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Accessibility of bus stops - a problem with platform width

Abstract: The article is devoted to the problem of accessibility of bus stop platforms for the disabled. The author analyzes the current legal status - the applicable regulations regarding the minimum length, width and height of the platform, as well as the implementation practices which they compare with the needs of people in wheelchairs and scooters. They demonstrate and justifi es the need to make corrections to the above mentioned legal provisions or interpretations - making platforms in the proposed variant.

Keywords: Roads; Bus-stops; Disabled

Introduction

The stop platform is a key element of the public transport infrastructure. It is just as much a vehicle that is responsible for the transport of people. However, often at less important stops (with a small number of lines and low passenger attendance), for economic reasons, the platform is sometimes made in a minimalist version - with parameters permitted in the legal provisions, but which may make it difficult for people using wheelchairs and scooters to use them.

Regulations and practice

Basic parameters which should be characterized by a bus stop platform are given in [3]. As for the needs of wheelchair passengers, these are:

- minimum platform length (stop edge),
- minimum platform width.

Moreover, a very important, although not mentioned in [3] is:

- platform height.

The **minimum platform length** requirement - 20 m accorsding to [3] is correlated with the maximum length of buses used in Poland – 18 m [6, 8], in such a way as to enable the driver to stop with the entire length of the vehicle (even the longest one in a straight line) parallel to the edge of the platform and to exchange passengers with all doors. While keeping the side mirror in view of all doors and passengers. Such arrangement of the vehicle also increases the safety of passengers while boarding or alighting and minimizes the width of the gap between the threshold of the vehicle door and the edge of the platform. A gap that is too wide can cause passengers' legs, wheels of wheelchairs as well as crutches and white canes of blind and partially sighted people to fall into it.

However, in the case of stops located in bays, the possibility of the driver placing the entire vehicle along the platform determines the shape of the entry and exit from the bay. Provision of easier maneuvers in the bay requires the implementation of bay slopes - entry

and exit, in accordance with [3] in the following proportions: 1: 8 (entry) and 1: 4 (exit) or "milder". Making "sharper" slants forces the drivers to make larger turns of the steering wheel (which drivers do not like), and also causes the bus body to protrude excessively beyond the wheel line. If the distance is incorrectly assessed, it may result in the wheels hitting the curb and cutting the tires. And in the case of excessive passenger load and uneven surface of the bay, lead to the body lump hitting the curb (Fig. **1**). A vehicle hitting the curb is also not indifferent to the curb, they cause its chipping, bending as well as breaking off and deforming the surface of the platform and the bay (Fig. **2**) [2].

1. The damaged lower part of the bus chassis body from hitting the edges of the platforms

2. Damage to the bay and the stop platform caused by vehicle impacts - abrasions and chipping of the curb and destruction of a too "sharp" entry slope of the bay

An improperly shaped bay means that drivers prefer not to risk driving close to the platform and stop at a certain distance from it, or approach the platform, but only with a part of the vehicle, e.g. through the first door.

Correct execution of the bay slants also affects the efficiency of the special stop/platform curb that has been used for several years as the edge of the platform [7]. Its appropriate profiling - the vertical part connected with the extended horizontal part and the rounded connection - makes the wheel already on the extended horizontal part when the bus rolls up before the wheel hits the vertical part, so it holds the curb at the moment of impact and the curb does not warp. Possible driving of the wheel along the rounded joint and then sliding back to the protruding horizontal part and rolling parallel along the edge of the platform does not result in cutting the tire, because the upper edge of the curb is also rounded (Fig. **3**).

The effectiveness of this curb depends on the vehicle's approach angle - the contact between the curb and the wheel, which must be minimal. And this can only be ensured by correct slopes of the bay, or not making the bay at all (bus stop in the lane).

