

From an Experimental Division to the Railway Research Institute

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Summary

In 1923, in the then Ministry of Railways, an Experimental Division, with Professor Albert Czechtz as its head, was established. The purpose of the Division was to specify the characteristic structural and operational features of the particular types of steam locomotives, especially new ones, and to test inventions and devices in order to verify their value and usefulness. Most of the research was conducted in railway sections located in the Eastern Borderlands of the Second Polish Republic, in the Vilnius Directorate. By 1938, the features of 26 steam locomotives had been described.

In connection with the introduction of new, heavier types of locomotives in the 1930s, new research on track response to increased dynamic load commenced. The research was carried out by Aleksander Wasiutyński, a professor of the Warsaw University of Technology. The research carried out at the Włochy post allowed, among others, the resilience coefficient of the track bed to be determined based on the vertical bending of tracks. In 1934, the Central Research Laboratory of the Polish State Railways was established in order to improve and standardize the quality of the materials supplied to the railways.

The development of railway research in Poland was interrupted by World War II. However, in 1945, the Experimental Division of the Ministry of Transport was re-established and research on railway vehicles was re-commenced. In 1951, utilizing the resources of the Division and the Central Laboratory, the Railway Science and Research Institute (today's Railway Research Institute) was formed.

Keywords: testing, rolling stock, steam locomotive, laboratory, track

1. The Experimental Division of the Ministry of Railways

From the very beginning of Polish independence, the authorities were aware that railways could only develop if new technical solutions were researched. This was especially true in the case of traction vehicles, which in that period were predominantly steam locomotives. This is why, in 1923, in the then Ministry of Railways, an Experimental Division was established. The Division was made a part of Section 22 (Rolling Stock Construction) of the Mechanical Department on the initiative of Dr. Adolf Langrod, the head of the Section. While establishing the Division, the experiences of the leading European and global railway companies were taken into account, as these companies had already been operating special experimental facilities for many years. These facilities were properly equipped with technical devices and employed qualified personnel. One of the first research facilities in Europe was established in 1890 in France. It was the Service des essais of the Northern Railway Company (Compagnie du Nord). Another example of

a similar organization with a very wide scope of activity was the Lokomotiv-Versuchabteilung functioning in Berlin and employing approximately 75 specialists [10]. The Polish Ministry of Railways also analyzed the American experiences, especially the organization and functioning of the Testing Department of the Pennsylvania Railroad Company [16]. Interestingly, various types of railway research had also been carried out in Japan since 1907. For this purpose, the Center for Railway Research of the Imperial Railway Agency was established, which today is the Railway Technical Research Institute (RTRI).

The importance of experimental research was related to the fact that, back then (and largely today, as well), there were no generally accepted theories allowing various everyday railway practice issues to be solved, such as determining traveling times, train loads, fuel norms, etc. The necessity of carrying out research in Poland was particularly high due to the differences between the rolling stock taken over from Russia, Austria, and Prussia, the lack of uniform norms in terms of using them, and the need to build new, Polish types of steam locomotives [10, 20]. In

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this context, the tasks of the Experimental Division included [20]:

- 1) specifying, with respect to the particular types of steam locomotives, especially the new ones, all of their characteristic structural and operational features, which was the basis for developing a reasonable plan for using steam locomotives and laying down the relevant norms,
- 2) testing inventions and devices for building steam locomotives in order to verify their value and usefulness for Polish railways.

The head of the Experimental Division was Professor Albert Czechtz, who in 1923 returned to Poland after many years spent in Russia and started to work at the Mechanical Department of the Ministry of Railways. Born in 1873, Professor Czechtz was a graduate of the famous Institute of Transportation Engineers in Saint Petersburg. He already had many years of service with the Moscow – Vindava – Rybinsk Railway, where he worked as the head of the Steam Locomotives Division and then the head of the Technical Department. He also acquired invaluable experience by designing steam locomotives for the Putilov Plant in Saint Petersburg from 1910–1911, at one time even holding the position of head construction engineer. In 1910, Albert Czechtz defended his doctoral thesis: *A new method of determining the traveling times of trains and its use in researching railway traffic conditions*. In 1914, he was nominated for the title of professor and became the head of the Department of Steam Locomotives and Railway Management at the Institute of Transportation Engineers. From 1918, he also headed the Steam Locomotives Laboratory of the Institute [27, 28].

The beginnings of the work of the Polish experimental facility were presented by Professor Czechtz at the 4th Convention of Polish Railway Engineers in Poznań on 8 September 1924 and published in issue 5 of *Inżynier Kolejowy* in 1925 [8]. In 1923, in the first months of its activity, the Experimental Division did not have sufficient financing, its own measuring equipment, nor permanent staff. The only employees were those posted from other organizational entities of Polish railways. In order to carry out the first tests, Professor Czechtz was posted to the Vilnius Directorate. In the area managed by the Directorate, railway sections with the required features were selected for testing. Test runs were carried out primarily close to the town of Zelwa, which was located on the Białystok – Baranowicze line, on the Zelwa – Jeziornica route. In 1923, the first tests of the Tr21 steam locomotive were carried out.

