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Underground Installation of Optical Fiber Cable by Pulling

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Abstract
Optical fiber cable 'jacket zippering' may happen in metallic armor cable during installation, use, or testing of the cable, where the cable is subjected to bending and/or twisting. This application note describes cable 'jacket zippering' issue.

Keywords
Fiber optic cable, Cable bend / twist, Jacket / sheath zippering

Armor optical fiber cable

Optical fiber cables are used to transmit voice, data, video signals and deployed in indoor and outdoor environments. Outside plant optical fiber cables are designed for use in the outdoor environment, and should be robust enough to withstand cable bending and twisting action, and attack by rodents. Additionally, an outside plant fiber optic cable should contain a component which inhibits the ingress of moisture into the cable core. Conventionally, armored tape used to protect against rodent attack. Such tapes, which may be metallic, e.g. steel, or nonmetallic, e.g. plastic, typically include a seam where edges of the tape touch or remain in close proximity with respect to each other. The seam may be, for example, an edge-to-edge configuration or an overlap configuration formed by longitudinally overlapping edges of the tape.

The optical fiber cable containing corrugated metallic tape along the circumference of stranded cable core is called as "metallic armor cable". These armor cables may be uni-tube or multi-tube, single or double jacket and these metallic tape armor cables are suitable for outside plant applications mainly underground application i.e. direct buried or inside duct installation.

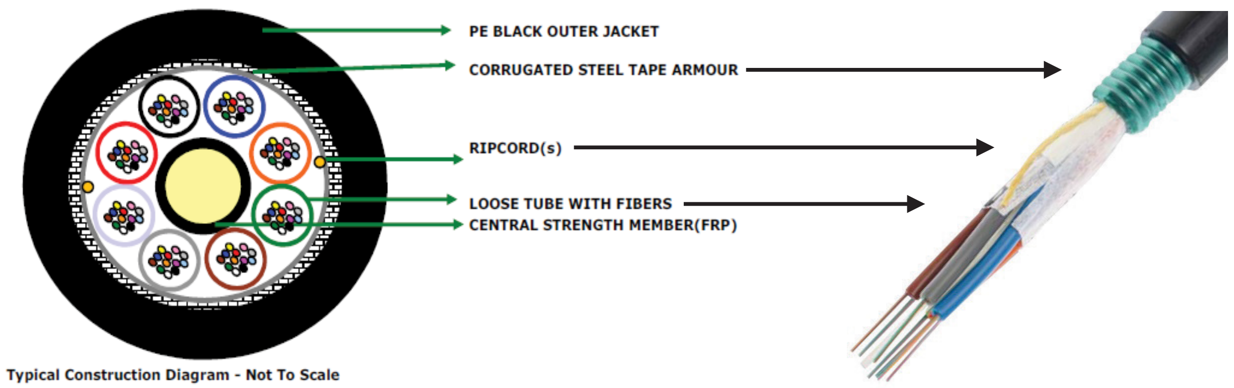

Figure 1 - An example of armor cable construction

Corrugated metallic tape as shown in figure 1 generally used in optical fiber cable for armoring protection to resist attack from rodents, electrical shielding, and tracing of cable and to prevent the ingress of moisture into the cable. The benefit of armor optical fiber cable is to provide extra mechanical protection to the fiber.

What is zippering in metallic armor cables?

As shown in figure 1, during cable manufacturing process a polymer material is extruded over the metallic armor tape to form a cable jacket / sheath. The edge of the metallic armor tape adjacent to the joint has a tendency to spring away from each other or miss-aligned and quite often form a step like uneven joint. During cable jacket extrusion process, the plastic material conforms the uneven shape of the joint. However, during cable installation, use, or testing, where the cable is subjected to bending and/or twisting, external stress concentrates near to the uneven portion of the jacket, which may cause the jacket to split or “zipper”. Longitudinal splitting of cable outer jacket at metallic tape overlap or joint portion is known as “jacket zippering” or “Jacket splitting”. Figure 2 shows ‘jacket zippering’ of metallic armor cable happened during cable installation. Zippering is more likely to occur at the point where jacket is joined to the edges of the metallic tape and sharp edge of the tape cut the jacket initiating the jacket to zipper. As ‘jacket zippering’ caused a crack/ gap in the outer jacket/ sheath, it destroy mechanical integrity of the cable and reduce in-service lifetime.

