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100 LAT BADAŃ W POLSKIM KOLEJNICTWIE

Scientific conference on 100th Anniversary of Railway Research and Development in Poland

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Summary

On 26–27 February 2025, on the occasion of 100th anniversary of railway research and development in Poland, the Railway Institute organised open lectures and a scientific conference. On 26 February 2025, at the Warsaw Railway Museum (Stacja Muzeum), experts from the Institute held a series of lectures. The lectures covered the history and tradition of railway research in Poland, as well as contemporary research directions and future challenges in the field of railway transport. On 27 February 2025, a scientific conference organised by the Railway Institute on the occasion of the 100th anniversary of railway research and development in Poland was held at the Sheraton Grand Warsaw hotel.

Keywords: scientific conference, railway research, Railway Research Institute (IK)

1. Brief history

The Railway Research Institute, a scientific unit with a tradition of more than 75 years, is an important part of the history of the Polish railway industry. It conducts research and scientific work of national and international scope. The Institute continues the traditions of the Experimental Division founded in 1923, formally established in 1924, at the then Ministry of Railways. As a supplement to the Experimental Division, the Central Research Laboratory of the Polish State Railways was established in 1934, with the aim of improving and standardising the quality of materials supplied to the railways. Sadly, the development of railway research was interrupted by World War II; however, already in 1945, the Experimental Division in the Ministry of Communication was re-established and rail vehicle testing resumed. The year 1951 is significant in the history of our research institution, as the Railway Research Institute was established at that time using existing research resources. The 1980s, and 1990s brought further organisational changes to the Institute, as well as challenges related to the systemic transformation. The current name – the Railway Research Institute – has been used since 2010.

2. Open lectures in the Railway Museum

The substantive program of presentations by the Institute specialists at the Railway Museum on 26 February 2025 included the following:

- Experimental Division at the Ministry of Railways – a historical outline, Ph.D., D.Sc. Eng. Andrzej Massel, Director of the Railway Research Institute;
- Genesis and design of the experimental track, M.Sc. Eng. Waldemar Szulc, Head of the Experimental Test Track Operation Centre at the Railway Research Institute in Żmigród;
- Activities of the Rolling Stock Testing Laboratory at the Railway Research Institute, M.Sc. Eng., An-

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drzej Zbieć, Expert from the Rolling Stock Testing Laboratory at the Railway Research Institute;
- Development of NDT techniques in the railway industry on the example of the ultrasonic method, M.Sc. Eng, Łukasz Antolik, Deputy Head of the Materials and Structure Laboratory, Head of the Metal Materials Laboratory at the Railway Research Institute;
- Transport forecasting and modelling of train traffic, M.Sc. Eng., Przemysław Brona, M.Sc. Eng. Piotr Chyliński, Experts from the Railway Track and Operation Department at the Railway Research Institute;
- Automatic railway couplings in Poland, history and present, Ph.D. Eng., Piotr Tokaj, Expert from the Rolling Stock Testing Laboratory at the Railway Research Institute, Brakes Working Group in Cracow, UIC Working Group Expert B126.13 Friction Materials;
- Railway vehicle brake tests in Poland – history and present, Ph.D. Eng., Paweł Urbańczyk, Expert from the Rolling Stock Testing Laboratory at the Railway Research Institute, Brakes Working Group in Cracow;
- Accreditation, calibration, history of the Metrology Laboratory at the Railway Research Institute, geometry measurements of rolling stock and railway infrastructure elements, M.Sc. Eng., Andrzej Aniszewicz, Deputy Head of the Metrology Laboratory at the Railway Research Institute.

After the lectures, the Museum, as a partner of the event and host on the first day of the celebrations of the 100th anniversary of railway research and development work, enabled all interested parties to familiarise themselves with the collections free of charge and provided the assistance of guides.

The lectures by the Institute employees and the Museum's activities resulted in great interest from both those who performed or participated in railway research and development works as part of their professional careers and enthusiasts of rail transport technology. In the large, beautiful, historic waiting room of the train station, from which the train journeies to Vienna began before the war, there were not enough seats many times.

3. Scientific conference

The scientific conference, which took place on 27 February 2025 at the Sheraton hotel in Warsaw, was held under the honorary patronage of the Minister of Infrastructure, the President of the Railway Transport Office, the Chairman of the Civil Engineering Committee of the Polish Academy of Sciences, the Chairman of the Transport Committee of the Polish Academy of Sciences, the Organisation for Cooperation between Railways (OSJD), the International Union of Railways (UIC) and the Main Council of Research Institutes. During the conference, the activities of the Railway Research Institute in selected key areas of transport development, implemented within the basic areas of railway technology, were presented. Such an overview of wide-ranging activities in different fields, with dynamic technological development, was considered by the conference organisers to be representative for the Institute's achievements and tasks against the background of the latest research directions in infrastructure and rolling stock.