The work of the Experimental Division was stabilized by the Regulation of the Minister of Railways of 7 April 1924, signed by Minister K. Tyszkiewicz and

published in the Official Gazette of the Ministry of Railways No. 7 (1924), which contained the following provision: “In order to test steam locomotives and properly use tractive force in the Polish State Railways through systematic measurements, a separate division shall be established in Section 22 of Department VI.” [14] The Regulation provided that the measuring car and other cars handed over to the head of the Division for the purpose of testing were to be kept at the Warsaw station during longer interruptions between tests. The measuring car was also considered to be the office of the head of the Division. The measurement and experimental issues arising in the Polish State Railways were to be assigned to the head of the Division for testing by Department VI (Mechanical) of the Ministry, in two forms:

- long-term tasks planned in advance,
- ad hoc tasks requiring immediate testing.

With respect to long-term tasks, the Division had a budget drafted for one year; works not covered within the program were to be financed from additional loans [14].

In the first years, the personnel comprised only the head of the Division (who at the same time was the measuring car master), three railway engineers, a locksmith of the measuring car, and a guide of the measuring car. Temporary staff included steam locomotive drivers, technicians from the particular Directorates in whose areas tests were carried out, as well as students of the Warsaw University of Technology completing their summer holiday internships.

In 1924, the Division already had a measuring car and several other cars, but still lacked measuring devices. This is why the staff used devices borrowed from private companies and higher education institutions. For instance, the Warsaw Steam Locomotive Building Company provided indicators, thermometers, and stopwatches, while the Boilers Supervision Association lent apparatus for the analysis of exhaust fumes. In turn, the University of Vilnius provided assistance in terms of chemicals. One of the positive aspects of using borrowed devices was the ability to plan the purchase of equipment in a more reasonable way [8]. It should also be emphasized that test results were treated as approximations. However, these results were very important since they allowed the Division to develop its own testing methods.

The tests of steam locomotives carried out by the Division employed an innovative method, which had theoretically been known before, but it was in Poland that it was first used on a larger scale. This method was based on running in a double traction. In addition to the tested steam locomotive, the test train also included an auxiliary steam locomotive whose task was to maintain a constant speed of travel, which en-

sured constant working conditions for the tested locomotive [10]. To use this method, it was necessary to select routes featuring the correct longitudinal profiles. Testing the rolling stock on railway lines ensured conditions as close to actual working situations as possible (the impact of temperature, wind, and vibrations), unlike in the case of laboratory tests. It's worth mentioning here that laboratory tests of steam locomotives, in specially designed facilities, were carried out in America. For instance, the already mentioned Testing Department of the Pennsylvania Railroad Company had an test bench for steam locomotives from 1904 [16]. The special conditions for carrying out tests, as described above, made it impossible for the Experimental Division to perform them in normal railway traffic. They had to be carried out according to the Division's own timetables and using its own rolling stock, often in sections far away from Warsaw. Most of the tests carried out by the Division took place in railway sections located in the Eastern Borderlands of the Second Polish Republic, in the area managed by the Vilnius Directorate, primarily on the Brest – Pinsk and Białystok – Baranowicze lines. An experimental facility was established at the Zelwa station, which was located on this line (in the Vaukavysk – Baranowicze section). Test runs were also carried out on the Kraków – Rzeszów line. The selection of sections for testing was not accidental [9]:

- 1) the Brest section had a nearly zero profile over more than 100 km,
- 2) the Zelwa section (the Zelwa – Jeziornica route), much shorter than the Brest section, featured a continuous incline of 8‰,
- 3) the Kraków section made it possible to carry out runs at speeds of up to 100 km/h and had a very gentle profile.

For instance, in the summer and fall of 1926, tests of new Ty23 and Os24 (Fig. 1) steam locomotives were carried out along the Zelwa – Jeziornica section. Through experiments, the tractive force and the resistance of steam locomotives were tested, as were the performance of the boilers and the use of coal, water, and lubricants. Every day, 5–6 tests were carried out. In September 1926, test runs of Os24 steam locomotives pulling passenger cars at speeds of 90–100 km/h were carried out along the Kraków – Rzeszów section [1].

