Joanna Gil-Mastalerczyk, Sylwia Mochocka, Małgorzata Wijas
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TRAFFIC ZONES ACCESSIBLE FOR ALL USERS. DESIGN SOLUTIONS AND MATERIAL RECOMMENDATIONS FOR OUTDOOR TRAFFIC ZONE PAVEMENTS

PRZESTRZEŃ KOMUNIKACJI DOSTĘPNA DLA WSZYSTKICH. ROZWIĄZANIA PROJEKTOWE I WYTYCZNE MATERIAŁOWE NAWIERZCHNI CIĄGÓW KOMUNIKACYJNYCH ZEWNĘTRZNYCH

Joanna Gil-Mastalerczyk, Sylwia Mochocka, Małgorzata Wijas*
Kielce University of Technology, Poland

Abstract

This article discusses the aspects of designing the pavements of pedestrian zones, shared spaces, city squares and other public spaces in terms of the selection of their parameters, colour and texture, which can significantly improve their comfort of use and, in a wider context, improve the accessibility of public spaces and buildings. When we think about a friendly city, we aim to create urban spaces free from any barriers that could exclude some people from the social life. Urban space can be defined as friendly from the perspective of an end user who moves around on foot, or uses crutches or a wheelchair, but also in the context of fully fit people, who are nevertheless limited in their movement because they are pushing a pram, carrying a baby or heavy luggage, etc. It has been proven that a well-designed pavement can significantly improve access to an area, reducing therefore the stigmatisation of elderly, disabled, blind, visually impaired people, etc. Solutions described in this article go well beyond the applicable legal acts in the context of the building law and therefore significantly improve the accessibility of public spaces and buildings and help to create spaces that are friendly to all users – i.e. spaces that are safe and free of any risks connected with disorientation, psychological security or the possibility of collision due to the existing barriers.

Keywords: universal design, accessibility, pavement, pedestrian zone, urban environment

Streszczenie

Artykuł porusza aspekt projektowania nawierzchni ciągów pieszych, pieszo-jezdnych, placów miejskich i innych przestrzeni publicznych pod kątem doboru ich parametrów, kolorystyki oraz faktury, które w znacznym stopniu poprawiają komfort ich użytkowania, a w szerszym kontekście, zwiększają dostępność przestrzeni i obiektów publicznych. Myśląc o mieście przyjaznym, należy wziąć za cel kształtowanie przestrzeni miejskich bez barier wykluczających z życia społecznego. Należy wspomnieć, iż o przyjaznej przestrzeni możemy mówić w kontekście bezpośredniego użytkownika poruszającego się przede wszystkim pieszo lub za pomocą kul i na wózku inwalidzkim, ale również osób w pełni sprawnych, lecz ograniczonych przez np. przemieszczanie się z wózkiem dziecięcym, dzieckiem na rękach czy ciężkim bagażem itp. Wykazano, że odpowiednio zaprojektowana nawierzchnia znacząco wpływa na dostępność przestrzeni, a tym samym na zmniejszenie wykluczania osób starszych, osób z niepełnosprawnościami, niewidomych, niedowidzących itp. Przedstawione w artykule rozwiązania szeroko wykraczają poza obowiązujące akty prawne w świetle prawa budowlanego, tym

*Kielce University of Technology, Poland, e-mail: wijasm@tu.kielce.pl

samym znacząco wpływają na dostępność przestrzeni i budynków publicznych oraz kreują przestrzeń przyjazną każdemu użytkownikowi, czyli bezpieczną i niestwarzającą zagrożeń związanych z dezorientacją, bezpieczeństwem psychicznym i ewentualnymi kontuzjami na skutek istniejących barier.

Słowa kluczowe: projektowanie uniwersalne, dostępność, nawierzchnia, ciąg pieszy, środowisko zurbanizowane

