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Safety of visually impaired and partially sighted people on rail platforms in Poland – existing state and mistakes committed

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Abstract: Accessibility of transport infrastructure and public space for visually impaired and partially sighted people depends on ensuring the safe movement. Tactile elements provide such safety for visually impaired people. In Poland, there is a lack of standards regulating the use of tactile elements in transport. This results in a variety of markings warning against the same type of danger, what leads to the new transport barriers. The article shows the action effects, which were not preceded by the preparation of standards (tram, rail) and reveals a sequence of proper approach for the Warsaw Underground. The procedure of proper operations is indicated. It arises through an analysis of trials and mistakes committed in Poland. Such procedure should be used by those countries, which have not yet applied tactile elements for visually impaired people and whish to apply them in transport infrastructure.

Keywords: households, disposable income, savings, loans and liabilities.

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1. Introduction

Visually impaired and partially sighted people suffer from the disorders which in varying degrees limit their smooth functioning and expose them to many dangers. This applies mainly to public space associated with transport. According to the World Health Organization report (WHO, 2011), nearly 300 million visually impaired people live the Earth, including approximately 39 million people having fully reduced vision. In the European Union for every 1,000 inhabitants, four people are visually impaired or partially sighted. It is predicted that by 2030, one in four Europeans will be in retirement age. This shows an expanding participation of older people in the society, among whom the number of eyesight disorders triples with each decade of their life (Helal, Mokhtari, Abdulrazak, 2008).

The number of visually impaired people currently living in Poland is estimated at 100,000. More than 500,000 people have a serious dysfunction of vision. Near to 4,000 people a year lose an eyesight due to an illness or an accident (Guzik-Makaruk, 2011).

In the adapting process of communication infrastructure for people with disabilities, communication infrastructure accessibility plays an important role for visually impaired and partially sighted people. Providing space free of obstacles does not fully meet the needs of this group of people. Free movement requires the support of warning system and conducting of the visually impaired people. It is associated, inter alia, with an information role of varied surface textures provided with various types of elements identifiable by touch.

The system of warning, conducting and informing of visually impaired people using tactile elements consists of:

– warning strips, made up of the series of systematically arranged nodules, signaling the approach to dangerous place and warning against impending danger,

– tactile pathways, representing a sequence of elements with longitudinal ridges, located on pavement, whose task is to enable visually impaired and partially sighted people to maintain a proper direction of movement,

– attention fields, whose task is to inform about crossing or branching of the paths leading to tactile paths or about the change of movement direction; they usually consist of convex nodules with corresponding size and shape to the one used on warning strips,

– tactile maps, which are schemes of communication networks (position of the line and stops relative to each other) or railway stations, which allow visually impaired people for better orientation in the position of many important elements related to the passenger processing and services (Poliński, 2013a; Poliński, 2013b).

Recently during any transportation investment, including the tram, metro and railway platforms, it has been introduced a tactile markings for visually impaired people. To facilitate the use of tactile elements for visually impaired person, in particular of warning, such markings should be of certain width and length and consists of standardized tactile elements and always be placed at a certain distance from the danger area (Poliński, 2012b).

Still in Poland, there is a lack of regulations and standards unified and common to the different modes of transport. Therefore, designers have been forced to rely on a variety of patterns. Lack of markings consistency leads to user confusions. For the visually impaired person confusion in the interpretation of the markings at stop or platform may end up with an accident.

2. Methodology

In the past few years, there has been a significant increase of the investments in Poland related to repairs, modernization as well as construction of new railway lines. These actions included:

– modernization and construction of tram lines in many cities, due to the transport vehicle replacement; exploited transport fleet of old construction is exchanged for faster and more efficient low-loader fleet; construction of fast tram in Poznan and Krakow;

– construction of second underground line in Warsaw,

– a through modernization of the main rail network line and point infrastructure related to traveler services, which was initiated by the preparations of European Championships in football EURO 2012 and is still continued.