The independent Experimental Division carried out traction tests for most of the types of steam locomotives either used by the Polish State Railways or built in Poland for foreign railways. By 1938, the features of 26 steam locomotives were described [27]. In 1927, the Ministry of Transport published *Charakterystyka parowozów* ("The Characteristics of Steam Locomotives") (Fig. 2), which contained guidelines on how to calculate their loads according to the new

methods developed by Professor Czeczott. When the publication was almost ready, the results of the experimental tests carried out in 1926 using Os24 steam locomotives (Fig. 3) and the observations for Pn11 and Pn12 steam locomotives were already available. This data suggested possible imprecisions when using the calculation method for steam locomotives belonging to higher calculation categories, due to them being equipped with larger boilers. This is why the load tables were corrected in view of this new data [5].

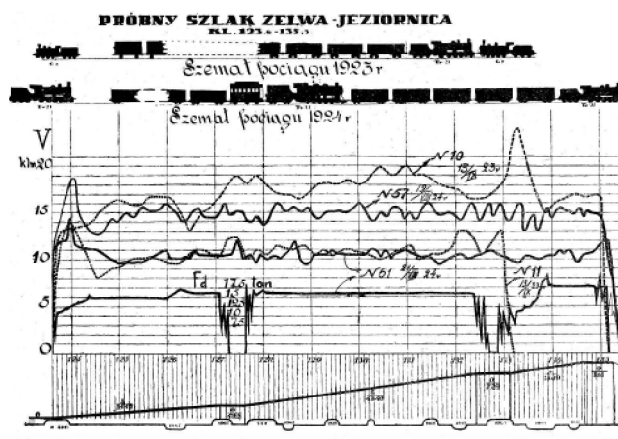


Fig. 1. Diagram of the measuring train used in the tests carried out in 1923 and 1924 on the Zelwa – Jeziornica route [8]

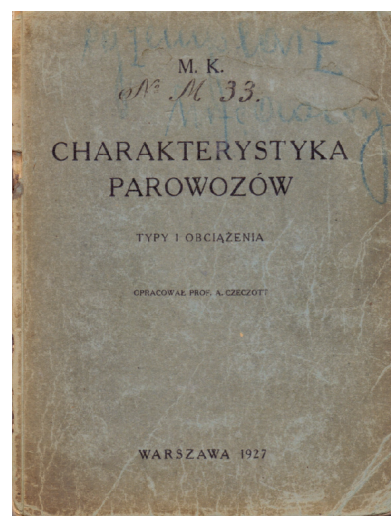


Fig. 2. The cover of *Charakterystyka parowozów* ("Characteristics of Steam Locomotives") by A. Czeczott [5]

In 1929, the Division had three cars for its exclusive use. The most important was the three-axle dynamometric car equipped with a hydraulic piston dynamometer, a measuring table for recording its readings, and a power belt connected to the car's wheel by means of a friction disk designed by Professor Czeczott. All of the devices were built in the Division's workshops. The measuring table was equipped with a Deuta-Werke speedometer [9]. In addition to

the measuring car, the Division was also in possession of a luggage car converted to a chemical laboratory equipped with devices to collect samples of exhaust fumes from the steam locomotive [9].

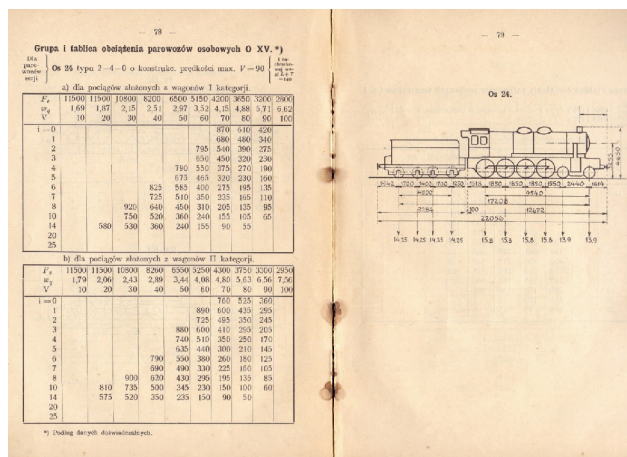


Fig. 3. A description of the Os24 steam locomotive produced on the basis of experimental research [5]

In 1928, the construction of a new measuring car for the Experimental Division started. Built and equipped according to the requirements specified by Professor Czeczott, the car was intended not only to test steam locomotives to the existing extent, but also to enable new research activities, such as [11]:

- 1) specifying the resistance of trains depending on their configuration and load;
- 2) specifying the train braking conditions and carrying out general brake trials (this was incredibly significant in view of the increasing popularity of railway air brakes in freight traffic);
- 3) specifying the dynamic effects of steam locomotives on the tracks (and vice versa, the way in which tracks influence locomotives).

