Design Principles for Inclusive Environment of Urban Agrorecreational Eco-complexes

Tetiana Pavlenko, Tetyana Lytvynenko, Viktoriia Ivasenko, and Alina Zyhun

Abstract The problem of creating an inclusive environment in urban agrorecreational eco-complexes are considered. The peculiarities of the criteria of accessibility, informativeness and comfort have been determined in the article. There were analyzed and classified requirements for the design of urban agrorecreational eco-complexes taking into account the needs of people with limited mobility. The main means of inclusive environment in urban agrorecreational eco-complexes have also been determined. There have been analyzed the following main means of barrier-free accessibility for the elements of the external space of urban agrorecreational eco-complexes: external ramp, exit ramp, raised pedestrian crossing, lifting device, external stairs, parking space for a person with disabilities. The authors have considered the main elements of universal (inclusive) design and barrier-free environment in interior space of urban agrorecreational eco-complexes: internal ramp, internal stairs, approach ramp, elevator, internal lifting device, escalator, ambulatory compartment for people with disabilities. The main means of universal (inclusive) design for the elements of external and internal space of urban agrorecreational eco-complexes have been outlined in this scientific survey. The following tactile elements of accessibility have been considered: tactile guiding strip, warning tactile strip, informational tactile strip, tactile resource book. Visual accessibility elements (signs in contrast colors, information plates and informers) and auditory accessibility elements (external detectors or speech systems), have also been identified and analyzed.

Keywords Inclusive environment · Inclusive space · People with disabilities · Universal design · Urban agrorecreational eco-complex · Vertical farm

T. Pavlenko (✉) · V. Ivasenko
O.M. Beketov National University of Urban Economy in Kharkiv, Kharkiv, Ukraine

T. Lytvynenko · A. Zyhun
National University «Yu. Kondratyuk Poltava Polytechnic», Poltava, Ukraine

V. Onyshchenko et al. (eds.), *Proceedings of the 3rd International Conference on Building Innovations*, Lecture Notes in Civil Engineering 181,
https://doi.org/10.1007/978-3-030-85043-2_51

1 Introduction

Acceleration of urbanization leads to the situation when high-rise buildings and municipal facilities are extensively constructed on croppable lands suitable for cultivating farm produce. Therefore, vegetables, greens and fruits for the cities with a million-plus population have to be transported from afar off, which has an impact on their freshness. It encourages the emergence of new directions in urban planning, when a considerable part of the afore-referenced products can be produced within the limits of the cities, and moreover–all the year round.

Due to the shortage of sizeable white lands, space in urban agrorecreational eco-complexes [8] is organized vertically for the purpose of compactness; greens and vegetables are grown for local shops, and the orchards growing on the roofs of the houses may help to control air pollution. But this requires special approaches to the creation and improvement of such space, which should be created on the principles of universal design and be inclusive.

In most of developed countries professionals are actively working on the creation of safe, comfortable, accessible, informative environment [1–7, 9–23], including the space for workers and visitors to urban agrorecreational eco-complexes for people with limited mobility, including people with disabilities.

2 Materials and Methods

When conducting the research, basics of the systems approach, the simulation mode, theoretical methods of analysis, synthesis, generalization and abstraction technique were used.

3 Results

3.1 Defining the Inclusive Environment of Agrorecreational Eco-complexes as a System

Vertical farm is the generic name for a highly automated agroindustrial complex located in a specially designed high-rise building. The main difference between vertical farms and traditional hothouse facilities and livestock farms is vertical multi-tiered arrangement of plantations and intensive approach to land use [8]. Pertinently, a vertical farm is a multitiered greenhouse. From the very beginning, vertical farms are always planned as a new element of the urban environment, which must comply with the terms of inclusivity, be accessible to all, and have inclusive space for people with limited mobility, including people with disabilities.

People with limited mobility are people who have difficulty with ambulation and orientation in space, in receiving services and necessary information. People with limited mobility are: people with disabilities, people with temporary health problems, pregnant women, the aged (the elderly, people with baby buggies, etc.) [9].

There is a tendency to the usage of such terms as barrier free environment for physically challenged people, adapted environment, **universal design (inclusive design)** [9]. These terms describe the elements of the architectural space taking into consideration the needs of people with disabilities (Fig. 1). The term **«barrier-free environment»** is in most cases used to refer to people with disabilities. Barrier-free environment provides for the installation of approach ramps and sidewalks with high quality roadway paving, fairly wide passages, lanes, drive-throughs and driveways, doors and other elements of the architectural environment that make it easier for people with limited mobility to move [9]. For people with limited mobility, the presence of barrier-free environment is a factor that significantly affects the quality of life [1].

Inclusiveness of buildings and related structures is a comprehensive set of architectural, planning, engineering and technical, ergonomic, structural and organizational measures to ensure the accessibility of buildings and related structures in

Fig. 1 Basic architectural-planning, engineering-technical and design elements providing for the inclusiveness of the environment

which any person, regardless of age, gender, disability, functional diseases, level of communication skills, can in all circumstances feel safe and comfortable without physical assistance and outside help to the best of their abilities [10].