Above mentioned actions resulted in a series of modernized tram and railway platforms. Lack of unified rules, relating to the placing of warning strips and tactile paths for these objects, leads to a number of solutions, that have been evaluated mainly by people with disabilities, and among them mostly by visually impaired and partially sighted people. Authors of this article in the years 2010-2013 carried out a series of diagnostic surveys with people who use tactile elements on tram, metro and railway platform. The information obtained deepened the authors knowledge, which was necessary to develop an appropriate normative act for Warsaw Underground.

It is worth noting that authors have acquainted with the rules of using tactile elements for the visually impaired and partially sighted people in various European countries, as well as with the irregularities encountered in their placement on urban infrastructure. Moreover, it has been acquainted with the available American, Asian and Australian literature also on the results of the past used tactile elements exploitation (e.g. Bentzen et.al., 2000; Newman, 2010; Tokuda, et.al., 2008; Lněnička, 2010; Kühhas et.al, 2003; Estakhri, 2005; Standards Australia, 2009).

A detailed and thorough analysis of the information obtained allowed to make a number of conclusions designated to bring an order to this issue in Poland.

3. Point infrastructure related to travelers services – actual state of affairs

Tram platforms

Currently tram transport in Poland operates in 14 metropolitan areas (Bydgoszcz, Częstochowa, Elbląg, Gdańsk, Gorzów Wielkopolski, Górnośląski Okręg Przemysłowy, Grudziądz, Kraków, Łódź, Poznań, Szczecin, Toruń, Warszawa, Wrocław). In the Olsztyn agglomeration tram network is under reactivation.

In order to easily identify the position of the platform edge by visually impaired and partially sighted people, there has been placed a strip with the surface of different texture and color, which can be felt underfoot. Tactile elements on the tram platform in addition to being indicative, play an important role in ensuring the safety for visually impaired passenger. A tactile element prerequisite for meeting the desired role in the warning process is a proper shape and size of individual nodules and their spatial relationship to each other.

Despite the need of applying such markings for safety reasons, for many years it has not regulated rules in Poland for the application of such elements on tram platforms with any legal act. Thus, there is a complete freedom in the use of different solutions for:

– the shape and size of tactile elements,
– positioning of tactile elements relative to each other,
– the strip width with tactile elements,
– rules for the placing of strip with tactile elements in terms of platform edge from the side of the track,
– selection of the material from which tactile element is made,
– colors facilitating the movement and ensuring safe distance from the stop edge for visually impaired people.

At the same time, on the market there is available a wide range of different tactile elements solutions used in different countries. It may be noticed that elements made of concrete dominate, often dyed in yellow or white. Up to now, the elements made of plastic, glued or screwed into the concrete surface were rarely used. This was because of variable weather conditions (high temperatures during the summer and freezing temperatures during the winter with snowfall, which must be removed manually or mechanically).

As a result of many studies on new plastics, warning plates have been developed on Polish market, which fulfill most of the conditions expected from such products. Those expectations include (e.g. Arai K. et al., 2008; Bentzen, et al., 2000):

– high resistance to attrition,
– resistance to low temperatures,
– incombustibility,
– resistance to road salt and lubricants,
– resistance to aging,
– color durability and scratch resistance.

Thanks to such parameters, plastic plates began to be used on tram stops in Trójmiasto (Gdańsk, Sopot, Gdynia). Strip with nodules is pasted in a special recess in the plates, used to made platform surface. No legislation has caused, that individual transport operators in most cases apply their own solutions on their network. It can be said today that, where such internal rules have been developed, the tactile elements are unified in the area of the carrier tram network. In those cases, when the transport manager does not have its own regulations on the use of tactile elements for visually impaired people, the surface of the tram platform is not marked or you can find different ways of markings even on the same line.

According to the guidelines of the Polish Association of the Blind (PZN), in the chapter entitled: “the rules of placing the contrasting and tactile signs in public space” (Oleksiak, 2009), it has defined the markings for visually impaired and partially sighted people on tram platform. According to these guidelines, “*looking from the edge of the curb at the track, it should be placed sequentially:*

– yellow strip with a width of 150 mm,
– black strip with a width of 150 mm,
– non-slip, grey surface with a width of 300 mm,

– warning strip consisting of nodules with a width of 400 mm (without recommendation of the shape and dimensions of tactile elements nor their positioning relative to each other)" (p. 23).