3. Platform curb with the lower part protruding towards the road and a rounded connection with the vertical part and a rounded upper edge, which makes it easier for the vehicle to drive up to the platform without deteriorating the technical condition of the vehicle and the curb

The minimum platform width of 150 cm is sufficient for "walking" people. It allows you to move freely on the platform, pass each other in opposite directions, enter or exit the vehicle, even pass a person in a wheelchair or a pram. This width also allows two people in wheelchairs to pass each other, but they must be narrow (so-called "active") because the others require a larger platform width - at least 180 cm [11]). At the bus stop, a person in a wheelchair not only moves straight ahead, but also enters or leaves the vehicle, and sometimes approaches the driver's cab. This requires maneuvering - turning the wheelchair in place by 90 °, 180 °, or even 360 ° in an unbuilt space (a circle inscribed in a square). A 150 cm wide platform such space (i.e. a circle with a radius of 150 cm inscribed in a square with

sides of 150 x 150 cm) provides, but only at a minimum level of freedom, to maneuver a wheelchair with electric and manual drive - the so-called "Active". Other types of handcarts already require a platform with a width (and space) of 160 cm, and if you want to do it in a more comfortable way - with less risk of sliding off the platform onto the lawn, rubbing against a standing bus, or falling into the bay - even 210 cm. And if you take into account the increasingly popular electric scooters, it is even 250 cm (minimum width is 210 cm) [5].

One should also mention a new and more and more popular type of wheelchair - a handcart with the so-called "Extra bed" in the form of a single driving wheel. Previously, it was a wheel driven manually by a person sitting in a wheelchair, now the electric drive is becoming more and more popular. There are no data on the turning radius of such a system, but it can be estimated that it is close to the turning radius of an electric scooter.

The minimum platform width given in [3] is understood as the overall width, which also takes into account the possible arrangement of a shelter (for a stop without a bay). On the other hand, the actual width of the platform is often smaller.

The downtown, compact character of the buildings and the increasingly higher standard of equipment of modern stops often force the set of elements that narrow the platform locally. Apart from infrastructure elements, such as lamp posts and electric traction of trams and trolleybuses, electrical boxes and elements of traffic organization and safety, e.g. bollards preventing incorrect parking, fencing, etc., equipment elements such as: benches, sheds, litter bins, sand, and salt, ticket machines.

The problem of narrowing down stops has been noticed and taken into account in detailed studies on providing disabled people with accessible public space. For example, in [11] there is an absolute necessity to maintain the minimum width of bus platforms - 150 cm, understood as the actual width, which cannot be reduced by infrastructure elements and greenery. Moreover, in [11] attention was drawn to the nuisance caused by placing the mentioned elements at stops in a sensitive place, which is the so-called Wait field. It is a designated place on the platform and marked with a textured surface, where, for example, the blind, partially sighted, in wheelchairs and with prams should be present when a vehicle enters the stop. And the driver should stop the vehicle so that there is a second door at the Waiting Field. In this place, after stopping the vehicle, if necessary, the ramp is folded out of the vehicle, so not only should it not be built up, but also access to it should be secured

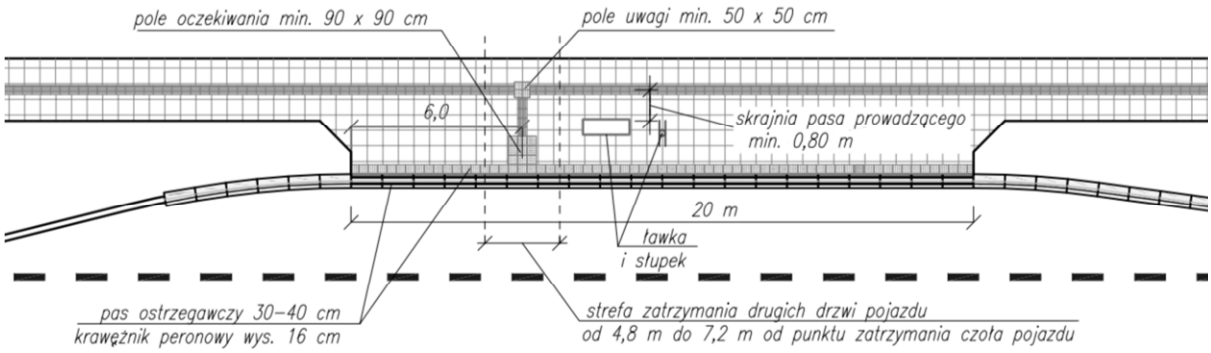
Access is understood as the space directly adjacent to the Waiting Field (including the Waiting Field), where there should also be no elements narrowing the platform and interfering with the performance of maneuvers in front of the unfolded ramp. In [11] it is described as "the stop zone of the second vehicle door". Its length and width have been determined: 240 cm x 250 cm (it should be emphasized that the required width is greater than the minimum width of 150 cm – Fig. **4**).

