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Optical Cable Anti-rodent Performance

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1. Introduction

Along with the further development of optical fibre communication, the use of optical cable becomes more and more popular; but different service environments have different cable protection requirements. In some areas subject to severe damage caused by rats, optical cables often get bitten off by murine, resulting great difficulty in line maintenance. Considering factors like ecological environment protection and feasibility, anti-rodent measures like poisoning and trapping cannot be used for optical cable lines; therefore, optical cables with anti-rodent function have become the choice of telecommunication operators. As the equipment of communication cable manufacturers are not unified, and the degrees of cognition on optical anti-rodent study are different, and besides there is no national standard for anti-rodent cables, the enterprises therefore have made many anti-rodent cables of various structures according to the features of their own equipment. This article briefly analyzes why rats bite cables, introduces the current situation of domestic and international cable anti-rodent technologies, analyzes anti-rodent principles of different cable structures, compares anti-rodent effects of different cable structures by rat bite tests, and solves the problem of optical cable damage caused by rates in view of the optical cable structure design and the material selection.

2. Brief Analysis for Cause of Optical Cable Damaged by Rats

Along overhead communication cable line, areas subject to severe damage caused by rats have a common feature: the vegetation is fairly developed, the natural conditions are good and very suitable for the survival of murine, especially for squirrels. Such rodent with tenacious vitality and fecundity has the habit of biting something to keep its tooth sharp, because its incisors are extremely developed and continuously growing. The overhead optical cable running through woods not only provides entertainment platform for murine, but also attracts them by the special hardness and fragrance of the cable sheath; the cable therefore becomes the teeth-grinding target of murine.

3. Study on Optical Cable Anti-rodent Performance

3.1 Concept of Optical Cable Anti-rodent

Anti-rodent is to adopt various organization forms to control the damage of optical cables caused by rats within the specified extent. The basic condition of anti-rodent performance is that the cable core cannot be damaged.

3.2 Optical Cable Anti-rodent Approach

Anti-rodent methods for optical cable mainly comprise chemical anti-rodent and physical anti-rodent methods.

Chemical anti-rodent methods: chemical

anti-rodent method is to add rat repellents in outer sheath of optical cable by certain proportion for the purpose of rat prevention; commonly used rat repellents comprise synthetic lindane and synthetic capsaicine.

Physical anti-rodent methods: there are two physical anti-rodent methods; one is to utilize the hardness of optical cable material to resist the rat bite, for examples, install rigid metal tape armor or fine round steel wire or FRP rod and the like in optical cable; the other is to utilize the sharpness of anti-rodent material to sting the rats, such that the rat teeth can hardly penetrate the cable or rats may feel uncomfortable after their mouth is stung by glass fibre, and the cable core is therefore protected; commonly used devices include glass fibre yarn and glass fibre tape.

3.3 Performance Comparison of Various Cable Anti-rodent Methods

Chemical anti-rodent methods. Tests on laboratory rat indicate that capsaicine can act strong stimulation to the mouth mucosa and gustatory nerves of rats and make them give up chewing, so as to effectively prevent damage caused by rats. In view of economic efficiency and easy operation, adding certain proportion of rat repellent (capsaicine) in cable sheath should be the best choice, if the long-lasting anti-rodent effect could be achieved. But in view of environmental protection and durability, the following problems must be solved for using capsaicine: first, the volatilization of capsaicine during production; a large quantity of spicy gas volatilizes when extruding the mixture of capsaicine and sheath material by extruding machine; such gas spreads quickly in workshop and hurts the respiratory tract and eyes of operators, which is against the people oriented idea of current enterprises; second, capsaicine is gradually lost from sheath material after a long period in outdoor environment; therefore the anti-rodent effect and effective time of such cable can hardly be guaranteed. Therefore, on the discussion for establishment of national standard of anti-rodent cables, all participating experts expressed that the chemical anti-rodent method should not be encouraged, in principle; and the possibility of proper introduction when conditions mature is reserved in the wording of the standard.

