NON DESTRUCTIVE EXAMINATIONS OF CABLE RAILWAY EXPLOITED IN POLAND

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1. Introduction

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2. Electromagnetic testing of wire ropes

There are many types of wire rope constructions in service which are used in many different applications (an example fig. 2). Whilst in service, the wire rope will be subject to loading and environmental conditions which will cause it to degrade. The level of the degradation must be accurately assessed in order to get the maximum useful life out of the rope, but also so that the rope may be retired before its condition compromises the safety of the installation. The length of time which a rope may remain in service is dependent upon many variables, such as: service loads, installation configuration, rope construction, etc. The way in which a rope will degrade, again depends upon many variables, but typical degradation includes:

- broken (inner and outer) wires,
- wear,
- corrosion
- structural (rope) deformations.

It can be seen that it is desirable to be able to inspect a rope in-situ, as this avoids costly downtime of equipment involving removing, inspecting and replacing the rope.

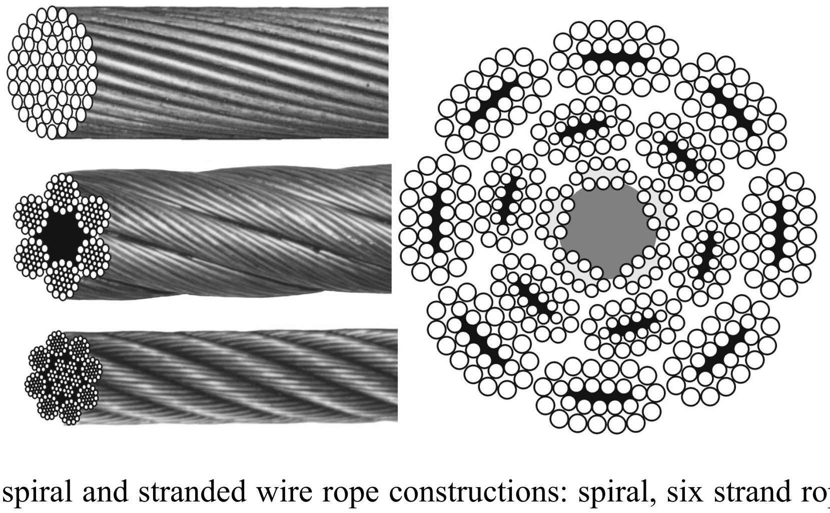

Fig. 2 Typical spiral and stranded wire rope constructions: spiral, six strand rope with IWRC and FC, multi-strand (nominally torque balanced) rope

There are two methods of non-destructive testing (NDT) or inspection for a rope in situ:

- visual inspection,
- magnetic (electro-magnetic) examination.

Visual examination on its own is a time consuming process, made harder by the fact that it is difficult to see all sides of a rope at any one time, and impossible to see inside (without opening it up) additionally, the surface of the rope may well be covered in lubricant. Visual inspection is however, an important aid to the effectiveness of magnetic NDT.
Magnetic inspection is in use on a world wide basis, and is accepted as probably the most effective way for locating wire rope degradation.
Traditionally the magnetic examinations of wire ropes allow the determination of rope Loss of Metallic Area (LMA) and Local Faults (LF). These are two main and world wide used determinants of rope condition by the way of magnetic non-destructive method and in most circumstances their application and some practical knowledge allows reliable quantification of wear in the examined rope.

Typical equipment for nod destructive wire ropes tests consists of two parts: sensing head and chart recorder. In this paper Polish made worldwide use set of equipment is presented: MD120 which is manufactured by ZAWADA NDT Ltd, originally designed by researchers from AGH – University of Science and Technology, Krakow, Poland.

The general arrangement of the GP2S equipment is shown in fig. 3. In this equipment, the LF and LMA signal is produced by sensors as a function of the rope position, (rather than time). This combination of sensors is probably the most commonly used for quantifying the loss of metallic area of a rope in the range of available testing equipment. The rope position is measured by the roller mounted at one end of the test head (fig. 3 - 5).