Examples of solutions are shown in fig. 1, taking into account the recommendations of Polish Association of the Blind.

Figure 1. Examples of markings the edge of the tram platform in Warsaw taking into account the guidelines of the Polish Association of the Blind

Fig. 1 shows that correct markings of the platform edge is made using colored, small paving elements. In contrast, in Grudziądz there has been used a monolithic plates of non-slip textured surface with warning strips. Coatings have been applied on the plates according to the recommendations of Polish Association of the Blind. It is worth noting that in current regulation (Regulation 1999), in the § 120, which provides guidance for the tram platforms, recommendations have not been included for platform surface and its adaptation to the need of visually impaired and partially sighted people.

Due to the fact that in the near future in Warsaw further tram lines will be modernized as well as new lines will be built, issues related to the adaptation of new tram platforms for the visually impaired and partially sighted people are given in the internal regulations of the Public Transport Authority (ZTM) in charge of urban transport in Warsaw. According to those rules the tram stops should fulfill, among others, the following requirements:

– along the edge of the platform, the strip with non-slip tiles (300 mm x 300 mm) should be placed at the curb and in parallel the safety strip of yellow tiles with nodules (400 mm x 400 mm),

– on the stopping platform at the distance of at least 1500 mm from its edge, do not place any elements of ground installation (poles, lanterns, electrical boxes) or tree trunks,

– other requirements are in accordance with the regulation (Regulation, 1999).

In this document contrasting strip has been forgotten for visually impaired people, which nevertheless is executed on renovated or new tram stops in Warsaw.

4. Warsaw Underground platforms

During design and construction of the first underground line in Warsaw, tactile elements for visually impaired people were not taken into account for placement on the platform. Such needs were not provided by any existing legal act. Actions in this respect have been taken only after accidents involving visually impaired people.

In order to solve this problem, Warsaw Underground turned for help to Railway Institute (IK) in Warsaw. Work in this area began with the broad recognition of:

– visually impaired people behavior in the public space, their needs, habits and expectations,
– applied solutions for metro lines, both in Europe and beyond,
– the materials used, the tactile elements dimensions and their positioning relative to each other,
– existing studies and normative documents in other countries,
– previous operating experience.

Then on the metro station, test stands were made for studying various solutions of tactile elements. The research is described in detail in the article (Poliński, Ochociński, 2013).

As a result of the research work, the shape of tactile element was selected, which became binding for an adopted solution at Warsaw Underground (Poliński,2009). This is shown on fig. 2.

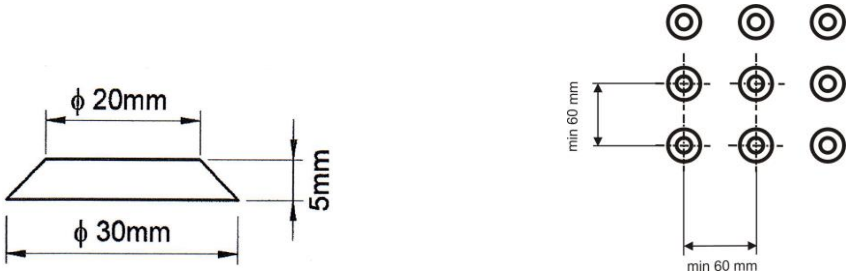

Figure 2. Dimension and shape of tactile element selected for the Warsaw Underground

It should be emphasized that such shape and dimensions of tactile elements are also applied to warning strips mounted in other dangerous places in the metro: before the stairs and elevators as well as to construct the attention fields of the paths conducting the blind.