The requirement for wheelchair users to use the bus's second door is not accidental. Behind them, inside the vehicle, there is a larger space with no seats and a so-called "Ironing board" with seat belts, used for safe travel of these people. This space can also be used by passengers with larger luggage, shopping carts, prams, or bicycles. Only in these doors, a folding ramp is placed on the floor, used for wheelchair entry and exit.

When the entrance or exit of a passenger to or from the vehicle requires the ramp to be deployed, the width of the platform in front of the ramp is reduced by the length of the unfolded ramp. Depending on the manufacturer, the length of the ramp may slightly differ, but for example for the Solaris Urbino 18 bus, which is very popular in Poland, it is 90 cm.

So theoretically, if the ramp was unfolded in the most unfavorable case - that is, horizontally (which can only be achieved with the height of the platform equal to the height of the vehicle floor - 32 cm), the width of the platform left in front of the ramp would be only 60 cm (150-90). As in Poland, due to regulations, the platforms are much lower, so the width

occupied by the ramp is also smaller - however, the unfolded ramp always limits the actual width of the platform (Fig **5**).



4. Scheme of rules for determining the Waiting Fields and the space free from obstacles at bus stops (stop zone of the second vehicle door) providing access and maneuvering to people in wheelchairs [7]

5. The range of the bus ramp depends on the difference in levels (heights) between the vehicle floor and the platform - the greater the height difference, the greater the angle of the ramp and the greater the difficulty of entering or exiting with a wheelchair, but the less "covering" of the pavement

For this reason, at stops with a minimum width of platforms, the ramps are often not folded out. A wheelchair user can enter or exit the bus only while "kneeling", with the possible help of a driver or assistant or fellow passengers. This is relatively easy with handcarts. The problem is the displacement of the electric wheelchair, which almost always needs a ramp. Then it is necessary to maneuver the trolley in front of the ramp on a narrow width, sometimes using the area adjacent to the platform and even driving partially over the side edge of the ramp. However, it is not always possible to use the adjacent area (Fig. **6**). On the other hand, entering the side of the ramp may result in loss of balance and a person in a wheelchair falling or breaking the ramp's fastening.

Drivers' response to minimize the “taking over” of the platform width could be to stop the bus at a certain distance from the platform so that the ramp is folded over the road and not on the platform. However, not all drivers, seeing a person in a wheelchair, would be able to judge the width and height of the platform and the required distance required from it quickly

enough. And what about other passengers using the other doors, who would have to move between the platform and the door on the road? Unacceptable solution.

6. A stop platform with a minimum width (150 cm), located on a slope with a safety railing that prevents a person on a wheelchair from using the adjacent area

The height of the stop platform in [3] it is not strictly defined. However, it was customary to assume the height as for the sidewalk located by the road, i.e. in the range of 6 ÷ 16 cm, and only in engineering structures according to [4] more - up to 18 cm.

The floor height of the above-mentioned Solaris Urbino 18 bus is 32 cm. Taking into account the so-called “kneeling”, that is the side tilt performed by the vehicle (for Solaris Urbino 18 it is theoretically 7 cm), the floor actually lowers to a height of 25 cm (32-7) [8]. Theoretically, that is, under the condition of full technical efficiency of the vehicle, which allows you to perform and maintain the "kneeling" in the maximum size, which, unfortunately, does not always occur.

Comparing the above heights, it can be seen that in both cases the curbs currently being made (and platform levels) are much lower by approx. 7 ÷ 9 cm than the floor of the exemplary bus (technically fully functional and performing a "kneeling").

