ice formation can exert pressure on the fiber cable inside. This additional compressive load from the ice expansion often exceeds the crush strength of the cable. The force can cause macrobends in the fiber and degrade the signal. Signal strength returns to normal as the ice melts unless the strands are physically damaged.

Fiber networks are installed as economically as possible, typically along rail or road rights-of-way until a bridge is encountered, where cable is routed through carrier pipes on the span. Bridge crossings can expose cables and water-filled conduit to freezing temperatures that, in turn degrade the signal or even cause permanent damage.

In addition to bridge crossings, fiber is susceptible to ice damage at any location where duct is exposed to freezing temperatures, such as culverts or burials above the frost line.

Water gets into duct via infiltration and condensation. Innerduct offers potential access points through duct

ends and various connections. Rain or groundwater infiltrates the access points and collects in sometimes shocking quantity. Field experience shows that, upon entry to an innerduct, literally hundreds of gallons of water can gush out.

Condensation is another culprit, caused by differences between ambient temperatures and those inside ducts. Condensation forms in exposed conduits just as dew forms on grass, yet has less opportunity to evaporate, thus accumulating substantially over time.

Solutions

After the problem was defined decades ago, potential solutions were investigated. One was to reroute cables via directional drilling at bridge crossings, ensuring that cables remain below the frost line to prevent ice formation. This is an expensive solution, sometimes costing more than $1 million per bridge, depending on location and length. Sometimes geological challenges render it nonviable.

Another idea, drilling weep holes in carrier pipes, fails because it doesn't always eliminate water in the duct. Undulations and elevation changes trap water where it can't drain. Weep holes can clog with dirt and ice or may invite insects and small vermin.

Foaming the carrier pipe ends or the entire pipe doesn't solve the problem because it doesn't address the water already trapped within the innerduct.

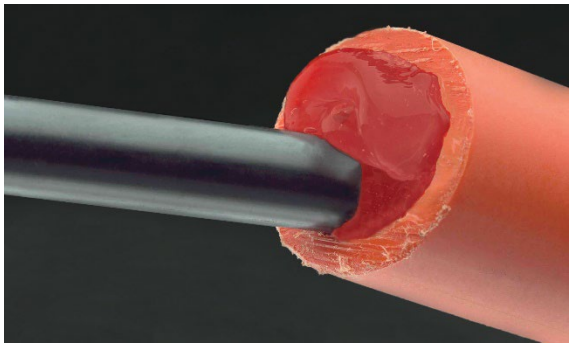
Polywater developed an alternative solution: an environmentally safe, freeze-proof gel that is injected into the conduit to dissolve ice, displace water, and permanently fill the void between cable and duct, thus blocking future water infiltration. The resulting product, IceFree™ Antifreeze Gel, is compatible with cable and has successfully protected countless fiber optic systems at far lower cost for many years.

Installation

To install the gel, access to the duct interior is needed. This may require excavation, cutting open duct and innerduct, or removal of existing duct plugs. Once opened, a hose is inserted to below the frost line and IceFree Gel is pumped in as the hose is slowly withdrawn, slowly filling the desired length of duct.

To reduce cost, gel is applied only in duct sections above the frost line, rather than the entire conduit run. Various methods of confining the gel without migration are used. Depending on the circumstances of the installation, these may include split duct plugs, Polywater's Hauff-Technik mechanical seals, Polywater's high-performance closed-cell FST™ Foam Duct Plugs, or Polywater's proprietary IceFree Chemical Duct Block. The block is a thick, dough-like, antifreeze material that absorbs water and IceFree Gel. The plug expands in contact with water, improving its effectiveness as a barrier. Consultation with the factory helps determine the optimal method.

Proven Results



IceFree has successfully protected fiber cables for decades in countless thousands of installations worldwide. In one project alone, product was installed in over 1,200 bridge crossings in the upper Midwest. During installation, 85% of the systems were found to have water trapped in the innerduct, proving the widespread nature of the problem. Wintertime installations were complicated by the presence of ice in many innerducts, 20% of which had to be thawed with steam before gel could be inserted.

In one efficacy test, a bridge crossing was treated with IceFree Gel on one side and with weep holes on the other. The bridge froze again in sub-zero temps. Visual inspection confirmed that the freeze-up occurred on the side with weep holes, while the side treated with gel did not.

In another case, a treated cable was removed for a reason unrelated to freezing, and no problems were encountered in its removal; the chemical duct block came out in chunks with the cable, and the IceFree gel was no hindrance.

With the ubiquitous and invasive nature of water, the likelihood of multiple cable failures is high for untreated ducts in cold weather. With monumental downtime costs, preventing ice formation is cheap insurance. Fiber optic lines treated with IceFree Antifreeze Gel routinely operate at maximum efficiency regardless of the weather.

For product questions:

Visit www.polywater.com or email: support@polywater.com