In accordance with world statistics, from a quarter to the third part of the population are the users of the barrier-free environment at one time or another [9].

Accessibility in urban agrorecreational eco-complexes should ensure easy movement and safe passage in space and the possibility of using public property and public benefits.

Many countries have already developed their accessibility standards, taking into account best practices. As a result, uniform standards for civilized countries have been formed and improved.

In general, **the criteria for accessibility** in urban agrorecreational eco-complexes should have the following requirements for the accessibility provisions:

- unobstructed movement along the sidewalks and surmounting vertical drops (level differences);
- possibility of convenient use of holding points, recreational facilities and additional service points;
- passage and vehicular access to the equipment for different purposes;
- access to public transport stops;
- road crossings;
- access to the information supply;
- availability and equipment of parking spaces;
- availability of means of surmounting pedestrian crossings (overground pedestrian crossings and pedestrian undercrossings);
- availability of means to cross over interchange ramps;
- unobstructed vertical and horizontal movement during technological (agro-industrial) processes in urban agrorecreational eco-complexes;
- unobstructed vertical and horizontal movement of visitors during recreational processes in urban agrorecreational eco-complexes.

Safety should be understood as the possibility of overcoming the obstacles safely, visiting urban agrorecreational eco-complexes without the concern for being injured in any way or causing damage to property or equipment. It also applies to the installation of fences, doors and etc., to the location of public utility sites of support service vehicles, platform jetties and landing stages, steps and lifting devices, their protection from precipitation; routes of people with limited mobility in the middle of pedestrian crossings (both overground pedestrian crossings and pedestrian under-crossings).

It is recommended to include into the requirements of **the informativeness criterion** for urban agrorecreational eco-complexes the following:

- timely identification of landmarks on the territory of urban agrorecreational eco-complexes;
- accurate identification of your location and the places that are the purpose of your visit;

– the use of information distribution media that meet the needs of different user groups;
– the possibility of effective orientation of visitors, both during daylight hours and at night time;
– shortening of time and contraction of efforts to obtain the necessary information;
– warning people of potential threat zones on the road and of the streets that may be possible hazards;
– the ability to have continuous information support while moving along the street.

Landscape comfort includes adaptation of the environment of urban agrorecreational eco-complexes, in which a person with disabilities appears to be, to his/her needs and capabilities.

Universal design (inclusive design) of urban agrorecreational eco-complexes should be suitable for the vast majority of people, as well as for a wide range of people with such disabilities, as trouble seeing, hearing and perception defects, taking into ac-count psycho-emotional and intellectual characteristics. Universal design (inclusive design) of urban agrorecreational eco-complexes addresses the problems of accessibility and gives an opportunity to make all the elements of its environment accessible. This is achieved by detailed planning at all design stages [9].

3.2 The Main Means of Inclusive Environment of Agrorecreational Eco-complexes

The peculiarity of creating an inclusive environment in urban agrorecreational eco-complexes is identification of two main groups of elements that must be provided by **means of universal (inclusive) design and barrier-free environment** (Fig. 1):

– *elements of the external space* of urban agrorecreational eco-complexes (pedestrian sidewalks, malls and alleys (their crossroads), traffic junctures and crossroads of pedestrian sidewalks, special sites for passenger pickups and passenger drop-offs [5], entrance space of an urban agrorecreational eco-complex, recreational space, sports grounds, outdoor manufacturing areas, public utility sites, etc.);
– *elements of the internal space* of urban agrorecreational eco-complexes (entrance lobby of an urban agrorecreational eco-complex, vertical communications, horizontal communications, public bathroom and laundry, main premises, etc.).

Taking into account the considered features of creating inclusive (barrier-free) space in urban agrorecreational eco-complexes, we have identified the main design aids for such construction entities.

Means of inclusivity (barrier-free space) for the elements of the external space of urban agrorecreational eco-complexes (Fig. 2):

