IK INSTYTUT KOLEJNICTWA

Advanced Rail Technologies

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IN THIS ISSUE

Editor's

Andrzej Massel
Deputy Director for the Study and Research Projects

In 2016 the Railway Research Institute carried 482 research works, i.e. 21 more than the year before. 376 works were contracted by various entities: industry, railway infrastructure managers, train operation companies. Moreover, 106 works were undertaken directly by the Institute its own projects, financed from the Own Research Fund as well as from the subsidy received from the Ministry of Science and Higher Education. Comparing the activity of particular units of IK, the largest number of works was carried in the Materials and Structure Laboratory (168).

Thanks to the effort of managing team, despite the difficult economic situation of the Polish rail industry, the Institute still proved to be profitable in 2016.

In the previous year two significant anniversaries were celebrated: the 65th anniversary of the Institute and 20th anniversary of the IK Test Circuit in Zmigrod. Both jubilees were celebrated with annual ART conference, organised in November together with Warsaw University of Technology. Moreover, the dedicated conference focused on the research capabilities of test circuits, was organised in Zmigrod in June 2016. It gathered specialists from European and American test centres and proved to be an excellent opportunity to exchange experience in full-scale testing of rolling stock and rail infrastructure components.

The Railway Research Institute is continuously enhancing its publishing activity, regularly issuing Railway Reports, IK Works as well as ART Newsletter. Moreover, three scientific monographs were published in 2016. All these monographs can be obtained directly at IK. For details please see our website: www.ikolej.pl

Delegation of the Ministry of Transport and Communications of the Republic of Belarus

On 20 March 2017, the Railway Research Institute hosted a delegation of the Ministry of Transport and Communications of the Republic of Belarus led by Deputy Minister Alexey Avramenko.
During the visit, the Belarusian Deputy Minister, accompanied by Deputy Minister for Infrastructure and Transport Justyna Skrzydło, was shown the Materials and Structure Laboratory, including the state-of-the-art research apparatus purchased for the Institute within the framework of a project co-financed by the European Regional Development Fund, executed within the Regional Operational Programme of Mazovian Voivodeship for the years 2007-2013.
The Deputy Minister Alexey Avramenko's visit to the Institute followed the talks carried out at the Ministry for Infrastructure and Construction on the cooperation between Poland and Belarus in the area of transport infrastructure, the update of legal – treaty base and engagement in Central Europe Initiative, currently presided over by Belarus.
More information on Poland and Belarus's cooperation can be found at: mib.gov.pl/2-514324a4ec 938-1797648-.htm


Photo: IK

Meeting of the International Rail Research Board (UIC IRRB)

On 2 and 3 March 2017, a meeting of the International Rail Research Board (UIC IRRB) was held at the Railway Research Institute in Warsaw. The IRRB was founded by UIC General Assembly in order to coordinate activities for effective implementation of technological, technical and organizational innovations in rail transport. The IRRB Chairman is Prof. Boris Lapidus (RZD), Vice Chairmen include Vicky Brown (ACRI), Güven Kandemir (TCDD), Prof. Mark Robinson (Newcastle University), Roman Štěrba (CD) and Dr. Andrzej Żurkowski (Instytut Kolejnictwa).
The Area 01 Working Group meeting on 2 March was led by Dr. Andrzej Żurkowski. The aim was to develop a plan to update and introduce possible changes into UIC document "Global Vision for Railway Development" (GVRD). More information can be found at: www.ikolej.pl


Photo: IK

ERTMS working groups

On 4 - 5 April, 2017, the Railway Research Institute was the host of ERTMS working groups, i.e. the 69th NB-Rail CCS Working Group and the 37th UIC Notified Bodies (NoBo) ad hoc Working Group. NB-Rail CCS WG operates within NB-Rail coordination group on the basis of Art. 28 of Directive 2008/57/EC of 17 June 2008 on the interoperability of the rail system within the Community. This WG task is to coordinate activities of notified bodies that conduct certification of interoperability constituents and subsystems within ERTMS. The working groups' meetings were attended by representatives of the European Union Agency for Railways (ERA) and around 20 notified bodies from all over Europe (from Portugal to Bulgaria).
More information can be found at: www.ikolej.pl


Photo: IK

Creating a stable transportation offer - National Integrated Cyclic Timetable

Piotr Chyliński
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Public transportation is a special type of service that can only be consumed at the same time as it is executed. That means that the lack of public transport at the right time in the expected direction will determine the choice of individual transport or the resigning from the journey. The timetable describing destinations, hours and frequencies of running is what characterizes the transport offer in public transport. Together with the transport tariffs, it describes a commercial offer for transportation [1].