From the point of view of wheelchair passengers, the ideal would be if the platform level was almost flush with the bus floor, with a possible deviation of approx. 2 cm in favor of the vehicle floor, which would take into account the excessive load of the vehicle with passengers, under-inflation of the wheels, tire wear and the thickness of the unfolded ramp. This would allow one to become independent from the always uncertain "kneeling". In this case, the height of the platform should be 30 cm (32-2).

The height of 23 cm (32-2-7) could also be satisfactory, which would equate the level of the platform with the floor of the bus performing a full "kneeling". An incomplete

"kneeling" must be "compensated" by the independent effort of the "wheelchair user" or with the help of a driver, assistant, or other people and unfolding the ramp.

Unfolding the ramp from the vehicle extends the overall journey time. Since this is the task of the vehicle driver, it requires at least two times out of the cabin. It is not recommended that assistants or co-passengers unfold the hand ramps placed on the floor faster, as they are often damaged in such cases.

Contrary to popular belief, unfolding the ramp is not a particularly burdensome activity that drivers do not want to perform, on the contrary. In private conversations, they emphasize that this is an additional opportunity to break away from the steering wheel for a moment and "stretch your bones".

At present, it can be concluded that the parameters of the bus platform adopted in [3] in terms of the minimum width and maximum height, concerning the possibility of using them by people in wheelchairs and scooters, are insufficient and require corrective changes. The proposed solutions are discussed further.

Optimum platform width

The following questions should be answered to ensure comfortable access by trolleys and scooters from the platform to the bus:

- Should the platform be adapted to be used by people on wheelchairs who move independently or with the help of a guardian, assistant, or driver, or also on scooters and wheelchairs with "extra beds"?

If the answer in the affirmative applies only to handcarts, assuming possible assistance in entering or exiting without a ramp or maneuvers in front of the ramp, a difference of several centimeters in height between the vehicle floor and the platform is not a problem, and the minimum width of the platform, i.e. 150 cm, is sufficient.

However, if we adopt the currently applied rule, i.e. as much independence as possible for disabled people, and assume that people in manual wheelchairs have to get to the vehicles on the ramp on their own (without the physical help of an assistant or driver) and we take into account people on electric wheelchairs, scooters, and wheelchairs with "extra beds", which use the ramp almost always, the width of the platform should be increased.

Taking into account the maximum unfavorable length of the bus ramp (e.g. in the case of Solaris Urbino 18 of 90 cm) and the minimum or comfortable maneuvering space in front of the ramp (at a rotation angle of 0 ° ÷ 360 °) intended for trolleys (160 x 160 cm or 210 x 210 cm, respectively)) and for scooters and prams with "extra beds" (210 x 210 cm or 250 x 250 cm respectively), the width of the platform should be concerning:

- manual and electric trolleys: minimum 90 + 160 = 250 cm and comfortably 90 + 210 = 300 cm,
- scooters and prams with "extra beds", minimum 90 + 210 = 300 cm and comfortable 90 + 250 = 340 cm.

The above values can be verified or reduced. The variable in these equations is the value of the ramp length, which in fact decreases when it is laid out on the platform. The reduction is influenced by the difference between the height of the platform and the height of the vehicle floor, taking into account the height of the "kneeling" as well as the average filling of the vehicle and its technical condition (approx. 2 cm). In the case of diversified rolling stock, the calculations should take into account the above-mentioned parameters of all vehicles.

- Should the platform of each stop be widened to allow for independent entry by all "vehicles" of the disabled - manual and electric wheelchairs, scooters, and wheelchairs with "extra beds"?

This question should be asked in light of the principle of rationalizing the route of public transport, e.g. in Warsaw, which currently prevails in public transport in larger cities. It consists of prioritizing the modes of transport in the general public transport system, which gives rail transport (SKM, metro, tram) a superior function, and a supplementary bus communication - whose task is only to bring passengers to railway stations or stops [1]. The supplementary function determines the area from which the bus should deliver passengers. The radius of this area should be several to several kilometers from individual stations or "rail" stops. Hence, unlike rail vehicles, buses are vehicles with less spacious interiors, in which it is difficult to place larger-sized trolleys, and even more so, scooters.

