

*Marcin Czarnecki, Robert Bińkowski:* **Problem of Damage to Curved Switch Rails in Ordinary Turnouts**

The article presents the problem of excessive wear of curved switch rails in ordinary railway turnouts, which is characterized by spallings and the decrement of material on a certain length of the switch rail near the tip. The problem is important, as such wear arises in turnouts on railway lines after several months of exploitation following modernization. The probable reasons behind the excessive wear of switch rails in railway turnouts are indicated on the basis of laboratory tests performed in accordance with PN-EN 13674-1:2011 and PN-EN 13674-2+A1:2010, as well as on the basis of simulations and analyses carried out by the finite element method (FEM).

Keywords: railway turnout, turnout switch rail, non-metallic inclusions, tension stresses, finite element method

*Paweł Kwaśniewski, Krystian Franczak, Grzegorz Kiesiewicz, Tadeusz Knych, Andrzej Mamala, Artur Kawecki, Szymon Kordaszewski, Wojciech Ścieżor, Radosław Kowal, Artur Rojek, Wiesław Majewski, Marek Kaniewski, Roman Majnusz, Romuald Wycisk, Michał Śliwka:* **Research on the Operational Properties of the New Generation of Railway Carbon Contact Strips Designated for Pantographs. Part I**

The system of supplying railway traction vehicles with electricity is carried out through direct contact of the contact wires with contact strips of the pantograph of the locomotive. Since 2011 in Poland, in accordance with the interoperability specification of the TSI LOC & PAS, the previously used copper contact strips have been prohibited and the use of carbon contact strips has been forced. Due to the lack of domestic solutions dedicated to railway contact lines powered with DC 3 kV, foreign solutions were adopted. In order for the contact strips to be used in Polish railway lines managed by PKP PLK S.A, they must meet a number of requirements regarding their operational properties. The first part of the article presents research on the new generation of carbon contact strips manufactured by Carbo-Graf in accordance with EN 50405:2006, which is specified in TSI LOC & PAS.

Keywords: carbon contact strips, carbon composite, pantograph, railway, contact system

*Piotr Lesiak, Aleksander Sokołowski:* **Preprocessing Algorithms of Vision Research Damage to Concrete Railway Sleepers**

The paper presents algorithms for the preprocessing of the visual method of detecting damages of concrete railway sleepers. It starts with acquiring images of the surface of the sleepers, by selecting the recorded frames of the images. Then, the color image is transformed into monochrome, so as to obtain the highest contrast possible. The Kanan and Cottrell algorithms were used for this purpose. A simple way is to segment the damage images of the sleepers, by thresholding, in order to binarize them. However, more elaborate algorithms are recommended. For this purpose, images are denoted using a median filter and further morphological operations to extract the edge of damage. For this purpose, noise is removed from images using a median filter, and morphological operations are carried out, to extract the edge of damage. In addition, texture images of the surface of the sleepers are used, removing them from the visual content. As the criterion for selecting the preprocessing algorithm, the shape of the image histogram and its standard deviation were assumed. Such prepared images form

the basis for further assessment of the size of damages (cracks and voids) and classification of concrete sleepers.

Keywords: railway track, concrete sleeper, image processing algorithms

*Ireneusz Mikłaszewicz, Marcin Czarnecki:* **Sulfur in Railway Elements**

The article presents the influence of sulfur as a harmful chemical element in railway elements working under load. The Baumann test shows the segregation of sulfur in the cross-section of the wheelset axle pivot, rail, wheel tyre and coupling elements. The tests were carried out in accordance with the standards PN-87/H-05414, ISO 4968:1979, PN EN 13674-1 + A1:2017, PN EN 13261: 2011, PN-84/H-84027/06, PN-EN 10083-3: 2006 and PN-EN 15566:2016-11, which require the de-termination of sulfur content and its distribution in those elements.

Keywords: sulfur, Baumann test, railway elements

*Vitalij Nichoha, Volodymyr Shkliarskyi, Volodymyr Storozh, Yuriy Matiieshyn, Liubomyr Vashchyshyn:* **Magnetic Flux Leakage Method of Railway Rails Defects diagnostics and its Place Among Mobile Means of Non-destructive Testing**

The task of mobile railway tracks defects diagnostics is to identify and recognize dangerous defects in order to prevent possible accidents. A review of the methods for controlling the physical and mechanical characteristics of metal constructions of engineering objects of long-term exploitation, which are used under different temperature regimes and conditions, is carried out in Among the described non-destructive methods on the used physical fields are allocated: magnetic, acoustic, electromagnetic, thermal and electrical. Electromagnetic methods are successfully used in various industries, such as the railway industry, the metal-working industry, the drilling, nuclear waste storage and so on. In particular, in the railway industry, using the technique of measuring the electromagnetic field of an alternating current, checks of carriages, wheel pairs and tracks are carried out. Recently, hybrid systems of diagnostics on the basis of carriages-defectosopes are actively used to detect defects in railway tracks while simultaneously using magnetic, ultrasonic, visual-measuring and optical methods of non-destructive control. The high efficiency of new methods for constructing the information diagnostic system (IDS) of mobile magnetic railway tracks defectoscopy objectively depends on the successful solution of the certain contradiction: this is the provision of high resolution and sensitivity of IDS for the detection, differentiation and classification of the defects signals – on the one hand, and on the other hand – reduction of the time allocated for the defectoscopic examination in the conditions of various obstacles and the need for defects detection in the early stages of their development. Solving this contradiction with the use of modern methods of railway tracks defects signals processing and new small size multichannel and component sensors forms the content of an important application problem, which is considered in this article.

Keywords: information diagnostic system, railway tracks defectoscopy, component sensors, non-destructive magnetic methods, wavelet analysis and neural networks

*Jan Raczyński, Tomasz Bużalek, Agata Pomykała:* **Concept of Integrating the Łódź and Kielce TEN-T Hubs**

The article presents an analysis of the economic and transport connections between the Łódź and Świętokrzyskie regions, in particular between Łódź and Kielce. Shortages in the railway network, which make it impossible to effectively use rail-way transport for both passenger and freight transport, were identified. An analysis was also performed concerning the use of opportunities arising from the course of the Trans-European Transport Network (TEN-T) through the territory of both regions. A program of necessary infrastructure investment was also proposed.

Keywords: transport, regional development, transportation systems

*Michał Urbaniak, Ewa Kardas-Cinal:* **Optimization of the Efficiency of Braking Energy Recovery in Rail Transport by Changing Arrival Time**

The article refers to the previous work of the authors, in which the model of traffic organization of cooperating trains including the optimization of the use of energy returned to the catenary was presented. In the presented article, the model was modified by changing the main control variable, which affects the efficient use of energy. Departure time was changed for the arrival time of the train to the stop or station. The optimization is done by controlling the arrival time to the station in the acceptable (scheduled) range while maintaining the scheduled departure time. This model assumed optimization using the interval halving method (bisection) to achieve the optimal solution. The modified optimization method has been implemented in the original model of railway traffic organization. It considers the optimal use of energy recovered during electrodynamic braking using the energy transmission strategy to the catenary, assuming the cooperation of a train pair and volume of all recovered energy and stop time at the station.

Keywords: rail transport, regenerative braking, optimization of energy recuperation, traffic organization