The availability of rail transport in a given area is determined not only by the density of the network and stops locations but when the network already exists - the availability of the network is determined by the timetable. The perceived attractiveness of public transport by potential customers is not only in the proximity to the stop but also - in terms of potential waiting times and number of available connections. In a complex multimodal transport system, rail transportation timetables may affect and offer a comprehensive range of other modes of transport in the region.

In some cases, the existence of frequent and stable railway service with a good timetable means that bus communication does not compete with rail: at least one service an hour in regional traffic and four or more services an hour in commuter areas. On the other hand, less than 6 trains daily means an increase of competitive bus transport. A radical improvement of the rail transport offer should be the answer for the lack of suitable, attractive rail offer and the unbalanced development of road transport.

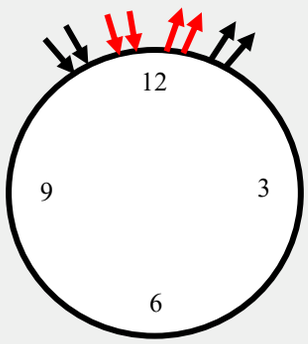

Fig. 1. Arrivals and departures time scheme in integrated cyclic timetable. Black arrows – regional trains, red arrows – long distance and express trains

Not only is a cyclical timetable a stabilization of departure times, but also, and perhaps above all, it provides an adequate and even distribution of supply during the day.

National Integrated Cyclic Timetable can be explained as:

- national – applicable throughout the country, implemented be all railway operators acting on the basis of the transport plan of the appropriate level and on other means of municipal, county and regional public transport,
- integrated – providing transfers (integration) on multimodal nodes and hubs. Arrival and departure times are symmetrical in each hour,
- cyclical – timetable in which departures and arrivals are held at regular intervals which are an integer multiple or submultiple of hour.

Switzerland, where a cyclical integrated timetable at national level was introduced in 1982, is a pioneer in introducing such a scheme for regional and long-distance connections in Europe. Moreover, it is also a country where the average number of rail journeys per capita is highest in Europe and the second in the world. The integrated timetable has been successfully used for many years in Germany, the Netherlands and Austria.

There had already been introduced in Warsaw area cyclic timetables in electric trains on the lines to Grodzisk, Otwock and Minsk Mazowiecki before the Second World War.

The implementation of the national, integrated cyclical timetable on the railway network in Poland - not only on the PKP PLK network, but also other infrastructure managers, can help solve the most important travel planning issues faced by passengers as well as attract new clients who have used railways very rarely or never before.

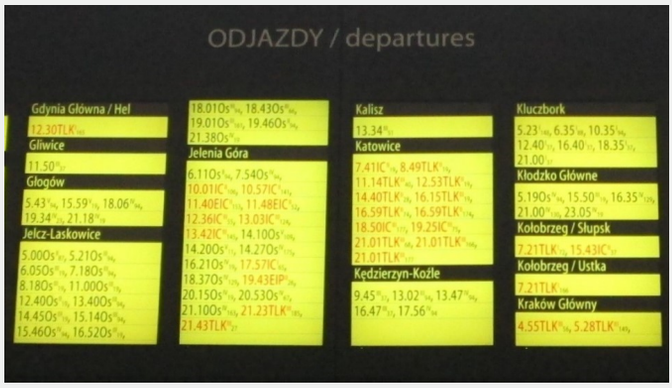

Fig. 2. An example of dynamic timetable information in Wroclaw

A wide range of modernization work on the railway network in Poland has significantly worsened the stability of railway timetables in recent years. Considering an implementation of a fully symmetrical, cyclic timetable where every hour the same departure sequence repeats, in the case of a train having to wait for crossing in a single track line, all trains of the same category will be shifted (delayed or accelerated) by the same time. However, on long single track sections, where the time between two successive trains in the same direction is greater than 30 (60) minutes, the introduction of cyclical timetable may not be possible.

The integrated timetable also allows synergy by transferring passengers between transport subsystems.

[1] National Integrated Cyclic Timetable Krajowy zintegrowany cykliczny rozkład jazdy. Chyliński P., Przegląd Komunikacyjny 4/2017

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Impregnation of wooden railway superstructure elements

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Wood material used for building railway superstructure (sleepers, switch timbers and bridge switch timbers) is exposed to biological agents and changeable weather conditions during operation. Therefore, its impregnation with suitable chemical substances is carried out for the purpose of maintenance and performance.