The result of the research, assessments and analyzes was to formulate a number of requirements, which are very important for warning tactile elements, including:

– the material from which the tactile elements are made - those materials should be preferred which characterized by high durability and resistance to abrasion, such as stainless steel, natural stone and concrete. Stainless steel should be a basic material for the production of single nodules. In this case, the face of the nodule should be equipped with a rough surface, which will reduce the possibility of an eventual foot slipping by the person passing through the protruding tactile elements. Stone products should concern the plates mounted especially at the historical buildings, where the nature of the object is important, often under supervision of the conservator or surrounded space (Poliński, 2012c);

– the width of the warning strip – in practice, solutions are encountered where the warning strip has a width of from 0.3 to 0.8 mm. Taking into account an average step length of adult person, as a result of blind people evaluations it has been assumed that the width of tactile element shall be not less than 0.4 m and no more than 0.6 m. Using a smaller strip width or unequal laying of strips from small plates can cause that visually impaired person will overpass the tactile element (Poliński, 2012b);

– workmanship – tactile warning elements should not have a slippery surface, as they may pose a risk to people with disabilities as well as to other travelers. Too big and slippery tactile elements may also hinder the movement using wheelchairs. In view of the above, the finished strips glued to the surface, made of plastic or synthetic rubber should be avoided. It should be remembered, that in heavy pedestrian traffic and changing weather conditions, the strips come unstuck from the surface, which create an additional risk to pedestrian (Poliński,2012b);

– coloring – tactile elements thanks to its color contrasting with the ground, can play a helpful role in indentifying dangerous places for partially sighted people. Yellow color should be preferred, because for people losing their eyesight is the last perceived by the retina of the eye (Poliński, 2012b);

– tactile elements should be performed according to one adopted model, that should be applied throughout the country (Poliński, 2012a).

Then, it has been proceeded to enlisted the requirements for tactile elements in the legal document. This document is Regulation of the Infrastructure Minister on the technical condition to be met by metro building

facilities and their location (Regulation, 2011). So far it is the only document relating to dimensions of the tactile elements and their positioning relative to each other.

It is worth noting that on the new platform stations - now finishing the central section of Underground Line II - there are applied tactile warning signs for visually impaired and partially sighted people according to the above mentioned Regulation. The view of the platform edges of Warsaw underground is shown on the fig. 3.

Figure 3. Markings of the platform edge at Warsaw Underground

5. Rail platforms

Railway platforms pose the greatest potential threat to the travelers. This is due to the fact that at platforms stops or railway stations, trains can pass without stopping. When the train moves at a high speed, passengers staying on the platform should be in a safe distance from the platform edge, such that the aerodynamic forces when driving could not have caused an accident to the people waiting for the train. Therefore, danger zone has been introduced along the platform edge in which staying during the rolling stock movement is not permitted. According to the Polish regulations (e.g., Technical Standards, 2009; Regulation, 1998), the width of this zone depends on the speed of passing without stopping trains and is:

– 0.75 m – on platforms where stop all vehicles or the speed or the speed of the vehicle without stopping is less than 40 km/h,

– 1.00 m – on platforms situated along the railway lines and where are possible rides of railway vehicle without stopping with the speed: $40 \leq v < 140$ km/h,

– 1.50 m – on platforms situated along the railway lines and where are possible rides of railway vehicle without stopping with the speed: $140 \leq v \leq 160$ km/h,

– 2.00 m – on platforms situated along the railway lines and where are possible rides of railway vehicle without stopping with the speed above 160 km/h.

According to the specification of interoperability TSI-PRM (Technical Standards, 2009), the boundary of the danger zone farthest from the platform edge from the track side must be marked with visual and tactile warning signs. This document of European Union does not specify how the tactile elements should look like, but stresses that such signs should be in accordance with the national legislation.

The visual warning markings shall be a color contrasting, slip resistance warning line with a width of not less than 100 mm. This line is white or yellow color in Poland. In practice, his line has a width of 200 mm and is painted in yellow to make it more visible during the snowfall. Warning line is a part of danger zone.

According to the standards TSI-PRM, a warning strip with tactile elements should be placed outside the danger zone for visually impaired and partially sighted people. Dimensional requirements of nodules have not been specified, their positioning relative to each other, nor the strip width.

In the past 10 years, a large scale modernization works concerning the railway infrastructure were carried out in Poland. Modernization also involved the railway platforms. These works intensified in the period before the European Football Championship in Poland (EURO 2012). During its arrangements, the biggest train stations have been modernized. A lack of regulations concerning the use of tactile signs on railway platform has caused, that designers have proposed different solutions which appeared on the Polish railway stations. As a result, three kinds of tactile markings may be found at Warsaw area, which are shown on fig. 4.

