Automatic monitoring of hoisting steel wire rope: practical approach

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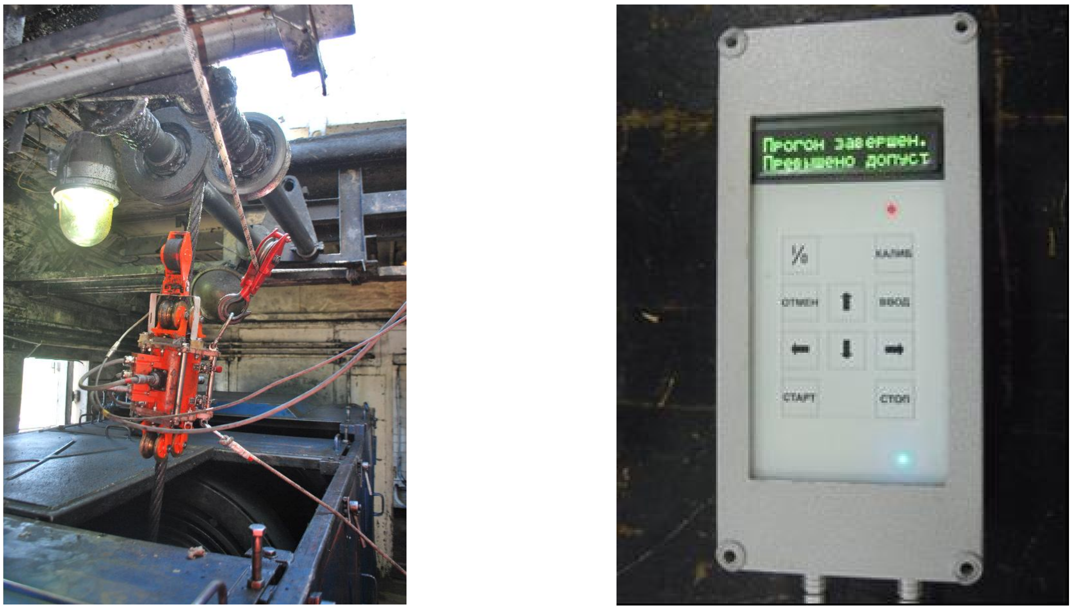
Non-destructive testing of steel wire ropes plays very important role in safety assurance of different lifting machines and mechanisms and allows reducing of costs of possible incidents; it also helps to reduce operating costs due to planning of rope replacement [1]. Conventional method of non-destructive rope testing is MFL (magnetic flux leakage) [2], which enables to locate and numerically estimate loss of metallic cross-section area (LMA), caused typically by corrosion and abrasion, and detect wire breaks (LF), both outer and inner. This type of rope instruction is recommended by different international codes, for example by IMCA M 197 [3]. Efficiency of non-destructive testing depends on the regularity of rope inspections during the whole lifecycle of the rope. The wide spread of rope non-destructive testing is limited first of all with necessity to have at place or involve a qualified expert with a special equipment. It is possible to invite some qualified service for onshore applications to check critical hoisting ropes, but it is very problematic for offshore applications. Similar situation is with drilling rigs, which have often an arduous location. So the development of automatic rope testing system to perform a regular rope inspection becomes an actual task.

Design of such a system should be aimed on a solution of somehow contradictory problems: the system should ensure high reliability and robustness, be easy in use, do not assume special qualification of service staff. It should also admit a permanent installation at the hoist. To ensure high reliability mechanical effect of the rope on the sensor should be minimized, at the same time the sensor should have high sensitivity for defects (wire breaks) and low level of maleficent influence factors. This leads to some conflicting requirements. High sensitivity to wire breaks presume a small gap between the sensor and the rope, but a small gap results in intensive mechanical effect on the sensor as the rope moves, which brings about a reduction of mechanical robustness.

One known approach is to make a big opening of the sensor to let a rope some transverse shift possible. At the same time the sensor is installed at the place with minimal transverse movement of the rope (just under the sheave). Such a solution is realized by Ansys Ltd. in the CRMS for mining ropes [4]. To ensure sufficient sensitivity magnetic head is made rather big, much bigger, then it should be necessary for magnetization system for such a rope – in such a way it reduces influence of disturbing factors. This solution can be applied in mining shafts with its static rope installation, but it does not suit for mobile hoists, such as offshore lifting machinery. The sensor for offshore hoist should be placed at such a position, where it enables to inspect the mostly effected by deterioration part of the rope.

Another approach is realized in an automatic rope diagnostic system of INTRON PLUS – Intros-Auto. It utilizes compact sensor (magnetic head), fixed on the rope, so it can be mounted at place with intensive transverse moving of the rope. The system is designed for monitoring of drill tower ropes and locates just above a winch (Fig. 1a). The sensor is not fixed on the rope permanently, but locates near the winch and can be put on the rope easily for the daily rope check. Result of the inspection appears on the display (Fig. 1b), which locates near the drill tower operator. Inspection procedure is fully automated, so the operator should switch system on and off and see results at the display. If some defect part of the rope passes thought the sensor, it lights yellow or red LED, depending of rope condition (yellow light corresponds warning condition and red light – critical condition). So far no valuable defects are found on the rope green LED is burning. It is important that every time the same length of the rope being checked, because it makes possible to compare successive inspections with each other to find out a moment as a rope begins to deteriorate intensively.



a b

Figure 1. Experimental model of Intros-Auto – automatic rope diagnostic system

It should be mentioned that continuous rope monitoring, that’s it when the sensor register measuring signal continuously during the whole working day, is not representative in many cases

– it does not bring additional information in comparison with regular (for example, daily) inspection for a proper used rope.

In practical application it is important that measuring data should be processed on-board – in the system itself. It guaranties autonomy of the system. So systems algorithms should check appropriate discard criteria for LMA and LF and give operator information about it. Decision of an automatic system has statistical character, so it can be incorrect in some specific cases. To make possible analyze and solve such specific cases the system should provide a possibility to store inspection data for a quite long time and upload it from a system in external computer for the further analysis by an expert. This data should be represented in some conventional form, for example, LMA and LF charts. Intros-Auto diagnostic system meets these requirements.

Implementation of rope monitoring systems entails development of appropriate rope condition criteria for warning and critical level. Obviously it should be based on rope residual strength calculation with respect to rope construction and load conditions. Furthermore it should concern probability of defect detection (POD) for the specific rope monitoring system.

In the conclusion it should be mentioned that rope monitoring system can not replace a standard non-destructive rope inspection, made by a qualified expert, but it can increase safety of hoist ropes and prevent potential accidents at lifting machinery.

References

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