The efficiency of wood material impregnate depends on the degree of the agent's absorption into the wood structure, whereas the penetration depth of impregnation solvent has a considerable impact on impregnated wood durability.

The major factors that influence the depth of penetration include:

- wood species and its characteristics (sapwood, heartwood, false heartwood, blue stain),
- wood moisture,
- kind of impregnate (preservation agent),
- preservation method and technology (Rüping's method).

Fig. 1. Impregnated wood material of railway superstructure

Moreover, the durability of impregnated sleepers in the track depends also on the method of rail fastening, kind of ballast, diligence in track maintenance, train speeds and transport volume on a given line. The basic standard defining requirements for wood materials is PN-EN 13145 standard which is harmonized with Commission Regulation (EU) No 1299/2014 of 18 November 2014 on the technical specifications for interoperability relating to the 'infrastructure' subsystem of the rail system in the European Union.

The durability of railway infrastructure is defined by the average time of its use in track for the whole impregnated lot. Consequently, the absorption and retention of the protection product in impregnated wood are used to define the quality of protection. On the basis of multiannual statistics from various countries' railways it is agreed and adopted that the average usage time of the whole lot of sleepers placed in track is the time during which the number of replaced sleepers amounts to 60% of their overall number in a given lot. Thus the durability of pine sleepers amounts to approximately 20 years, whereas beech and oak ones – 25 years. The most common and effective products used to preserve wood materials for railway superstructure id creosote oil. It is a combination of various aromatic compounds obtained by the distillation of high temperature coal tar boiling in the range of 200 °C to 360 °C.

Fig. 2. Impregnation cylinder used for impregnation of wood material by the Rüping method

Currently creosote oil type B and C is used to impregnate wood materials designated for railway superstructure, which complies with the requirements of PN-EN 13991 standard's chemical/physical properties. Studies carried out by the Railway Research Institute in the area of wood materials impregnation show a wide range of creosote oil retention's variety in Europe reflecting different environmental conditions, local traditions, experience and expected time of use. The lowest applied required retention values are recommended by DIN 68811 standard, whereas the highest ones by BS 8417 and PN-D-95014 standards.

Fig. 3. Wooden elements of the railway pavement

Wood materials of railway superstructure are an important element of the railway permanent way. Therefore, their proper manufacture and preservation against destructive impact of biological agents is essential. Their advantages include the lack of electrical conductivity (vital in relation to railway electrical installations) and effective vibration dampening (thus they are used in engineering facilities like bridges or viaducts). They are also applied in curves with a radius of less than 250 metres, as well as on steep gradients.

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Passengers' safety in Poland's railway stations

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Safety in Polish railway stations has considerably improved recently. It is due to PKP S.A. Group's extensive and comprehensive policy in this respect which leads to the improvement in this area year by year.

Any fears of adverse events are purely subjective and they might come from different sources, e.g. dirt, darkness in some parts of railway stations, negligence visible in the stations and in trains. Research shows that railway stations situated in remote areas or worse districts, in addition if they are designed or look dark or grey, worsen the traveller's sense of well-being.

Railway companies (undertakings and managers) are obliged to analyse risks and weak points on railway premises. Travellers' trust is vital to enhance their sense of safety and therefore relevant activities must be undertaken in order to minimize passengers' perception of insecurity.

In order to reduce fears and concerns as well as increase safety in railway stations in Poland, several activities are carried out on various platforms. It is worth mentioning such developments as modernization of railway lines, turnouts, level crossings and railway stations taking into account persons with disabilities. Modern command control and signalling equipment, directly increasing the level of safety, is installed on upgraded lines. Many railway stations have been equipped with monitoring systems (CCTV cameras), whereas the biggest premises have been guarded by 24/7 security service. Major railway stations and trains with the highest number of negative events are regularly patrolled by Railway Security guards. Due to these measures the numbers of events and victims keep decreasing.

The railway stations' renovation scheme started in 2005 and is still underway. Many railway stations still require to be modernized. One of the most important aspects of their investments is to adapt them to persons' with disabilities needs.

The necessity to adjust railway infrastructure to persons' with disabilities needs resulted from the European Union's regulations. This process began on 1 July 2008. Until 31 December 2014, railway infrastructure had been modernized, repaired or built basing on Commission Decision 2008/164/CE of 21 December 2007 concerning the technical specification of interoperability relating to persons with reduced mobility (PRM) in the trans-European conventional and high-speed rail system. Since 1 January 2015 the mentioned above aspects have been following the Commission Regulation (EU) No 1300/2014 of 18 November 2014 on the technical specification of interoperability relating to accessibility of the Union's rail system for persons with disabilities and persons with reduced mobility.

