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Noise control plans in cities – selected issues and necessary changes in approach to measures and methods of protection

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Abstract

The Directive (2002) establishing the assessment and management of environmental noise mandates that the Member States of the EU to prepare action plans to manage noise-related issues and consequences of acoustic impact on areas adjacent to the busiest roads, railway lines, main airports and the biggest agglomerations. Every five years there are environmental noise control plans developed in the EU countries for the biggest cities with a population exceeding 100 thousand inhabitants. Each plan contains a set of proposed remedial measures aimed at improving noise conditions of the areas that have the greatest number of inhabitants exposed to noise above the limit values. As a rule, a few selected remedial measures are possible to apply in those areas and their combined effect is meant to result in a sensible improvement of noise conditions. In most programs, the tasks related to protection against environmental noise are based on single methods, which often present little effectiveness and are unrelated to other programs and policies.

The present report describes the results of studies and analyses that were performed in most Polish cities where noise control plans were delivered. The studies enabled to determine the basic problems encountered in relation to noise control plans as well as issues confronted while adopting actual measures protecting the environment against noise. The conclusion points out the necessity to introduce changes in the approach to noise protection measures and methods in cities.

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Keywords: traffic noise; protection against traffic noise; action plans; noise control plans in cities

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1. Preface

Under the current European Union and Polish legal rules every five years there are noise maps and programs prepared for environmental protection against noise. These programs are developed for cities with a population exceeding 100 thousand inhabitants, busiest roads and railway lines, as well as major airports. Each of them proposes corrective actions in order to improve the acoustic conditions for those areas where greatest number of people is exposed to noise impact. As a rule, it is possible to use few selected remedial actions for these areas and total implementation of these actions should lead to noticeable improvement of acoustic climate. Described below are some of the basic problems in the implementation of programs prepared for cities to protect against noise, mainly from the road and rail traffic noise point of view – industrial noise impact usually represents marginal problem in bigger Polish cities. In order to illustrate some of these problems, the examples of streets and railway line sections located in large cities' areas have been presented.

2. Legal rules that regulate the implementing of programs for environmental protection against noise

Implementation and amendments of programs for environmental protection against noise are strictly determined by both national and European legislation. The most important of them is the Directive (2002) and National Act (2001). The Directive (2002) mandates that the Member States of the European Union develops action plans designed to manage noise issues and consequences of acoustic impact on areas adjacent to busiest roads, railway lines, main airports and biggest agglomerations. These plans are also intended to protect quiet areas which should be marked within urban areas. Requirements to be met by programs for environmental protection against noise are defined in the Annex V of the Directive (2002). It presents, among others, a list of items that such document should include and general proposal on the actions which competent authorities can take in order to reduce the noise impact.

The basic Polish legal act which implies the necessity to draw up a program for environmental protection against noise is the Law (2001). In accordance with the provisions of the Act (2001) "for areas where noise levels exceed the permissible level, programs for environmental protection against noise are created and their aim is to adjust the noise to a permissible level". A program for environmental protection against noise should be developed within one year from the date of noise map presentation by the entity responsible for its preparation. These programs should be updated at least once every 5 years, and in the event of circumstances justifying a change of this document or a change of a schedule of particular tasks, programs can be updated more frequently. The Act (2001) also regulates matters related to public participation in the proceedings, the object of which is to prepare a program for environmental protection against noise.

Following the provisions of the Act (2001), the Minister of Environment was obliged to determine through regulation the detailed requirements to be met by a program for environmental protection against noise. Regulation (2002) is the result of this provision and it sets on the detailed requirements to be met by a program for environmental protection against noise (hereinafter referred to as recovery plan or action plan). It defines that each document of this kind should consist of three parts, for which the Regulation provides detailed merits-related scope:

- descriptive,
- specifying constraints and obligations arising from the implementation of the program,
- justify range of issues.

In addition, Regulation (2002) provides guidance on scheduling the tasks set out in the program which should be completed in order to improve the acoustic climate. This schedule should be based on the so-called M. indicator. It is one of the main parameters analyzed during the development of programs for environmental protection against noise. It is calculated using the following formula:

$$\mathrm{M} = 0.1m(10^{0.1\Delta L} - 1) \tag{1}$$

where:
m – number of inhabitants in the area that exceeds the permissible sound level,
ΔL – value of exceeded permissible sound level [dB]

According to Ordinance (2002), the order of the realization of tasks of the program should be determined by taking into account:

- exceeding of the threshold level of noise for areas endangered by noise,
- exceeding of the permissible noise levels in areas designated for hospitals, nursing homes, spa protection areas A,
- exceeding the permissible noise level for residential areas,
- exceeding the permissible noise level for other areas for which permissible noise levels are determined.

In accordance with Regulation (2002), the order of the realization of the tasks of the program in the residential areas occurs, above all by including the index that characterizes the size of exceeding the permissible sound level and the number of inhabitants in the area, that M index. First actions should be taken for areas where this indicator achieves peak values.