The car was ordered from the Lilpop, Rau & Loewenstein Company of Warsaw. Specialist measuring equipment was purchased from Amsler, Siemens, and Richard [11]. The new measuring car (Fig. 4) was ready in 1930. It was demonstrated during the International Transport and Tourism Fair in Poznań [18] (Fig. 5), with demonstration runs of the experimental train carried out between Poznań and Leszno [31].

At the beginning of the 1930s, the Experimental Division was involved in testing two new high-speed steam locomotives: Pu29 and Pt31 [24]. The high level of the research carried out at the Experimental Division is confirmed by the fact that, in 1931, the General Directorate of Romanian Railways asked the Polish Ministry of Transport for permission to draw on Polish experiences in the field of testing steam locomotives [6]. The assistance provided to Romanian railways covered a detailed design of dynamometric devices for the planned Romanian measuring car. Then, from June 1932, a group of Romanian specialists was trained in Poland for several months. In turn, in November 1933, the first tests using the dynamometric car were carried out in Romania, with Professor Czeczott attending.

Throughout its history, many outstanding specialists worked for the Experimental Division. Between mid-1927 and 1929, the Division employed Kazimierz Zembruski, who back then was finishing his studies at the Warsaw University of Technology. In later years, he became famous as the constructor of steam locomotives at the First Polish Steam Locomotives Factory in Chrzanów (designing, for instance, the excellent high-speed Pt31 steam locomotive) and then as a professor of the Department of Steam Locomotives Construction of the Warsaw University of Technology [39].

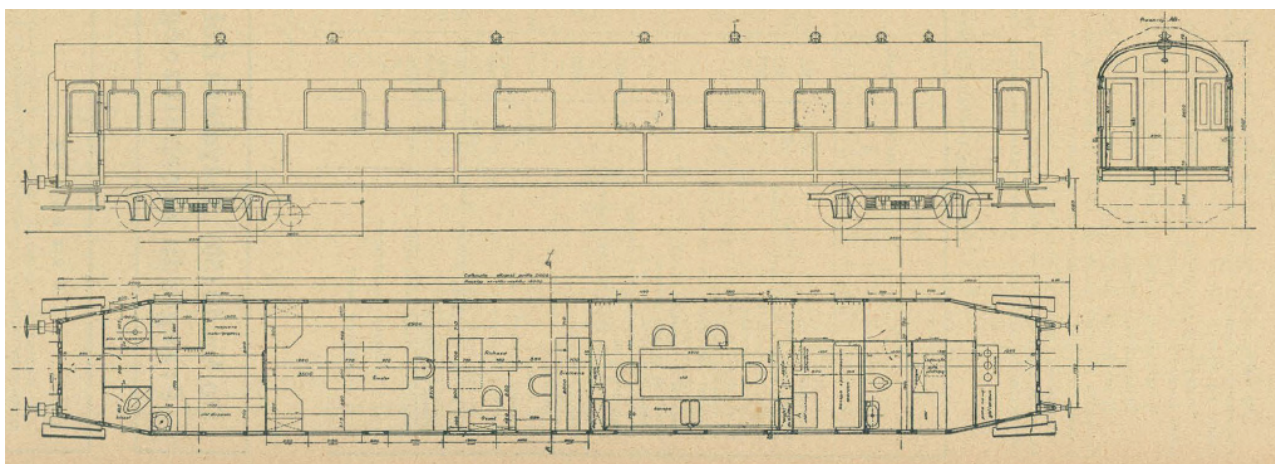


Fig. 4. The 1930 measuring car of the Experimental Division [11]

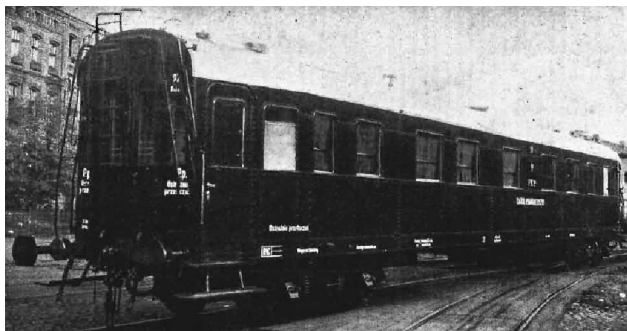


Fig. 5. The new dynamometric car of the Experimental Division at the International Transport and Tourism Fair in Poznań in 1930 [18]

According to the 1933/1934 *Rocznik Komunikacyjny* yearbook, the Experimental Division of the Polish State Railways was a part of the Department of Mechanics and Railway Resources and was attached to Section I (Mechanics and Traction). In addition to Professor Czeczott, the employees included [22]:

- Leon Małecki, an engineer,
- Józef Szunejko, an senior technician,
- Piotr Lungis, an assistant,
- Tadeusz Seidler, an engineer,
- Jakub Pinczower, an engineer,
- Eugeniusz Błoński,
- Mieczysław Kornaszewski.