1. INTRODUCTION

Disability is a social problem. Global forecasts indicate that by 2050, the percentage of people over the age of 65 will rise to 22% of the whole population. According to the WHO, in Europe this percentage will even rise to 33% [1]. The composition of our population is changing, which is connected with the ageing of the society and with the noticeable increase in the disability of people as a result of illnesses and accidents. Some elderly people suffer from physical limitations and lower perception. Additionally, there is a significant number of younger people with congenital disability, or disability acquired as a result of accidents or illnesses. Their numbers continue to rise together with the progress of civilisation. The current level of medicine offers a better chance of survival and continuous functioning for patients who suffer from illnesses that were previously incurable. Similarly, more people with serious accident injuries can now be saved. The functioning of such people depends to a large extent on spatial and product-related solutions in the context of the built environment [2, 3]. Groups of people with mobility impairments (the users of wheelchairs and crutches) experience discomfort when the quality of pedestrian zones is not sufficient. But mobility impairments affect a much larger group of people, including groups particularly vulnerable, such as the blind and visually-impaired persons, the elderly, or fully fit people whose movement is limited because they are pushing a pram, carrying heavy luggage, etc [4]. Limited physical ability is a frequent problem among the elderly, but it can also be a temporary issue for many young people with temporary injuries. We must also take note of the fact that the carers or assistants of elderly and disabled people also have to overcome physical barriers that exist in the urban environment (pushing wheelchairs, prams, etc.).

The concept of universal design, which represents a product- and environment-related design philosophy, attempts to answer these challenges, but is still considered to be more of a line and method of thought than a method as such [5]. The concept of universal design was created by the American architect Ronald Mace (1941-1998) and initially only related to architectural design. As an architect who had been confined to a wheelchair since birth, Ronald Mace stated that: *'universal design is the designing of products and environment to be usable by everyone to the greatest possible extent, without the need of any modifications or individual design'* [6]. The concept of universal design sets out new ways of thinking. It is based on the principle of equality to a higher extent than the concept of ensuring general accessibility to people with mobility impairments, which means that any actions related to this concept will in essence cater to the needs of all users and will not require any special solutions. Designing is therefore understood as a common term that describes all actions connected with the shaping of the environment [7]. The concept of universal design is constantly evolving because of the growing needs of disabled, elderly people, etc. and because of their ever higher conscience and willingness to participate in all aspects of the social life. In view of the above information, all actions related to universal design and spatial accessibility are significant, because they lead to the creation of friendly spaces that encourage people to walk and by this minimise the effect of social exclusion due to problems such as personal disability [8]. Research has shown that one of the main factors that affect the mobility, and therefore the social activity, of particularly vulnerable/disabled people, is an inappropriately organised pedestrian zone, in terms of the type and quality of its pavement and the method of its construction. Problems most often arise due to incorrectly designed or built sidewalks (pedestrian zones, shared spaces), poor maintenance, the absence of a smooth transition between different types of pavement, or the omission of natural terrain properties in the design. Barriers that can be found in pedestrian zones include: ridges of the height of more than 2 cm, uneven pedestrian zone pavements covered by greengrowth, inadequate, inappropriately steep pedestrian sidewalk surfaces, as well as inappropriate arrangement of the elements of street furniture, e.g. benches, rubbish bins or lampposts – which can constitute movement-restricting barriers [9, 10].

2. AIM

The aim of this publication is to establish the guidelines for the design and construction of pedestrian (shared) zone pavements and for their connection with roads, in terms of solutions related

to the type of designed pavement – dedicated under the principles of universal design in order to improve the freedom and comfort of movement, thereby improving the accessibility of public spaces and buildings for people with mobility impairments.

3. LEGAL REGULATIONS

The aspect of accessibility of buildings and spaces in Poland is defined by the *Regulation of the Minister of Infrastructure on technical conditions to be fulfilled by buildings and their location* [11].

These regulations currently define elements such as:

- pedestrian and vehicle approaches to buildings, entrances (stairways, outdoor ramps, access ramps, entry doors to buildings, etc.) (Chapter 2 – pedestrian and vehicle approaches, § 16 – pedestrian approach for the disabled);
- stairs and access ramps (Chapter 4, § 71);
- solutions for parking spaces for the disabled – their dimensions and distances from entrances to buildings (Chapter 2 – car parks and garages, § 20 – parking spaces for the disabled);
- width of corridors, pedestrian zones, their forming methodology, etc. (Chapter 5. Rooms for human accommodation, § 73, § 74, Chapter 3. Entrances to buildings and apartments, § 61, § 62);
- sanitary rooms for disabled persons (Chapter 6, § 86).

Another applicable regulation is the *Regulation of the Minister of Infrastructure of 17 June 2011 on the technical conditions to be fulfilled by metro structures and their location*, which defines, among others, the accessibility of the area within metro structures [12].

