

■ Introduction – <i>Jarosław Moczarski</i>	1
News	
■ Work of Rolling Stock Testing Laboratory, Brakes Unit in Kraków	2
■ Stage 3 of InRaVis Project Implementation	2
■ Submission of Application under the GOSPOSTRATEG V Programme	2
■ The Young Talent Symposium – SYMTA 2021	2
■ Work on Technical Standards: Detailed Technical Conditions for Construction of Central Transport Hub's Railway Infrastructure	2
Articles	
■ Implementation of the Project “Innovative and standardized model for purchase of passenger rolling stock INNORAIL” – <i>Agata Pomykała</i>	3
■ Modernization of the ETO Building no. 26 vs New Research Possibilities of the Railway Research Institute in Warsaw – <i>Łukasz John</i>	4, 5
■ Financing of Projects Implemented by the Railway Research Institute – <i>Magda Antolik</i>	6, 7
■ Comparison of the Railway Research in the USA and Europe with a Special Consideration of IK – <i>Przemysław Rakoczy</i>	8

Editor's

Jarosław Moczarski - *Scientific Secretary of the Railway Research Institute*



Dear Readers,

The scientific activity of the Railway Research Institute is carried out within the framework of numerous projects run together with domestic and foreign partners. The Institute's departments and laboratories also perform work for commercial purposes in the field of broadly defined rail transport. Effective implementation of these tasks requires comprehensive theo-

retical knowledge as well as practical skills and professionalism.

In order to maintain continuity and high quality of conducted activities, as well as to make effective use of modern apparatus and measurement devices, a constant supply of new personnel is necessary. Currently, among employees working in scientific, research and engineering positions, over 25% are young people, not older than 35.

Working in multi-generational teams, led by experienced staff with extensive work experience, enables young adepts of research activities to acquire the necessary knowledge and skills. At the same time, it enriches the implemented projects with new, unconventional methods and solutions proposed by young employees. It also encourages the implementation of innovative technologies and technical solutions.

Young researchers have the opportunity to publish their work results in *Problemy Kolejnictwa* (Railway Issues) and *Prace*

Institu Kolejnictwa (Works of Railway Research Institute) quarterly journals published at the Institute. Information on ongoing work can also be found in the Newsletter published in English.

Monthly open scientific seminars and the Institute's internal seminars, during which the staff present their latest achievements, improve methods of presenting research results. Especially for young employees, the SYMTA 2021 Symposium of Young Talents of the Railway Research Institute was organised in May 2021. More than twenty interesting papers were presented in seven sessions, covering various areas of the Institute's activity.

Such events enable young employees to present their scientific and professional achievements. They create opportunities for integration and exchange of experience. They show methods of creative problem solving and encourage joint implementation of interdisciplinary projects. They also serve to exchange practical experience in presenting and publishing the results of conducted work. At the same time, they prepare young staff for independent scientific and research activity. Doctoral seminars are organised for those interested in further scientific development at the Institute.

The organised undertakings prepare young workers for presentations at national and international conferences and for publication of research results in highly scored journals.

A significant group of young employees create grounds for optimism and hope for the continuation of the good, 70-year research traditions of the Railway Research Institute.

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Work of Rolling Stock Testing Laboratory, Brakes Unit in Kraków

In the first quarter of 2021, the Rolling Stock Testing Laboratory, Brakes Unit in Kraków carried out stationary and traffic tests of two electric multiple units manufactured by NEWAG S.A., i.e. 31WEb vehicle for Małopolska Railways and 37WEa vehicle for Regional Transport in Lublin. There were also conducted comprehensive tests of a freight

car for transporting of metal sheet coils type S12A equipped with an innovative braking system produced by Wagony Swidnica sp. z o.o., and a tank car with symbol WP55 produced by Chemet S.A. to transport chemical substances, optimized for carrying NaOH.

Stage 3 of InRaVis Project Implementation

The Railway Research Institute, within the framework of the Smart Growth Operational Programme together with the Faculty of Civil Engineering of Warsaw University of Technology (Project Leader) and companies Tines Rail and Budimex, completed the third stage of the InRaVis project concerning

the testing of vibration insulation elements (pads) used in the railway superstructure. The project started June 2018 and covered a range of issues related to the protection of people and buildings from vibration caused by rail traffic.

