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SELECTION AND APPLICATION OF THE TOUCHABLE ELEMENTS FOR BLIND AND PEOPLE IN THE WARSAW UNDERGROUND

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ABSTRACT. Background: The aim of this work was to design a warning belt for blind people as well as an inclusion of the requirements in the normative document.
Methods: A diagnostic survey using the questionnaires and the interviews with disabled people (especially with blind and visually impaired people).
Results and Conclusion: As a result of the research and a participation of the blind and visually impaired people, the tactile elements were chosen and parameterized for use in the underground buildings in Warsaw. The relevant information in this filed, which should correspond to Warsaw underground buildings, were included in the regulations of the Minister of Infrastructure. On this basis, all the edges of the Warsaw underground platforms were indicated.

Key words: underground platform, danger zone, touchable element.

INTRODUCTION

A human vision plays an essential role in the process of exploring reality, surrounding objects and occurring events. A visual analyzer receives up to 80% of all information coming from the surrounding. This includes a spatial orientation and safe movement for example with the use of different modes of transport. A lack of vision significantly reduces or even eliminates an independent movement and an orientation in the space around. The phenomenon of a compensation endeavors to avoid such situation by replacing the damaged sensory with others. In the case of vision loss by hearing, smell and touch.

With regard to the people who are blind and visually impaired, in addition to the sense of hearing, it is necessary to make greater use of the touch sense. While recognizing objects, a major role plays the sense of touch located in the upper limbs. In the case of spatial orientation the most important role plays the sense of touch in lower limbs. The touch provides information for blind people whether the space is free or blocked with the obstacles. It lets the visually impaired or blind people to know the specificity of an area. A special role is played by the indirect touch, for example by means of walking sticks.

A unified information system of the understandable colors has a great importance for the visually impaired people. The colors and contrasts fulfill an important function related to the orientation and the warnings for impaired people. They are selected on the basis of the color impact on the eyes.

A design of all infrastructure facilities available for the blind people should be on the one hand a process of a consistent implementation of the danger warning, and on the other hand, should be the process of

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drawing safe roads and of elimination of any obstacles that may be placed on them. The tactile warning strips have a great importance as a danger warning. They are placed in front of dangerous places such as: the stairs and an edge of the platform. [Poliński 2012], [Guidebook 2009].

A construction of the first metro line in Warsaw did not consider placing the warning touchable elements along the edges of platforms and in the front of other dangerous places. Such markings were not required by any law act. A series of terrible accidents involving the blind people, were the reason to equip Warsaw Underground with touchable marks.

The objective of the study was to design a warning belt on the platform and to include the related requirements in the normative document. It was assumed, that the realization of this objective will lead to apply the touchable warning belts on the platform edges of Warsaw Underground stations.

OBJECTIVE AND PLACE OF RESEARCH

Currently there is no common global system for the use of touchable elements for the blind people. In one group of countries, such as Japan, Australia, United Kingdom and France, there are internal regulations ordering this issue. In the second group, which includes Poland, these issues are not settled yet.

The research subject was the assessment and the analysis of the single touchable elements ("nodules"). It included:
- the choice of a suitable material and a shape for touchable element,
- the selection of a deployment mode of the touchable elements,
- the determination of the correct width of the warning belt.

Considering the large traffic on the metro platform, high resistance to abrasion was required from a single element, and a relatively large non-interference in the existing pavement during the installation. The choice was guided by the characteristics of the individual elements of touch, set in an analysis of the world solutions [Bentzen L. 2000], [Terauchi F.2000]. For the research purposes two types of nodules were selected (Figure 1a, b), they were made of stainless steel.