You should pay attention to the possible driving ranges of electric trolleys, scooters, and "extra beds". They depend on the capacity of their batteries and can range from 25 km [9] to even 55 km [10]. Therefore, they make it possible to overcome the distance to stations or "rail" stops on their own, without taking the bus, and therefore not everywhere and not always getting to these stations and stops must require the use of the bus by these people. You can risk introducing an acceptable distance from the rail communication stop, at which bus communication does not have to provide these people with access. Then the stops and platforms will not have to be adjusted (enlarged) for them. The disadvantage of the following decision is the need for these people to walk long distances on the sidewalks or on the road - where they are not and in different weather conditions.

This rule may not apply in areas where there is no access to rail transport and therefore the only available means of communication is a bus, and where rail stations and stops, as well as rail vehicles, are not yet adapted.

- Does the extension of the platform have to cover the entire length of the platform or can it be limited to a specific section only?

Building a platform with increased width along its entire length makes sense if maneuvers justifying this expansion take place along the entire length of the platform. On the other hand, it is more rational to have an intermediate solution, i.e. to make a platform with a variable width - increased only on the front part of the platform (near the first and second doors), and on the remaining part, to maintain a minimum width (150 cm) ensuring, first of all, straight passage. The enlargement should take into account the adopted principle of transporting various types of prams and scooters as well as the level of freedom of maneuvering - minimal or comfortable. For example, in the case of allowing scooters and "extra beds", the platform width of 210 cm can be taken as a combination of different levels of freedom: for wheelchairs - comfortable, scooters and "extra beds" - minimum.

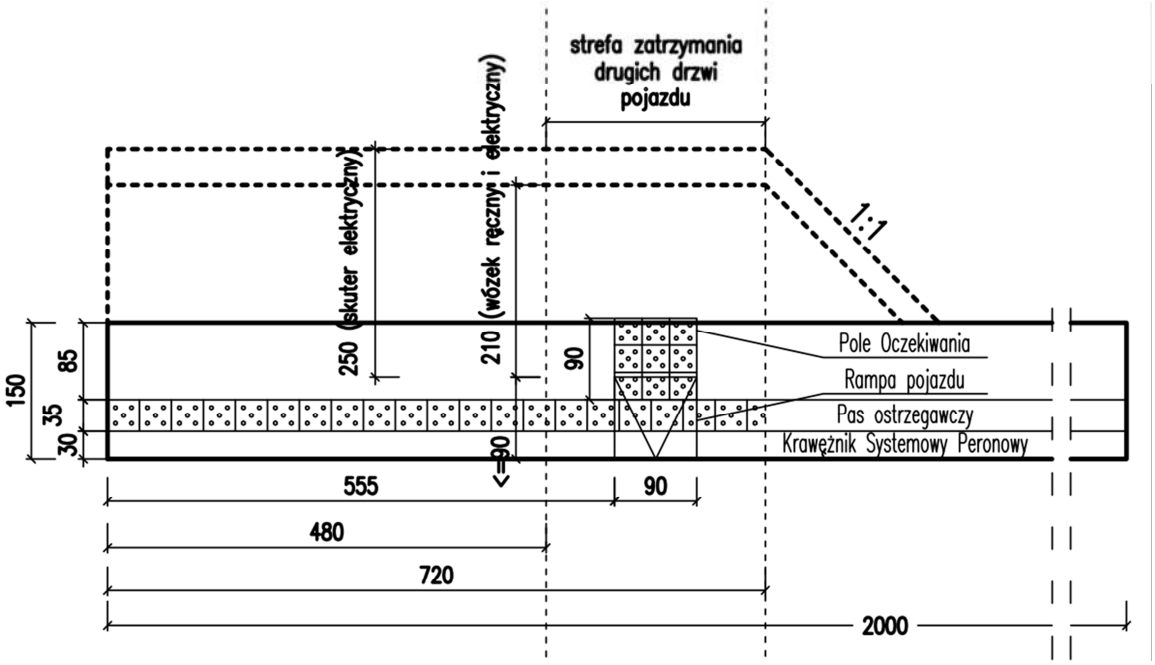
The proposed widening of the front part of the platform may also be beneficial for "walking" passengers using long-distance buses. There is a principle of entering through the first door to pay the toll, so the queue is usually placed in the front part of the platform.
The range of the platform front widening should extend from the front of the platform to the stopping point of the second vehicle door and e.g. according to [11] it would be 720 cm (Fig. **7**).