2. Research on railway superstructure

The research work of the Experimental Division of the Ministry of Transport was focused on rolling stock, especially steam locomotives. However, as new steam locomotives were introduced in Poland, including four-axle high-speed locomotives that could achieve speeds of up to 110 km/h (Pu29 and Pt31), the Technical Council attached to the Ministry of Transport decided that it was necessary to examine how tracks respond to increased dynamic load. The research was carried out by Aleksander Wasiutyński, a professor of the Warsaw University of Technology. Considering his major contribution to the development of Polish railways, at least several of the most important facts from his life should be listed here.

Aleksander Wasiutyński was born in 1859 in the Lisowce estate in the district of Brzeziny [21]. Having graduated from high school, he became a student of the Institute of Transportation Engineers in Saint Petersburg, from which he graduated in 1884. He acquired extensive practical experience by working on the project of building railways from Łuniniec to Homel (in the Polesie region) and from Siedlce to Małkinia (in the Podlasie region). It was then that he started to combine his interest in practical ap-

plications with academic pursuits. His first publication, *Budowle hydrotechniczne przy moście na rzece Bugu pod Małkinią* ("Hydrotechnical structures at the bridge over the River Bug in Małkinia"), was published in 1889 in Saint Petersburg. Between 1889 and the outbreak of World War I, Wasiutyński served at the Warsaw – Vienna Railway. In 1898, he organized an experimental station for researching railway track. He carried out extensive research on temporary track deformations during the passing of rolling stock using a new method: the so-called photographic method [21, 25]. This made it possible to determine the value of the coefficients of track bed resilience. This research, carried out at the turn of the 20th century, formed a new experimental basis for surface-related calculations and, even though it was performed with much smaller axle loads and travel speeds, it was extensively quoted in academic publications as one of the most precise. In 1899, for his outstanding academic achievements, Wasiutyński received the award of the Saint Petersburg Technical Society and the badge of the Institute of Transportation Engineers, while, in 1900, he won the gold medal at the Universal Exhibition in Paris.

In independent Poland, he became the head of the Department of Railways at the Warsaw University of Technology. He was involved in the great task of designing and then redeveloping the Warsaw railway junction [33–35]. Between 1913 and 1914, an earlier concept by the engineers Adam Świętochowski and Julian Eberhardt was supplemented, without major alterations, under the supervision of Aleksander Wasiutyński. In 1918, this concept became the basis for Professor Wasiutyński to develop a provisional plan for a central railway line. From the first weeks of independence, he was the chairman of the Commission for the Redevelopment of the Warsaw Junction of the Ministry of Transport (which was called the Ministry of Railways between 1919 and 1926) [15]. There, he proved to be far-sighted, as he correctly predicted that the new central line (commissioned in September 1933) would produce a massive increase in passenger transport, which would soon lead to the Warsaw junction needing more tracks [3]. As it turned out, this was precisely the case. From 1925, Aleksander Wasiutyński was also a member of the Technical Council attached to the Ministry. For everyone who came into contact with this activity and who read his fundamental book *Drogi Żelazne* ("Railways"), which was first published in Warsaw in 1910 and then expanded in 1925, it was clear that this great scientist and railway engineer was a truly outstanding person [3].

At Professor Wasiutyński's own request, the Ministry of Transport agreed to establish, with him as the head, an experimental post for research on the resilient deformations of track. The post was located

close to the Włochy station near Warsaw (Fig. 6). The tests, carried out between 1932 and 1936, were based on the photographic method [17]. At the Włochy post, a number of new measuring devices were installed. The photographic equipment for the purpose of the tests was provided by the P. Lebieński company [17]. The issues investigated by Professor Wasiutyński's team at the Włochy post included [32]:

- 1) determining the track bed resilience coefficient on the basis of vertical bending of tracks (considering the speed of travel and the construction of the steam locomotives),
- 2) track stress (considering the speed of travel, also in combination with subsiding),
- 3) longitudinal movement of tracks.

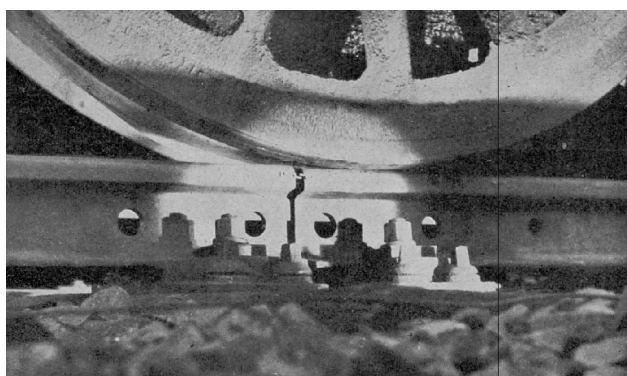


Fig. 6. A track joint under load at the Włochy experimental post [source: *Inżynier Kolejowy* 1937]