For persons with reduced mobility, new and modernised railway facilities are devoid of architectural barriers and they are equipped with lifts, ramps, platform lifts, escalators, adjusted ticket offices and toilets. For the blind and visually impaired persons, there are installed special paths and plans of railway stations describing them in Braille. Also the dump-deaf persons have been taken care of. For the hearing-impaired, since 2015, the major railway stations have been fitted with, inter alia, inductive loops and another innovative solution, i.e. sign language interpreter online.

Fig. 1. Touch map

In order to adjust railway stations for the needs of people with disabilities, the following solutions have been adopted:

- tactile elements (warning visual lines, tactile paths, tactile walking surface indicators, Braille maps),
- audits have been carried out in order to increase railway stations accessibility,
- rolling stock adaptation is carried out by PKP Intercity - this railway undertaking constantly works to increase standards of service quality and comfort for all passenger groups, trains are equipped with devices facilitating entering and exiting trains such as lifts, platforms and ramps.

Fig. 2. Field of attention

Increasing passengers' sense of safety and security is a priority for all entities operating in the railway sector. Therefore, it is necessary to improve railway stations' infrastructure and keep these places clean. The provision of information to both abled and disabled persons is of utmost importance.

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Methods of detecting areas of GSM-R network interferences in Poland

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In accordance with ECC/DEC/(02)05 Decision, within the European Union the bands 876 – 880 MHz (uplink) and 921 – 925 MHz (downlink) are designated for the needs of the European rail digital mobile communication system GSM-R. It is a part of ERTMS system. At the same time, the dedicated to GSM-R UIC band is directly adjacent to public operators' network band (880-915/925-960) designated pursuant to 87/372/EEC and 2009/114/EC Directives. The research and experience of Western operators have proven that direct adjacency of radio bands leads to interferences and has negative impact on mobile stations in GSM-R network. The matters connected with in GSM-R network and public operator's coexistence are dealt with by, inter alia, International Union of Railways (UIC), European Union Railway Agency (ERA), as well as Electronic Communication Committee (ECC) working within European Conference of Postal and Telecommunications Administrations (CEPT) and operating GSM-R network managers. The results of work in the areas under discussion were presented in, among others, CEPT and UIC reports as well as within ERA technical workshops in previous years.

Fig. 1. Selective radiation meter SRM-3006 for measuring Base Stations

The Signalling and Telecommunication Laboratory at the Railway Research Institute has conducted research in order to assess the impact of public GSM, UMTS and LTE operators' transmitters on proper work of GSM-R mobile stations.

The scope of tests included:

- analysis of the subject matter status quo,
- review of acts of law, regulations, reports and technical specification connected with the subject matter,
- identification occurrence of interference,
- other countries' experiences and methods to prevent interference occurrence,
- simulation tests range of the scale selected interfering phenomena,
- analytical and simulation tests of the impact of public network transmitters on railway areas,
- estimation of threat for GSM-R terminal,
- developing methods of identification high risk interference of GSM-R network areas.

It has been established that the direct reason for interference of GSM-R receivers' performance is intermodulation and blocking of GSM-R terminals' input circuits resulting from strong out-of-band signals coming from nearby Base Stations of mobile phones' public operators.

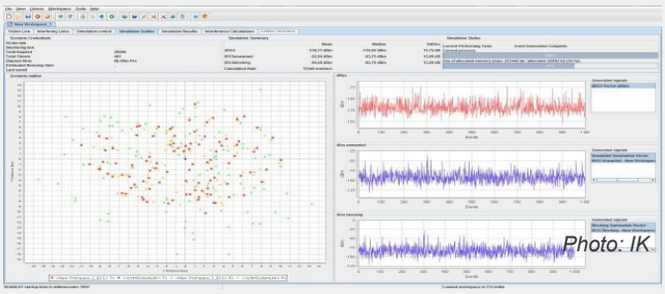

Fig. 2. Tool for statistic estimation of radio interferences in a given area

Criteria to be followed while identifying such geographic areas are strongly dependent on:

- geographical location of public operators' Base Stations and other terrain limitations,
- power of signal emitted by public operators' Base Stations,
- distance between interfering networks' identification high risk interference of GSM-R network areas.
- radio technology (2G, UMTS, LTE) used by public networks' operators in adjacent Base Stations.

