

NEW INSERTS FOR FORCE MEASUREMENT IN ROPES OF MINING SHAFT HOIST

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Abstract: Test results and assessment of the inserts used for a measurement of forces in mining hoists ropes of WSP-Ec type, carried out in the Attestation Laboratory at the KOMAG Mining Mechanization Centre, Gliwice, Poland, were discussed in the paper. The inserts are used for measurement of forces in ropes of mining shaft hoists and they are installed, for that purpose, in suspensions of vessels as well as of ropes. Use of measurement inserts means an application of additional safety measure during operation of shaft hoist ropes, which have a wide range of applications. Such a measure is a practical, but not commonly used, tool to be implemented by the shaft operational teams, which are responsible for operational safety of the shaft hoists.

Keywords: hoisting ropes, force measurement

KOMAG Mining Mechanization Centre is the R & D organization notified by European Commission within the following directives:

- 98/37/EC machinery directive,
- 73/23/EC electric equipment directive,
- 94/9/EC directive concerning protective systems and equipment designed to be used in area threaten by an explosion hazard.

Attestation Division as the part of the KOMAG Centre is one of organization authorized to carry out tests and assessment of products which have to be accepted for use in mining plants according to a decision given by the Chairman of State Mining Authority. We conduct an assessment of shaft hoisting machines from over 30 years.

The assessment of products as regards the operational safety requirements in the mining plants is main objective of the Division. Recently in our Division we carried out the tests and assessment of inserts of the WPS-Ec type for force measurement in hoist ropes of shaft hoisting machines manufactured by the TEMIX Ltd. in Żarki.

Knowledge of real forces in lines is important for safe operation of shaft hoists, especially those which have multi-rope suspension for hoisting vessels and hanging platforms. That enables to carry out the equalization of rope loads. Advantages resulting from use of such inserts are unquestioned. The studies shown that use of these inserts in place of separating pads in suspension clevises does not influence the suspension operation. Due to that fact, having the safety as the superior objective, it is reasonable to promote the use of measuring inserts in shaft hoists.

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The insert symbol WPS-Ec are the first letters from Polish name - **W**kładka **P**omiarowa **S**ily z układem **E**lektroniki i **cyfrową** transmisją (Force Measuring Insert with electronic system and digital transmission). The inserts are designed to be used in suspensions of shaft hoists.

The inserts of WPS-Ec type are used for force measurement in the following ropes:

- hoisting, guide and fender ropes in shaft hoists,
- hoisting and hoisting-and-guide ropes in technical equipment for bucket shaft hoists in sunk shafts,
- hoisting ropes in auxiliary equipment for bucket shaft hoists in sunk shafts.

The WPS-Ec inserts are designed both for periodical force measurements as well as for continuous monitoring of forces in shaft hoist ropes.

Periodical measurements of forces in ropes are realized by implementation of the said measuring inserts and additional measurement equipment together with instruments which record testing conditions and electric and non-electric measured amounts.

While the constant monitoring of forces in ropes is realized by use of the said inserts together with additional measurement equipment and computer hardware.

The WPS-Ec inserts are new technical solution in which an essential idea, comparing to the present measuring inserts of WPS type has not changed. Previous version of the measuring inserts, inserts of WPS type, are used for force measurements in hoisting ropes of shaft hoists in R II and R I shafts of "Rudna" Mining Plant of KGHM Polska Miedź JSC., for continuous monitoring of force in hoisting-and-guiding and hoisting ropes of hanging platform of the shaft hoist in R XI shaft "Rudna" Mining Plant of KGHM Polska Miedź JSC., for force measurements in the hoisting ropes in shaft hoists in the "Lechia" shaft of "Wujek" Colliery.

The WPS-Ec inserts ensure much more accurate force measurement than the WPS measuring inserts.

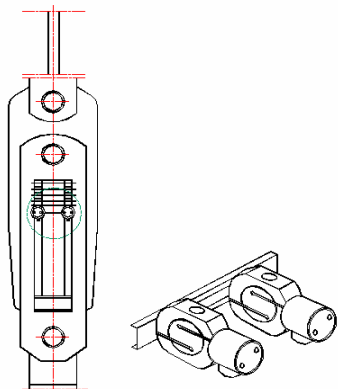


Fig. 1. WPS-Ec inserts installed in connector for rope length change manufactured by RYFAMA



Photo 1. WPS-Ec inserts installed in connector for rope length change manufactured by RYFAMA

During an assessment procedure the measuring inserts were subjected, among other to compressing tests carried out in the Laboratory of Building Engineering at Silesian University of Technology. The tests consisted in compressing the force measuring component placed between washers (from up side and bottom side). Washers used in the tests were the original distance inserts of 30 mm thickness for hoist vessels suspensions, which are used in connectors for length change of ropes hoist vessels suspensions.