The widening should be done on the same surface as the rest of the platform - hard and full.

In the widened part of the platform - provided that a minimum maneuvering area is left - the so-called "Squat" could be installed - resting place while standing [11]. It would make it easier for people who have difficulty getting up from the benches to wait for the bus at the front of the platform using the first door.

There are cases of incorrect parking on the platforms at stops. To counteract this, managers often install safety poles along the entire length of the platform edge, which unfortunately also block access to the vehicle door, unfolding the ramp and limit

maneuvering. For this reason, at least along the length of the platform extension, their installation should be abandoned.



7. Diagram of a platform with variable width ensuring easier access to the bus for people in wheelchairs, scooters, and "extra beds"

Optimum platform height

The height of the platform should take into account the need for easier access to the vehicle for disabled passengers in wheelchairs while maintaining the safety of other passengers, pedestrians, and vehicles. The possibility of increasing the height of the platform should be analyzed, depending on whether the platform is located in a bay or without a bay (at the edge of the road) and whether it also serves as a sidewalk.

Thus, the height of the platform in the bay can be increased by at least 2 cm, up to the height of 18 cm - that is, allowed [3] in engineering structures. This solution can be used provided the high standard of bay surface maintenance is maintained, vehicles are moderately filled and the slopes of the bays are made by [3] and the stop curb (platform curb) is used.)

On the other hand, the height of the platform located at the edge of the road (the platform edge is parallel to the direction of traffic) should be raised to a height of 21 cm (maybe even up to 23 cm). Such a height would make it easier for people in wheelchairs to board or alight, in many cases even without having to extend the ramp (only when "kneeling"). Turns at a minimum angle in combination with a stop curb (platform) will ensure the safety of buses. In some cities in Poland, bus and tram stops with a platform height of 21 cm are already present and the author's observations and experiences of using them are positive - with the "kneeling" performed, the difference in the levels of the vehicle floor and the stop platform allows people in wheelchairs to enter or exit on their own without an unfolded ramp.

The proposed increase of the platform height requires taking into account the diversity of the rolling stock serving a given stop (floor height and the value of the "kneeling" of all vehicles) in such a way that the bus floor level is not below the level of the platform and the curb.

The reservation, which is often explained as the inability to increase the height of the bus stop platform, which is also the pavement, is the risk of a pedestrian falling from a height greater than the currently permitted height (16 ÷ 18 cm), which is the result of the lack of fencing or at least notification of the increased height. Since in many places along the entire length of the platform edge, there is a Warning Strip and sometimes even a Waiting Field (e.g. according to [11]) and a Guiding Strip located across the width of the pavement, there is a risk of people with visual impairment falling from such a curb. is minimal. For this reason, when constructing a platform with an increased height, which is also a pavement, it is mandatory to install a Surface Guiding System with an extended range, e.g. in [11].

Summary

The platform, constructed in the manner described above - raised and partially widened, could provide passengers on wheelchairs (possibly on scooters and with "extra beds") a more comfortable possibility to move around by public bus transport while minimizing the costs of making and maintaining stops. However, this requires either legislative changes at the national level (amendment to the regulation) or the development of relevant provisions in the already functioning "Accessibility Standards" in individual cities.

A similar analysis can be carried out for the platforms of tram stops. At the same time, the operational specificity of tram vehicles should be taken into account, i.e. the wear of wheel rims and rails and the lack of the "kneeling" function. As well as the greater minimum width of the platforms, amounting to 2.0 m [3], and the possible interpretation of the regulations indicating that the tram stop on the separate track is not also a pavement, which allows you to freely increase the height of the platform. However, real widening of tram platforms due to their frequent location in the lanes dividing streets may be at least difficult.

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