Physical anti-rodent methods. In general, physical anti-rodent method is guaranteed by the structure and material of optical cable; and the anti-rodent performance can usually be validated by tests and inspections. Therefore, before comparing the anti-rodent performance of each structure, have a look at the laboratory comparison test on rat bite control of each cable structure.

3.4 Laboratory Anti-rodent Performance Comparison Test

By far, there is no national or industrial standard for test method of anti-rodent cables; and the validation is generally carried out with reference to the 7-day anti-rodent test invented by the U.S. fish and wildlife service organizations. The test standard is to compare and evaluate the damage degree of samples of test after the test; it should be noted that the damage degree of sample means the damage degree of the rat barrier layer. Among the given set of 10 samples, if the damage index is 2 or less than 2, it should be deemed as pass. Such test is only a conformity test. The damage index of optical cable is given in Table 1.

Table 1 Damage Index of Optical Cables in anti-Rodent Test

Index	Definition
0	No damage
1	Single partial penetration in outer sheath
2	Multiple penetrations in outer sheath
3	Penetration in armor layer
4	Optical fibre damaged

According to this standard, we have made the anti-rodent performance comparison test at Laboratory Animal School of Medicine of Tongji Medical College of Huazhong University of Science and Technology; fifty 250-300g SD male rats were selected and randomly raised in 10 cages, with 5 in each cage; 10 pieces of 30cm optical cable samples with sheath A (GYTA), steel belt sheath (GYTS), FRP band and fibreglass yarn sheath were put into the 10cages respectively; the

samples were fixed by steel wire; and the rats were provided with sufficient food and water. During the experiment, SD rats were free of any poisoning/death, and their diet was normal; after 14days, the damage of each sample was checked.

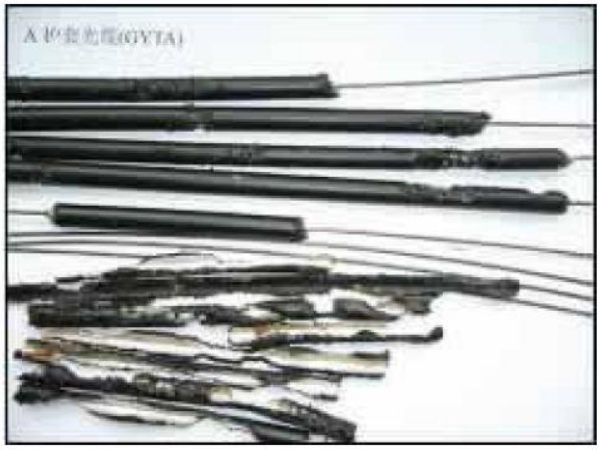
The following table describes results.

Table 2

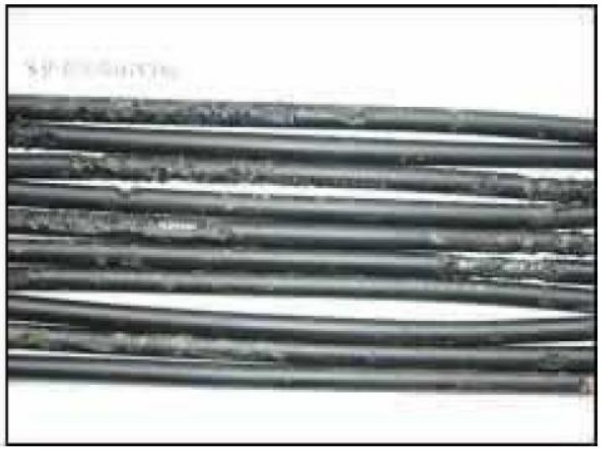
Type of optical cable	Damage index	Definition	Sample number	Quantity of sample
Sheath A	0	No damage		
	1	Partial penetration in outer sheath		
	2	Multiple penetrations in outer sheath		
	3	Penetration in armor layer	1#, 7#,	2
	4	Optical fibre damaged	2#, 3#, 4#, 5#, 6#, 8#, 9#, 10#	8
Steel belt sheath	0	No damage		
	1	Partial penetration in outer sheath	3#, 5#,	2
	2	Multiple penetrations in outer sheath	1#, 2#, 4#, 5#, 7#, 8#, 9#, 10#	8
	3	Penetration in armor layer		
	4	Optical fibre damaged		
FRP tape or fibreglass yarn sheath	0	No damage		
	1	Partial penetration in outer sheath	1#, 5#,	2
	2	Multiple penetrations in outer sheath	2#, 3#, 4#, 6#, 7#. 8#, 9#, 10#	8
	3	Penetration in armor layer		
	4	Optical fibre damaged		

Cable samples of various structures are as shown in Figure 1.