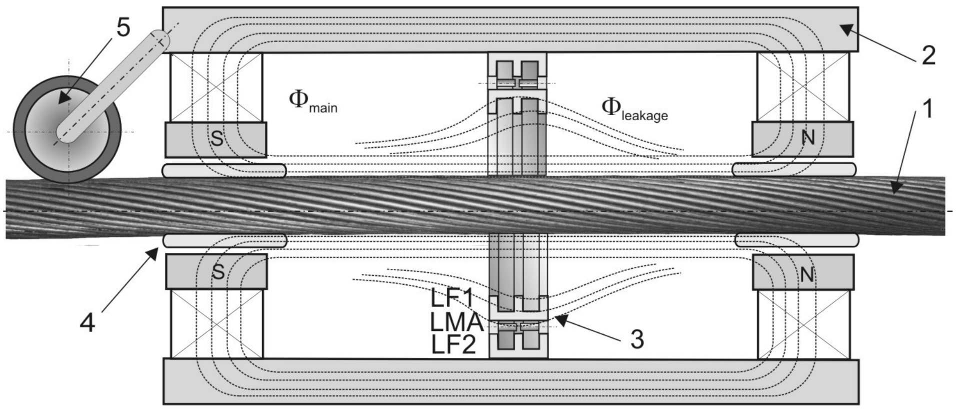

Fig. 3 Schematic diagram and one of typical NDT head and the arrangement of the sensors for determining position, local faults and loss of metallic area. Where: 1 Tested wire rope, 2 magnetic circuit with Permanent (rare earth) magnets and keeper; 3 LF (two sets) and LMA sensors; 4 Sliding guides; 5 Position transducer

The outgoing signals are registered by chart recorder. MD120 data acquisition unit was the first digital equipment used in the non destructive testing of wire ropes. It is equipped with a SRAM type PCMCIA memory card. The system enables transferring the digital signal from GP series test heads. It works as a computer where it could be analysed using proprietary software. In the figure 4 is presented the most practical way of analysing the signal from the NDT magnetic tests: visualisation by Browser software. Main window which shows typical signal obtained during tests is shown on fig. 4. This principle is designed to take one reading every 2.5mm. Hence, at a rope speed of, for example, 1 m/s, the data acquisition rate will be 400 Hz.

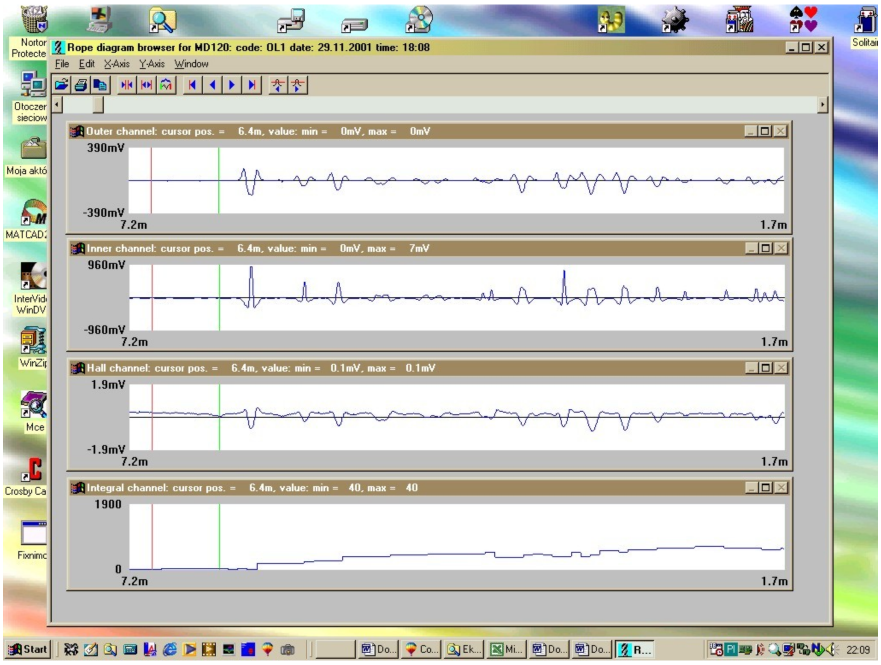

Fig. 4 Window of the Browser software

Typical full locked coil ropes being in service are usually the longest lasting parts of wire rope transport installations. They are also the most difficult ropes for magnetic testing. Theirs expected endurance is high and almost impossible to predict precisely. Such ropes are usually discarded not because degradation but because of limited length of spare coils on griping drams. Here is an example showing abilities of non-destructive magnetic method. It shows still in use the hoisting rope on old passengers cabin ropeway (two cable Bleichert system ropeway). The used hoisting rope was introduced into service in 1985.
From the beginning in 1985 when the rope was installed several broken wires has been found and observed on short 200meters long distance. The first fault was detected few years ago. It was almost invisible by visual inspection. This fault and its NDT trace is shown on fig. 5.