The presented criteria are not the only ones, thus the diagnosing of areas subjected to interference is not obvious. Such an estimation is necessary due to a certain dynamism occurring in public networks since public networks' operators periodically introduce changes in their networks' configurations and implement new technologies (LTE currently). One of the simplest methods of diagnosis is a periodical diagnostic of GSM-R network's radio environment. Such diagnostics are carried out in some European countries. Unfortunately, conducting such research is expensive and time-consuming.

Signalling and Telecommunication Laboratory carries out tests of radio coverage levels on railway areas within conducted certification processes of railway lines equipped with ETCS system. For this purpose special research procedures were developed and advanced measurement instruments are used.

The Laboratory also strives to develop methods facilitating the identification of GSM-R network interference areas. Consequently, tests on using expert methods such as fuzzy logic or the Monte Carlo method, have been started. The application of such methods may shorten the time necessary to identify parts of railway line vulnerable to interference, narrow the scope of necessary empirical tests, shorten the time of research and reduce costs.

These methods have been considered as a sufficient tool to roughly identify places of high risk of interference occurrence.

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Polish railway market in the light of new EU proposals relating to noise reduction

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Deputy Head of Rolling Stock Testing Laboratory

The European Union's document of 2011- the White Paper on transport "Roadmap to a Single European Transport Area – Towards a Competitive and Resource-Efficient Transport System", among 10 goals to achieve a competitive resource efficient transport system, mentions the necessity to shift approx. 30% of freight from road transport to alternative modes such as rail or sea shipping if the distance exceeds 300 km. Potential increase of railway services will be connected with its growing impact on the natural environment. In Polish legislation there are two basic documents defining the ways of assessment and management of railway risk management, i.e. the Act – Environmental Protection Law and Technical Specifications for Interoperability (TSI Noise). It was stressed in Commission Decision 2006/66/EC that due to the long life cycle of railway vehicles, noticeable reduction of the perceived noise level may take place only if actions are taken towards the existing stock. The priority, however, should be placed on freight wagons. Therefore "The Commission will take initiatives to discuss options for retrofitting of freight wagons with the relevant stakeholders to achieve a general agreement with the industry".

European Union's efforts to date followed two tracks: firstly as activities to promote brake blocks renewal (via Connecting Europe Facility – CEF) and secondly as the possibility to differentiate infrastructure charges due to the noise-differentiated track access charges (NDTAC).

Within the first activity it was adopted that the cost of renewal shall be financed by the outside rail sector. However, the maximum level of co-funding is 20% of costs directly connected with composite brake blocks. It has been agreed that the renewal of cast-iron blocks into LL composite brake blocks is economically reasonable and cost-effective (theoretically – lack of the necessity to interfere into the brake system and running gear of the vehicle) as well as the volume of noise after this exchange. It is estimated that the renewal of iron-cast block into LL block causes noise reduction even by 8 dB. Tests carried out in the Rolling Stock Laboratory show that an essential factor affecting the difference in noise level between the wagon equipped with iron-cast block and a composite one is also the frequency of breaking. Thus the highest differences by 6 dB were registered directly after breaking but later (after a long drive without breaking) this value dropped to approx. 3.5 dB.

Within the second activity, certain freedom was implemented among EU Member States relating to the application of CEF, i.e. infrastructure access charges promoting "silent' rolling stock. This element was used by the following countries: Germany, the Netherlands and Switzerland. The tendency to reduce the impact of railway noise level in these countries results both from high population density and the location of the main transport corridor which covers the high population density area. Differentiated charges are possible till the end of 2020. With regard to this deadline, the European Union Agency for Railways (ERA) started work connected with preparing proposals to apply binding Specifications for Interoperability Noise to existing freight wagons. The proposal to adopt prescriptive solutions results from the fact that while assuming 2.5% ratio of rolling stock's renewal typical only for market forces, complete renewal of rolling stock for the silent one will occur after 2050.

The solutions' analysis carried by the Agency at the end of 2016 allowed suggesting initial one or two-phased solutions introducing the obligation to apply current TSIs to the whole existing freight rolling stock since 2022 – (the most restrictive) one-phased variant or by 2022 – 2028 two-phased one depending on the kind of rolling stock (stock for domestic and international traffic). Due to rather short time to implement these new solutions, some questions arise:

- Are Polish rail operators and the Polish railway market ready for such changes?
- Will the introduction of noise emission reductions not cause the loss of rail services' competitiveness particularly in relation to road transport services?
- To what extent will railway noise emission improve?
- How many of the population will benefit from it?