Although the applicable regulations define the principles of designing elements such as pedestrian zones, in practice the compliance with their requirements is often not sufficient to fulfil the mobility requirements of disabled persons. Therefore many spaces and buildings become inaccessible for such users, including particularly vulnerable people. The above Regulations are complemented by the so-called accessibility Standards, which were drawn up in response to the growing needs of particularly vulnerable people, in order to ensure equal access to buildings and spaces for everyone. These standards are intended to improve the levels of accessibility. They take into consideration the needs of people with different types of disability, especially those with mobility impairments, blind and visually impaired persons, deaf and hard-of-hearing persons, people with intellectual disabilities, mental disorders or illnesses, or those with communication impairments. They constitute a set of guidelines for architects and designers that include agreements on the elimination of barriers and the implementation of means that provide better access to public spaces, especially for disabled persons. These standards cover the aspects of designing sidewalks, pedestrian crossings, mass transit stops, temporary traffic organisation during renovation works, parking spaces, recreational areas and universal information (pictograms, colour scheme, etc.).

The standards may apply to individual cities, or may refer to buildings of a specific function – most frequently they apply to public buildings (as defined in the technical conditions) and to public spaces [13].

Below is a description of solutions for elements of public spaces in the context of pedestrians, i.e. for pedestrian zones and shared spaces (sidewalks, city squares, pedestrian crossings, mass transit stops, parking spaces), with the emphasis on the selection of the type and technology of their pavement, which can significantly improve their accessibility and comfort of use. Information presented below exceeds the scope of the Technical Conditions and concentrates mainly on the Standards of Accessibility of Public Spaces for Disabled Persons for the city of Kielce and on the authors' experience and research in the context of the accessibility of public spaces [14].

4. PEDESTRIAN SPACE – ANALYSIS

The aspect of accessibility of pedestrian space has been analyzed in terms of:

- selection of pedestrian route parameters (width of the string and buffer, location of accompanying elements and elimination of obstacles and barriers in space);
- selection of surface colours;
- selection of surface materials;
- organization of parking spaces;
- selection of lighting;
- overcoming terrain differences (elimination of thresholds, terrain stairs and ramps).

4.1. Pedestrian zones

A safe and obstacle-free pedestrian traffic gauge should be established in a clear and legible way, with particular emphasis on the needs of visually impaired people. The width of a pedestrian zone should be established on the basis of an analysis of the current and forecast traffic density patterns. The width necessary for two wheelchairs to pass each other should be taken into account. Technical conditions stipulate that approaches to buildings should be at least 1.5 m wide,

whereas the width necessary for two wheelchairs to pass each other is 1.8 m (the Standards recommend 2 m). Due to the tendency of pedestrians to maintain a certain distance from obstacles or from the carriageway, a pedestrian zone should include a so-called buffer zone, representing an extension of the sidewalk in the form of an additional safety zone, which will inform the pedestrians that they are crossing the border of the safe zone via a different pavement texture and colour than for the pedestrian zone. The width of the buffer zone must ensure a safe distance from all obstacles, but should also allow a blind person to touch the walls of buildings situated along the pedestrian zone with a cane. For example, the width of the buffer zone alongside a building's wall is 30-70 cm, whereas alongside the edge of a carriageway or a bike path it is 50 cm (Fig. 1).

Fig. 1. An example of a correctly implemented path on both sides of a pedestrian zone. Spain. Photo: W. Tracz

It is especially important to eliminate technical, visual obstacles, barriers and physical obstacles from the pedestrian zones that reduce the minimum width of the pedestrian zone, such as:

– elements of street furniture (benches, rubbish bins, information boards, bike racks, road signs, posts, etc.) and temporary street elements (tables, chairs, stands, booths, exhibition elements), which must not reduce the minimum width of a pedestrian zone (2 m) – it is recommended to situate them for example in the greenery belt or in the buffer zone (Fig. 2);

Fig. 2. Shared zone. The arrangement of street furniture (lighting, rubbish bins, tables) in a way that does not reduce the minimum width of pedestrian traffic space. Spain. Photo: W. Tracz

– drainage gullies and drainage gutters – which can trap a blind person's cane or the wheel of a wheelchair, or crutches (Fig. 3) – if it is necessary to situate these within a pedestrian zone or a public square, it is recommended to ensure that they are flush with the pavement (in the case of gullies), or to apply the principles of implementing ridges and the mutual connection of different materials (Fig. 4).