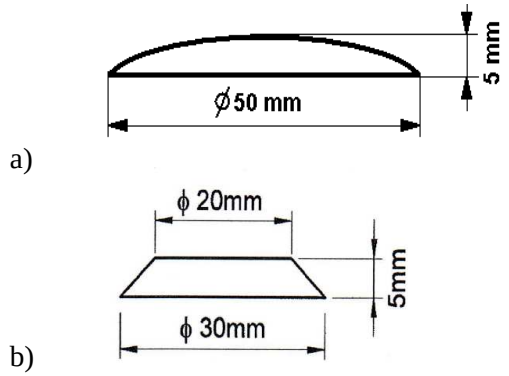


Fig. 1. Tactile elements tested
Rys. 1. Elementy dotykowe poddawane badaniom

The study was conducted in three areas, namely:
- Metro Kabaty station (tested tactile elements placed on the "1" level before the gates, at the southern exit of the subway, a tactile path led from the elevator on the"-1" level to the entrance gates),
- Wilson Square metro station (tactile elements mounted on "-1" at entresol before the gates, at the southern exit of the subway on Wilson Square, the tactile path was placed between the elevator at the "-1" level and the entrance gates; the belts with the touchable elements were placed in the front of the hallway towards the exit to the Krasinski Street).
- Warsaw Central Station (warning belts installed in the main hall at the "O" level . The warning belts arranged at a distance of ca. 3 meters from the stairs leading to the"-1" level, the tactile path has been placed between the warning belts and ticket office and an exit to the bus depot at the Golden Terraces.

The selection of the locations to install tactile elements was agreed with Warsaw Metro, PKP SA Branch Railway Stations, the Polish Blind Association, Associations Friends

of Integration with the participation of the Railway Institute.

METHOD

The lack of legislative act in Poland for using the warning stripes consisted of the tactile elements in public areas initiated a literature analysis of a specific designations. The available normative documents were examined and the application of such signs was analyzed in over 40 companies operating on the underground railway.

In order to study the tactile elements, they were mounted in the places with very intense pedestrian traffic. With a view to ensuring the safety of the research, the places along the edge of the platforms were abandoned which were the places of the future use of tactile elements.

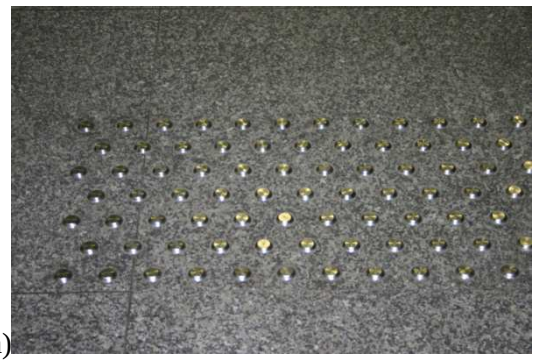
Diagnostic survey method was used during a few weeks of research. It has allowed the analysis of the documents related to the applicable regulations, including: ensuring adequate safety zones and adequate technology of making tactile elements. In the study, a questionnaire for travelers was used, including travelers with diverse disabilities. The questionnaire method was supplemented by the interviews, mainly on passengers with disabilities.

The study involved people with disabilities in the age between 15 to 65 years old, as well as the elderly persons. Among people with disabilities were both the blind persons and the persons with reduced mobility: moving with a walking sticks or wheelchairs.

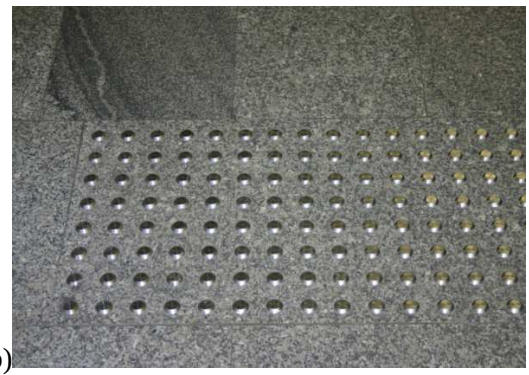
THE COURSE OF STUDY

On the subway Wilson Square Station tactile elements were used according to Figure 2 a) and c), while on the Kabaty Station - according to the Figure 2 b) and d). On the Central Warsaw Station all kinds of samples were installed - in front of the stairs leading from the main hall to the gallery on "-1".

a)



b)



c)

d)

Fig. 2. Patterns of tested warning belts with tactile elements
Rys. 2. Wzory ocenianych pasów ostrzegawczych

The path consisted of a flat with an oval cross-section and trapezoidal touchable elements. The path was made from stainless steel and was glued to the ground - Figure 3.