The problem becomes even more serious if we take into consideration the fact that the Polish freight transport is the second largest in the European Union (12% of the total number of tonne-kilometres) following Germany (27%), before France (8%) Italy and Great Britain. Approximately 108.500 vehicles (13% of the EU stock) are registered in Poland, 85% of which are freight wagons. There are operating 244 railway vehicle keepers (9% of the total EU owners). This number includes both operators who have thousands of wagons at their disposal and small entities as well. It is assessed that among about 93,000 freight wagons only 79,000 are planned to be modernized in order to adjust them to comply with current TSI Noise requirements. Currently 2367 wagons meet these requirements (composite brake blocks), 16571 wagons have monoblock wheels without composite brake blocks, whereas 59976 wagons have rimmed wheels where retrofitting them with composite brake blocks is not possible due to high temperature of performance while braking and relating threat connected with easing the rim.

It should be underlined that wagons with rimmed wheels registered in Poland make 47% of their total EU number. Calculations concerning overall wagon modernization costs show that the cost of such retrofitting would amount to 2241.5 million PLN (537 million Euro), which means that on adoption target year of 2022 to modernize existing wagons to comply with TSIs, the investment expenditure will be about 89.5 million Euro/year and in 2026 – 59.9 million Euro/year. Such a cost and not being able to take advantage of CEF funding results from the necessity to replace rimmed wheel sets with monoblock sets, which consequently increases the cost 8 times. In comparison, the profit of the biggest Polish operator listed on the stock exchange amounted to 7.5 million euros in 2015. The cost of complying the currently used wagons to TSI Noise requirements equals buying 9100 new wagons that are fitted with K composite brake blocks.

Polish railway market in the light of new EU proposals relating to noise reduction

(continuation from page 7)

To sum up, it must be stressed that the specific character of the Polish railway freight rolling stock market due to:

– very high percentage of wagons with rimmed wheels,
– composite brake blocks' installation involving the necessity to use monoblock wheel sets,
– high average age of the stock which casts doubt on the sense of modernization

prevents or seriously restricts the possibility to comply the existing railway freight rolling stock with TSI requirements in the time suggested by the EU. In addition, there is a risk of losing railway transport competitiveness in relation to road transport since the modernization costs will be borne upon customers.

Moreover, it should be stressed that the carriage of goods by train consisting of 40 freight wagons equals to using about 60 trucks to perform the same tasks, what generates much higher level of noise due to the fact that the source of noise is located much closer to buildings and due to people's higher sensitivity to car than rail noise. It would increase the problem of car or truck noise which, according to the Chief Inspector's of Environmental Protection report, is the basic problem of noise generated by different means of transport.

Presenting the specific character of the Polish railway market in relation to the possibility to reduce noise was the topic of the author of this article as well as the Railway Research Institute representative's speech in a public hearing "Transport noise: harmful to people! How to avoid?" at the European Parliament on 11.10.2016.

Polish government's activities, the Office's of Rail Transport active participation in ERA work, PKP representative's in Brussels and PKP CARGO operator's engagement in OTIF work led to inclusion in the ERA report version in March of, inter alia, Polish postulates to introduce "silent corridors" as opposed to the whole network on which wagons meeting the TSI Noise requirements would be able to operate and defining wagons in international traffic not as wagons that are registered for international traffic but as wagons that really cross state borders. These proposals will significantly decrease the number of wagons to be modernized, however, they will not eliminate the problem for instance for the inhabitants of Poland. It seems that without devising an adjustment programme and financial support for the domestic market, the proposal that rail sector will bear the costs itself is unrealistic and inadequate to the EU strategic goals.

Fig. 1. Public hearing at the EP on 11.10.2016.
"Noise from transport: harmful to people! How to avoid?"

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6th International Conference „Advanced Rail Technologies" Warsaw, 15 – 16 November, 2017

The conference organized by the Railway Research Institute (IK) and the Faculty of Transport of Warsaw University of Technology is a platform to exchange views related to aspects of innovations in rail transport. It aims to present the achievements of scientific research, as well as industrial centers, both national and international, dealing with implementation and operation of modern technologies related to the rail transport.

Conference includes the following research areas of rail transport:

– Railway timetable and traffic,
– Rail transport infrastructure,
– Traffic control and IT for railways,
– Traction and rolling stock,
– Materials engineering and recycling in the rail transport,
– Transport organization and technology,
– Certification in the rail transport.

Information about the conference can be found at: www.artik.info

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