Submission of Application under the GOSPOSTRATEG V Programme

In April this year, the Railway Research Institute (IK) submitted a project application under the fifth competition of the Strategic Scientific Research and Development Programme called "Social and economic development of Poland under the conditions of globalising markets" GOSPOSTRATEG V. The competition had a formula of "commissioned" projects. Their thematic scope was indicated in advance by institutions conducting the development policy.

In response to the topic indicated by the Ministry of Infrastructure, i.e. Analysis of the scale of transport exclusion on the territory of Poland together with recommendations for legislative changes in the context of public collective transport, the IK, as a consortium leader, submitted a project proposal entitled "Interactive map as a tool to improve transport accessibility" – TRANSMAP. The GOSPOSTRATEG programme is dedicated only to scientific entities. The TRANSMAP project consortium consists of a team of four research institutes: Railway Research Institute as project leader, Motor Transport Institute (ITS), Road and Bridge Research Institute (IBDiM) and Institute of Geodesy and Cartography (IGiK). The duration of the project is to be 2 years and the budget is to amount to nearly PLN 4 million.

The subject of the project is to analyse the problem of transport exclusion on the Polish territory with the use of Geographic Information Systems (GIS), enabling identification of areas excluded from transport and threatened by this phenomenon, together with a proposal of legal solutions improving the accessibility of public collective transport.

The fundamental objective is to identify areas with poor transport accessibility or lack of public transport, assess the scale of the phenomenon, spatial differentiation, together with a diagnosis. The research will be carried out with the use of a geoportal which allows generating maps of the public transport offer and maps of temporal and spatial accessibility.

The beneficiaries of the project include governmental and local government units, transport operators and inhabitants of these areas. The proposed solution will identify areas requiring public intervention and support the creation of functional public transport.

The key tasks will include, among others,

- defining the transport exclusion along with a selection of indicators to identify it, taking into account socio-economic indicators, infrastructure and transport offer,
- development of a database with an interface which allows generating a map of accessibility to public transport, based on available cartographic, statistical and transport data resources,
- a comparative analysis of good practice for improving accessibility to public transport, as implemented in other countries,
- a proposal for legal solutions to eliminate the problem of traffic exclusion, based on opinions obtained from entities involved in the organization of transport.

The final result of the project will be a multi-faceted diagnosis of the transport exclusion problem, providing a basis for proposals of legislative changes aimed at improving transport accessibility, supported by an updateable geo-portal.

The Young Talent Symposium – SYMTA 2021

The Young Talent Symposium - SYMTA 2021 was carried out at the Railway Research Institute (IK) on 19-20 May 2021, with 22 papers presented by young IK staff. The Symposium had an internal nature and was conducted in video-conference mode.

The participants of the Symposium presented their scientific and professional achievements, shared information about the work performed in the organisational units of the Railway Research Institute. IK young employees gained experience in presenting and publishing their achievements and in inde-

pendent scientific and research activities.

The two-day session was divided into the following thematic sessions:

- fire safety,
- rail vehicles,
- electromagnetic compatibility,
- infrastructure elements,
- certification processes,
- simulation in tests and operation,
- railway communication systems.

Work on Technical Standards: Detailed Technical Conditions for Construction of Central Transport Hub's Railway Infrastructure

The Railway Research Institute is working on technical standards, detailed technical conditions for the construction of the railway infrastructure of the Central Transport Hub (CPK).

The main aim of the standards being developed by the Railway Research Institute is to ensure uniformity of technical parameters when different design offices plan new railway lines for the CPK. These lines are to be adapted to a maximum speed of 350 km/h. The company Centralny Port Komu-

nikacyjny, within the scope of the so-called associated investments, assumes the construction of a total of almost 1800 km of new railway lines, including a significant part of the railway lines of the High Speed Rail (HSR) standard until 2034.

Stage I was completed and accepted by the contracting authority. Currently Railway Research Institute's specialists are working on Stage II, the handing over of which to the contracting authority is planned according to the adopted schedule.