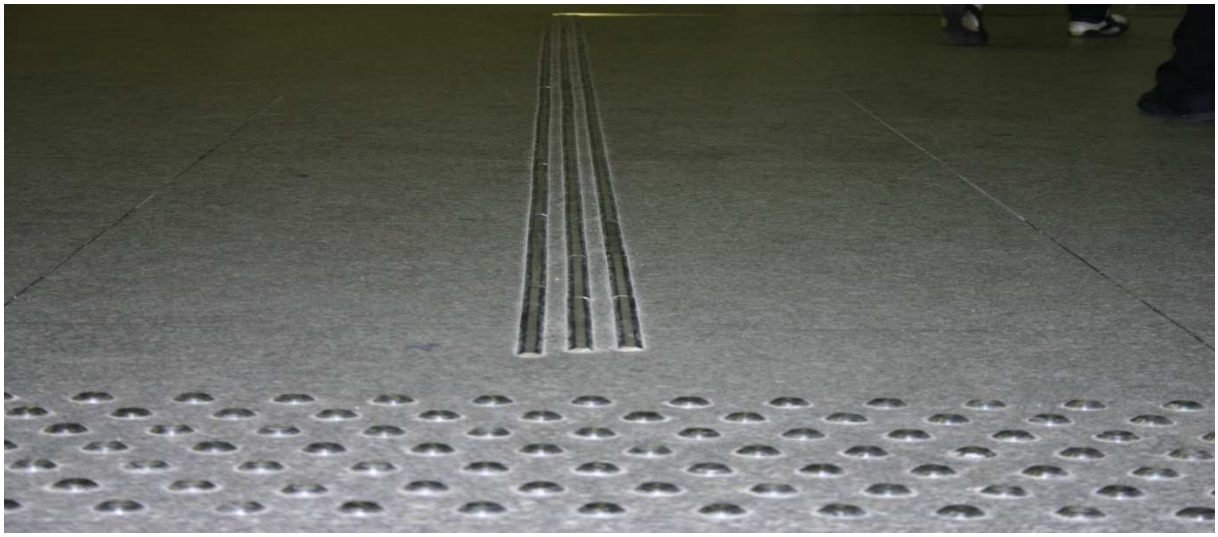


Fig. 3. Pattern of tactile path made of the flats with trapezoidal cross section
Rys. 3. Wzór ścieżki dotykowej wykonanej z płaskowników o przekroju trapezowym

The tests were conducted in the summer and lasted for five weeks. During a supervised exploitation of the signs the opinions were collected from:

- People who are blind and visually impaired, who in testing places gave their opinions on sensing by feet (in shoes with thick soles). Their opinions were related to the types of tactile elements and their placement relative to each other (pattern). During the study four groups of blind people were organized at the Warsaw Central Station and several meetings with blind individuals were performed on subway stations.
- People moving on wheelchairs (two meetings with users of wheelchairs - both manual and electric
- Elderly people who have difficulty in moving independently without the walking sticks or crutches (several meetings fruiting many opinions)
- Sighted and physically fit people of all ages

For all people a questionnaire was prepared with the following issues: sensibility of the tactile elements; their placement relative to each other and evaluation of the ease of walking on the elements. More than 200 interviews were conducted on various possible solutions. Thanks for providing monitoring provisions by the Warsaw Metro the passengers' behaviours were analyzed on the different sections of tested areas during different traffic intensities.