Quite important from the implementation of programs for environmental protection against noise point of view is the method of determining the value of a noise indicator L_{den} (the so-called noise day-evening-night). This indicator is used in strategic environmental studies (noise maps, programs for environmental protection against noise) in the EU. When determining the value of this indicator in Poland, use the following calculation algorithm:

$$L_{den} = 10\lg\left[\frac{12}{24}10^{0.1L_d} + \frac{4}{24}10^{0.1(L_e+5)} + \frac{8}{24}10^{0.1(L_n+10)}\right] \quad (2)$$

where:
L_{den} – means the long-term average sound level A in decibels (dB), appointed during all days and nights of the year, taking into account the time of a day (understood as the time interval from 6:00 am to 6:00 pm), times of the evening (understood as the time interval from 6:00 pm to 11:00 pm), and time of night (understood as the time interval from 11:00 pm to 6:00 am),
L_d – means the long-term average sound level A in decibels (dB), appointed during all times of a day of the year (understood as the time interval from 6:00 am to 6:00 pm),
L_e – means the long-term average sound level A in decibels (dB), appointed during all seasons of the all times of an evening in the year (understood as the time interval from 6:00 pm to 11:00 pm)
L_n – means the long-term average sound level A in decibels (dB), appointed during all times of a night of the year (understood as the time interval from 11:00 pm to 6:00 am).

3. Types of corrective actions used in programs for environmental protection against noise

Polish cities having a population in excess of 100 thousand persons possess legally implemented programs for environmental protection against noise, which contain the corrective actions with aim to improve a condition of an acoustic climate. These activities are often very costly and their implementation in many cases troublesome or even impossible to implement. Among others, six programs of noise protection (Krakow, Lublin, Lodz, Poznan, Warsaw, Wroclaw) were analysed as a part of the analysis of used protection solutions in corrective programs. The authors of the programs used a variety of solutions aimed at reducing or mitigating the adverse impacts associated with traffic noise. The most recommended methods in the six analysed corrective programs are listed below (there are number of occurrences of protection methods in individual corrective programs in brackets):

- noise barriers (5 – Krakow, Lublin. Lodz, Warszawa, Wroclaw),
- speed limits (4 – Krakow, Poznan, Warszawa, Wroclaw),
- noise-reducing pavements (4 – Krakow, Poznan, Warszawa, Wroclaw),

- tonnage limit – the number of heavy vehicles (3 – Krakow, Lodz, Warszawa),
- embankments (2 – Łodz, Warszawa),
- coordination of traffic lights at intersections in order to liquidate traffic (2 – Krakow, Warszawa),
- traffic calming solutions (2 – Krakow, Poznan),
- traffic organization changes (2 – Lodz, Wroclaw),
- resurfacing (2 – Krakow, Wroclaw),
- construction of new sections of roads (1 – Lodz),
- green (1 – Warszawa),
- new window frames (1 – Lublin).

Most of the time, the recommended method of protection against noise in analysed corrective programs is noise barriers. This is the method which is the fastest to use and is one of the worst solutions in the cities. The application of speed limits and noise-reducing pavements are the second solution used in the analysed corrective programs. These methods, while being effective on rural roads, will not always be appropriate in an urban environment, where speed limits have already been implemented and use of special pavements is not always effective and feasible. All methods require incurring the relevant costs. Based on the analysis performed by Jucewicz (2013) share of activities most frequently proposed to implement in programs for environmental protection against noise in all costs is as follows:

- noise barriers/ embankments – 49.7%,
- pavement repairs/modernizations – 30.5%,
- resurfacing for so-called „low noise surface" (noise-reduction pavements) – 12.9%,
- speed limits together with speed limit controls – 1.3%,
- other – 5.1%,
- restricting the heavy vehicles' traffic – 0.5%.

The data presented above indicate that the costs of noise barriers constitute nearly 50% of all costs for corrective actions. These activities are very costly and very troublesome (if not impossible) to be used in urban conditions. Actions carried out primarily in the area of sound emission (an area of carriageway) should be proposed in their place. Very good alternative for noise barriers in urban conditions is the use of physical traffic calming solutions, which are used primarily to improve the road safety (speed reduction). Studies on the effects of traffic calming and maintaining its liquidity conducted in European programs such as SILENCE (2008) and for specific solutions, e.g. Bohatkiewicz et al. (2013, 2014), indicate that they are effective methods of noise reduction. These include the use of noise-reduction pavements (so-called „low noise surface") that can be used only on the arteries with traffic speed over 50 kph – the use of this type of solution should be preceded by a thorough analysis related to the speed of vehicles and possibility of implementation of such a road surface. However, the basic action in case of Polish cities should be at first to determine the hierarchy of streets in the communication system. This action results from years of negligence in terms of spatial planning and sometimes chaotic investment activities focused mainly on quick results. Prioritizing of network of streets communication system is primarily designed to determine the arteries or an indication of need of their construction in order to shift a dominant traffic flows on them. These actions should also indicate the areas where it is possible to identify traffic calming areas, which will allow the formation of quiet zones in the city. This approach should be used especially in the emerging urban areas (residential areas).

