Principles of architectural and planning arrangements for school complexes on difficult terrain

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Abstract. The article deals with issue of educational infrastructure in Ukraine. The authors analyzed recent research and publications with respect to development, design and construction of educational institutions. The article provides the rationale for the necessity to have school complexes on difficult terrain in Ukraine at this stage, given the needs of education, architecture and urban planning. The article provides the definition of school complexes on difficult terrain. It identifies specificities of building on difficult terrain and points out the advantages and disadvantages of shaping architectural setting of educational institutions given these conditions. The article lists and characterizes principles of shaping architectural and planning arrangements of these complexes. The distinction is made between individual principles directly linked to the object of research, school complexes on difficult terrain, and general ones applicable for all types of buildings. The study distinguishes artistic and composition principles that have an impact on forming school complexes on difficult terrain. The article also identifies approaches, means and techniques to apply identified principles.

1. Introduction

Environment plays crucial role in shaping personality of an individual. It is especially important for the children. We are responsible for the future of young generation and our state. It is important to provide decent conditions for the life, well-being and development of children. Unfortunately, at this stage most of the educational institutions in Ukraine do not meet modern requirements, schools need to be modernized, adjusted and sometimes completely overhauled. The country needs institutions that can become an alternative to most Ukrainian schools. Therefore, these institutions will reflect the values of ongoing educational reform in the country, modern architectural trends and construction technologies. They will promote development of new Ukrainian school and contemporary educational institutions architecture. All that prompted the need for a new type of educational institutions — school complexes on difficult terrain.

School complexes on difficult terrain are multi-profile multidisciplinary educational centers meant for temporary stay of people for the purpose of education, upbringing, spending leisure time, children physical development and sport, culture and entertainment, their nutrition, health care and exercising administrative and economic functions.

2. Analysis of recent research and publications

Issues and development of educational institutions buildings and their network in the system of agglomeration, development of architecture of educational institutions with unconditional teaching
methods, the influence of information age in science and architecture as well as construction in challenging geological-engineering conditions have been subject of research of the following scientists: Oleg Sleptsov, Leonid Kovalskyi, Vadym Kutsevych, Helena Kovalska, Josif Karakis, Oksana Dyachok, Larysa Shuldan, etc.

Oleg Sleptsov conducted PhD research Designing space planning structure of school buildings in challenging engineering and geological conditions (collapsible soil and undermining areas)) [1]. A scientist and architect examine innovative approaches to organizing learning space and covers the issues of alignment of educational institutions in urbanized environment and compliance of educational buildings with the modern standards. He conducted serious theoretical research in architectural development of educational institutions in Ukraine and introduced it into practice. The book authored by Oleg Sleptsov «Modern school architecture: gymnasium of the latest biotechnologies» [2] can be considered a reference book on arranging educational institutions environment. Leonid Kovalskyi conducted theoretical research on architecture of educational institutions and had Doctoral thesis «Problems of development of architecture of educational institutions buildings» [3] and authored a publication «Architecture of educational institutions buildings». He has enjoyed cooperation with Oleg Sleptsov on designing, construction and operation of educational buildings in challenging engineering and geological conditions. Vadym Kutsevych made a significant contribution to theoretical issues of development that deal with legal basis for educational institutions design.

Research on general theoretical issues of development of modern education pedagogics, history of educational science, psychology and philosophy was conducted by Myhaïlo Levkivsky, Vâsyl Madzigon, Valentyna Dorotuk, Lubov Tarabasova, Hans Brugelmann and Ken Robinson.

3. Objective of the article
The article is aimed at determining grounds for introducing a new type of educational institutions in Ukraine, identifying and defining principles and approaches to architecture and planning of school complexes on difficult terrain.