TEST RESULTS, EVALUATIONS AND ANALYSIS

Analysis of the collected test results, the observations and the interviews, on the background of the current rules allowed us to formulate the following requirements:

a) **Selection of the tactile elements from the set of tested solutions**

As the result of analysis of the information gathered, it was found that 69% of respondents have chosen the tactile elements in the form of a truncated cone (fig. 1b), and 31% indicated a better detection of a lens nodule (fig. 1a). In the group of blind people, 82% indicated the nodules in the form of truncated cones as better detected by the foot, as well as using a white walking stick, and 18% better recognized lenticular nodules.

With regard to the placement of nodules relative to each other, the vast majority of the

people participated in the test indicated a very good shape of nodules shown in Fig.2b. This solution also advocated disabled people moving in wheelchairs and with walking frames. Wheels of equipment used by these persons can move freely between the rows of nodules, which does not result in shock and does not interfere with the uniformity of driving.

b) **General requirements for tactile elements**

As the result of testing and observations, it was found that the solutions should be safe for all types of visitors, durable in use and perform the expected information functions (you can feel surface even in the winter footwear).The individual elements should not be slippery. At the same time they must be easy to keep clean. They cannot be flammable and cannot release toxic chemicals in contact with high temperatures, such as during fire. In addition, it should be easy to clean (the possibility of using chemical and mechanical cleaning method). The tactile elements should contrast with the surface of the platform. These requirements concern both the warning belts and tactile paths.

c) **Requirements for warning belts**

The warning belt should be placed along the edge of the underground platform, before the security zone, at the end of the platform, and in the distance of 0.6 m before the first ascending stair and 0.6 m before the first stair down. The warning belt width should be not less than 400 mm and not more than 600 mm. Consumption of the touch elements cannot cause a reduction in the height of the item less than 4 mm. In the case of the achievement of the nodules height limit, it is necessary to use appropriate techniques to adjust their desired size and the assumed information functions.

During operation, tactile signs should be illuminated with light of intensity min. 50 lux (an important condition for all passengers including visually impaired people.

d) **Expectations for tactile paths**

Tactile path should be an element of each passenger platform. It should be free from obstacles and possibly the shortest. It connects entrances and exits available for people with limited movement abilities with the platform. The minimum width of the tactile path should not be less than 330 mm. Each path should be terminated with the warning belt or an attention field. The dimensions are shown in Figure 4.

The attention field should be also located in those places where tactile path changes its direction. The height of the tactile elements should be within the range 4,0 - 5,0 mm.

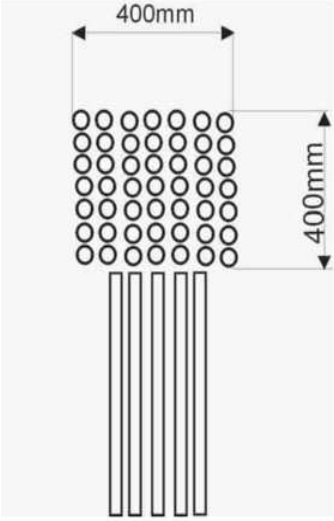


Fig. 4. Dimensions for an attention field of the tactile path
Rys. 4. Wymiary pola uwagi ścieżki dotykowej

e) **Indication of the danger zone on the platform**

A boarder of the danger zone of the Underground's passenger platforms extends the entire length of the platform, 0.65 m from the edge of the platform on the side of subway track. The edges of the platform should be highlighted with the visual warning signs (for the visual impaired people) and the tactile signs. The visual signs should contrast with the color of the floor surface. A first sign should be a continuous line of minimum 0.1 meters placed directly along the edge of the platform. Second sign should be0,05 m wide placed on

the entire length of the platform, in the distance of 0,6 m from the platform edge. The visual warning signs should be antiskid and contrast with the surface of the platform.

The warning belt should be placed outside the danger zone. Figure 5 shows the location of visual and tactile warning signs along the edge of the underground platform.