Sheath A optical cable



Steel belt sheath cable



Fibreglass yarn or belt cable

Figure 1 Cable Samples of Different Structures

Based on comparison of these damaged samples, it can be seen that sheath A cable has no anti-rodent ability at all; steel belt sheath and FRP belt sheath both have anti-rodent abilities.

Steel belt sheath has utilized the hardness of the steel belt. Based on this principle, manufacturers have developed the GYTS structure of general anti-rodent function, the GYTS53 and GYTA53 and GYTY53 cables with better anti-rodent performance; and some even use fine round steel wire as the armor of cable. In view of structure, all these cables have anti-rodent ability, but they also have disadvantages. First, conventional chrome plated steel belt or phosphate steel wires rust very soon and lose the protection ability after being bitten by rats and exposed in air; but if stainless steel wires are used, the material cost will be much more expensive than conventional materials, which is not economically efficient; second, the repeated anti-rodent ability is poor, because only for the reason of difficult to bite, rats will not stop attacking the cables, and the line will be damaged sooner or later. Third, such cables are heavy, leading great loads to poles and towers; and the cables are fairly rigid, resulting in inconvenient laying and maintenance. Fourth, metals are good electric conductors; after the cable is damaged, exposed metal may cause significant danger to the line.

Fibreglass anti-rodent method uses the principle that the rat gives up biting after its mouth being stung by the fibreglass. Fibreglass anti-rodent method is often reported and used abroad. Fibreglass is very small and fragile, when rats bite the optical cable, the fine glass fibre will sting the mouth of rats, make them extremely unconformable; meanwhile, the specific memory and information exchange

among biotic population makes the rats fear the optical cables in some extent, so as to realize the anti-rodent effect. This anti-rodent structure has two forms; one is to use fibreglass yarn, i.e., many fibreglass yarns are wrapped clockwise and counterclockwise on the inner sheath surface to a certain thickness prior to extruding the outer sheath. This form has high equipment requirement, and needs many awls to arrange the fibreglass yarns. The other is to use fibreglass belt; i.e., the extremely fine fibreglass yarns are bonded into belt of uniform thickness and suitable width; and modified capsaicine (microencapsulated capsaicine wrapped by organic matters) is mixed into the belt when curing the belt. During production of optical cable, the fibreglass belt is wrapped outside the inner sheath, and then the outer sheath is extruded thereof. The capsaicine is between the inner and the outer sheaths, even the microcapsule breaks under high temperature, there is no irritant gas leaking during production; and in long-term use, the capsaicine migrates into the outer sheath, which enables better anti-rodent effect in association with the fibreglass. The two anti-rodent forms can effectively improve the problem of continuous rat attack on optical fibre; meanwhile, the used protective materials are all non-metal materials, thus no adverse effect will be caused to the optical cable maintenance after the outer sheath is penetrated by rats; therefore, these are much better choices.

4. Conclusion

In general, chemical method is economical, but not recommended, because of the environmental protection and durability problems. In terms of physical anti-rodent method, all optical cables having rigid metal structure have certain anti-rodent ability, with only different in repeatability and durability of anti-rodent effect, and with certain hidden dangers in line maintenance; when using fibreglass yarn, it must be wrapped on the cable core by certain thickness to achieve good anti-rodent effect, and certain amount of yarn equipment is required, the anti-rodent method may not be very economical, but the resultant optical cable is of flexibility and bending performance; using fibreglass in anti-rodent method of optical cable has relatively simple requirement on paying off equipment, and the optical cable shaping is more easier, the cost is relatively economical.

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