3.1. Official part

In the first part, the conference host, Ph.D. D.Sc. Eng. Andrzej Massel, Director of the Railway Research Institute, welcomed the guests (Fig. 1): Tomasz Warsza, Director of the Department of Railways in the Ministry of Infrastructure, Minister Ph.D. Ignacy Góra, President of the Railway Transport Office, Professor Marcin Ślęzak, Vice-President of the Main Council of Research Institutes and members of the Scientific and Honorary Committee, representatives of the world of science, presidents and executives of railway entities and the railway industry, including:
- railway undertkings.
- railway infrastructure managers,
- rolling stock manufacturers,
- manufacturers and suppliers in the area of rail infrastructure services,

and all other guests at the ceremony.

Fig. 1. Opening of the conference by the Director of the Railway Research Institute Andrzej Massel [photo: own resources of the Institute]

The official welcome was followed by the ceremonial granting of state and departmental decorations to

distinguished employees of the Institute. On behalf of the President of the Republic of Poland, the decoration was performed by Tomasz Warsza, Director of the Department of Railways in the Ministry of Infrastructure (Fig. 2). Also, Minister of Infrastructure Piotr Malepszak granted badges to the employees of the Railway Research Institute (Fig. 3).

Fig. 2. Speech by Tomasz Warsza, Director of the Department of Railways in the Ministry of Infrastructure [photo: own resources of the Institute]

The President of the Republic of Poland, Andrzej Duda, also granted state decorations to the employees of the Institute. Medals for long service and exemplary, exceptionally conscientious performance of professional duties were granted to 15 Railway Research Institute employees. Gold medals were awarded to: Juliusz Furman, Artur Golina, Robert Kamiński, Stanisław Kamiński, Norbert Rustowski, Ryszard Siejka, Ryszard Skóra, Urszula Skuza, Krzysztof Stępień and Waldemar Szulc. Silver medals for long service were awarded to: Przemysław Barcikowski, Piotr Chyliński and Izabela Tarka. Bronze medals for long service were awarded to: Krzysztof Ortel and Małgorzata Poprawa.

Badges of "Merit for the transport of the Republic of Poland" were awarded to: Dominik Adamski, Magda Antolik, Jerzy Cejmer, Jacek Kukulski, Magdalena Kycko, Krzysztof Ochociński, Anna Sałańska and Lucyna Sokołowska. Badges of "Merit for the railways" were awarded to the following employees of the Institute: Andrzej Aniszewicz, Joanna Cybulska, Jacek Jendrusik, Adrian Kaźmierczak, Andrzej Kowalski, Iwona Nowosińska, Michał Sierakowski, Jerzy Warpas and Marek Woś.

For their long-term work at the Institute (starting from the Central Research and Development Centre for Railway Engineering (COBiRTK) through the Railway Scientific and Technical Centre (CNTK) to the Railway Research Institute), for professionalism, conscientiousness, exemplary fulfilment of official duties and commitment to the development of rail transport in Poland, awards were granted by the Director of the Railway Research Institute to: Andrzej Białoń, Witold Groll, Andrzej Kazimierczak and Wojciech Rzepka.

The first part of the conference was closed with a presentation Andrzej Massel entitled: "Professor Albert Czeczott – the creator of the Experimental Division". The presentation covered the history of the establishment, changes, current activities and functioning of the Railway Research Institute, including persons of particular merit for the development of research in the field of the railway industry. The full article is published in the 203rd issue of Railway Reports (Problemy Kolejnictwa).

Fig. 3. Distinguished employees of the Railway Research Institute – state decoration [photo: own resources of the Institute]

3.2. The substantive part

During two scientific sessions (Fig. 4), selected research and development works of the Institute, recently implemented and in progress, were presented. The session moderators were: Ph.D. Mirosław Antonowicz, professor at the Kozminski University, Ph.D. D.Sc. Eng. Piotr Gołębiowski from the Faculty of Transport at the Warsaw University of Technology.