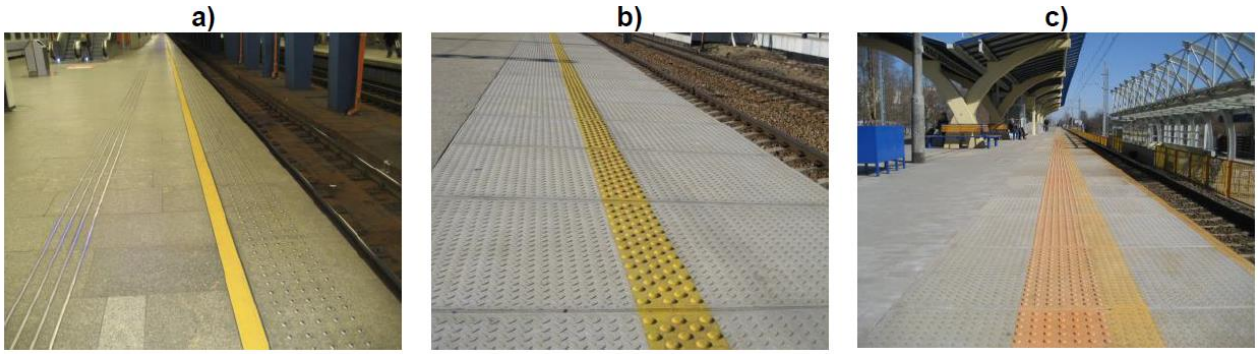

Figure 4. Different solutions of additional warning tactile strips on station platforms in Warsaw: a) Warszawa Centralna, b) Warszawa Wschodnia, c) Warszawa Ursus Niedźwiadek)

Blind people often sense the tactile elements not using a walking sticks, but using the feet. This is particular the case, when there is a lack of leading pathways for visually impaired people on the railway platform. Bad location of the tactile warning strip may cause the traveler will stay in the danger zone which violates the basic rules of safety. Therefore, the warning strip for the visually impaired people should be located directly behind the warning line and not be included in the danger zone.

6. Incorrectness related to the use of tactile elements in Poland

Figure 4a,b shows the execution of the tactile elements in the danger zone (Fig.4a) and on the warning strip laying in the danger zone (Fig.4b), which lets the blind in the danger zone. It should be noted that in the cases shown on these figures, the plates surfaces are covered with the series of flutes of 2 mm height, which greatly hinder finding the warning strip for persons using a white stick.

Some manufactures have begun in recent years to produce the plates with correct location of tactile warning strip, according to the guidelines for the underground, placing a tactile warning strip with a width of 0.40 m outside the danger zone. Such plates are already installed at some modernized or built railway platforms (Fig. 4c). However, objections may be related to the adopted coloring of warning strip.

Placing the nodules on the warning line, the width of which on the Polish railway stations does not exceed 200 mm, is pointless. A blind person approaching toward the platforms edge may overpass this too narrow markings, both when uses the sticks and feet to identify the surface. While moving along the platform, especially on those platforms where there is no tactile paths, markings may be “lost” by such person.

The modernization of Polish railway platform is associated with using edge concrete slabs with dimensions of 1.00 x 2.00 m, often dyed cherry color. Tactile elements are an integral part of the slab surface, whose shape and pattern is formed in the manufacturing process. Most of the slabs, that in recent years were used during modernization of platforms in Poland, have nodules placed on the 200 mm warning line. This has led to the loss of the ability to correct and secure mark of the platform edge for visually impaired people (Fig. 4b).

Interoperability specification TS-PRM (Technical Standards 2009) foresees the markings of visual and tactile signs at the platform end (EU Regulation 1300/2014 provides for the designation of both visual or tactile). On many platforms, this requirement is not executed, but instead fencing (barrier, metal mesh) are used – figure 5. This is result of the lack of edge slabs production with the tactile elements to be mounted at the platform end. This is a serious problem with regard to the safety of blind persons on the railway platforms. According to the interoperability specification TSI-PRM, such termination shall also be marked with visual and tactile signs. With the release of underground regulation (Regulation, 2011), the shape and dimensions of tactile elements (nodules) were standardized also on the concrete slabs. Mostly the nodules shape and dimensions were taken into consideration, however some manufactures used a staggered arrangement of nodules relative to each other (Fig. 4b and 5a).

