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Pantograph Strips Failure Analysis and Artificial Intelligence Prevention Methods

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Abstract

In rail transport, reliability and operational safety in large part depends on the correct reception of power from the catenary by a traction vehicle. In this paper, a special attention was paid to consumption of sliding strips of a current collector (AKP-4E and 5ZL type), measured during periodic reviews of locomotives EU07 and EU09. Pantograph data, collected during periodic technical reviews, was provided by one of the biggest railway carrier in Poland.
To investigate the reliability assessment of the selected pantograph strips a non-destructive degradation analysis was carried out. On the basis of the wear measurements of the strips and the critical value of wear, the failure distribution model was developed. It was used to obtain the selected reliability characteristics and to predict the lifetime of the strips.
Such analysis was carried out for two variants. In the first one, analysis was based on data selected during standard technical review of a pantograph. Second variant considered Artificial Intelligence method to predict and prevent cases of pantograph strip damage. Applied and tested methods of artificial intelligence were mainly related to classification algorithms. For this purpose was used techniques such as: decision trees (Complex Tree Medium Tree, Simple Tree), supporting vector machines (Linear SVM, Quadratic SVM, Cubic SVM, Fine Gaussian SVM, Medium Gaussian SVM, Coarse Gaussian SVM), methodics of nearest neighbors (Fine KNN, Medium KNN, Coarse KNN, Cosine KNN, Cubic KNN, Weighted KNN) or classifiers (Boosted Trees, Bagged Trees, Subspace Discriminant, Subspace KNN RUS Boosted Trees).
The results of conducted analyzes may be used to build a preventive maintenance strategy of the pantographs. The applied reliability models of wear propagation can be extended by the parameters of the cost and repair time becoming the basis for estimating the costs of operation and maintenance.

Keywords: Reliability Assessment, Failure Distribution Model, Pantograph Strip, AI Methods, Machine Learning, Artifitial Neural Network, Damage Prevention