Fig. 4. Substantive debate with the participation of guests [photo: own resources of the Institute]

Ph.D., D.Sc. Eng., Marek Pawlik, professor at the Railway Research Institute discussed the railway infrastructure standards in Poland from 2002 to 2009 for Polish Railway Lines (PKP Polskie Linie Kolejowe S.A.), and from 2021 to 2023 for Main Communication Hub (Centralny Port Komunikacyjny sp. z o.o.). The Institute has accumulated relevant experience during the conceptual work on high-speed railways. It has also made use of the knowledge accumulated and widely used by the Institute's employees in the field of European railway interoperability and the need to maintain railway interoperability in Poland. This enabled the development of thirty-two volumes of railway standards for speeds up to 350 km/h, based on which new railway lines in Poland are designed today.

The development of rolling stock material fire testing and the implementation of a methodology for assessing the fire safety of railway vehicles in the years 1984–2025 was presented by **Ph.D. Eng., Jolanta Radziszewska-Wolińska**, professor at the Railway Research Institute. New materials, including plastics, have emerged during the development of railway transport. The Railway Research Institute is an authorised body for approving materials used in railway passenger rolling stock and has all the laboratory equipment necessary for fire safety testing. Some of the conducted tests are: ignitability of products subjected to direct flame, heat release and smoke generation, heat emission rate during combustion, critical heat flux and toxicity index of combustion products. The research is intended to implement fire safety requirements for railway vehicles. An important role of the Institute is also to disseminate knowledge on fire safety of railwy vehicles, supported by the organisation of periodic international conferences and a monograph on modern trends in rolling stock fire protection.

The study on crashworthiness, from the research and development of standards for trams and railways to the verification of the design of cabs of various vehicles, was presented **M.Sc. Eng., Witold Groll**. In the years 1960–2024, there were 92 railway accidents, resulting in 465 deaths. The scale of the accident consequence, and therefore the safety of rail transport, is significantly influenced by the design of rail vehicles. Since 1990, the Institute has been conducting crash tests of vehicles on the experimental track in Żmigród using a test zone specially designed for that purpose. Initially, many crash tests were conducted using different crash scenarios. The tests were the basis for developing crash requirements and principles of rolling stock design. Based on the tests, a standard defining carshworthiness requirements for trams was developed, followed by a standard defining requirements for railway vehicles. The numerous full-scale destructive tests in that area are spectacular. However, the information is not made public as the tests are carried out while maintaining the confidentiality of the rolling stock manufacturers. They are also the basis for design improvements. Thanks to research conducted at the Institute and actions taken by manufacturers, improved structures are developed that significantly reduce the effects of collisions through controlled crushing of selected elements and absorption of collision energy.

Ph.D. D.Sc. Eng., Andrzej Toruń, professor at the Railway Research Institute presented studies of trackside and on-board installations of the European Train Control System (ETCS) using the railway network and the Institute's test track. Control command subsystems consist of all "all the trackside equipment required to ensure safety and to command and control movements of trains authorised to travel on the network". and "all the any on-board equipment required to ensure safety and to command and control movements of trains authorised to travel on the network". The ETCS L1 test stand is located on the test track of the Institute in Żmigrod. It is used for testing of on-board ETCS installations. The tests are supplemented by tests carried out during track closures on lines utilized for commercial traffic, used primarily to test

on-board installations in the scope of ETCS L2 ESC confirmation, i.e. compliance of the on-board ETCS installation with the trackside ETCS configuration within the defined area of use.

The issue of dynamic load capacity of railway overhead contact lines was discussed by **Ph.D. Eng., Artur Rojek**. At the design stage, it is important to calculate the current capacity of the contact line, and during operation, it is crucial to make sure that the temperature of the contact line elements does not exceed the permissible level. The assessment of conductor temperature and current capacity is based on the conductor's heat balance. The current capacity of an overhead contact line depends on the current capacity of contact wires, catenaries, additional power supplies, etc., wind speed, network design, wear of contact wires, length of the power supply sections, train speed and the sequence of trains. The presented paper included the results of overhead contact line load testing while taking various factors into account. This is a very important research area, in the overlap of many technical fields (materials science, mechanics, electrical engineering, etc.), as overhead contact lines heat up as a result of the flow of traction currents. This causes changes in the microstructure of materials, as a result of which, if the permissible conditions are exceeded, the mechanical strength parameters change significantly, which, due to the network tension forces and the interactions between the pantographs and contact wires, may result in the overhead wires breaking. This can lead to tragic consequences, especially as the heating of the overhead wires is most intense where vehicles stop and draw electricity at the standstill and for starting, and therefore also at platforms.