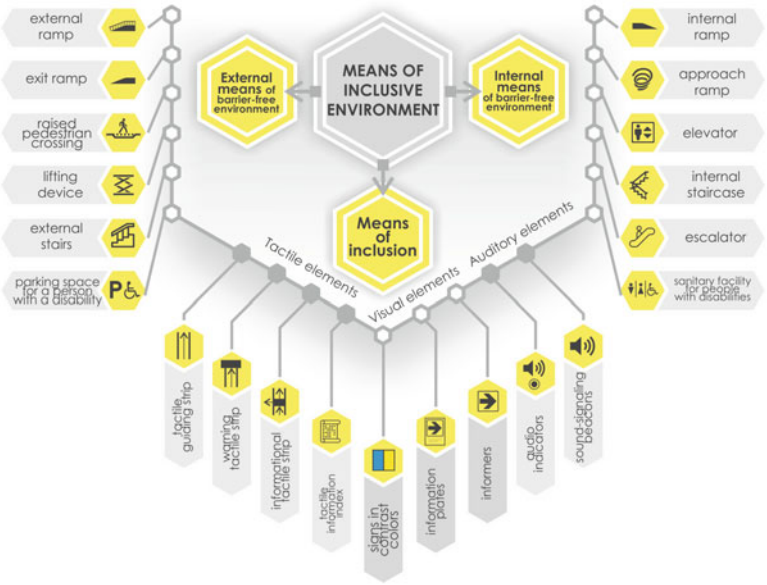

Fig. 2 Means of inclusive environment in urban agrorecreational eco-complexes

– *external ramp* (Fig. 3)–external continuous inclined pane (structure), which connects two uneven horizontal surfaces and is arranged for barrier-free movement of wheelchairs, baby buggies, other various wheeled vehicles and people from one flat surface to another [5];
– *exit ramp* (Fig. 4) is an inclined pane (structure), which is located at all the crossings of pedestrian paths/footwalks/sidewalks with carriage ways of different movement directions (parking lot exits, public transport stops) for barrier-free movement of people and wheelchairs, baby buggies and other various wheeled vehicles [9];
– *raised pedestrian crossing* (Fig. 5) is the means for more convenient barrier-free movement of people and wheelchairs, baby buggies, other various wheeled

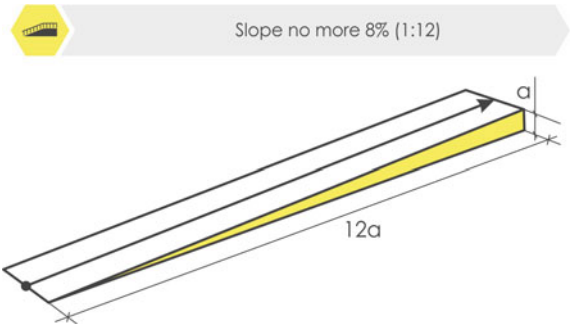

Fig. 3 External ramp sample

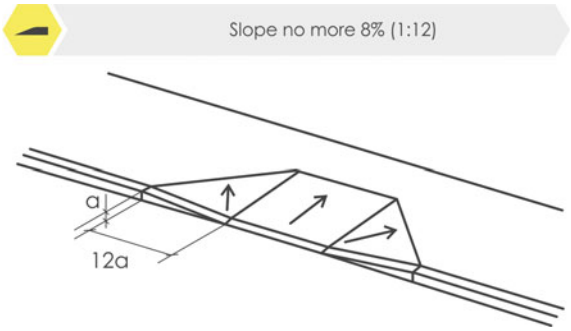

Fig. 4 Exit ramp sample

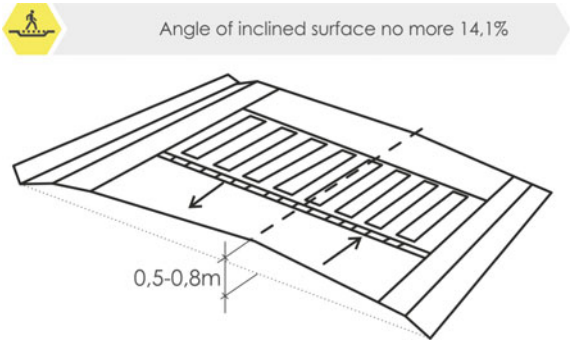

Fig. 5 An example of a raised pedestrian crossing

vehicles across the carriage way at the pedestrian crossing by mechanical speed restriction of vehicles [9];

– *lifting device* (Fig. 6) is the means used to get over the significant difference in levels between the nearest horizontal faces (vertical and sloping direction) [5];
– *external stairs* (Fig. 7)–the stairs on footpaths/footways/sidewalks, planned for the cases when, in a certain place, there is a slope of the ground more than 10%, should be duplicated with ramps, and if necessary–with other lifting devices with vertical movement or moving in parallel with the slope of the stairs and meet the basic requirements for the arrangement of street and road network [9];
– *parking space* (Fig. 8) for a person with a disability (a place for parking private vehicles belonging to people with disabilities or the vehicles used for transporting people with disabilities) is recommended to be placed at the entrance to the buildings and structures, but not further than 50 m in compliance with standards specified [3].

Barrier-free devices for the elements of the internal space of urban agrorecreational eco-complexes (Fig. 2):

– *internal ramp* (Fig. 9) is internal continuous inclined pane (structure), which connects two uneven horizontal surfaces and is arranged for barrier-free movement