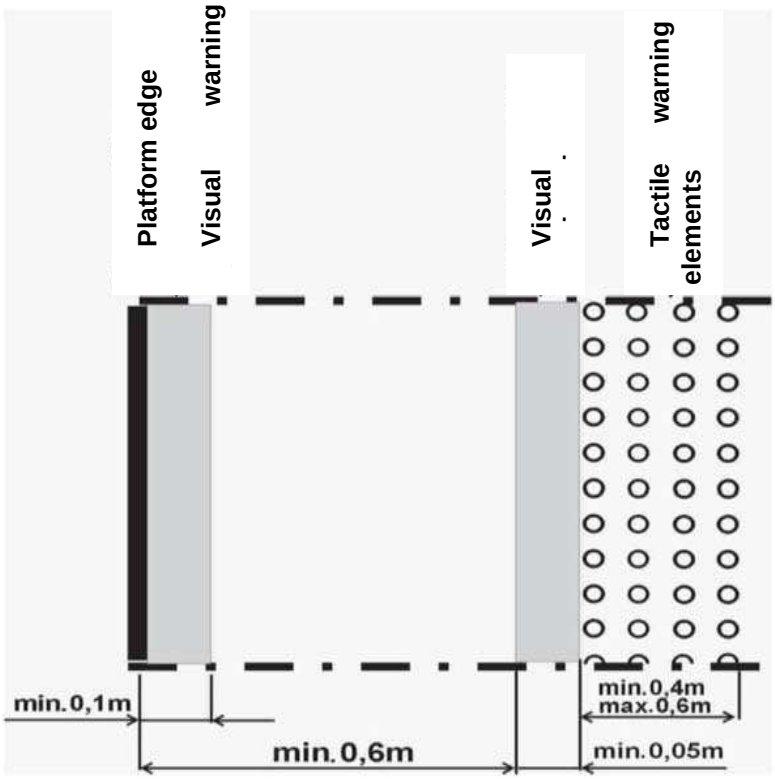


Fig. 5. Indication of the danger zone on the underground platform
Rys. 5. Oznakowanie strefy zagrożenia na peronie metra

IMPLEMENTATION AND OBTAINED RESULTS

As a result of the conducted researches with the participation of blind and visually impaired people, the tactile elements are chosen for implementation in the area of Warsaw Underground. They were carefully selected and parameterized. The relevant information in this field was given to the Ministry of Infrastructure, where work regarding the preparation about legislation on the technical infrastructure underground was conducted. An implementation of the research results was determined by the existence of a legal basis for labeling the danger zone with the visual and the tactile sign as well as highlighting the potentially dangerous places.

The visual and tactile singling is specified in a document defining the technical conditions which has to be met while building underground facilities [Regulation, 2011].

The legal law regulations allowed appropriate signaling of all platform edges of Warsaw Underground, as well as all other danger zones and places such as: the stairs or the ramps. Examples of the applied results of are shown in Figure 6.