4. Results and discussions
Selection of a building site depends on several factors. In Ukraine, challenging terrains are virtually unused for mass building. Typically, there you can see private dwelling housed based on individual design or recreation zones with landscape design, otherwise, they mostly remain in their original condition. Difficult terrains have one big advantage: price of a plot of land. Normally it is considerably lower than that of the sites on the even land, therefore they are affordable for developers. Their disadvantage, though, is the complexity of construction works and the need in larger investments. Provided you pursue the right approaches to the development these areas, you can balance construction expenditures. For instance, if you choose hillside facing south, south east and east with sufficient insulation and visibility conditions, you can have an energy-efficient house and save on heating and electricity bills. Additional advantage that can be provided there are green terraces and easy drainage of surface waters. Sloping terrain has an effect on architecture, planning, structure of the buildings and their artistic composition. Thanks to latest construction and technological methods challenging terrains do not cause any major difficulties for architects and they can become an asset in case of right architectural and planning approaches employed.

The research proved that school complexes (centers) on challenging terrain can see several types of spatial organization, formation solutions and artistic composition image. These types are determined by specific features and are governed by common principles of development. The notion «principles» provides for a number of general requirements and rules impacting forming different projects.

You can distinguish nine individual principles of architectural and planning organization of school complexes on difficult terrain. They are characteristic of a specific object. You can also single out four general groups of requirements for all public buildings. Individual principles include «localization of a setting», «integration», «accessibility», «functional distribution», «adaptation», «ethical expressiveness», «environmental friendliness and energy efficiency», «progressiveness» i «visibility».
General requirements are based on the rules of functionality and technical feasibility, cost-effectiveness and artistic expressiveness. All these principles are closely interlinked and complement each other.

Principle of «localization of a setting» deals primarily with the choice of slope, its configuration and location with regard to cardinal direction as well as its location in relation to a populated (build-up) area. This principle serves the basis for categorizing/ distinguishing main and additional functions of the center/complex objects. Principle of «localization of a setting» is closely linked to the principles of «integration» and «accessibility».

«Integration» principle unites all the buildings of the complex and the landscape into one integral whole through the development of their interconnectivity and adjustment. These requirements are linked with the principle of «ethical expressiveness». They include visual interaction of nature and architecture.

«Accessibility» principle is crucial to find solution to transport and pedestrian connections horizontally and vertically on the slope, passages and driveways are arranged on the territory of the center and external accesses are provided for. In other words, the complex is getting connected with the existing transport infrastructure outside the construction object and inside the complex. Fire safety requirements are essential to the principle.

«Functional distribution» principle establishes the rules to determine functional zones on the project site and provides for their accessibility. That is the principle that provides the solution to the location and grouping of the school complex building depending on their functionality as set out by general layout and spatial planning structure– developing the center buildings separately. The principle governs the choice and location of points of entrance (from the top, in the middle or at the bottom of the hill), main and ancillary construction objects.

«Adaptation» principle is aimed at ensuring prospective development of the center thanks to internal and external objects transformation and tailoring buildings spatial and planning structure to the needs dictated by the time. The principle also provides for universal use of buildings internal space.

«Ethical expressiveness» is defined by architectural, composition and artistic solutions and artistic expressiveness. It is based on the combination of the function and form and philosophy of the architecture. Developing the exterior and reflecting its elements in the interior.

«Environmental friendliness and energy efficiency» secure sufficient greenery to meet various needs, including recreational. This principle requirements are part of site organization and contribute to the development of architectural and artistic character, create the best controlled environment, temperature and humidity control, radiological and wind regimes within the site and adjoining areas. The principle is based on effective energy use. It is achieved by installing solar cell panels and solar power generators and «passive houses».

«Progressiveness» means compliance with modern social conditions and needs. It is achieved by using cutting edge technologies, scientific, technical, architectural, artistic and engineering achievements.

«Visibility» will ensure realization of the intended use of the buildings. The principal provides for common stylistic solution of all school complexes /centers. This principle is closely intertwined with the fundamentals of «ethical expressiveness».

Since school complexes on challenged terrains are public buildings, they should meet general common principles of buildings design and development: functionality and technical feasibility, cost – effectiveness and artistic expressiveness.