Implementation of the Project “Innovative and standardized model for purchase of passenger rolling stock INNORAIL”

Agata Pomykała

Senior Specialist, Project Coordination and International Cooperation Unit, Railway Research Institute



Responding to the demand of the railway passenger transport market, Instytut Kolejnictwa (Railway Research Institute) has undertaken a research project aimed at delivering a tool to support the effective operation and development of railway passenger transport. A consortium of four entities, i.e. Ministry of Infrastructure (project leader), Ministry of Economic Development, Labour and Technology, Kozminski University and Railway Research Institute, completed the

project within 16 months, obtaining information to support the process of rolling stock operation and acquisition. The project was divided into:

- a research part, covering an analysis and diagnosis of the current legal status, organisation of the rolling stock operation process, assessment of the provision of services related to operation,
- an implementation part, consisting in preparation of guidelines in the form of a manual concerning both legal requirements and recommended solutions related to the production, purchase and operation of rolling stock for railway passenger transport.

As part of individual tasks implementation, an analysis of the rolling stock market in Europe with an indication of development trends was conducted. Best practices for acquisition were identified, maintenance and operation of rolling stock described, as well as practices for the approval of rolling stock for operation and guidelines for the effective organisation of the maintenance process were developed. Moreover, principles for optimal selection of rolling stock for needs and operating conditions were elaborated and guidelines for the development of rolling stock strategies and recommendations for optimal design of rolling stock under Polish conditions were prepared.

In order to get acquainted with the public opinion, an analysis of travellers' preferences towards trains and their variations was carried out. The qualitative research was performed as focus group interviews in two groups in six locations. Questionnaire surveys were conducted on a nationwide sample of 1,500 adults (18+) purposively selected but representative in terms of basic socio-demographic features and on 500-person groups in the Warsaw agglomeration and Western Pomerania (region selected due to the mobility patterns of its inhabitants). The results of the analysis were used to formulate recommendations for changes in the equipment of the passenger trains.

A significant element of the project implementation was to carry out workshops with the participation of European rolling stock manufacturers (30-31 January 2020) as well as workshops with transport organisers, including local governments and the Ministry of Infrastructure, railway operators and the Office of Rail Transport (4 February 2020). The information obtained during the exchange of opinions and discussions was enriched by information obtained from literature studies.

As part of the project work, proposals were prepared for regulatory and legislative changes in public procurement law at the national level that could increase the effectiveness of procurement procedures for the supply of rolling stock, and 2 sets of guidelines were developed:

- a handbook/manual for designers and manufacturers of rolling stock containing legal and technical, operational requirements as well as recommendations for innovative technical solutions,
- a handbook/manual for transport organisers and operators containing guidelines for carrying out the process of preparing and implementing the procurement of rolling stock, including the scope of a typical feasibility study on the purchase and modernisation of rolling stock, good practices to conduct the procurement process and guidelines for the contract award organization. The advantages and guidelines relating to the use of LCC (Life Cycle Cost) methodology in assessing the economic efficiency of purchasing, modernising and maintaining rolling stock were indicated.

Project implementation period: 02.09.2019 – 31.12.2020.

Project stakeholders: railway operators, public transport organisers.

Product indicators		
Number of diagnoses	10	111%
Number of developed documents, policies, strategies	3	100%
Number of solutions developed	20	100%
Result indicators		
Number of people involved in developing solutions	114	38%
Number of publications on the solutions developed	9	90%

Due to COVID-19 restrictions the result indicators did not reach the target level.

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Modernization of the ETO Building no. 26 vs New Research Possibilities of the Railway Research Institute in Warsaw

Lukasz John

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Due to the intensive development of the Signalling and Telecommunications Laboratory of the Railway Research Institute in Warsaw (IK), the purchase of new measuring equipment as well as the construction of new electromagnetic compatibility (EMC) and photometry test stands, in 2019, with the consent of the IK Management, an open tender was announced under the procedure "Public Procurement Law" concerning the modernization and reconstruction of

some of the premises of a 2-storey office building and an accompanying hall that had not been used for 15 years.



