EVALUATION OF TECHNICAL CONDITION OF SPLICES IN STEEL CORD CONVEYOR BELTS ON THE BASIS OF ANALYSIS OF MAGNETIC SIGNALS

TOMASZ KOZŁOWSKI, MSC

Splices in steel cord conveyor belt in many cases have reduced strength and durability. In mine conditions, the statement of this fact is possible only after a failure, which can happen a long time after the splice has been made. This exposes the mine to unplanned production interruptions. Earlier detection of reduced strength due to manufacturing defects is possible only during destructive laboratory tests, which require the cutting of the belt sections along with the splice and its delivery to the laboratory. The solution to this problem could be tests on the splices made, directly on the conveyor belt and without the need to destroy them.

The aim of this dissertation is to take measurements on real objects, develop algorithms and implement them in the Matlab environment by extracting diagnostic parameters from magnetic signals from two-step splices in steel cord conveyor belts. The obtained results will allow to characterize the technical condition of the splices without the need to perform destructive tests in the laboratory. In addition, the influence of time on the change of determined parameters and tracking changes in the splice geometry will be examined.

As part of the doctoral dissertation, the concept was presented and methods were developed allowing for the parameterization of magnetic signals from the splices in steel cord conveyor belts. The parameter values are influenced by the method of making the connection, its compliance with the required scheme and the current technical condition.

The first chapter is an introduction to the dissertation and provides general information on the types of splices in conveyor belt made and how to perform them.

The second chapter lists systems for conveyor belt testing using magnetic methods which developed in Poland and around the world. In addition, the current state of knowledge in the field of magnetic testing of the steel cord conveyor is presented.

The third chapter presents the examined objects. Magnetic data from belt sections and their splices obtained from three overburden belt conveyors operating in one of lignite opencast mines. Measurements were made on the same conveyors three times over a two-year period.

The fourth chapter describes the construction and operation principle of the HRDS magnetic system using to conduct magnetic tests of steel cord conveyor belt. It has been developed at the Wroclaw University of Science and Technology.

The fifth chapter presents the rationale for undertaking the topic, objectives and thesis of the dissertation.

The sixth chapter presents the output data obtained from HRDS measurements on a real object. Examples of signal waveforms for damages of belt sections and splices are presented. A procedure for detecting magnetic signals from a complete belt loop was developed and implemented.

In the seventh chapter, a procedure for detecting splices from complete belt loop has been developed and implemented. Detected signals from the splices are intact and the informations from the belt segments are deleted. In this way, the amount of data for further analysis has been limited. A procedure for saving detected splices to separate files has been developed.

The eighth chapter describes three methods of synchronizing magnetic signals from bias splices: manual, point-to-point and genetic algorithm. The first of them was rejected due to the low repeatability of results and time-consuming. For the other two automatic synchronization methods, criteria for assessing their effectiveness were developed and then compared with each other. In addition, similarity measures were used to assess the technical condition of splices. For connections in the correct technical condition, narrower confidence intervals were obtained.

The ninth chapter is devoted to determining the reference waveform for the magnetic signal from splices. On its basis, diagnostic parameters based on the analysis of the self-similarity of real signals were extracted. The values of these parameters includes the locations of defects that may be present in the splice, splice length, relative elongations of the splice in time and the angle of the bias.

The tenth chapter presents sets of parameters developed in the dissertation (point clouds) after converting signals from all splices. Due to the multidimensionality of the data from each measurement channel, no classification methods have been developed that allow the connection to be classified into the correct and incorrect (optionally: warning) condition. The need for further researches in this area is justified.

The doctoral dissertation is concluded with a summary and conclusions.