Fig. 3. Obstacle in the form of a drainage gutter installed below the pavement level, thus creating a ridge. Kielce. Photo: M. Wijas

Fig. 4. A correct solution of a drainage gutter, which has been installed flush with the pavement of a shared zone. Photo: M. Wijas

One of the important factors which define the safety of moving within a pedestrian zone is the drainage of storm water, which in effect reduces the risk of slipping on a wet or icy surface. Such comfort is ensured using an appropriate cross slope. According to the Regulation of the Minister, the value of the cross slope of a pedestrian zone should be between 1-3%. Whereas according to the Standards, this slope should be lower than 2%, because a higher slope means more force is needed to move a person on a wheelchair, or prevents the movement along such a zone without the help of other persons [15].

4.2. Pavement colour and contrast

An important aspect of universal design in the context of designing urban areas is the choice of colour and contrast. Very dark colours used next to each other, on similar surfaces with a similar texture, may become indistinguishable. Very bright, pastel colours used in such conditions will be blurred. We must be aware that visually-impaired and intellectually disabled people pay attention mostly to colour contrasts, while blind people to texture contrasts. According to British standards, colour contrasts are calculated on the basis of the light reflectance value (LRV). The difference in contrasts of less than 30 on the LRV scale does not generate sufficient visual information. The recommended contrast for safety marking is 70%. Ophthalmologic tests have clearly shown that the last colour seen by a human eye that is losing sight is yellow. On one hand, the colours and textures of routes should be variable (the use of different combinations of pavement types and colours on pedestrian pavements to emphasise the main directions of movement and to demarcate different functional areas), but using too much contrast must not create an impression of a difference in levels. The use of different colours and suitable colour contrast levels not only provides adequate spatial perception, but also serves to indicate risks present in this space, e.g. yellow colour of pavement next to pedestrian crossings, yellow marking of steps in the case of stairs (Fig. 5) and the edge of a railway platform (Figs. 6, 7) and a bus stop (Fig. 8), the use of different colours for sidewalks and bicycle paths, or increasingly frequent marking of pedestrian crossings with a distinctive and strongly contrasting red colour (Fig. 9).

Fig. 5. An example of the correct yellow marking of staircase steps. Bus terminal. Kielce. Photo: M. Wijas

Fig. 6. The correct use of variable pavement textures and colours at a metro station. Milan, Italy. Photo: M. Wijas

Fig. 7. The correct use of variable pavement textures and colours at a transport hub, Wrocław, source: https://www.bryla.pl/bryla/1,85301,12275613,Przystanek_we_Wroclawiu__Rzezba_z_betonu__ktora_zachwycila.html

Fig. 8. The correct use of tactile pavement at a bus stop. Opole. Photo: S. Mochocka

Fig. 9 The correct use of contrasting pavement colours in the location of a pedestrian crossing. Kielce. Photo: M. Wijas

4.3. Materials

The pavements of pedestrian zones must be made of elements that ensure a hard and even surface that is comfortable not only for people in wheelchairs, but also for prams or women in heels. The pavement must maintain its properties throughout a long operating period, in variable weather conditions and must be resistant to mechanical and chemical wear (e.g. during the removal of snow or due to sprinkling with salt). Materials classified as adequate for pedestrian zones include:

– large concrete or stone slabs;
– non-chamfered concrete setts;
– asphalt, or stabilised stone dust in more natural spaces;
– tartan track or fluted panels.

The pavement of a pedestrian zone should minimise the possibility of slipping. The slip resistance of setts, concrete and stone slabs is selected on the basis of applicable standards. In locations where the intensity of pedestrian traffic makes it difficult for blind people to receive stimuli, i.e. near bus stops, in the area of intersections, pedestrian crossings or approaches to buildings, it is recommended to install tactile walking surface indicators (TWSIs) and to design tactile pavement paths, which are intended to help blind people with their orientation and to show them the direction of movement. This system should be also installed in areas without any natural navigation elements, such as: large squares, wide pedestrian zones, or other areas which require more attention from pedestrians, such as the discontinuation of protruding kerbs, in order to act as the replacement of the kerb.