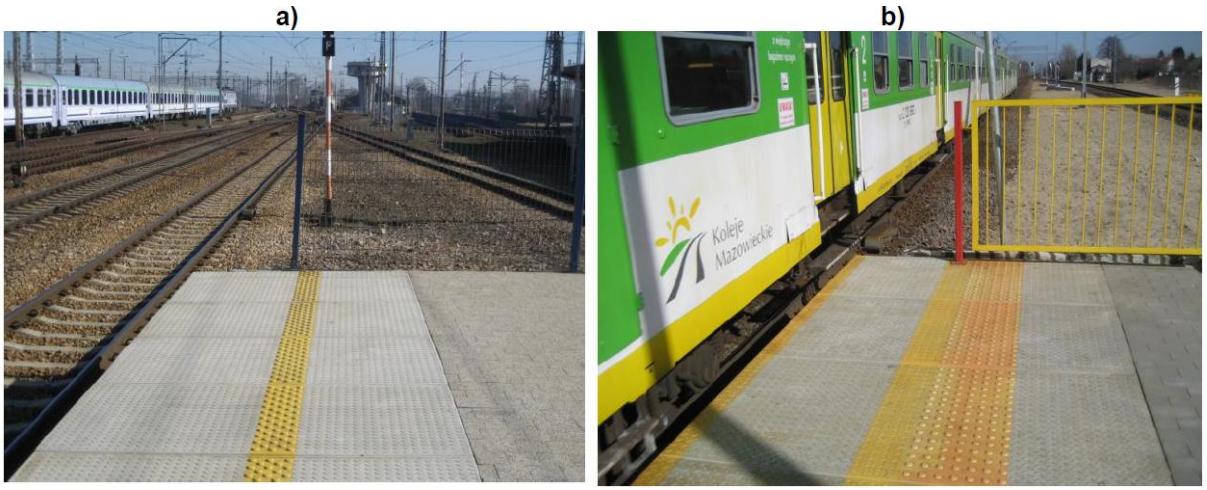

Figure 5. Examples of the lack of visual and tactile markings of the platform end: a) Warszawa Wschodnia, b) Warszawa Ursus Niedźwiadek)

While tactile warning strips are located on the edge slabs, it often ignores the need of using the tactile elements at other dangerous places on railway platform, which include mainly: the stairs entrance to the underpass, the entrance to the ramp, the end of the platform. The requirements for such warning strip should be the same as for the warning strip along the edge of the platform.

On many railway stations (small and medium-sized stations and stops), tactile guiding paths are not applied in addition to warning tactile strip along the platform edge. Such path allows safe movement of visually impaired people on the platform and in the case of using color contrast – also of partially sighted people. In such cases, the tactile warning strips also act as a tactile paths.

The tactile paths have been placed for blind on platforms of recently modernized large railway stations (e.g. Kraków Główny, Warszawa Centralna). Also for this type of tactile elements, the relevant provisions governing their use in transport infrastructure have not been developed in Poland.

At some stations (for example at Warszawa Centralna), tactile elements made of steel were used. This applies to both nodules and lines leading of tactile paths. The disadvantage of tactile elements used therein, is their slippery surface. Slipperiness increases for moisture or frost in the winter (especially tactile elements directly exposed to weather conditions). Therefore, this type of tactile element is criticized by travelers. In addition, individual components should be carefully attached to the surface. Markings defects have been observed in some areas of the platform, which should be quickly replenished but they are not.

Most reservations are addressed to the tram platform in Poland. Lack of uniform provisions related to the platform edge markings, has caused a large variety of applied signs. In most cases, the warning tactile elements are located at the distance of 0.50 m from the platform edge. The paths leading are not applied on the tram platforms.

Innovative solutions have appeared on tram platforms in Gdansk. Similar slabs to those used on railway platforms were applied on modernized tram stops.