The fact of having an equipped experimental post allowed other research to be carried out as well. For instance, in 1937, the effects of temperature on 15-meter long tracks were investigated [38]. As part of these tests, the actual value of the α coefficient (which defines the expansion of railway steel) was determined. While discussing the issues related to railways, one should not forget about Professor Karol Wątopek. Born on 22 September 1875 in Dobczyce, he was an outstanding specialist and teacher, directly involved in the development of Polish railways and the process of educating generations of railway construction engineers. Karol Wątopek studied at the Department of Engineering of the Lviv Polytechnic between 1894 and 1898. After graduation, he found employment in the Lviv Railway Directorate and took part in the expansion of the local railway network, holding the positions of assistant engineer and then senior commissar on the Sambor – Sianki line construction project. Working as a constructor, he published several papers on railway surfaces and track systems. In 1906, he received Ph.D. in Engineering on the basis of a thesis concerning track transition curves. Just two years later, he published his habilitation thesis on transverse surfaces under a vertical load. In 1909, he

was appointed as an assistant professor and took the position of the head of the Department of Earthworks and Road and Tunnel Construction. Three years later, he was granted full professorship (aged only 39). In 1919, he crowned his academic career at the Lviv University of Technology by taking over the Department of Railway Construction after Professor K. Skibiński retired. Additionally, as the dean of the Faculty of Engineering, he became the 53rd elected president of the Lviv University of Technology. At the same time, he was a Corresponding Member of the Academy of Technical Sciences in Warsaw [26].

Professor Wątopek actively participated in numerous projects intended to develop and consolidate the Polish railway system. As a member of the Technical Council attached to the Ministry of Transport, he shaped the policy in terms of railway surfaces, e.g. by submitting a plan to introduce three standardized types of tracks. In his academic output, which covered railways, roads, and tunnels, the most important piece is the two-volume textbook *Budowa kolei żelaznych* ("Construction of Railways"), which was published in 1924 [36]. Nearly a hundred years later, this book is still largely up-to-date, which is extraordinary considering the advancement of technology [26].

3. The Central Research Laboratory of Polish State Railways

Until 1934, some railway directorates had chemical research facilities attached to their main resource warehouses. There were also mechanical and saturation laboratories attached to the Ministry of Transport and an oil products laboratory in Drohobycz. However, the possibilities in terms of carrying out tests at these laboratories were limited and, therefore, some of the materials had to be sent for analysis to private laboratories, institutes, and universities.

In October 1934, in order to improve and consolidate the quality of the materials supplied to railways (and eliminate irregularities in terms of purchases), the Ministry of Transport decided to establish the Central Research Laboratory (Fig. 7). Even though it was a part of the Warsaw Directorate of the Polish State Railways, it was designed to operate as a separate unit supervised directly by the Minister of Transport and providing services to all Polish State Railways. The tasks of the laboratory, as specified in a Regulation of the Minister of Transport, were as follows [29]:

- 1) carrying out tests of all types with respect to the materials used by the Polish State Railways;
- 2) developing technical requirements for the Polish State Railways in terms of chemistry and metal science;

- 3) analyzing the goods transported by railways and issuing cargo decisions on this basis;
- 4) mechanical and electrotechnical testing of the materials used by the Polish State Railways in order to verify their usefulness.

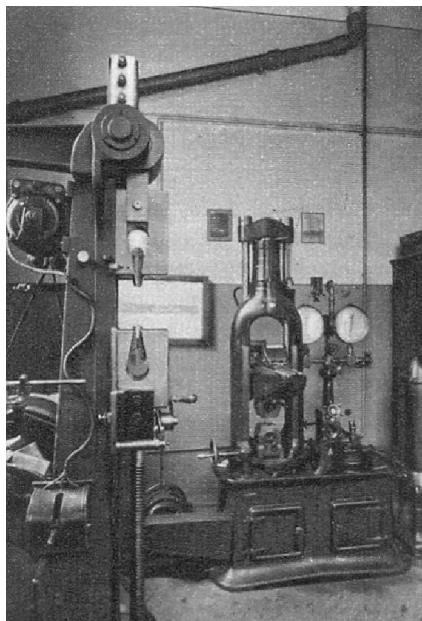


Fig. 7. The Central Research Laboratory [13]

The Central Research Laboratory was divided into the following divisions: Non-Organic Chemistry Division, Organic Chemistry Division (Fig. 8), Mechanical and Electrotechnical Division, and Experimental and Research Division. Most likely, at a later date, an Impregnation Division was added. At the same time, the chemical laboratories of the particular directorates were dissolved, leaving only those serving special purposes.

