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Applications
Engineering Note

Rodent Resistance of Fiber Optic Cable

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Introduction

Optical fiber cables are exposed to a number of potential hazards in outdoor environments. One such hazard is cable damage induced by gnawing rodents. Such damage can occur in a relatively short period of time and can significantly impact the long-term reliability of outside plant optical fiber cables. The propensity for damage depends on several factors including the specific species of rodent, the type of installation, and the geographic location of the installation. In North America, direct buried optical cables are susceptible to attack primarily from gophers. Aerial cables however are susceptible to attack by squirrels – especially in areas where trees are in close proximity to cables, thereby affording squirrels easy access. Rats have also been considered to be a potential threat to cables deployed in manholes, tunnels, or in other confined spaces. In any case, rodent damage to communications cables is more than just a nuisance, as it can result in costly repairs and service interruptions.

General Considerations

Rodent protection for optical cable is generally based on making it difficult for the animal to gnaw into the core of the cable where the optical fibers are located. Unless protected by some external barrier such as a ducting, concrete, etc., gnawing rodents are usually able to breech the cable outer jacket. The challenge then is to prevent additional penetration and prevent access to the innermost portions of the cable. Cable design and placement methods are key to assuring a long-term resistance to rodent attacks.

The primary cable design features for improving rodent resistance are increasing the overall cable outside diameter and incorporating metallic armoring into the cable construction. The primary placement options with respect to rodent resistance are dependent upon the specific installation method. For direct buried applications, cable depth and soil type are the primary considerations. For aerial applications, the use of anti-rodent barriers and frequent tree trimming in the vicinity of cables may reduce the cable's susceptibility to attack.

Cable Design

With respect to cable design, rodent resistance can be improved by increasing the outer diameter of the cable and/or armoring the cable core with a metal tape.

Cable Size

Optical fiber cables are smaller than copper communications cables, and cables with an outside diameter less then 1.9 cm (0.75") are especially susceptible to damage because they are small enough for a gopher to gnaw completely apart. However, the small size and low weight of optical fiber cable are two of the attributes that make it attractive, so simply adding material to increase cable diameter is typically not a viable or cost effective solution.

Armoring

Testing over many years has shown the most effective method of rodent resistance to be the use of a corrugated carbon steel tape longitudinally wrapped around the cable core. Stainless steel has also been used in some designs, but its use does not provide an increase in resistance that can justify the additional cost. The hardness of these materials leads to their excellent performance in inhibiting rodents from damaging optical fiber cable to the point that the core integrity is compromised. Steel tape has proven its effectiveness over many years of service and is the most widely accepted method for rodent protection. In extreme instances, multiple layers of metal armoring can increase the resistance of a cable installation, but such is typically not necessary.

Installation and Placement

Direct Buried

With respect to direct buried applications, studies have shown that rodents will typically not dig to a depth of greater than four feet. The depth to which rodents will penetrate underground is largely a function of the frost-line location, which rarely reaches four feet in the continental United States. Therefore placing cables deeper than four feet will increase their survivability. Backhoe accidents or damage due to trenching are also reduced when the depth of cable placement is increased.

The type of soil in which the cable is buried can also have a significant effect on the amount of damage that may be sustained. Clay or other hard, lumpy soils, which hold their form well, are conducive to tunnel formation and help burrowing animals establish access to buried cables. Also, these soil types are the worst fill materials because of the voids they leave. These voids provide the rodents with ready access to buried cable. Sand, on the other hand, is extremely fluid and more difficult for rodents to burrow through because it does not hold form well, so tunnels through it collapse readily.

Finally, buried cables can be placed in plastic or metallic ducts for additional protection against rodent attack. However, the use of ducts can be expensive, so the benefits must be weighed against the increase in the cost of an installation.

Aerial

The primary concern in aerial applications is damage from squirrel attacks. Cables installed in areas with dense squirrel populations and old growth trees are at the highest risk. The best way to prevent damage from squirrels is to prevent them from reaching the cable. There have been a variety of strategies attempted, which cover a wide range of methods and costs. One method

involves placing a plastic or metallic conduit or "cage" around the cable in the areas of highest risk. Other methods involve placing tent-like structures above the cable and barriers on poles to prevent easy access to the cable. Trimming trees away from cables effectively removes potential access points for squirrels, but may have to be repeated frequently.

General

Over the years a variety of chemical repellents applied externally to the cable or compounded into jacketing materials have also been employed to deter rodent attacks. Rodent repellent methods based on chemicals with unappealing tastes or other toxins have been attempted as "stand-alone" methods, as well as in conjunction with other preventive measures. Unfortunately, the habits and physical anatomy of gnawing rodents do not leave them particularly vulnerable to these types of defenses. The gnawing behavior is more for "dental maintenance" than for sustenance and rodents typically will chew anything that strikes their fancy without necessarily ingesting it. The location of the incisors and biting action exhibited by gophers and squirrels does not automatically result in ingestion of material. These factors make chemical repellents that depend upon taste or toxins somewhat ineffective. Also, environmental concerns have significantly reduced the use of toxic substances due to the potential hazard to organisms other than the targeted pests.

Testing

Corning Optical Communications' has worked in the past with the U.S. Department of Agriculture, Denver Wildlife Research Center, to study the effect of exposing cable samples to live rodents in a controlled environment. Testing consisted of attaching cable samples horizontally across a 5 cm square opening in a stainless steel panel. The test rig was then exposed to the gophers for 7 days, during which time they gnawed on the cables. A damage index was used to indicate the severity of the damage.

While these cooperative studies unquestionably confirmed the effectiveness of metallic armoring against rodent attack, trial results varied largely based on individual animals, as well as on the interpretation of the resulting damage. Thus achieving repeatable results was difficult. This is in large part why no such testing has been incorporated into US standards; however, this testing represents the only functional-type evaluation attempted to date. Of note, this type of testing was discontinued in 1994 due to concerns over the humane treatment of the animals used. Corning Optical Communications' has not conducted this type of testing since.

Conclusion

Over many years of research, development and evaluation, Corning Optical Communications' has concluded that the use of a metallic armor barrier is the most efficient and cost effective method for providing adequate protection from rodent attack. Corning Optical Communications' offers several armored cable designs that can be used in applications where rodent resistance is a concern, and include single and double armored options. The armor used in Corning Optical Communications' cables is a corrugated, electrolytically chrome coated, low-carbon steel tape, coated with a polymer material on both sides for superior corrosion resistance. The armor is applied to the cable longitudinally with an overlapping seam.

Testing has demonstrated no significant difference in the rodent resistance capability of low carbon steel vs. stainless steel tape armors. However, low carbon steel tapes demonstrate

better lightning protection as a result of their inherently lower electrical resistance, compared to stainless steel. The double armored cable is superior to the single armored cable in terms of rodent resistance because of the additional layer of steel, but such is typically only necessary in extreme cases.

References

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