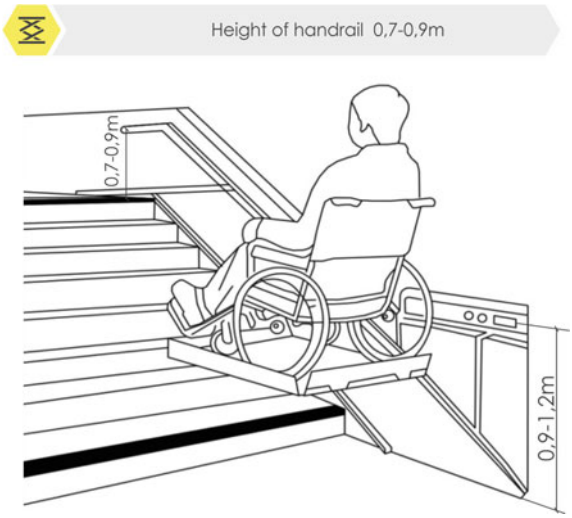

Fig. 6 An example of a lifting device

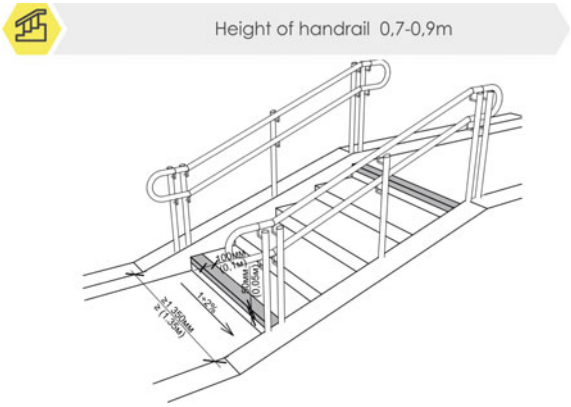

Fig. 7 An example of external stairs

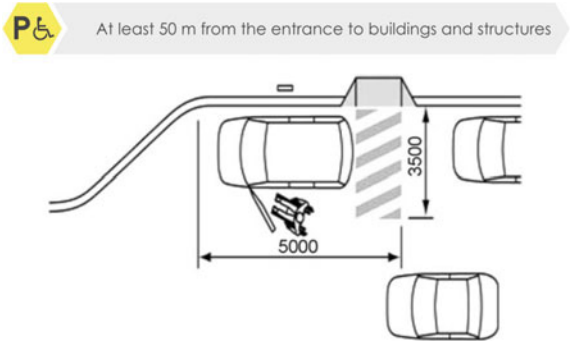

Fig. 8 An example of a parking space for a disabled person

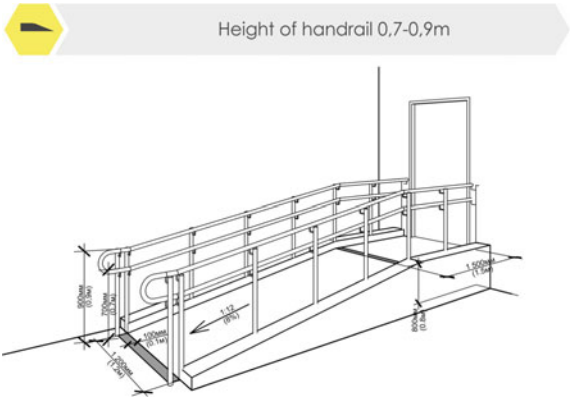

Fig. 9 An example of an internal ramp

of wheelchairs, baby buggies, other various wheeled vehicles and people from one flat surface to another [9];

- *internal stairs* (Fig. 10)–the structure of horizontal ledges or stairs, which is used for equipment maintenance and in order to connect the floors, rooms, roofs of the buildings and structures [10];
- *approach ramp* (Fig. 11)–spiral horizontally curved ramp [9];
- *elevator* (Fig. 12)–an engineering structure with a special cabin for the vertical movement of people or goods [10];