Slabs are grey and have pasted a yellow strip with tactile elements made of plastic. The strip is pasted in a special hollow in the slab. In the building of railway stop Gdańsk Stadion Expo, located on the route of Fast Urban Railway (SKM), platform edge slabs are also grey color and have a yellow strip of tactile elements with a width 0.20 m. It is a step towards unification of the markings for visually impaired people on the rail platforms within the town.

A negative example is a rebuilt tram line in Bytom. Despite existing guidelines of Polish Association of Blind, the designers did not take into account the need of performing signs for blind travelers. Due to numerous protest of persons and organizations of visually impaired people, it has started to eliminate the irregularities and put the warning strip with tactile elements bearing additional costs.

For the tram transport running in the old city centers, where the tracks are not on a separate track lines, but are located directly on the pavement, there is no tram platforms. These solutions, which are now minimized, hinder independent use of this means of transport by visually impaired people. In practical, such situations occur in almost all cities, where tram transport operates.

Relatively the best marked tram platforms are in Warsaw and Grudziądz. Care was taken not only for blind people but also for the partially sighted, for whom a contrast line (yellow-black) is applied at platform edge. In the case of Warsaw, the quality of tactile elements raises the claims. Those tactile elements have a height of 4-5 mm, lenticular shape with a base diameter of 20 mm. These nodules are located on concrete slabs with dimensions of 0.40 x 0.40 m. In the areas of intensive passenger traffic, these elements are subject of accelerated wear, therefore are weekly detected by foot. In winter, when the shoes have thicker soles, this detection is

negligible or absent. Much better are large slabs used on tram platforms at Chełmińska street in Grudziądz, on which the nodules have the same shape as at Warsaw Metro. However, symmetrical position of the nodules, chosen by the visually impaired people, was not applied. Nodules were applied alternately. It is worth noting that such nodules position relative to each other is worse assessed by visually impaired people in Poland.

In many cases of tram platforms, the defective elements are not reconstruct, which introduces large difficulties to the blind. The causes of visual markings damage are an extended operation of the tram platform surface at high passenger flows, as well as the changing weather conditions. Defects and damages of such markings for visually impaired and partially sighted people pose a risk and may cause an accident. Improperly maintained tram platform surface is shown on figure 6, where the damaged plates are replaced by others. However, yellow-black strip meaning the platform edge, was not reconstructed.

Markings for the blind at metro has been standardized and is the same on the platforms of all stations. Any damage of such markings, mainly related to detachment of single nodules from the surface, are constantly repaired.

Figure 6. Example of improper maintenance of tram platform

7. Summary and final conclusions

Form the standpoint of an able-bodied person, it does not really matter, how the tactile elements look and how they are placed on the platform. For visually impaired people using dissimilar markings can result in a number of dangerous situations. Tested tactile markings for metro is governed by regulation in Poland. For the blind, they designate a zone “allowed to stay here”, upon placement of the nodules in front of warning line and danger zone. At Warsaw Central Railway Station, the same nodules are already placed between the warning line and the platform edge, so in a place where the visually impaired person should not stay. The use of different markings methods of the same hazard adversely affects the orientation of the blind people in space, which they can not see and they do not know what to expect.

In Poland, there is a lack of comprehensive regulations concerning the rules for applying tactile elements for visually impaired and partially sighted people in transport infrastructure. This applies to standardized solutions, which should be used for rail and urban infrastructure, as well as at bus stations, airports, ferry stations and seaports. The variety of markings requires from blind memorizing of different markings ways, appearing on various transport facilities. Such situation can be called a new kind of architectural barriers for this

group of people with disabilities. Currently, a legal document is under preparation for publishing, which will include requirements for tactile elements used in railway infrastructure facilities, including on railway station platforms.