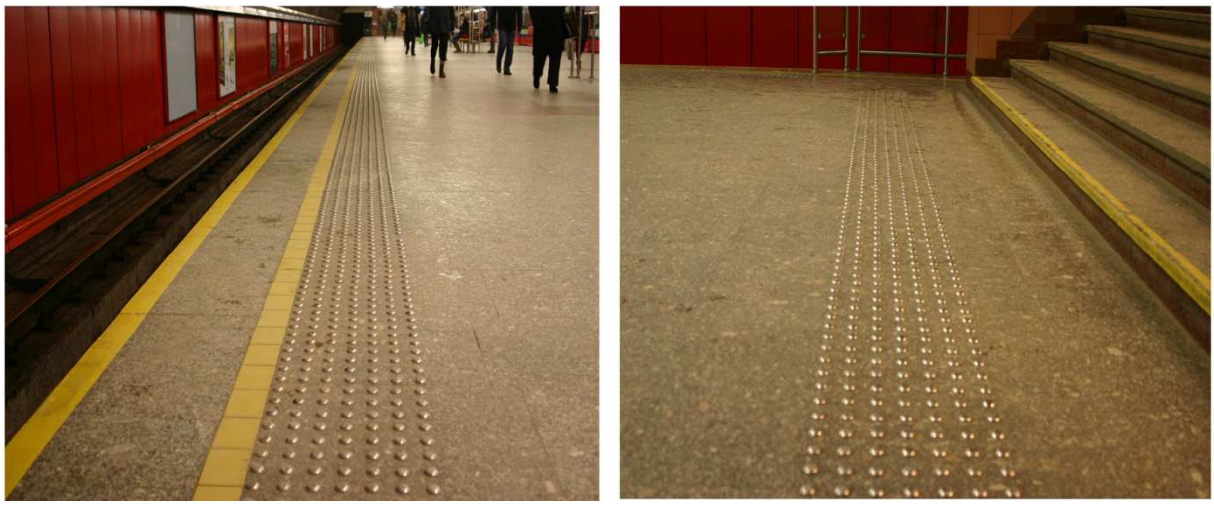


Fig. 6. The examples of the visual and tactile indication of the danger places for blind and visually impaired people of Warsaw Underground, a) on indication of platform edge, b) on indication of the stairs
Rys. 6. Przykłady oznakowania wizualnego I dotykowego niebezpiecznych miejsc dla osób niewidomych i słabowidzących w Metrze Warszawskim, a) oznaczenie krawędzi peronowej, b) oznaczenie schodów

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Rozporządzenie Ministra Infrastruktury z dnia 17 czerwca 2011 roku w sprawie warunków technicznych jakim powinny odpowiadać obiekty budowlane metra i ich usytuowanie. (Dz. U. 2011 nr 144, poz. 859) Regulation of the Minister of Infrastructure from 17th of June, 2011 on the technical conditions to be met by building underground facilities and their location.

WYBÓR I ZASTOSOWANIE ELEMENTÓW DOTYKOWYCH DLA OSÓB NIEWIDOMYCH W METRZE WARSZAWSKIM

STRESZCZENIE. **Wstęp.** Celem pracy było zaprojektowanie pasa ostrzegawczego dla osób niewidomych i zamieszczenie wymagań z tym związanych w dokumencie normatywnym.
Metoda: sondaż diagnostyczny z wykorzystaniem ankiet i wywiadów z osobami niepełnosprawnymi.
Wyniki i wnioski. W wyniku przeprowadzonych badań i udziału w nich osób niewidomych i słabowidzących, wybrano i sparametryzowano elementy dotykowe do stosowania na obiektach Metra Warszawskiego. Stosowne informacje z tego zakresu, którym powinny odpowiadać obiekty budowlane metra, znalazły się w rozporządzeniu ministra Infrastruktury.

Słowa kluczowe: peron metra, strefa zagrożenia, element dotykowy

DIE AUSWAHL UND DIE ANWENDUNG DER TAKTILEN ELEMENTE FÜR BLINDE MENSCHEN IN DER WARSCHAUER U-BAHN

ZUSAMMENFASSUNG. Einleitung: Ziel der vorliegenden Arbeit waren der Entwurf eines Blindenleitsystems und die Veröffentlichung der entsprechenden Erfordernisse im normativen Dokument.
Methode: Meinungsforschung mithilfe von Fragebögen und Interviews mit behinderten Menschen.
Ergebnisse und Schlussfolgerungen: Im Ergebnis der durchgeführten Studie und dank der Teilnahme der blinden und sehbehinderten Menschen wurden die taktilen Elemente zur Anwendung in den Anlagen der Warschauer Metro ausgewählt und parametrisiert. Die Zusammenstellung von Informationen zu diesem Thema, denen die Anlagen der Warschauer Metro entsprechen sollen, wurde in der Verordnung vom Minister für Infrastruktur erfasst. Im Hinblick darauf wurden alle U-Bahnsteigkanten der Warschauer Metro mit Leitsystemen ausgestattet.

Codewörter: U-Bahnsteig, Gefahrenzone, taktiles Element.

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