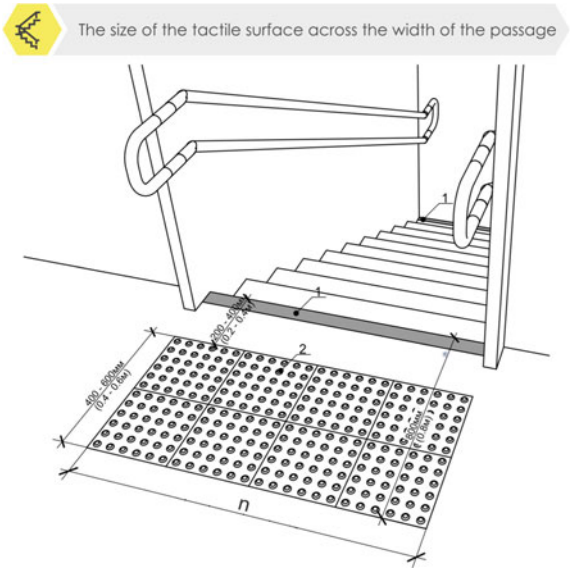

Fig. 10 An example of an internal staircase

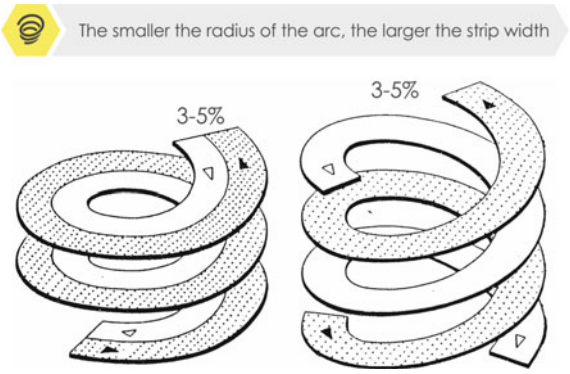

Fig. 11 Examples of ramps

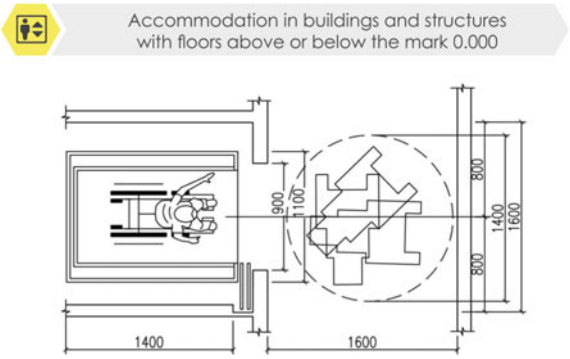

Fig. 12 An example of an elevator

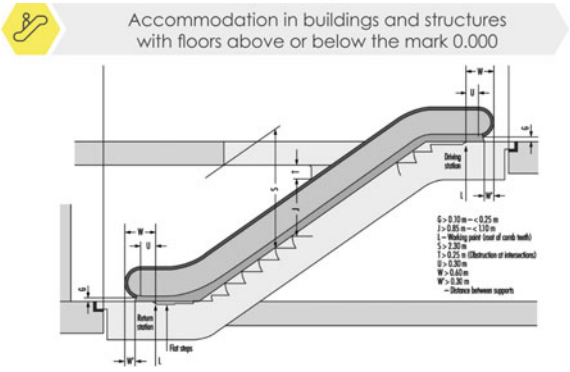

Fig. 13 An example of an escalator

– *internal lifting device* (Fig. 6) is a means used to get over the significant difference in levels between the nearest horizontal surfaces (vertical and sloping direction) [9];
– *escalator* (Fig. 13) is a device, a moving lane in the form of a moving sidewalk

or a sloping staircase with movable horizontal steps for moving horizontally or between different levels of the surface (vertical and sloping direction) [9];

– *sanitary facility for people with disabilities* (Fig. 14)—ablution facility, which is intended for use by all social categories (including people with disabilities) and provides for the installation, in addition to basic accessories (a flush toilet and a sink) of handrails, bars, swiveling seats or fold-back seats, etc. [1, 9, 10].

Means of universal (inclusive) design for the elements of external and internal space of urban agrorecreational eco-complexes (Fig. 2):

Tactile elements of accessibility (TEA)–the system of safety and orientation facilities, means of obtaining information for people with sensory impairments (Fig. 15) [1–7, 9, 10]:

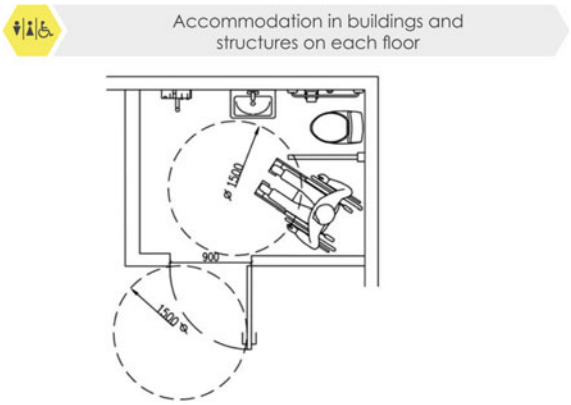

Fig. 14 An example of a sanitary facility for people with disabilities

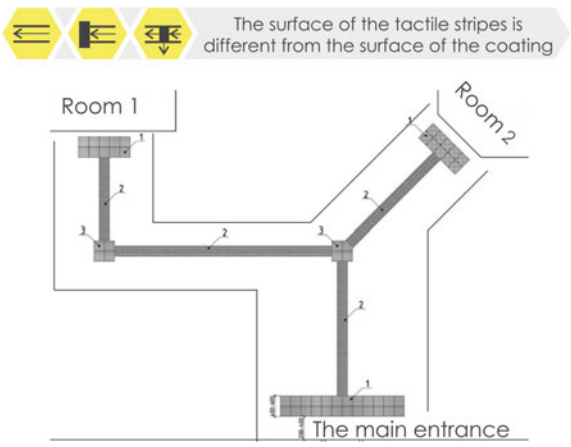

Fig. 15 An example of tactile strips arrangement: 1–warning tactile strip; 2–tactile guiding strip; 3–informational tactile strip; which indicates the place of turning (divergence) of the tactile guiding strip

– *tactile guiding strip* (Fig. 15)–a means of warning or orientation for people with vision impairment and for other users, which warns of the direction of movement to the objects of social, engineering and transport infrastructure, on footpaths (pedestrian routes), on the premises of the objects and inside them [9];
– *warning tactile strip* (Fig. 15)–a means of warning or orientation for people with vision impairment and for other users, which warns of potential danger or hindrances while moving to the objects of social, engineering and transport infrastructure, on footpaths (pedestrian routes), on the premises of the objects and inside them [9];
– *informational tactile strip* (Fig. 15)–a means of warning or orientation for people with vision impairment and for other users, which informs of direction change while moving to the objects of social, engineering and transport infrastructure, on footpaths (pedestrian routes), on the premises of the objects and inside them [9];
– *tactile information index* (Fig. 16)–a tactile element of accessibility that duplicates flatly printed text or graphic information in tactile form and in Braille type [9].