At the same time there is a necessity to use mixed acoustic protection solutions for roads, streets, railway and tramway lines in programs for environmental protection against noise. The mixed means are a combination of several methods of protection against noise for a section of street, tram and railway line and in special cases, both street and tram line. They can be suggested to be used in programs for environmental protection against noise and relate primarily to the noise emission zone (carriageway of road or street, track, rolling stock) and the area of protection solutions (surroundings of thoroughfare with e.g. noise barriers).

Selected favourable and feasible examples of mixed acoustic protection solutions for roads, streets, railway and tram lines, Bohatkiewicz et al. (2103, 2014) are shown in the following part. These activities are often investment

activities and require coordination between various road authorities. Acoustic effect in such cases is the largest and most persistent – often associated with the solving of the most difficult problems of noise protection.

3.1. The construction of alternative roads, traffic liquidation on existing roads and the speed limit of vehicles

The majority of investment activities related to the development of the road network will usually improve an acoustic insulation in the surrounding of the previously utilized routes. These activities can be called as somehow "accidental" while implementation of the planned investment activities. This effect can be best observed in case of alternative road (e.g. bypasses) construction, which have an aim, among others, to relieve the village or district of a traffic, reduce nuisance in the vicinity of existing roads that so far served transit functions. The use of the investment activities related to the liquidation of traffic on existing roads (liquidation of the so-called "bottlenecks") and speed limits introduced with respect to the improvement of road traffic safety, can also result in reduction of acoustic impacts. As a part of the planned investments and rebuildings, it becomes possible to use opportunities of these activities toward improving the acoustic climate in the surrounding roads as well.

An example of corrective actions is presented below. The source of this example is a program for environmental protection against noise, which was adopted in 2013 by the City Council of Rzeszów. The scope of the activities proposed in the framework of this document covers sections of Krakowska Street and Okulickiego Street – one of the busiest thoroughfares in Rzeszow. The investments that will be implemented in Rzeszów and in its vicinity were analysed. The analysis was focused in those investments, the realization of which will improve the acoustic conditions in the vicinity of Okulickiego St. and Krakowska St. in the next 5 years (the duration of the program for Rzeszów) investments will be conducted, involving construction of the A4 motorway and S19 expressway, which will provide a bypass of the city. The construction of these roads will take over some of traffic, particularly heavy of transit nature, from presently existing urban streets system, including Krakowska St. and Okulickiego St. This will have an effect on reducing the noise level in the areas located in the vicinity of two analysed streets. A system that integrates public transport of Rzeszow and its environs will also have additional effect. This project was completed in June 2015. Its one of the most important elements is the zonal traffic management system and introduction of a public transport priority as well as introducing 80 new environmentally friendly buses. At this moment there is no more detailed information about achieved effects associated with e.g. improvement of traffic flow at intersections and other effects. However, such actions also have a definite influence on the acoustic climate in the city center. Such actions, although not resulting directly from the program for environmental protection against noise, but implemented independently of the provisions of the program, should always be taken into account in the first place in the analysis conducted under the programs. Noise abatement resulting from the reduction of heavy traffic in cities significantly reduces acoustic nuisance suffered by inhabitants but not always leads to reduction of the noise level in such a way as not to exceed the permissible noise values in the environment.

Another investment planned for realization for Krakowska St. and Okulickiego St. in Rzeszow directly affects both city streets. It will consist of the extension and rebuilding of intersections within these streets. These activities will also result in the noise level abatement in the areas of adjacent streets. Coordinated traffic lights will be used on the rebuilt intersections, which should eliminate traffic and thus reduce the acoustically adverse manoeuvres of starting and stopping the vehicles. In addition, thanks to this investment, the functioning of public bus transport in Rzeszów will be improved, which indirectly may affect noise reduction too. Through actions improving the functioning of public transport in cities and encouraging as many residents to choose this mode of transport as possible (e.g. through environmental education), a decrease in car traffic can be caused, which will also lead to noise reduction.

In proposing corrective actions one should also be aware of the investments realized for the entire area of the city, which cause e.g. traffic liquidation in communication system. In case of streets in Rzeszow, including Krakowska St. and Okulickiego St., it will be a system of area control traffic system throughout the city. Just as the coordination of traffic lights, this investment should lead to improving the acoustic conditions in the vicinity of the most trafficked streets by limiting adverse acoustic phases of traffic.