Thanks to the establishment of the Central Research Laboratory of the Ministry of Transport, the scope of research was extended to cover nearly all of the materials supplied to the Polish State Railways. New resources and materials were also examined before their introduction for use in the Polish State Railways. Detailed norms and requirements in terms of supplies of materials were developed. The Laboratory was equipped with the latest devices [13]. The Laboratory was located at Chmielna 71b in Warsaw, in the former complex of workshops and depots of the Warsaw – Vienna Railway².

In the 1930s, one of the major issues investigated by European railways was the welding of tracks. Poland was no exception. For instance, Chrzastowski carried out strength tests on electrically welded tracks using a piledriver [4]. Another example of testing new

technical solutions by the Central Research Laboratory were the tests of track joints with respect to tracks joined using the so-called combined method [2]. Between 1934 and 1936, along a section of one of the railway lines close to Warsaw, this method was used by the State Gunpowder Manufacturing Company of Pionki to weld nearly 5,000 type-39 tracks³. A relatively large number of joints (724, which amounted to 15% of all joints) were damaged when the tracks were put into operation. The tests of the working joints, cracked joints, and repaired joints were carried out at the Central Research Laboratory. This included testing the microstructure, microscopic tests, and strength tests (in order to specify the breaking force). The Laboratory also defined the impact of annealing joints in the technological process on the changes to their structure and, consequently, strength [2].

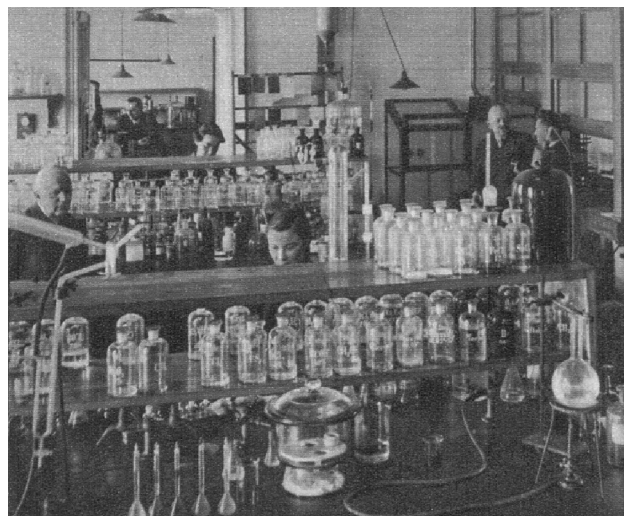


Fig. 8. The chemical laboratory of the Central Research Laboratory [13]

4. The Experimental Division of the Ministry of Transport after World War II

Immediately after returning to Warsaw in February 1945, Professor Albert Czczott recommenced work at the Mechanical Department of the Ministry of Transport and started to organize the Experimental Division. Importantly, the Division was recreated with the same pre-war organizational structure. However, it had to function in very difficult conditions, as during the War and under the occupation, nearly all equipment was destroyed or taken away by the Germans. None of the measuring cars or even dynamometers or indicators survived. In these

² Information provided by Mr. Zbigniew Tucholski.

³ In 1934, the State Powder Manufacturing Company of Pionki launched a facility that produced thermite for welding railway and tram tracks.

conditions, the first tests of steam locomotives were carried out using a simplified method developed by Professor Czechtz (without an indicator and a dynamometer). The idea was to increase the speed of the train pulled by the tested steam locomotive on a route with a constant longitudinal slope (with no profile fluctuations), with the cylinders filled to the same extent during the entire run. The only measuring instrument used during these tests was a stopwatch [7]. In the first years after the War, the Ty2 (Ty42), Ty4, Ty43, Ty45, Tr201 (Tr203), Tr202, and Ty246 steam locomotives were tested. The results of these tests were published in the form of traction descriptions by the Ministry of Transport [7, 19, 28].

In 1949, a dynamometric car was built for the Experimental Division (by the Central Workshops in Bydgoszcz) and three Hungarian steam locomotives (type Os424, series 424 while in service in the Hungarian MAV railways) were converted to steam locomotives/compressors for producing artificial resistance. In honor of Professor Czechtz, they were later named Cz1, Cz2, and Cz3 [28].

The technical back-up facilities, dynamometric cars, Cz1, Cz2, and Cz3 resistance steam locomotives, and the technical cars of the post-war Experimental Division (and from 1951, the Railway Science and Research Institute) were located at the former Warszawa Zachodnia (Warsaw West) Steam Locomotives Depot. Today, the Diagnostics Center of the PKP Polish Railway Lines is located there. Professor Czechtz organized two testing trains: for traction research and for heat-related research. In the 1950s, these trains were temporarily based at the Steam Locomotives Depot in Tuszcz. After the construction of the Central Unit for the Research and Development of Railway Technology (COBiRTK), the rolling stock and the technical equipment were moved there from the Warsaw West Steam Locomotives Depot. One of the Os424 (Cz) resistance steam locomotives was later used to heat the new halls of the Central Facility while they were under construction.

