Universal Cables with integrated Fibre Optic

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Abstract – The Universal Cable concept with self-suspending fully insulated and screened cables for use as aerial cables is today a well-established system. The use of fibre optic cables has expanded significantly during this period. Fibre optic cables integrated with power cables have been developed over the years and different concepts have been used. One solution to these problems is to integrate a plastic tube in the cable and to blow the fibre optics into the cable after the power cable is installed. The paper discusses the design challenges and the solutions chosen for this project.

Univerzalni kabel z integriranimi optičnimi vodniki

Povzetekt – Koncept univerzalnih kablov kot samonosnih, popolnom izoliranih in oklopljenih kablov za uporabo v zračnih vodih je danes dobro vpeljan sistem. V tem času se je zelo razširila uporaba kablov z optičnimi vlakni. Skozi leta so se razvili tudi kabli z optičnimi vlakni integrirani z energetskimi kabli, pri čemer so bili uporabljeni različni pristopi. Ena od rešitev tega problema je, da se v energetski kabel integrira plastična cevka v katero se naknadno, ko je kabel že instaliran, vpihajo optična vlakna. V članku so prikazani izzivi konstrukcije in izbrane rešitve tega projekta.

I. INTRODUCTION

The Universal Cable concept with self-suspending fully insulated and screened cables for use as aerial cables is today a well-established system.
It has been on the European market since 1994 and has proven excellent service experiences.
The use of fibre optic cables has expanded significantly during this period. Fibre optic cables integrated with power cables have been developed over the years and different concepts have been used.
Integrating fibre optic with Universal cables imposes some technical problems. One solution to these problems is to integrate a plastic tube in the cable and to blow the fibre optics into the cable after the power cable is installed. The high mechanical stresses of the cable can be handled and long distances can be used for blowing fibre of different types.
The paper discusses the design challenges and the solutions chosen for this project

II. BLOWN FIBER IN POWER CABLES

The use of combined power cables with tubes for blowing fibre optics is well established today. Most commonly in 1 kV service cables but also in 12-24 kV medium voltage cables. The mechanical stresses on the cables are relatively small, normally only radial forces by stones etc. when used as underground cables.

Fig. 1. 1 kV service cable with tube for blown fibre

Fig. 2. 12 kV underground cable with tube(s) for blown fibre.

III. BLOWN FIBER IN UNIVERSAL CABLES

In a self-suspending aerial cable like the Universal cable the mechanical stresses on the cable is higher. At the dead-ends a spiral grips around the sheath of the cable, the longitudinal forces, that can be as high as 60 kN, must be transferred into the conductors without damaging internal parts of the cable.

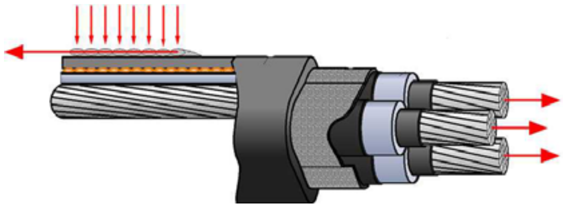

Fig. 3. Forces in a Universal cable

Fig. 4. Dead end spiral

A tube intended for blowing of optic fibre would collapse under the dead end spiral unless something was done to support it. Placing the tube in the center of the cable would protect it well but in a 3x70 sqmm cable there is not room enough for the tube.
The solution chosen is to extrude a supporting profile around the tube. With this design, the tube does not collapse, even at the high pressures on the sheath in dead-end spirals and at suspension clamps.
A general rule for blowing fibres through a tube is that the larger diameter in the tube the longer length of fibre can be blown. In an aerial cable, the available space is limited and so is the diameter of the tube. The tube selected has an outer diameter of 7 mm and an inner of 5.5 mm.