In a result of the compressing test of the measuring component by the nominal force i.e. 150 kN it was found that it was not permanently deformed as regards the heights (photo 2 element from the left side), and on upper and bottom washer there were no visible traces of cooperation between components. Compressing test of the measuring component using a force equal to 1500 kN shown that a permanent deformation, as regards the height, and a reduction of gaps occurred. The sensor deformed by force 1500 kN was additionally compressed by force 2250 kN and it was further deformed (photo 2 element from right side).



Photo 2. Tested force sensors



Photo 3. Distance inserts after testing

The tests confirmed the fact that measuring components used in force measuring inserts of the WPS-Ec type have a strong resistance to overload by compressing forces. Both compressing force 1500 kN referring to 10 times of nominal overload of the sensor and compressing force 2250 kN referring to 10 times of static operational stress caused permanent deformations of the sensor. Deformations caused by overloads caused gap clamping and reduction of the sensor height by 4 mm. These deformations do not cause any damages to the sensor as regards its function as the distant insert.

The results have proved, among others, that implementation of those measuring inserts do not worsen the strength properties of mine suspensions of shaft hoists and do not reduce a safety of operating parts of the shaft hoist.

The measuring inserts of the WPS-Ec type are approved to be used in the underground mine plants according to a decision of the Chairman of Mining State Authority dated 7 March 2005 No. GEM/4707/0002/05/03112/AZ, to the suspensions of guiding and fender hoist ropes as well as to hoisting suspension of hoisting vessels.

Present operation of measuring inserts of the WPS type enables to get some information about the real force values in the following ropes:

- hoisting ropes of hoist vessels, what enables to undertake some actions to balance the forces in every rope, e.g. in a result of that it is possible to detect any differences in rope stiffness, in spooling diameters of the hoisting ropes on a drum in hoisting machine as well as it is possible to help in assessment of technical conditions of the suspension with balance levers,
- hoisting and hoisting-and-guide ropes in technical equipment for bucket shaft hoists in sunk shafts, what enables to balance the force values in every rope, as a result of that it is possible to facilitate a transport of the operational platform as well as to reduce safety coefficient from 7 to 5.

First of all the force balance in ropes leads to an increase of their operational safety and at the same time to the following:

- an even wear of operating set of ropes in the hoist, what means an extension of their life,
- an improvement of the vessel operation, what means a reduction of slide bearing wear and in a longer time a reduction of wear of shaft ways, can lead to an extension of time of their operation.

Use of the force measuring insert of the WPS-Ec type means an implementation of additional and versatile safety measure during an operation of shaft hoist ropes. The measure is a tool which has not been commonly used so far. Proper use of the tool by the shaft maintenance services, which are responsible for operational safety of shaft hoisting machines, enables to reduce and elimination of hazards which can occur due to differentiation of force amounts in shaft hoist ropes.

Examples of implementation of the force measuring inserts in shaft hoist ropes:

1. Monitoring of load of the hoisting-and-guide ropes in hanging platform of the shaft sunk by PeBeKa JSC Lubin for the KGHM JSC. "Rudna" Mining Plant.

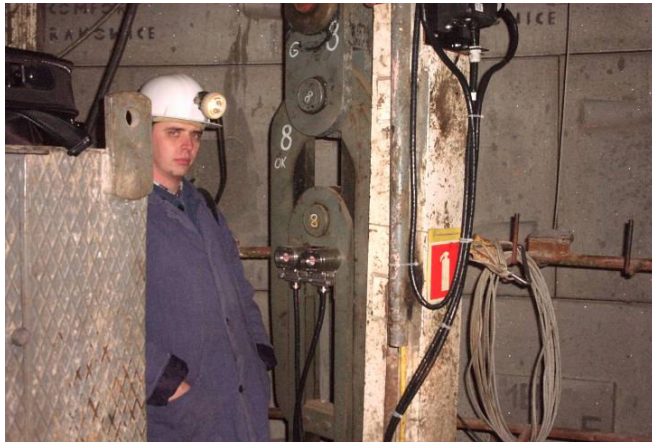


Photo 4. WPS inserts in a suspension of the hanging platform



Photo 5. Visualization of the force level in the ropes on the stand for winches control ($F_{sr} + 5\%$; F_{sr} ; $F_{sr} - 5\%$)

2. Periodical force measurements in the shaft vessel hoisting ropes in the 1.3 shaft of Lubelski Węgiel "Bogdanka" Colliery