One more corrective action was proposed for Krakowska St. and Okulickiego St. in Rzeszow under the program for environmental protection against noise. It was to enforce the speed limit of vehicles traveling on both streets. Speed is one of the main parameters (next to the traffic congestion and the share of heavy vehicles) to determine the

level of noise coming from traffic. It should be noted that the optimal (due to the acoustic conditions) speed with which cars should be driven, is 50 kph. Below this value, the noise from vehicle engines becomes dominant, while above the noise of rolling wheels (interaction with the road surface) and aerodynamic noise.

Each of the actions proposed for the Krakowska St. and Okulickiego St. in Rzeszow, used separately, would result in a small reduction in noise level and would be feebly sensed by inhabitants. Implemented together can therefore result in significantly greater improvement in acoustic conditions that effectively increase the quality of life of the residents. In case of traffic calming implementation, 30 kph may be an optimal speed. However, it should be noted that achieving this speed level is associated with the introduction of physical traffic calming measures. Due to the fact that Krakowska St. and Okulickiego St. play an important role in the hierarchy of network of streets, they were not analyzed in the context of implementation of 30 kph speed limit.

The following fig. 1 shows a graphic picture of the state of acoustic climate before and after the implementation of the proposed set of corrective actions described above. Analysing the data presented in this figure should be noted that the noise levels in the vicinity of the Krakowska St. and Okulickiego St. still exceed the permissible noise levels in the environment. However, it can be noticed that the reduction of noise levels resulting from implementation of corrective actions amounts of approx. 5-6 dB. Keeping the permissible noise levels in the environment appointed by the Minister of Environment in urban conditions are often very difficult or even impossible. Achieving a reduction in noise level of approx. 3-6 dB is often the maximum attainable goal. Despite not meeting acceptable levels, improving the acoustic climate to such a level is significantly noticed by people living in the centres of large cities.

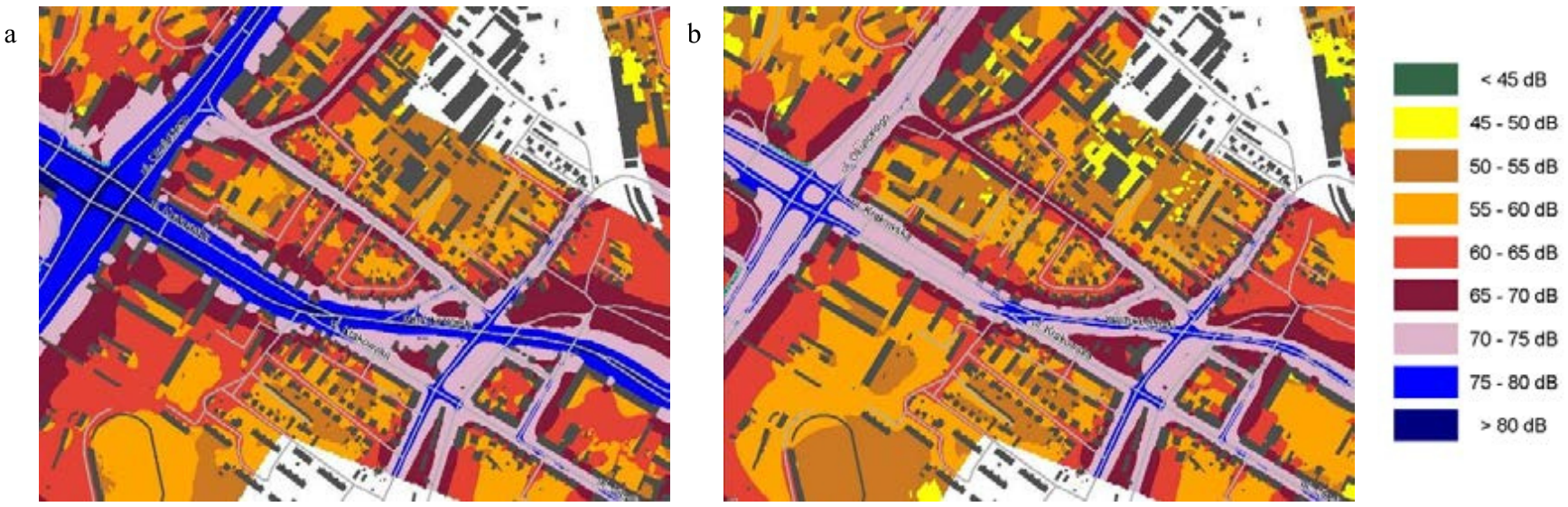

Fig. 1. The state of acoustic climate in the vicinity of the Krakowska St. and Okulickiego St. in Rzeszow (a) prior to the implementation of corrective actions; (b) after the implementation of corrective actions.

3.2. Resurfacing and reduction of speed limits of vehicles

Another set of corrective actions possible to carry out in urban areas that may be proposed often in programs for environmental protection against noise is resurfacing (often due to the very bad technical condition) combined with a speed limit of vehicles. Such actions have been proposed, among others, for Gen. Grota-Roweckiego St. in Sosnowiec as a part of program for environmental protection against noise adopted for the city.