Previous experiences suggest that in the absence of national regulations on the use of tactile elements for the blind, it is extremely important to standardized the requirements even for one branch or mode of transport. As it has been done at Warsaw Underground. It is worth noting that sequencing actions are very important. This aspect is significant for those countries, where tactile markings for the blind has not yet been used and which wish to enter such markings to the public space. After review and recognition of foreign solutions, several projects of our own solutions should be performed, which should then be tested by research centre. The studies must be carried out with a broad participation of the visually impaired people and must include all internal conditions, people habits and other characteristics of a specific community. It is worth to consult with other groups of disabled people, who will ambulate using such markings, such as older people moving with crutches, with zimmerframes, etc.). The research results should be used to develop a legal act governing the principles and methods of using the tactile elements in transport infrastructure. Only in accordance with established law, you are ready for using a tactile markings in a transport infrastructure. This will allow the application of standardized solutions in the infrastructure facilities of all modes of transport, which greatly facilitates the movement of blind people in public space.

In designing the tactile elements application for transport infrastructure objects, the ready-made foreign solutions should not be uncritically transfer, which is often associated with so called "importing errors". As has been shown (Poliński, 2012 c), "*dissimilar markings of the same danger leads to the creation of the new barriers and may cause an accident*"(p. 37). All tactile warning strips should be made according to one pattern and uniform rules adopted for using throughout the country.

Warning strip on the rail platform should be located outside the danger zone. In other cases, the distance of placing the warning strip should be 0.50 m from the dangerous place. This value was also adopted by Polish Association of the Blind (Oleksiak, 2009). This distance should be applied to: the beginning of the flight of fixed stairs and escalators, elevator doors, the beginning of the fixed or moving ramp, the front door, crossing the tracks at level crossing, the platform ends, the edges of public transport stops from the side of the road (bus, trolley-bus) or rail (tram).

The effectiveness of the warning strip depends on their width. Based on the research conducted by the Railway Institute in Warsaw (Poliński, 2012 c), "*the width of the warning strip should be greater than 0.40 m and not exceed 0.60 m*" (p. 41).

Pathways leading should consist of strips leading and attention fields. So far in Poland, it has not been developed a legal act, which would contain the requirements for the design rules of tactile pathways, developed for the Polish conditions. Such document should contain information on:

– ensuring a reconnoitering and allowing the continuity of the visually impaired people conducting,
– dimensional and quality parameters of tactile pathways,
– rules for applying the attention fields and marking the end of the tactile pathway,
– coloring which support the movement of partially sighted people,
– requirements for the design of tactile pathways in transport infrastructure.

Tactile elements for visually impaired people located in areas of heavy pedestrian traffic should be of: high durability, abrasion resistance, suitable roughness, appropriate coloring if they fulfill the needs of partially sighted people. In the case of elements exposed to changing weather conditions, it is required that the tactile elements were characterized by resistance to freezing temperatures, color stability, resistance to mechanical damage (snow removal) and chemicals (cleaning of contaminants such as chewing gum).

Tactile elements can be made of different materials. It is not desirable to use tactile elements made of different materials, shapes and various ways of positioning on the same communication facility. Tactile paths and warning strips of different widths can not be used at one object.

Proper use of tactile elements requires their ongoing maintenance, as well as quick repair any of the damaged element. Keeping in full suitability also applied to winter period. Then the tactile paths located at open space should be primarily cleared of snow. While mechanical clearing, used hardware may not cause damage to the nodules of the lines leading. At the same time, as stated in the article (Poliński, 2013 a) "*the rail object which has no tactile pathways for the visually impaired and partially sighted people, can not be included in the group of objects fully adopted to disabled people"* (p. 31).

The use of tactile elements related to the rail platform surface (warning stripes, the pathways leading) should be reflected on tactile maps (diagrams). Currently, on transport facilities in Poland there is a lack of such facilities for visually impaired people. Soon the work related to the development of tactile schemes rules for visually impaired people will be taken by Railway Institute in Warsaw.

Research and analyzes indicate the need to comply with the sequence of operations of introducing the tactile elements for visually impaired people to the transport infrastructure. The sequence of actions is important according to three steps:

– preparing and publishing a legal act,
– designing based on existing law,
– implementation of the project.

The lack of such order undermines the designers efforts, who unknowingly create an architectural barriers for visually impaired people.

Appendix A. Supplementary material

Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.14254/2223-3822.2016.14-1.7

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