Visual accessibility elements (VAE)–tools that ensure safety and provide for orientation, obtaining information by all users, including people with vision impairments, with the help of color layouts, information plates, informants, markers and signs [9]:

– *signs in contrast colors* (Fig. 17)–visual accessibility elements that use contrast color relation in order to ensure the structuredness of the space (for free orientation, receiving information and safety when moving on the way to the objects of social, engineering and transport infrastructure, on footpaths (pedestrian routes), on the premises of the objects and inside them [9];

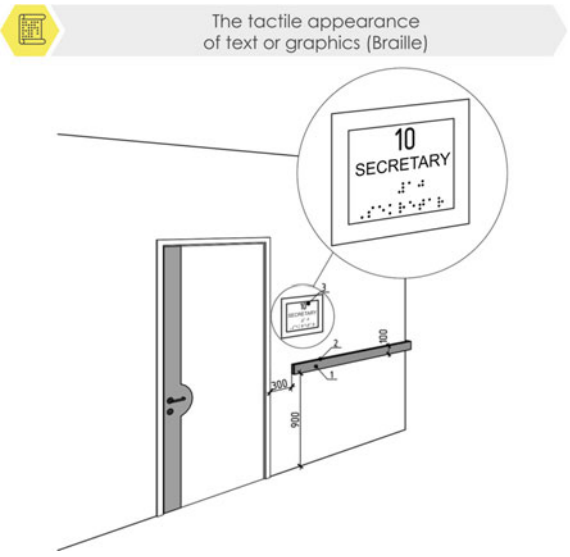

Fig. 16 An example of a tactile information index: 1–information guide; 2–informational tactile marking; 3–informational tactile sign plate that duplicates textual information in the tactile form of flatly printed text and in Braille type

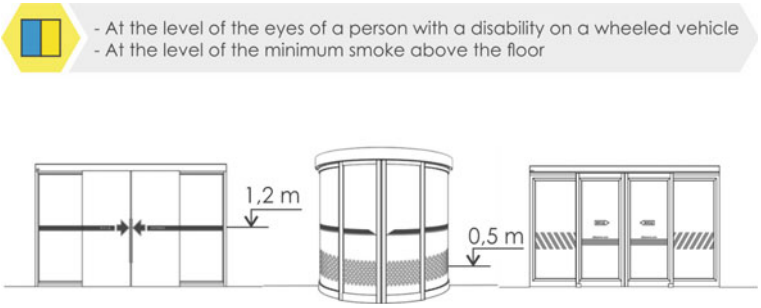

Fig. 17 Usage samples of signs in contrast colors (contrasting markings on transparent doors)

Fig. 18 Examples of information plates combined with a tactile resource book: 1–flatly printed graphic information, 2–duplication of flatly printed graphic information in Braille type

– *information plates and informers* (Fig. 18)–visual accessibility elements that are clear and accessible to all categories of people with limited mobility, made in enlarged font and in a contrasting color relation of fonts to the background of the plates. They can be combined with a tactile resource book [9];

Auditory Accessibility Elements (AAE):

– *audio indicators* (Fig. 19)–auditory elements of accessibility that help people with vision impairments obtain information about the object and the services provided in it [9];

Fig. 19 Examples of an audio indicators combined with an information plate and a tactile resource book: 1–flatly printed textual information, 2–duplication of flatly printed textual in-formation in Braille type, 3–play button for reproducing audio information

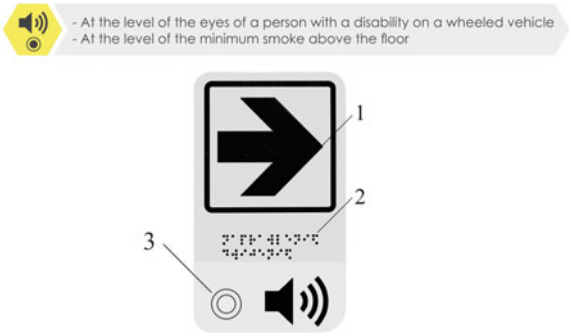

Fig. 20 Examples of a sound-signaling beacons combined with an information plate and a tactile resource book: 1–flatly printed graphic information, 2–duplication of flatly printed graphic information in Braille type, 3–play button for reproducing audio information

– *sound-signaling* (Fig. 20) are auditory elements of accessibility, located at the entrance lobbies of the objects that point to the required direction of movement [9].