Improving the condition of roads results in the reduction of sound generated at the interface: the wheels of vehicles – surface. It is estimated at approx. 2 dB. Resurfacing effects on the improvement of road conditions, which often encourages drivers to drive faster. Increasing the speed of cars will increase the level of sound generated by passing cars. For this reason, for such solutions it is appropriate to introduce an additional speed limit (if previously it was not in force) and/or enforce these restrictions (if the speed limit was not respected by drivers), e.g. through the use of speed cameras or enhancement of speed control by the police (especially during night hours). The combination of these two solutions can cause all together a noticeable reduction in sound level, which can be estimated at approx. 3-4 dB, which in urban conditions can be considered a noticeable improvement.

Example of usage of these both corrective actions is shown below in Fig. 2. An improvement in the acoustic environment of the street can be seen while analysing the state of acoustic climate for the environment of Gen.

Grota-Roweckiego St. in Sosnowiec before and after implementation of the activities. As in the previous case, the sound level is not reduced in a way that ensures adherence the permissible noise levels in the environment, however, the change should be felt by people living in the vicinity of the street.

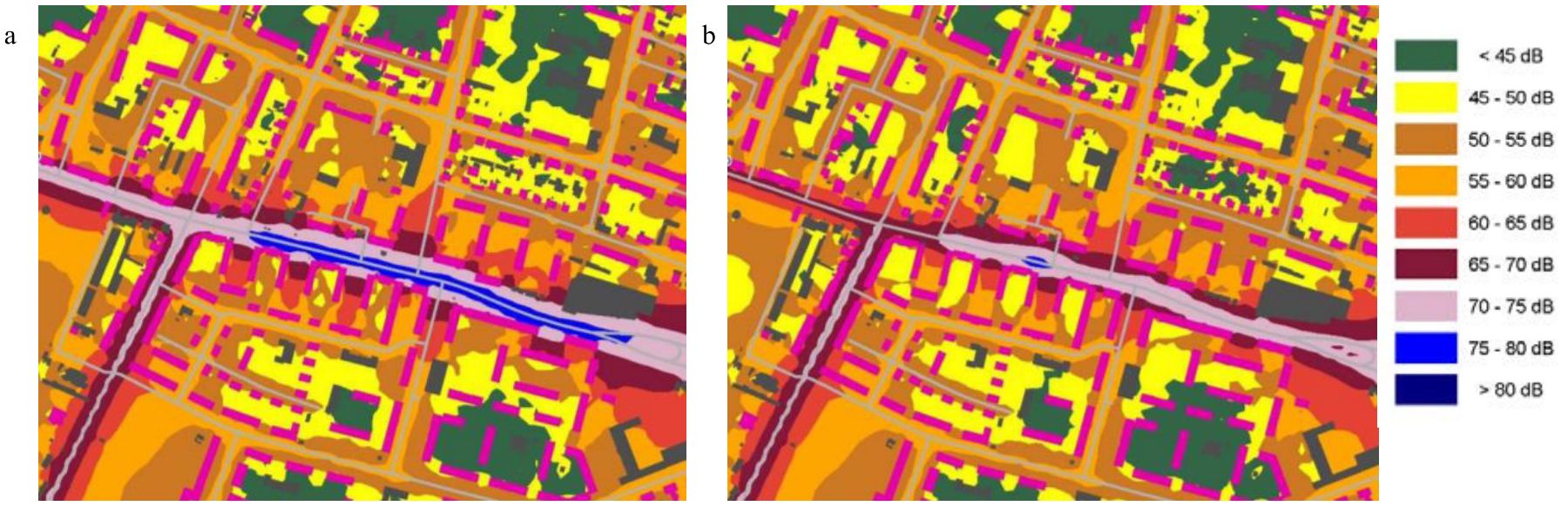

Fig. 2. The state of acoustic climate in the vicinity of the Gen. Grota – Roweckiego St. in Sosnowiec (a) prior to the implementation of corrective actions; (b) after the implementation of corrective actions.

What should be mentioned while describing the corrective actions aimed at the resurfacing and limiting the speed of vehicles is that sometimes so-called quiet porous pavement can be additionally proposed in the programs for environmental protection against noise. These surfaces may cause the reduction of sound levels, but only in certain cases, with a few additional conditions fulfilled. One of them is the vehicle speed, which should be greater than 50 kph. At lower speeds, the noise from the rolling wheels of vehicles is so low that its reduction will not result in a noticeable improvement in the noise generated by passing cars. It is due to the fact that the dominant source of noise at low speeds is the noise coming from the motor vehicle. Using the porous surface in this case does not cause the expected effect of reducing the sound level. It is usually found only at the ex-post research stage. In addition, the maintenance of this type of road surface in an urban environment is very problematic due to proper dehydration, which often can generate additional costs. Described surfaces can be used only on those streets where the speed of the vehicles is higher than 50 kph and traffic congestion is high (above all the streets for transit traffic). In addition to porous pavements (e.g. PA8, BBTM8) sealed pavements with low particle size (e.g. SMA5) might be preferred in cities. They may have a lower or comparable effectiveness of noise reduction effect. Their maintenance is simpler and decrease in reduction effect in time is not recorded, as it is in the case of porous surfaces.