Jacket zippering is also subjected to the type of jacket material. HDPE (High Density Poly-Ethylene) is having better crack resistance as compare to LSZH (Low Smoke Zero Halogen) or PVC material. So it is always recommended to use Poly ethylene base material as outer jacket in metallic armor cable design.

Figure 2 - Jacket ‘Zippering’

What are the laboratory tests as per international standards?

Various cable tests are standardized to evaluate performance of a metallic armor optical fiber cable to resist ‘jacket zippering’ to happen. In these tests, cable samples are exposed to bend and / or twists. Torsion test mentioned in IEC 60794-1-2 (method E7) standard, is a test to check ‘jacket zippering’. In this test a 1 -2 meters of cable sample (length of sample is depend on type of cable) is subjected to 10 cycles of + 180 degree twist. The cable sample is kept straight by applying tension during the test.

As mentioned in Telcordia GR-20-CORE standard, cable sample of maximum 3 meter length subjected to the rated installation load shall be capable of withstanding a twist of 360 degree without resulting armor zippering or jacket splitting. Alternatively the cable under tension load can be 6 meters or 12 meters but must ensure that the ratio of 120 degree twist per meter cable length or 360 degree twist per 3 meters cable is there.

Best practices to avoid 'jacket zippering'

Metallic armor optical fiber cable which doesn't show 'jacket zippering' during above mentioned two laboratory tests, is capable to withstand cable twists and / or bends during installation and in-service lifetime. However, not following the best practices in cable handling could lead to 'jacket zippering' even after the cable is qualified to meet the laboratory standard tests.

Some of the best practices mentioned below will avoid cable 'jacket zippering'.

a. Cable mechanical parameters

Cable mechanical parameters shall be respected as per supplier's specification sheet during handling of cable. Minimum cable bend diameter, cable twisting/torsion are to be maintained as mentioned in the cable specification sheet.

b. Un-winding of cable

Cable reel to be loaded on pay-off during unwinding. Cable reel pay-off is very important in optical fiber cable installation set-up to ensure cable is smoothly unwind without damaging and subjecting excessive tension on cable. It is always recommended to use cable reel pay-off during cable installation. The cable reel should be kept in level to avoid cable rubbing against the reel flanges. The cable reel orientation should be such that the natural payoff direction is towards the pulling direction. Figure 3 shows unwinding of cable loaded in a cable reel pay-off set-up.

Figure 3 - Cable reel Pay off

c. Use of anti-twist device

It is strongly recommended to use anti twist device (also known as swivel) during cable installation by manual pulling or machine pulling. The swivel is to be placed in between cable grip (also known as 'pulling eye') and pulling rope as shown in figure 4 to remove the twist in cable and pulling rope. It is strongly recommended to use breakaway swivel during manual pulling installation. During manual pulling, applied pulling tension higher than the cable tensile rating can damage the cable and negatively impact its lifetime. The main function of breakaway swivel is to break the swivel if excess tensions compare to cable tensile rating is applied during cable pulling.

Figure 4 - Anti-twist device/ swivel placed in between cable end and pulling rope

d. Bending of cable

Optical fiber cables are designed with a minimum bending radius. The cable should never be bent below its minimum bending radius. Doing so can result in bending losses and/or fiber breaks & jacket zippering in the cable. Generally the minimum bending radius of an optical fiber cable under load is 20×D, where D is the diameter of the cable.

It is very important to maintain minimum bending radius while storing coiled cable at manhole & hand hole. During intermediate blowing and pulling, the cable storage should always be in Fig-8. Coiling in Fig-8 shape removes residual twists in the cable.

Figure 5 - Cable coiling in manhole or hand-hole and intermediate pulling/blowing

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