Photo 6. WPS-Ec inserts in the suspension of the vessel in 1.3 shaft

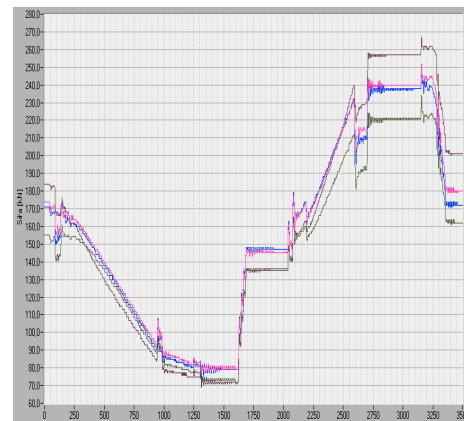


Fig. 2. Diagram of the forces in ropes during the hoist cycle of operation

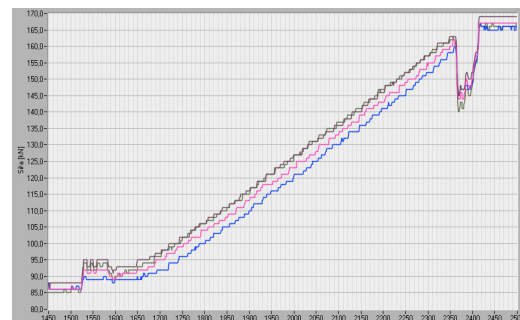
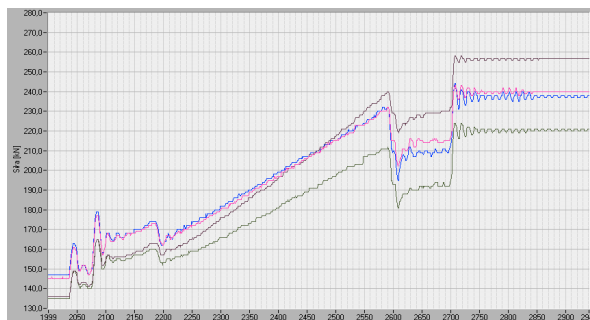


Fig. 3. Diagram of force in ropes before a correction of spooling diameter on the winch (left), after a correction (right) during upwards travel of the vessel,

3. Force measurement in hoisting ropes of R II hoist shaft - North and South field of Rudna Mining Plant

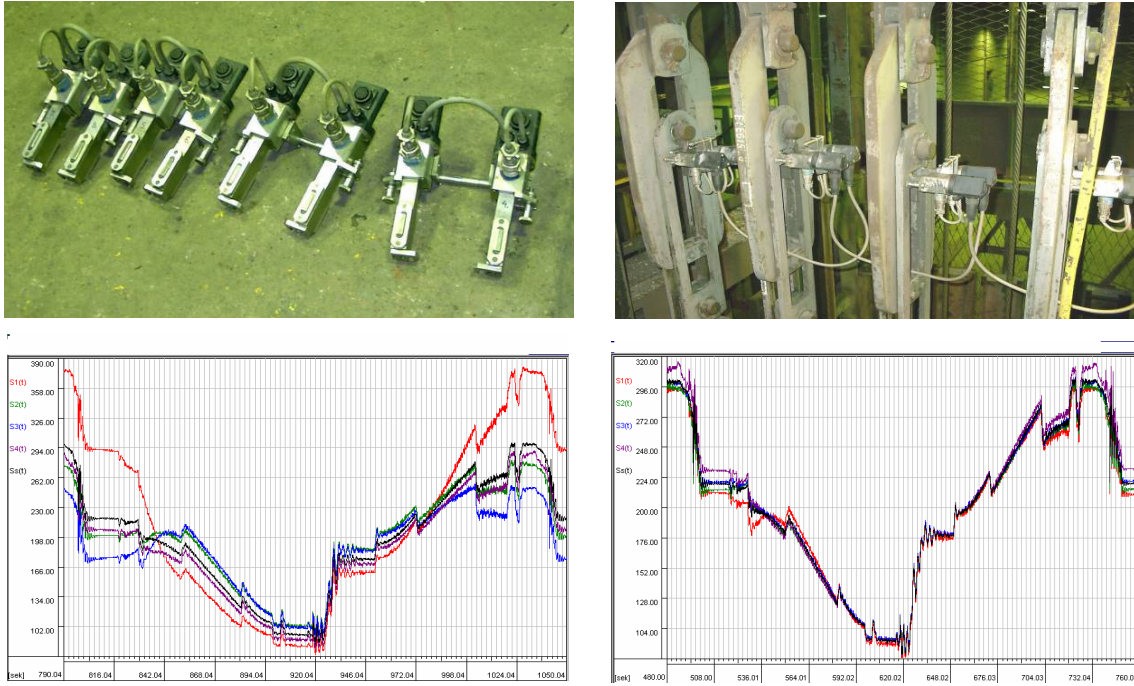


Fig. 4. View of the WPS set (up left), after installation in a suspension of the vessel rope (up right). Diagram of forces (left) before and (right) after a correction (change of length of ropes and spooling diameters of the machine's driving drum)

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