3.3. The modernization of rolling stock, protection solutions on acoustic raceway and the use of noise barriers

The first examples of mixed corrective actions for railway lines which are usable in the programs for environmental protection against noise are presented on the basis of analysis performed for the diametrical railway line in Warsaw. This section is located in the central part of Warsaw. Its common courses are the regional railways and forming part of the second pan-European transport corridor linking Berlin and Moscow. An example of implementation feasible corrective actions aims at improving the acoustic conditions resulting from the modernization of rolling stock, usage of the acoustic hedge on the raceway and the construction of noise barriers. Replacing the older generation fleet for modern one (less noisy) is often the only feasible action in the centres of large cities, where the use of other solutions aimed at improving the acoustic climate is impossible. Application of raceway hedge and noise barriers resulted additionally in a significant reduction in sound level, which can be seen in Fig. 3 below. It presents the noise levels before and after using this type of corrective action.

The use of mixed corrective actions involving the modernization of rolling stock, vibration and acoustic hedge in the raceway rail and noise barriers in the vicinity of the analysed section of the railway line, Fig. 3 (b) resulted in improvement of acoustic climate so large that all floors of buildings located in the vicinity of the analysed section of

the railway line were effectively protected against the effects of noise. There are no exceeded permissible noise levels at the height of any of floors. However, this set of protection solutions negatively impact on the urban landscape due to the use of noise barriers. It should be noted that the use of noise barriers in areas where there are historic buildings is very difficult and often negatively evaluated by the conservator. In the absence of possibility of the use of noise barriers, a set of mixed corrective actions can be proposed, in which noise barriers can be replaced by organizational activities such as train speed reduction (down to 30 kph), or change in a timetable (if this is possible) in such a way that the number of train journeys in the evening and night-time will be reduced as much as possible Fig 3 (c).