Photo 1. General view of the modernized building 26 of the ETO

The aim of this project is the thermal modernization of the construction and technical infrastructure of the ETO building no. 26 located on the premises of the Railway Research Institute in Warsaw, as well as the conversion of some offices into two new test stands:

- SAC-3m EMC semianechoic chamber of measuring distance in the centre up to 3 m for electromagnetic compatibility (EMC) tests, fitted as the first in Poland with a power supply system for equipment under tests (EUT) up to a voltage of 3 kV DC,
- modern goniophotometric test stand (so called photometric darkroom) of measuring distance up to 10 m for photometric measurements for the need of railways.

Both modern test stands will be implemented at the turn of 2021/2022 as part of the project: "RPMA.01.01.00-14-9845/17-00 Purchase of modern research and laboratory equipment for the Railway Research Institute".

The investment will cover the purchase of laboratory and research equipment for three IK units: Materials and Structures Laboratory, Electric Power Engineering Department and Signalling and Telecommunications Laboratory. Modern equipment will allow performing research tasks in the field of strength tests, fire safety of rolling stock elements and rail transport infrastructure, and in the area of fire tests. It will also allow carrying out research and development work in the area

of electric traction and power supply. The development of research facilities will also enable the implementation of specialized EMC tests and photometric tests.



Photo 2. General view of the modernized building 26

The scope of thermal modernization along with the reconstruction of some of the rooms in building no. 26 includes the following:

- insulation of walls, ceilings and roof,
- replacement of windows in the entire building,
- replacement of doors in the entire building,
- replacement of the entrance door to the hall,
- replacement of central heating installation,
- replacement of the sanitary installation,
- replacement of the electrical installation,
- installation of air conditioning in the building,
- installation of ventilation systems for laboratory rooms along with the building,
- installation of LAN structured cabling,
- installation of the external lightning protection system.



Photo 3. General view of a future photometric laboratory in Building 26

The mentioned-above work will primarily provide better conditions for the statutory and scientific activity of the Railway Research Institute. Limiting CO₂ emissions, as well as reducing the consumption of heat and electricity, will not only allow achieving environmental objectives, but will also improve the IK financial condition, and thus create the possibility of incurring greater expenditure on statutory activities.

Modernization of the ETO Building no. 26 vs New Research Possibilities of the Railway Research Institute in Warsaw

The building will house laboratories where conceptual and experimental work in the field of automation, telecommunications, photometry and electromagnetic compatibility will be carried out. The aim of these activities is the development of modern railways in Poland.

The first laboratory room will be housing a photometric laboratory, i.e. photometric darkroom, in which the following measurements will be conducted:

- goniophotometric test stand,
- test stand for measuring the colour of light,
- test stand for measuring the direction of light,
- test stand for measuring the luminance uniformity of the reflecting surface,
- auxiliary accessories,
- dedicated measurement computer with control software for carrying out tests and automatic reports with measurement results.



Photo 4. General view of a new laboratory room in Building 26



Photo 5. General view of a new laboratory room in Building 26 where absorbers for EMC chamber will be stored

The other laboratory room will be SAC-3m EMC semianechoic chamber for electromagnetic compatibility tests where the following measurements will be performed:

- radiated emission for 3 m distance from EUT,
- conducted emissions,
- immunity against radiated electromagnetic field of radio frequency for 3 m distance from EUT.



Photo 6. View of the hall in Building 26 where SAC-3m EMC semianechoic chamber will be constructed; stage 1



Photo 7. View of the climatic chamber for environmental research in the building hall 26

Planned renovation works, including reconstruction of some offices and building's complete acceptance, are scheduled for July 2021.

At the moment, advanced works are underway on the preparation of the description of the subject of the contract and the specification of essential terms of the contract (SIWZ) under the Public Procurement Law in the basic mode, without negotiations on. As a result of two procedures, potential Contractors will be selected for:

- a) equipping the photometric laboratory with the necessary test equipment for photometric measurements,
- b) SAC-3m semianechoic chamber of measuring distance in the center 3m for electromagnetic compatibility (EMC) tests.