4 Conclusions

The article studies and classifies the requirements to the space of urban agrorecreational eco-complexes (Fig. 21) taking into account the needs of people with disabilities, which should have the following priority sequence: accessibility, safety, in formativeness, comfort, universal (inclusive) design. The main requirements to the environment of urban agrorecreational eco-complexes have been analyzed and systematized, taking into account the needs of people with limited mobility. The main elements of barrier-free and universal (inclusive) design have been considered and analyzed in this article in order to determine the main design parameters in further studies of urban agrorecreational eco-complexes. It is determined that inclusive design changes the requirements not only to the design of territories, but to civil and structural design as well. It will affect layout concepts, construction solutions and operational characteristics of agrorecreational eco-complexes, and also require further rigorous research.

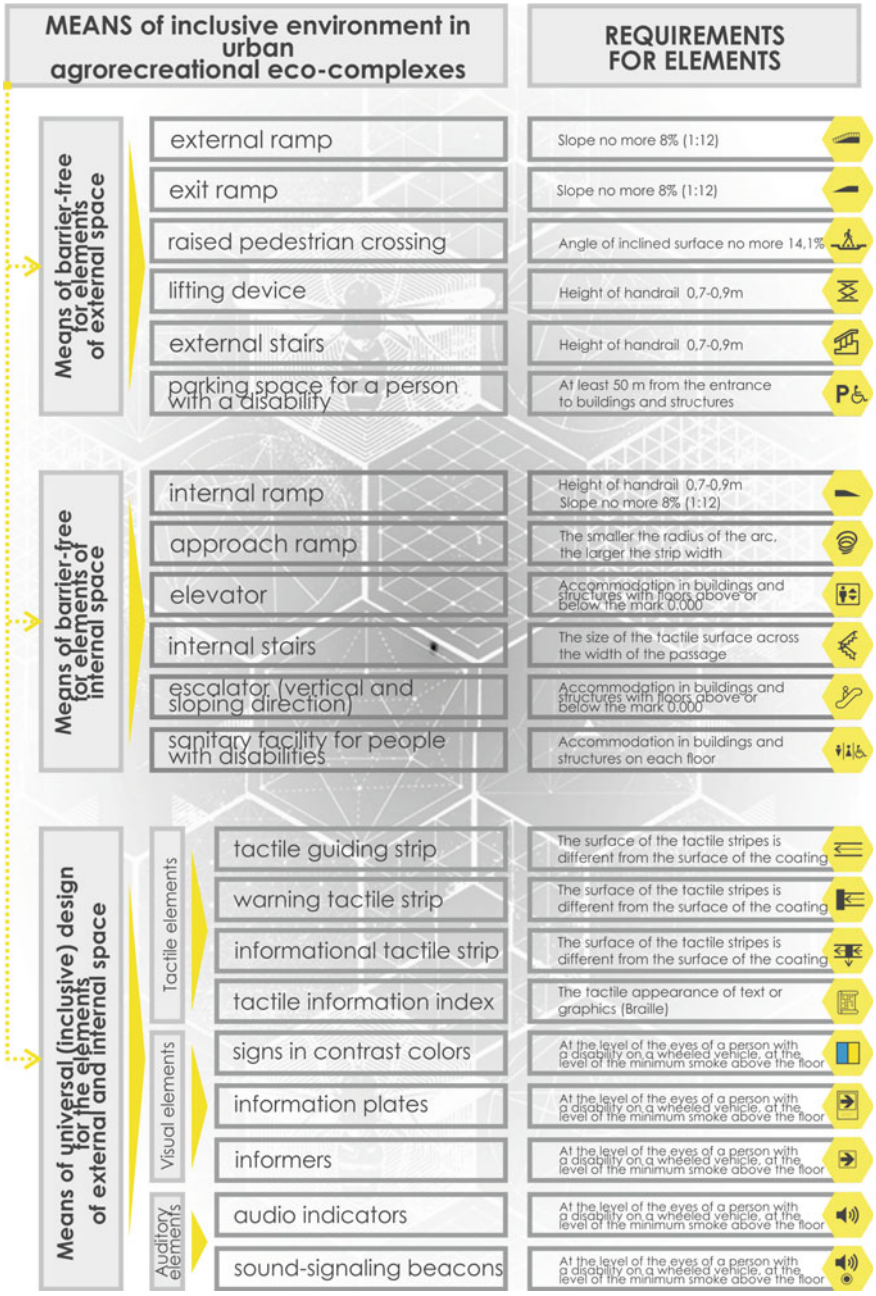

Fig. 21 Defining inclusive environment in urban agrorecreational eco-complexes

References

1. Jones P (2014) Situating universal design architecture: designing with whom? Disabil Rehabil 36:1–6. https://doi.org/10.3109/09638288.2014.944274
2. Khalil M (2016) An assessment of street design with universal design principles: case in Aswan/As-Souq. Megaron/Yıldız Tech Univ Fac Archit E-J 11(4):616–628. https://doi.org/10.5505/megaron.2016.98704
3. Lytvynenko T, Tkachenko I, Ivasenko V, Lvovska T (2020) Application of the universal design principles in the improvement of street and urban road environment. In: Onyshchenko V, Mammadova G, Sivitska S, Gasimov A (eds) ICBI 2019, vol 73. LNCE. Springer, Cham, pp 143–150. https://doi.org/10.1007/978-3-030-42939-3_16
4. Lytvynenko T, Gasenko L, Ivasenko V (2019) Design principles of inclusive street-road environment. In: Mechanisms for ensuring sustainable development of society: collective scientific monograph, pp 203–217. Katowice School of Technology, Katowice. http://reposit.nupp.edu.ua/handle/PoltNTU/6545
5. Lytvynenko T, Ivasenko V (2013) Classification of elements of barrier-free space road network and their requirements. Collection of scientific works [Poltava National Technical Yu. Kondratyuk University]. Ind Eng Const 4(2):66–73. http://nbuv.gov.ua/UJRN/Znpgmb_2013_4(2)__11
6. Lytvynenko T, Tkachenko I, Gasenko L (2017) Principles for road beautification elements placing. Period Polytech Transp Eng 45(2):94–100. https://doi.org/10.3311/PPtr.8592
7. Lytvynenko T, Tkachenko I, Ilchenko V (2018) Principles of street and urban road space formation in modern cities. Int J Eng Technol 7(3.2):642–648. https://doi.org/10.14419/ijet.v7i3.2.14606
8. Mukha T, Demyanchuk A, Savchenko O (2016) Analysis of experience designing vertical agricultural and recreational complexes. Res Prod Collect Archit J KNUBA 10:312–315. http://repositary.knuba.edu.ua/handle/987654321/5073