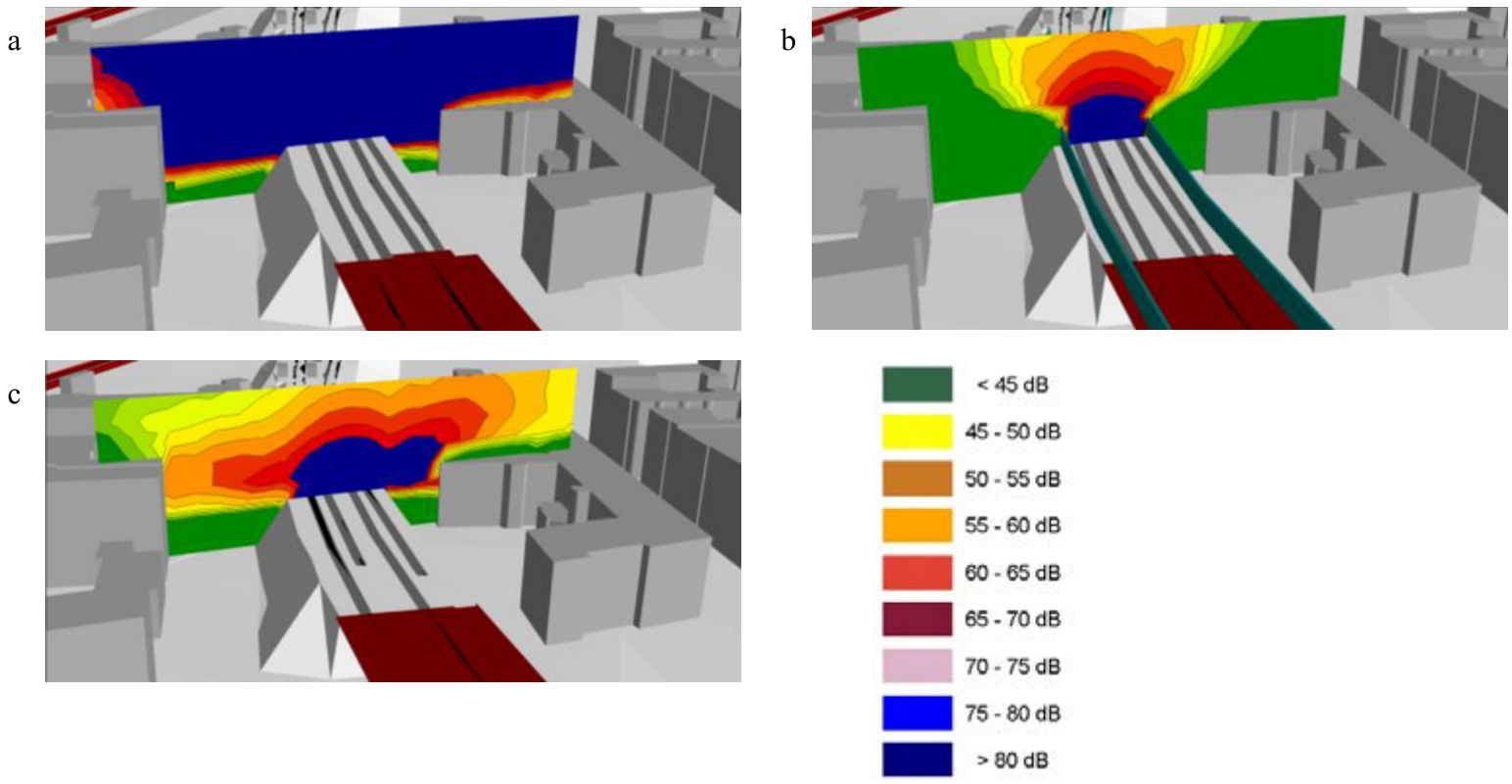

Fig. 3. The state of acoustic climate in the vicinity of the diametrical railway line in Warsaw (a) prior to the implementation of corrective actions; (b) after the implementation of corrective actions involving the modernization of rolling stock, vibro-acoustic hedge and noise barriers (c) the implementation of corrective actions involving mainly the reduction of train speed to 30 kph.

Having analysed the results of calculations after applying the corrective actions described above, one can notice the improvement in acoustic conditions. No necessity for noise barrier implementation is a major advantage of the activities using the speed limit of trains as a solution – Fig. 3 (c). In this case, the reduction of the sound level is slightly lower. However it should be noted that in many of these situations (heavily urbanized areas in the central parts of large cities in Poland), where there is a cumulative impact of multiple sound sources (automotive, railway, tramway, air, or municipal noise) use of a highly effective, but also costly noise protection solutions for only one source may not lead to a noticeable improvement in acoustic conditions. Despite the use of protection solutions reducing the sound level coming from rail traffic, other sources of noise will still affect the areas to be protected, causing a nuisance impacts. The best solution in this case is proposing corrective actions for all the dominant sound sources.

3.4. Resurfacing the street and modernization of the tramway

Acoustic climate within the largest cities in Poland (especially in their centres), for which programs for environmental protection against noise must be developed, is generally formed by several sources. These are mainly: the road noise, railway, tramway, industrial and municipal noise. Reducing the sound level coming from only one source does not cause a noticeable improvement in acoustic conditions for the inhabitants due to the cumulative impact of other sources. The programs for environmental protection against noise must therefore attempt to propose the corrective actions for all the dominant sources simultaneously. Only then is it possible to achieve real sound level restrictions in areas adjacent to them. Recommendations for the section of the 3-go Maja St. in Zabrze,

as a part of program for environmental protection against noise, are the example of this type of actions. A set of corrective actions consisted in this case of planned modernization of the tramway track and the simultaneous resurfacing of the street. The effect of sound level reduction (Fig. 4) after the implementation of these solutions will be noticed by people living in the vicinity of the street, due to the fact that it reduces the sound level (more than 5 dB) of the two most disruptive at the present time audio sources (car noise and tram). This reduction could be even greater, e.g. after the additional grinding of rails in the raceway tram.