Photo 8. View of the hall in Building 26 where SAC-3m EMC semianechoic chamber will be constructed; stage 2

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Financing of Projects Implemented by the Railway Research Institute

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Between 2014 and 2020, the Railway Research Institute (IK) received funding for many projects financed from both European and national resources. Most - as many as 5 projects - are being implemented by the Institute under the Innovative Development Operational Programme (POIR) Sub-measure 4.1.1 Strategic research programmes for the economy Joint Undertaking of the National Centre for Research and Development (NCBR) and PKP Polskie Linie Kolejowe S.A.:

- 1) **Standardisation of selected computer interfaces to command control and signalling equipment and systems.** The objective of the project is to develop requirements for the interfaces used in computer equipment in control command and signalling, safe train drive and maintenance and diagnostic centres, which will provide a standard to allow combining system components from different manufacturers and of different types.
- 2) **Optimisation of the ultrasonic transducers system for detection of internal rail defects according to the catalogue of defects in force at PLK S.A.** The aim of the project is to develop an optimum configuration of ultrasonic transducers for the flow detection car and individual handheld measurement stations allowing detection of a greater number of defects, which will lead to increased safety of vehicle traffic.
- 3) **Development and implementation of elements of an anti-theft system for the catenary in rail transport.** The subject of the project is to carry out industrial research and development works aimed at creating a system monitoring the catenary in terms of continuity, completeness and efficiency - anti-theft system securing elements of the overhead contact line, improving safety and economics of railway traffic operation.
- 4) **Development of an innovative system for lighting infrastructure management on the network managed by PLK S.A.** The aim of the project is to develop a system for management, control and monitoring of lighting in the railway areas operated by PKP PLK S.A. The idea of the project is to use modern LED luminaires equipped with digital control interfaces.
- 5) **Innovative solutions for protection of people and buildings against vibration from railway traffic.** The subject of the project is the development of innovative solutions for the protection of people and buildings from vibrations caused by railway traffic.

The main objective of the BRIK Joint Undertaking is to increase innovation and competitiveness of railway transport by 2026. The implementation of the programme is to contribute, among others, to:

- increase in R&D activity in the rail infrastructure area,
- increase in the number of innovative solutions in this area,
- improved effectiveness of railway infrastructure operation and management,
- reduction of the negative environmental impact of railway transport.

Another Institute's project financed from European funds under the POIR "Fast Track for SMEs" is the project entitled **"Development of a prototype of an innovative system preventing icing and frosting of the railway catenary network with the use of an automatic weather station"**. The aim of the project is to develop an innovative system preventing icing and frosting of the catenary with the use of heating current. The implementation of the system will enable to conduct faster, including preventive, de-icing and defrosting, which, in turn, will result in improved continuity of transport services. The solution will also increase the safety of works carried out on the catenary.

The final documentation will be created at the end of the project, describing the method of the innovative de-icing system's manufacture, operation and maintenance. The developed solution will ultimately be able to be installed and operated on any chosen section of the infrastructure of railway managers, whose DC direct voltage traction network is exposed to the winter weather conditions.

In addition to the implementation of research and development projects, the Railway Research Institute carried out the project titled **"Comprehensive thermal modernisation of buildings together with the accompanying heating system"** under sub-measure 1.3.1 Reducing the decarbonisation of the economy of the Operational Programme Infrastructure and Environment. The project involved thermal modernisation of IK building and technical infrastructure (7 buildings with a total area of 13,112.9 m² and a section of the heating network with a total length of 1,042 m). The scope of thermal modernisation included: insulation of walls, ceilings and roofs, replacement of windows, glass bricks and skylights, replacement of doors, entry gates, replacement of central heating installation, replacement of heaters, domestic hot water replacement, modernisation of heat distribution centres and replacement of circulation pumps.

Within the framework of the Regional Operational Programme of the Mazovian Voivodeship for 2014 - 2020, the Institute is implementing two investment projects. The first one entitled **"Purchase of modern research and laboratory equipment for the Railway Research Institute"** includes the purchase of research and laboratory apparatuses for two laboratories: Materials and Structure Laboratory and Signalling and Telecommunications Laboratory, as well as the Department of Electrical Power Engineering.

The project will impact the modernisation and achievement of higher quality of research corresponding to the highest European standards and will contribute to the strengthening of cooperation between the scientific sector and the economy through the development of R&D infrastructure. The implementation of the project aims at comprehensive R&D work in the field of rail transport safety. This will allow the development of new technologies and new design solutions, which should affect a larger range of innovative products, the development of the industry and rail transport.