The TWSI system consists of the following tactile tile types:

– directional tiles (TWSI – type A) – used to create paths that guide users along a certain route (Fig. 10);
– attention tiles (TWSI – type C) – so-called indication tiles, which are installed at the bends of a tactile path, in places where the path branches out, or before the path's end points (Fig. 11);
– warning tiles (TWSI – type B) – installed in the form of warning strips that contrast with the pavement and are installed flush with the pavement, these are used in front of pedestrian crossings, approaches to and exits from stairs, in front of surfaces with an inclination of >3%, in front of entrances to buildings, at rail platforms and bus stops and to inform the users that they are approaching an entrance to a building or a hazardous zone (e.g. an edge between a carriageway and a sidewalk) (Fig. 12).

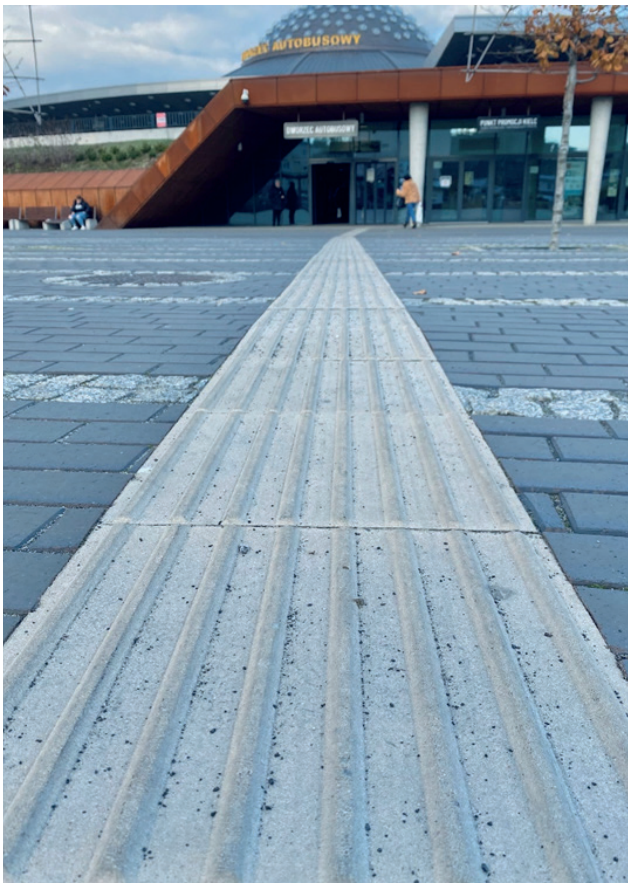

Fig. 10. Tactile path (directional tiles) leading to a railway station entry door. Kielce. Photo: M. Wijas

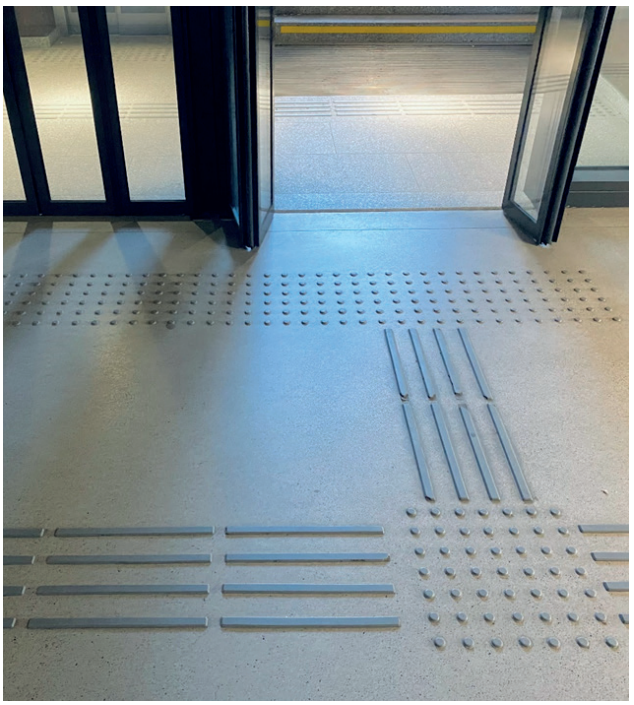

Fig. 11. Tactile path. Bus terminal in Kielce. Photo: M. Wijas

Fig. 12. Tactile pavement in a hazard zone (along the carriageway edge). A correct, ridge-less connection between different pavement textures. Kielce. Photo: M. Wijas

The optimum materials to be used for tactile pavement are:
- concrete and its derivatives;
- resin – considered by blind people to be the best solution, because of material differences and its high contrast with other pedestrian zone elements, as well as high anti-slip properties.