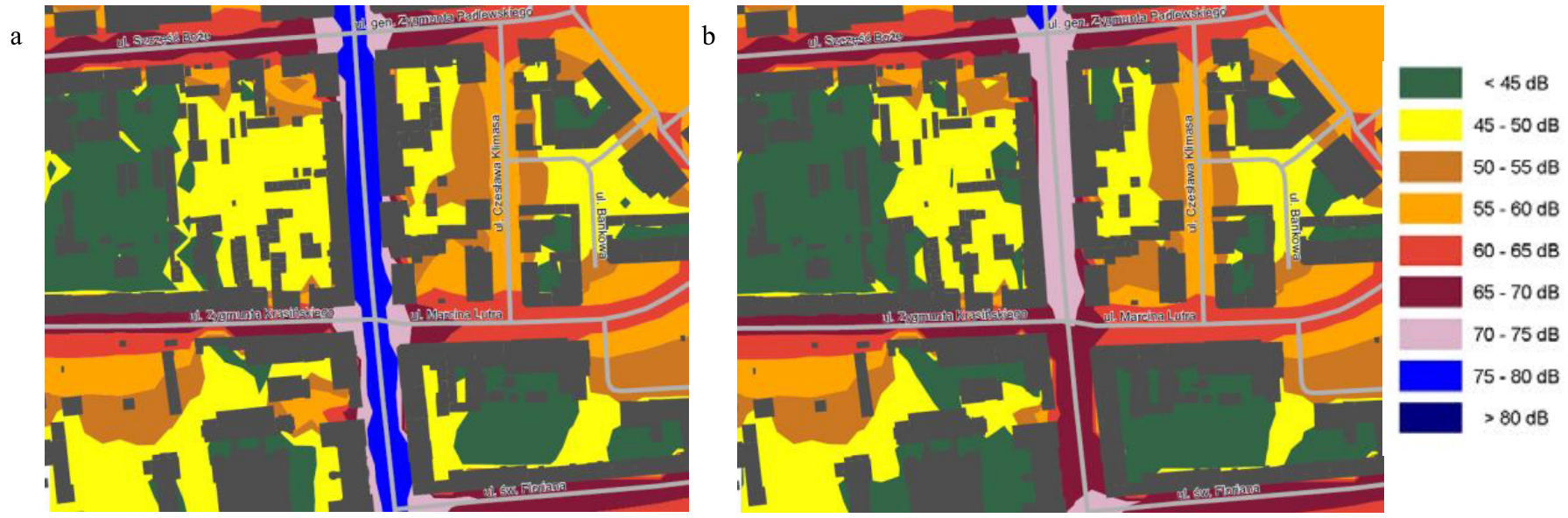

Fig. 4. The state of acoustic climate in the vicinity of the 3-go Maja St. in Zabrze (a) prior to the implementation of corrective actions; (b) after the implementation of corrective actions.

4. The need for change in the implementation and approach in the programs for environmental protection against noise in cities

Some cities in Poland and Europe in the coming years will carry out programs for environmental protection against noise for the third time. The experiences gained from the realization of existing programs allow to determine the recommendations for their implementation and changes in the approach to the realization of these programs:

- It is necessary to develop a uniform methodology and approach procedures related to the selection of methods of protection against noise. The existing programs often propose unrealistic methods of protection against noise to apply. They are often noise reduction solutions from a single source. It is extremely important that the analysis take into account methods of protection in a comprehensive way, respecting the cumulative effects generated simultaneously from several sources. In preparation of procedures, possibility of a hierarchical selection of methods to protect the environment should be taken into account, where noise barrier should be used in cities only in special cases. According to the author's opinion, first actions should be taken in the area of emissions – where the noise is generated. The methods in this area should be selected individually but generally should be analyzed in the order: traffic management (speed reduction, increase of traffic flow, the use of traffic calming measures, reductions in the tonnage and certain types of vehicles, for example: motorbikes, scooters or preference to modern, ecologically friendly public transport vehicles), resurfacing and changes in cross-section of the street (e.g. a street in the excavation). The second step is to consider methods for immision areas among which the use of noise barriers can be taken into account.
- The programs should be more important in the documents of the city – especially in terms of planning. The programs should be strongly correlated with other documents in the city on issues connected with communication matters such as: transport policy, parking policy, etc.
- One of the basic elements of work under programs should be accurate identification of the functioning of the transport system in the city and plans for its development. The program should clearly define the hierarchy of streets in the communication system and refer to the multi-annual investment plans of the city and in some cases, should be an argument for change or additions. This approach will enable programs to gather the most effective methods of protection related to zoning of the future buildings and traffic calming – this will enable the creation

of quiet zones in the city. The common traffic areas related to the protection of atmospheric air and at the same time protection against traffic noise will be possible to implement.

- Programs for environmental protection against noise should refer not only to compulsory time period, i.e. 5 years. The programs should also possess a reference to the long-term plans of cities, mainly in the area of the planned investments and development plans.
- The programs should refer to educational activities related to the use of the car, use of public transport, travel completed on foot and by bicycle.
- Public consultations which are properly carried out are an extremely important element of the program. Public consultations not only make obtaining information about the so-called hot spots (areas most at risk of noise) possible, but they also play an educational role.
- Active participation of all lines of communication's authorities for whom the program applies is required during execution of program. Thanks to the cooperation between the executors of the program and authorities, it is possible to develop a real action plan mainly from economic point of view.
- Work on the program should be carried out in interdisciplinary teams, which will gather i.a.: sound technicians, planners, traffic engineers, civil engineers.

5. Summary

Programs for environmental protection against noise are very necessary and important studies nowadays, supporting the long-term strategies which aim is to reduce noise pollution in large cities. It should be noted that the vast majority of the actions proposed in the programs for environmental protection against noise for cities in Poland concerns mainly on individual methods and fewer mixed activities (several methods simultaneously). The corrective actions proposed in the programs in each case make financial expenditure necessary for the roads, tram lines and railways authorities. Selection of these methods must therefore be very precise in points of view of acoustic and economic performance. Properly prepared programs will constitute the elements of real strategy for improving the lives of city inhabitants.

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