The state-of-the-art equipment will enable to carry out research tasks in the area of strength tests, fire safety of rolling stock components and rail transport infrastructure, and in the area of fire testing. It will also enable scientific research and development work in the field of electric traction and power supply. The development of research facilities will also foster specialised EMP and photometric tests to be carried out.

Financing of Projects Implemented by the Railway Research Institute

The second project, entitled: **"The purchase and modernisation of modern research and laboratory equipment for the Rolling Stock Testing Laboratory of the Railway Research Institute in Warsaw"**, involves the retrofitting and modernisation of a specialist station for tribological tests of railway brakes in the Rolling Stock Testing Laboratory. According to the project the stand will be equipped with:

- a new monitoring and diagnostic system for the torque test stand equipment;
- a system for programming the test stand with the possibility of importing batch files;
- a system for recording and processing measurement data from tests;
- a system for spraying brake friction pairs to simulate the behaviour of these elements during tests in both wet and winter conditions.

This modernisation will allow for modernisation and higher quality testing in line with EU standards and will strengthen the cooperation between science and industry in the field of research on rolling stock components and rail transport infrastructure.

The project will enable the implementation of R&D projects that will affect the development of rail transport at national and local level, i.e.:

- development of new technologies and new structural solutions for rolling stock,
- extending the offer of innovative product research,
- improving the safety and efficiency of brake components in railway traffic,
- development of the railway industry.

Furthermore, under the national funds of NCBR, the Railway Research Institute implemented a project entitled **"Simulation training system for shunting locomotive drivers and employees of sidings and marshalling yards involved in shunting processes, increasing the efficiency and safety of their operation"**. The aim of the project was to conduct R&D, resulting in the development of a simulation training system designed for the railway sector. The simulation system consists of a driver's station, a shunting manager's station and an instructor's station. The aim of the project is to reduce the costs associated with shunting work.

Within the framework of the national funds from NCBR, the Institute is also implementing a project entitled: **"Intelligent Video Monitoring (IMW) of Containers"**. In this project, the aim is to develop a demonstration installation and technology

validation leading to an innovative product called IMW in the form of an intelligent system for monitoring railway containers. The monitoring system will consist, among others, of the following:

- intelligent data analysis for risk assessment and forecasting of maintenance costs through the use of real-time data on the technical condition of wagons and their geolocation,
- detecting faults in freight wagons through vibration diagnostics and sensor networks,
- forecasting failures and defects and taking preventive measures.

The Institute, in cooperation with the Ministry of Infrastructure, Ministry of Economic Development, Labour and Technology and Kozminski University, within the framework of the strategic programme of scientific research and development works "Social and economic development of Poland under the conditions of globalizing markets" - GOSPOSTRATEG, implemented a project entitled **"Innovative and standardised model for the development of the purchase of passenger rolling stock"**. As a result of the project, manufacturers of rolling stock and its components as well as national railway operators and public transport organisers will obtain a comprehensive set of information necessary to make fact-based planning and investment decisions, including:

- an analysis of the rolling stock market in Europe, together with development trends,
- a description of best practice in procurement of rolling stock,
- indications for effective organisation of the rolling stock maintenance process,
- principles for optimal selection of rolling stock for operating conditions,
- guidelines for developing rolling stock strategies,
- recommendations for optimal design of rolling stock in Polish conditions,
- good practice in the scope of rolling stock placing in service.

In addition, in 2019–2020, the Railway Research Institute obtained funding from the Ministry of Education and Science to finance science dissemination activities. As part of the funding received, English-language versions of scientific publications – *Railway Issues* - were prepared and published, DOI identifiers for archival and current articles were purchased, procedures to safeguard the originality of scientific publications were raised to a higher level and the participation of foreign reviewers in the assessment of scientific publications was increased.

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Comparison of the Railway Research in the USA and Europe with a Special Consideration of IK

Przemysław Rakoczy

Research Assistant Professor, Materials & Structure Laboratory, Railway Research Institute



Providers of the research, certification, and product development services need to respond to the local market needs. Therefore, depending on the rail industry needs and authorities regulations the research efforts can be directed to different areas. On the other hand, there are global trends in the rail industry development. An example could be passive and active rail safety systems or automation of rail operation. Similar systems such as Crash Energy Management, European Rail Traffic Management, and Positive Train Control in the USA were or are under development in both regions.