9. Pavlenko T, Ivasenko V (2020). Basic means of barrier free space in urban agrorecreational eco-complexes. Municipal Econ Cities, 4(157):54–60. https://khg.kname.edu.ua/index.php/khg/article/view/5633
10. Ward M, Bringolf J (2019) Universal design in housing in Australia: getting to yes. In: Transforming our world through design, diversity and education. Open access by IOS Press, pp 209–355. https://doi.org/10.3233/978-1-61499-923-2-299
11. Rimshin V, Borkovskaya V, Degaev E, Shubin I (2020). Barrier-free urban environment and risks of project solutions implementation. In: Paper presented at the E3S web of conferences, vol 164. https://doi.org/10.1051/e3sconf/202016410019
12. Bascom GW, Christensen KM (2017) The impacts of limited transportation access on persons with disabilities' social participation. J Transp Health, 7:227–234. https://doi.org/10.1016/j.jth.2017.10.002
13. Melnikova E, Lepert M, Popov A, Sorokoymova T (2019) Adapting urban areas for people with limited mobility. In: Paper presented at the E3S web of conferences, vol 97. https://doi.org/10.1051/e3sconf/20199701033
14. Asfaw B, Azage M, Gebregergs GB (2016) Latrine access and utilization among people with limited mobility: a cross sectional study. Arch Public Health 74(1):1–8. https://doi.org/10.1186/s13690-016-0120-5
15. Bekk NV, Taube MV, Boychenko IA, Cherkasova MA (2020) Ergonomic features and social demand for means of transportation for people with limited mobility. Paper Presented IOP Conf Ser Mater Sci Eng 944(1):012002. https://doi.org/10.1088/1757-899X/944/1/012002
16. Bezyak JL, Sabella SA, Gattis RH (2017) Public transportation: An investigation of barriers for people with disabilities. J Disability Policy Stud 28(1):52–60. https://doi.org/10.1177/1044207317702070
17. Aldred R, Woodcock J (2008) Transport: Challenging disabling environments. Local Environ 13(6):485–496. https://doi.org/10.1080/13549830802259847

18. Gamache S, Routhier F, Morales E, Vandersmissen M, Boucher N (2019) Mapping review of accessible pedestrian infrastructures for individuals with physical disabilities. Disability Rehabil Assisti Technol 14(4):410–422. https://doi.org/10.1080/17483107.2018.1449018
19. Gamache S et al (2020) Methodological insights into the scientific development of design guidelines for accessible urban pedestrian infrastructure. J Urban Technol 27(1):87–105. https://doi.org/10.1080/10630732.2019.1632677
20. Al Taweel Z, Challagundla L, Pagan A, Abuzneid A-S (2020) Smart parking for disabled parking improvement using RFID and database authentication. In: 2020 IEEE 6th world forum on Internet of Things (WF-IoT), New Orleans, LA, USA, 2020, pp 1–5. https://doi.org/10.1109/WF-IoT48130.2020
21. Carr K, Weir L, Azar D, Azar N (2013) Universal design: a step toward successful aging. J Aging Res 3:324624. https://doi.org/10.1155/2013/324624
22. Harsritanto B, Wijayanti A (2017) Universal design characteristic on themed streets. IOP Conf Ser Earth Environ Sci 99(1):012025. https://doi.org/10.1088/1755-1315/99/1/012025
23. Harsritanto B (2018) Urban environment development based on universal design Principles. E3S Web Conf. 31:09010. https://doi.org/10.1051/e3sconf/20183109010