4.4. Parking spaces

Parking spaces for the disabled are one of the elements that help to improve the accessibility of public spaces and are fundamentally connected with pedestrian traffic. Apart from issues defined by technical conditions, such as their sufficient quantity, dimensions and their proximity to buildings, of significance is also their direct and appropriate connection with pedestrian zones and the suitable choice of their pavement in order to improve their comfort of use.

When designing parking spaces for the disabled, it is recommended to use an even, smooth, hard and uniform asphalt concrete or cement pavement (or possibly non-chamfered setts), in order to avoid the entrapment of crutches in openwork elements and to minimise the amount of force needed to move a wheelchair over an irregular surface (Figs. 13, 14). Stone paving setts can be used in the vicinity of historic buildings (it is recommended to use cut stone setts, which allow the construction of the smoothest and grout-free pavements). The use of unpaved surfaces is acceptable only in the case of parking spaces located within protected areas, but it is recommended to stabilise them or to strengthen them using geogrids with a cell size of less than 2 cm.

Fig. 13. Unsuitable pavement and incorrect marking of a parking space for disabled persons. Kielce. Photo: M. Wijas

Fig. 14. An example of the correct marking of a parking space for disabled persons. Ridge-less connection with the carriageway and sidewalk via a 2 cm ridge. Appropriate pavement colour and type. Kielce. Photo: M. Wijas

4.5. Illumination

The illumination of pedestrian zones significantly improves the safety of pedestrians after dark, or in difficult weather conditions. When designing the illumination of pedestrian zones, special attention must be given to light sources located below the line of sight (0-1.2 m). These elements should be installed in a way that prevents the blinding of the users, which can be achieved for example by using directional lamps. When using pavement lights installed in the sidewalk or in the floor, it is recommended to use lights with anti-slip properties and to install the lamps flush with the floor.

4.6. Outdoor stairs and ramps

Stairs are an integral element of pedestrian zones and undoubtedly present an obstacle in an area characterised by variable terrain levels. Beside ramps, they are one of the elements of the built environment that help pedestrians to scale the differences in terrain. The dimensions of stairs are defined in the Technical Conditions (Chapter 4. Stairs and Ramps). There are however many more improvements that enable appropriate spatial perception of stairs and therefore a higher comfort of using them. One of these solutions is to use a different pavement type or colour, by using contrasting marking along the entire length of the first and last step of each flight of stairs, or to use a suitable step profile to prevent pedestrians from tripping when going up, or from catching the stair edge with the back of their shoe when descending. Using single steps in urban spaces is especially dangerous, because they are difficult to notice and to detect, especially by blind or visually impaired people. Ramps are a universal solution that can be used to scale the differences in terrain, as they are useful to wheelchair users, mothers with prams, cyclists, as well as fully fit people. The gradient, as well as other parameters related to ramp design, are described in the Technical Conditions (Chapter 4. Stairs and Ramps). In practice, however, it has turned out that even the lowest recommended gradient of 6% is difficult to scale for some people, therefore it is recommended to choose the lowest possible gradient in each situation. The available ramp should: be provided with a manoeuvring area at the entrance to and at the exit from the ramp, as well as an anti-slip surface, a 50 cm wide yellow-coloured warning strip at the beginning and at the end of the ramp across its entire width, should not have a cross slope and should be equipped with appropriate hand grips and guardrails.

4.7. Ridges

Ridges are one of the main obstacles encountered by all people moving across urban spaces, especially by people in wheelchairs, on crutches, etc. The presence of ridges is a result of the incorrect connection of different types of pavement (Fig. 15) (at the point of connection of the sidewalk and the carriageway, bicycle path, at the point of connection of the carriageway and the sidewalk at pedestrian crossings (Figs. 16, 17), but also as a result of the installation of drainage gutters and of the destabilisation of pavement with time (Fig. 18). As a result, pedestrian zones, city squares and other public areas become inaccessible to elderly and disabled people without the assistance of other persons. The maximum allowable ridge height is 2 cm and if the difference in levels is higher, the ridge has to be replaced with

a slope of the maximum inclination of 1:12. In the case of a ridge of the height of less than 1 cm, it will be rounded or bevelled with a gradient of 1:1, whereas the height of 1-2 cm will be replaced with a wedge of the gradient of 1:2 (Fig. 19). However, the best solution seems to be the complete elimination of all ridges (Figs. 20-23).