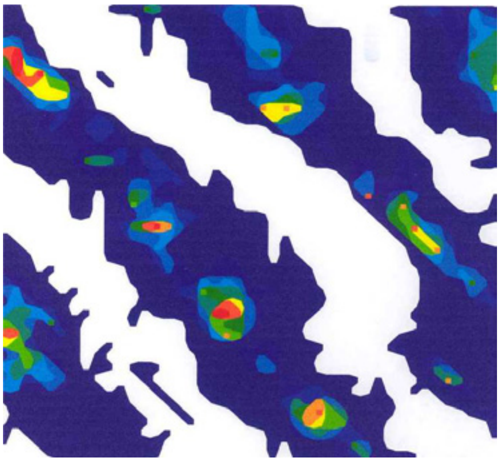

Fig. 5. Surface pressure measurements on cable surface from dead-end spiral under load.

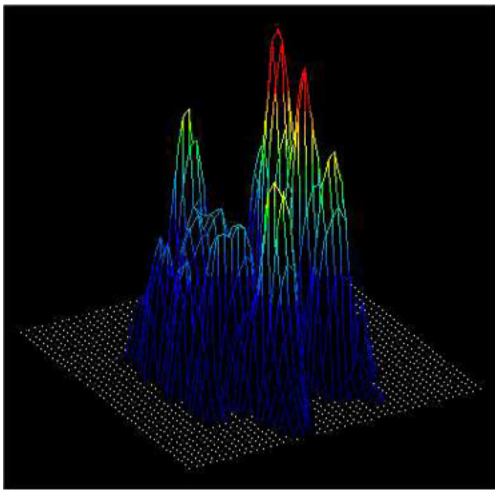

Fig. 6. Surface pressure measurements on cable surface from suspension clamp under load.

Fig. 7. Cross-section of AXCES+O 3x70/16 12 kV showning the embedded tube.

This gives the possibility to blow a Micronet® optical cable with up to 24 individual fibres or a Ribbonet™ ribbon with up to 8 fibres. The maximal length of blowing is in excess of 1 km. Longer lengths can be handled without fibre joints by using an intermediate store of fibre after 1 km which then is reblown into the next length. The tubes can easily be jointed by simple plastic joints.

Fig. 8. Joint for the tube

Fig. 9. Universal cable with Micronet® optical cable

IV. ALTERNATIVE SOLUTIONS

Of course, there are alternative ways to combine power cables and optical fibres. In for example submarine cables, a FIMT (fibre in metal tube) can be used. This is a very good mechanical protection of the fibre as well as a totally water tight enclosure

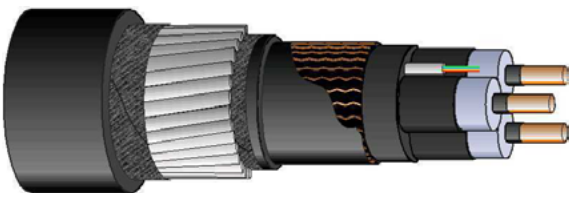

Fig. 10. Submarine cable with FIMT optical cable

However this type of design have disadvantages compared to the design described in AXCES+O. Mechanically the FIMT has small margins for stretching while an optical cable in a tube is not straight and has better margins for possible elongation of the cable. In a Universal cable installation the cable is erected and tensioned before the fibre optics is blown in place, thus the initial stretching of the cable is done without the fibre optics.

Another disadvantage with preassembled fibres in the power cable is that normally the fibres and the power cables have different end points. When using blown fibre the tubes can be jointed and routed to the final destination before blowing the fibre. This eliminates the need for splicing of the fibre at cable joints and ends.

Fig. 11. Universal cable installation in remote area

V. SUMMARY

The technique of blowing fibre optic cables in plastic tubes integrated in power cables is today well established.

Using the same technique in self-suspending aerial cables can be done if the cable design is done with respect to the high mechanical stresses, both radial and longitudinal, that the Universal cables are exposed to.

With this design the fibre can be blown in excess of 1 km in one step and longer in many steps without the need for fibre splicing