5. Establishment and development of the Institute

On the basis of an Order of the Minister of Railways from 30 May 1951, the Railway Science and Research Institute was established in Warsaw [37]. It was based on the Experimental Division of the Ministry, which provided the entire personnel, rolling stock, and measuring equipment, and which was later transformed into the Track Vehicles Unit. The Institute had its own Central Research Laboratory. Other units included the Track Unit, the Operational Unit, and the Documentation Unit. More units and laboratories were established in the following years.

Initially, the Institute was located on Hoża Street in Warsaw. Carrying out tests for railway institutions was very difficult, mainly because of the inadequate number of laboratories and other facilities. This is why, in 1957, the decision was made to build a modern research facility in the Olszynka Grochowska quarter of Warsaw. In 1958, the Railway Science and Research Institute was transformed into the Central Facility for the Research and Development of Railway Technology (COBiRTK). At the same time, the organizational form of the Institute was changed: from a budget entity to an organizational entity of the Polish State Railways. In 1959, the COBiRTK was moved to Olszynka Grochowska. In an area of 11 hectares adjacent to the Warsaw Grochów railway station, a hall for track vehicles with testing stands, a hall for research on structures and materials, a rail track hall, a propulsion laboratory, and a center for machines and apparatuses were built. In addition to research, the COBiRTK also coordinated the development of railway technology across the entire Ministry. The specialists employed at the COBiRTK supported projects such as the introduction of heavy track structure, the construction of the Central Trunk Line (CMK), the electrification of railway lines, and the automation of classification yards.

In October 1987, the Minister of Transport decided to change the name of the Central Facility for the Research and Development of Railway Technology to the Railway Scientific and Technical Center (CNTK). In the late 1980s, the construction of an Experimental Loop located in Węglewo by Żmigród (in the Lower Silesian Province) was started. The Loop was commissioned in 1996. This track, originally designed to test the durability of infrastructure elements, is used today primarily to test rolling stock in conditions that do not affect regular railway traffic.

In 1999, under Order No. 7 of the Minister of Transport and Maritime Economy of 30 December 1999, the Railway Scientific and Technical Center was excluded from the structure of the Polish State Railways and transformed into a R&D entity supervised directly by the minister competent for transport. This was a very difficult period in the history of the Institute, which had to adapt to the new conditions of functioning for railways in Europe and in Poland. The period of carrying out works for one enterprise (Polish State Railways) came to an end and it was necessary to commence cooperation with many entities: infrastructure managers, carriers of passengers and cargo, the railway industry, and central and local public authorities. The Institute also became involved in producing studies and providing advisory services, supporting the projects implemented in the Polish railway system thanks to European Union financing.

Under the Regulation of the Minister of Infrastructure of 12 April 2010 regarding the Reorganization of the Railway Scientific and Technical Center (Journal

of Laws No. 75, item 475), the entity was renamed the Railway Research Institute and still exists under this name today [23]. The Institute, functioning on the basis of the Law of 30 April 2010 on Railway Research Institutes, continues to support Polish railways in implementing new technical solutions, both in terms of rolling stock and railway infrastructure [30].

6. Conclusions

Almost immediately after regaining independence, research on various aspects of railways started in Poland. Understanding the research needs of the reborn Polish state in terms of railways was possible thanks to many talented engineers and several outstanding professors, who became authorities even before Polish independence. In addition to Professors Albert Czczott and Aleksander Wasiutyński, who are mentioned in this article, major contributions in their fields were made by other Polish scientists, such as Maksymilian Tytus Huber, one of the classics of mechanics, or Karol Wątarek, an outstanding professor and president of the Lviv University of Technology and the author of the fundamental *Budowa kolei żelaznych* ("Construction of Railways") published in 1924.

The research undertaken during the interwar period was of great value for the development of railway technology in Poland. It allowed new research methods to be introduced. The work initiated by Albert Czczott and Aleksander Wasiutyński has been continued by the scientific and research personnel of the Railway Research Institute. Professor Wasiutyński is commemorated by his bust standing in the conference room of the Institute (Fig. 9). In turn, Professor Czczott is honored by a plaque (Fig. 10) installed in the spring of 1972 by the entrance to the engine test stand of the Rolling Stock Testing Laboratory [12].



Fig. 9. A bust of Professor Aleksander Wasiutyński at the Railway Research Institute



Fig. 10. A plaque commemorating Professor Albert Czczott at the Railway Research Institute

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