Ph.D. Eng., Marek Sumiła introduced the conference participants to the concept of the FRMCS test-bed, i.e. the 5G railway test-bed, including the construction schedule and scope of the planned tests. Against the background of the future railway radio communication system, the assumptions for the creation of a 5G railway communication test-bed in Żmigród were presented. The implementation of this task requires, e.g., the construction of radio infrastructure and technical support, installation of 5G devices and research stations, installation of devices of the GSM-R network operator in Poland, integration with switching and network systems and with communication systems and traffic control systems. The railway test-bed will enable the testing of prototypes of devices and systems intended for the FRMCS, and the radio infrastructure of the Test Track Centre will create the possibility of verifying and confirming the compatibility of on-board systems with trackside systems under the future railway standard for wireless communication of traffic controllers with train drivers and field workers.

Dynamic tests of railway turnouts were discussed by **M.Sc. Eng., Jerzy Cejmer**. Such tests are carried out by the employees of the Institute as part of the verification of individual types of turnout structures from different manufacturers. On that basis, the Institute issues certificates of structure type conformity, which are necessary to obtain the Railway Transport Office permit for use in the type of structure dedicated to railway traffic. These tests are also carried out to confirm the possibility of increasing the speed on the tested sections of railway lines. The performed tests included ordinary turnouts with radii from 300 m to 2,500 m with fixed and movable frogs and double cross turnouts at the following locations: Psary, Korytów, Brzoza Bydgoska, Świdnik, Grodzisk Maz., Strzałki, Szeligi Ciechanów and Pszczółki. Based on the studies, the characteristics of different types of turnouts were presented.

In the final part of the conference, **Ph.D. D.Sc. Eng., Marek Pawlik**, professor at the Railway Research Institute, presented the requirements for rolling stock and railway infrastructure in terms of protection against cyber threats, ranging from formal requirements and recommendations developed by the Institute to audits in railway entities and verification of the resilience of digital solutions**.** Railway interoperability and safety are linked to ICT security audits. In October 2020, the ISAC-Kolej Information Sharing and Analysis Centre for the rail transport subsector was established. The coordination of the ISAC-Kolej work is carried out by the Institute in cooperation with PKP PLK and PKP Informatyka. As part of this work, cybersecurity guidelines have been prepared for the employees of railway entities and cybersecurity guidelines for passenger rolling stock. The work on guidelines in the field of cybersecurity of railway infrastructure is almost complete.

The briefly discussed papers were presented at two sessions, between which a scientific debate took place on the following issues: safety, development of young staff in railway transport and scientific projects. The debate was attended by eminent scientists representing universities and scientific institutes in Poland dealing with various areas of transport technology. The debate was led by Col. Prof. Tomasz Jałowiec, from the Management Institute at SGGW. The following persons took part in the debate: Ph.D. Eng. Janusz Bohatkiewicz, Director of the Road and Bridge Research Institute, Ph.D. Eng. Ignacy Góra, President of the Railway Transport Office, Ph.D. D.Sc. Eng.

Andrzej Massel, director of the Railway Research Institute, prof. Andrzej Szarata, Rector of the Cracow University of Technology, prof. Marcin Ślęzak, Director of the Motor Transport Institute, prof. Adam Wysokowski, Head of the Department of Roads, Bridges and Railways at the Institute of Construction at the University of Zielona Góra, Chair of the Bridge Builders Association of the Republic of Poland, prof. Henryk Zobel, long-standing Dean of the Faculty of Civil Engineering at the Warsaw University of Technology. The topics discussed made it possible to identify and assess the key directions of railway transport development in the current and forecast national and international conditions. The conference participants who actively participated in the discussions on various issues during the debate fully agreed that the topics addressed by individual experts clearly indicated the need for a multidimensional, interdisciplinary approach to research and development work in the field of railway transport. The opinions and conclusions expressed during the debate will certainly be an important point of reference for the dynamic development of rail transport in Poland. Attention was also drawn to the challenges of staff development and educating the young generation.

4. Conclusions

The Railway Research Institute carries out research, scientific and development work of national and international scope. At the same time, it continues the traditions of the Experimental Division at the Ministry of Railways, founded in 1923, formally established in 1924.

The papers presented on the day before the conference provided an insight into the history and current scientific and research activities of the Railway Research Institute. During the conference, selected key research capabilities of the Institute were also presented in the area of broadly understood contemporary needs of railway transport. The papers presented at the lectures at the Railway Museum and the conference are made available on the Railway Research Institute website.