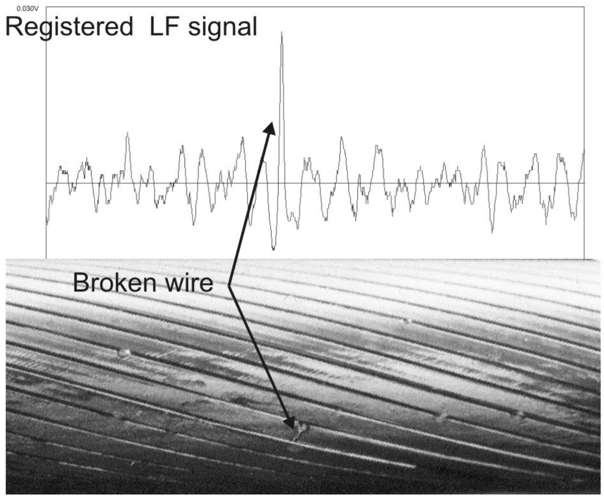

Fig. 5 Broken wire in outer layer and its LF diagram

This rope is regularly electro magnetically and visually checked. Based on NDT information taken from NDT traces some damaged part have been regarded as possible to repair. Longer faults have been repaired by filling gaps with inserted plastic resin. From that time repaired parts of the rope are regularly observed and non-destructively tested. Since the time of

repairing no new faults have been observed. After one and half year of service after repairing based on results of regular inspections the value of used technology was confirmed.
On fig. 6 are presented two NDT diagrams where damaged length of the rope is shown. Geometry of repaired faults after 1,5 year of service is the same. Not even number of faults is the same but lengthens of air gaps between ends are the same as well. NDT method in this case is the best way to guarantee safety use of this partly damaged rope.

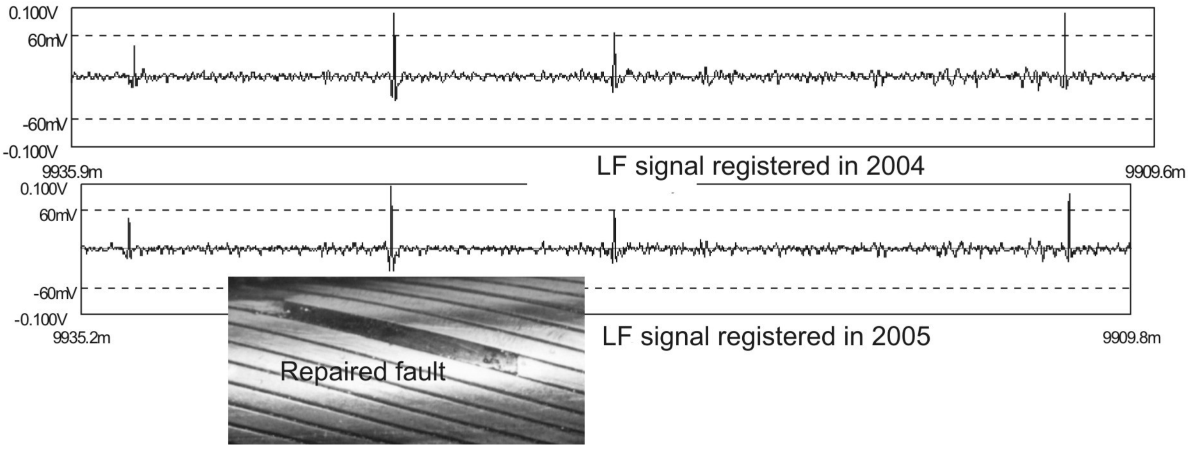

Fig. 6 Damaged part of rope with repaired broken wire, NDT traces from 2004 and 2005 year

3. Non destructive examinations of used cable railway in example of chair railway

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4. Final conclusions

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