The biggest provider of these services in the USA as well as in the world is Transportation Technology Center Inc. (TTCI). TTCI is operating the government-owned test center in Pueblo, Colorado. In Europe, there are several smaller test centers in different countries such as Instytut Kolejnictwa (IK) - Railway Research Institute in Poland.

The rail freight operation in the USA is the backbone of the national transportation of goods. Class I railroads e.g. Union Pacific, BNSF, or Norfolk Southern to name a few are moving over 20 million carloads every year. With one of the biggest railcar weights in the world approaching 130 tonnes, the freight rail industry has many needs to reduce maintenance and operation costs. The Association of American Railroads supports continued research and development projects that enhance the safety, security, and efficiency of the railroad industry. This includes research conducted at the Facility for Accelerated Service Testing (FAST) at TTC.

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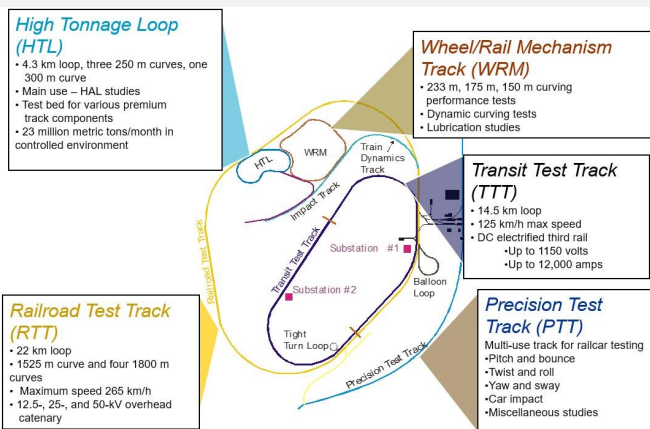


Fig. 1. Test tracks in TTC (source: autor's own study)

FAST includes a 4.3 km long High Tonnage Loop for research on track component reliability, wear, and fatigue. This facility is used to quickly evaluate the performance of rail, ties, fasteners, frogs, turnouts, ballast, subgrade, bridges as well as diverse rolling stock equipment by operating up to 127-million gross tonnes per year. FAST also includes a testbed for the evaluation and development of the diagnostic equipment.

Other areas of research in the USA are the safety and security of the passenger rail. This research is typically funded by the government to provide the technical basis for rulemaking.

Despite the difference in scale and capabilities, IK provides the rail industry with similar services. On the test track in Żmigród, IK is conducting tests evaluating durability, reliability, strength, and dynamic properties of the equipment and systems for the railway applications. This year is the 25th anniversary of the operation of the test track in Żmigród.

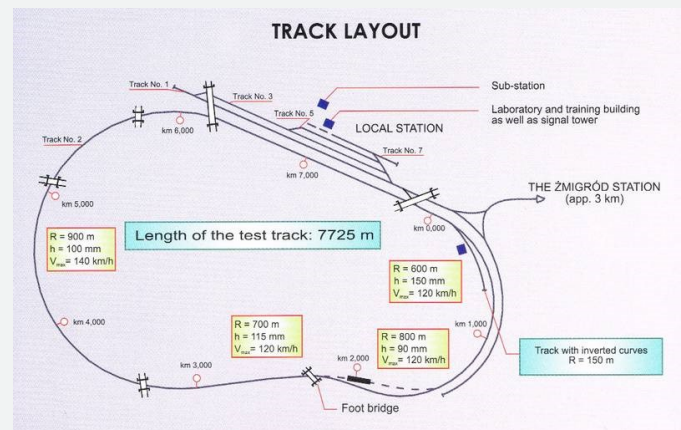


Fig. 2. Test track facility in Żmigród (source: autor's own study)

IK's laboratories gather experts and equipment for research and development projects in the areas of:

- railway traffic control and communication,
- railway track infrastructure and operation,
- rolling stock,
- structural rail component and materials.

Recent IK's investments in new equipment, for example, state-of-the-art Finite Element software, hydraulic actuators, or versatile data acquisition system increase its capabilities.

Rail research centers are accelerators for research and innovation in the industry around the world.

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