Fig. 15. An incorrect transition between a carriageway and a sidewalk at the location of a pedestrian crossing. Opole. Photo: M. Wijas.

Fig. 16. An incorrect transition between a carriageway and a sidewalk at the location of a pedestrian crossing. Opole. Photo: M. Wijas

Fig. 17. An incorrect transition between a carriageway and a sidewalk. Obstacle in the form of a ridge of the height of more than 2 cm. Opole. Photo: M. Wijas

Fig. 18. A barrier in the form of deformed sidewalk pavement. Opole. Photo: S. Mochocka

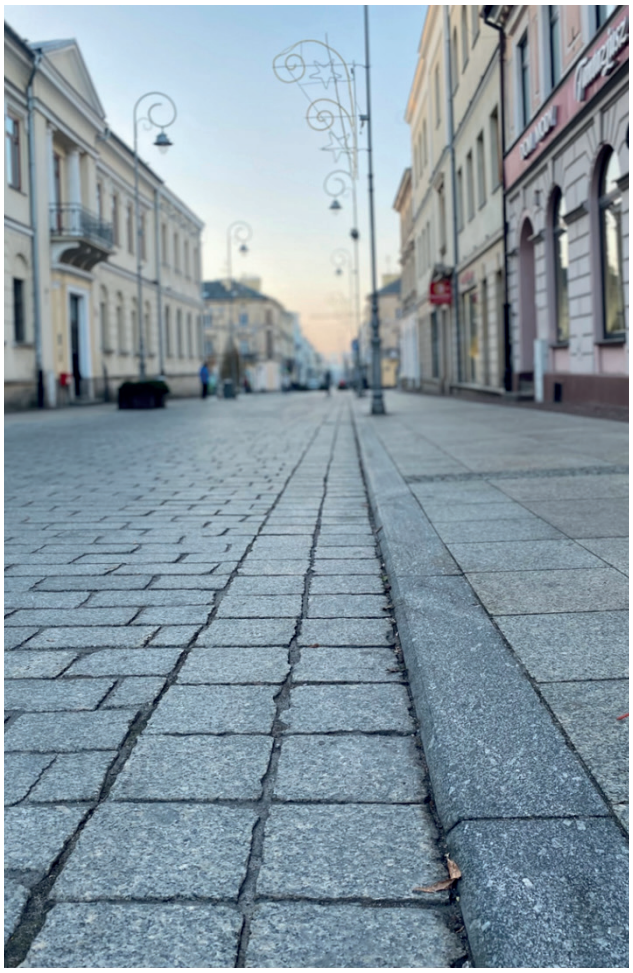

Fig. 19. An acceptable transition between a shared zone and a sidewalk using a 2 cm high wedge. Sienkiewicza Street in Kielce. Photo: M. Wijas

Fig. 20. A ridge-less connection of different pavements that constitute the Porta Nuova square in Milan, Italy. Photo: M. Wijas

Fig. 21. A ridge-less connection of different pavements that constitute the Porta Magenta square in Milan, Italy. Photo: M. Wijas

Fig. 22. An example of the correct transition between pavement types at the approach to building and the correct installation of an outdoor entrance doormat flush with the sidewalk surface. Opole. Toyota Park. Photo: M. Wijas

Fig. 23. A correctly installed door sill at the entrance to a shopping mall. Opole. Photo: M. Wijas

5. SUMMARY

Public spaces, in accordance with the requirements of sustainable development and universal design, should be accessible to all residents, irrespective of their level of mobility or perception. Self-reliance is very important in the context of the development of social integration of elderly and disabled people. Such people stress out the importance of safety in the context of using public spaces. The urban landscape is suitable mainly for people without visual impairments – we receive 86% of all information via visual perception. Solutions related to pedestrian zones, city squares, public spaces presented in this article in the context of texture, colour and construction, significantly affect the accessibility of public spaces and buildings and help to create spaces that are friendly to all users. Suitable design and technological solutions help to eliminate spatial barriers and provide comfort to those with wheelchairs, crutches, prams, heavy luggage, etc. The use of appropriate pavement texture and colour can consciously 'guide' users with perception disorders. Solutions related to pavements presented in this article go beyond the applicable standards and provide user comfort and safety, and in a wider context improve the accessibility of public spaces and buildings.

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