«Functionality» principle means that buildings should be in full compliance with their intended use. Technical feasibility is to ensure building’s protection from the climatic and natural impact (snow load, wind, precipitation, temperature variations, etc.). The principle determines the choice of the most relevant and proper construction design for each public building type.

«Cost-effectiveness» provides for the choice and use of the most efficient way of buildings construction, with the least financial and human labor costs. To comply with the requirements construction costs should be estimated and recovered in the course of building upkeep and use.

Implementation of the abovementioned principles of school complexes construction on difficult terrain require engaging specific techniques and means. They interact with each other and are employed.
simultaneously by several principles. Key elements for «localization of a setting», «integration», «accessibility», «functional distribution» are the choice of specific spatial and construction volume solutions of the buildings design, their architectural and construction solutions. «Ethical expressiveness» is determined by the color scheme and construction materials used for the decor. «Visibility» principle is secured through the external display of understanding of the intended use of the building. Techniques employed in «adaptation» principle are spatial modification and transformation by using movable partitioning and transformer furniture. These techniques are partly applicable in the «progressiveness» principle. To implement «environmental friendliness and energy efficiency» principle we use solar and wind energy, environmentally friendly materials for construction and decoration. This is achieved through solar cell panels, solar power generators, «passive houses», vertical and horizontal landscaping, modern ventilating systems, air humidification and purification, creating the best controlled environment.

Except to the generally accepted rules and approaches that influence the establishment of educational institutions, the school complexes considered in this study have a number of individual ones. They are associated with the design area a complex terrain. Difficult terrain is the dominant environment, creates a silhouette of the building, affects the development of architectural and planning organization and artistic and compositional image.

When designing buildings on the terrain should be guided by two basic rules of interaction between architecture and landscape: «polarization» (separation) and «integration» (merger) [4] (Fig. 1). The first work due to the approaches of contrast - the opposition of architecture to the natural landscape, the accentuation of their differences, the second is a nuanced relationship - the fusion of terrain and buildings. The rules of «polarization» and «integration» have two types of formation: visual and construction. The visual is the maximum preservation of natural terrain, the approaches of contrast and nuance work only as visible. During this type of building rises above the natural landscape with the help of columns and supports, consoles are used. with the construction type, the territory undergoes significant changes, and the approaches of contrast and nuance are formed by the architecture itself. Buildings can go significantly deeper into the ground, to straight them you need to level or fill the ground cover, terracing the area.

The interaction of architecture and landscape according to the principles of «polarization» involves the use of materials that will bring dissonance between buildings and nature. This effect can be achieved through architectural and structural and finishing solutions. To do this, you should use metal, glass, bright colors, textures, open structures, tools that will clearly distinguish between natural and human activities.

In the case of organizing an artistic and compositional image according to the rules of «integration», the building should be disguised in a natural landscape. They must fit organically into the terrain with the help of terraces, ramps, stairs, retaining walls. One of the main methods of merging architecture and nature is the subordination of buildings to differences in terrain. In this case, the objects seem to repeat the slope, parallel to it. To achieve harmony using nuanced approaches, natural materials (stone, wood) and pastel, earth tones are used. Landscaping of vertical and horizontal surfaces of buildings plays an important role.

When searching for the most profitable solution, depending on the specific case, the principles of «integration» and «polarization» can be combined in one object. Successful examples of compliance with the rules of «polarization» and «integration» in modern buildings located on difficult terrains are educational institutions: Lusitania Paz de Colombia School and Jean Moulin High School (Fig. 1. a, b). They reflect opposite directions to the organization of architectural objects on difficult terrains. Lusitania Paz de Colombia School - is a model of «polarization» with contrasting approaches, and Jean Moulin High School – merges with the environment through nuanced grounds.

Lusitania Paz de Colombia School was built in 2015 in Medellin, Colombia by architect Camilo Avellaneda. The project uses pure forms which are taken into account in order to divide the program into three buildings, thus creating open spaces linked to the surroundings. The articulation of the volumetric composition puts in evidence a double scale relation: a territorial one that establishes visual
links along with the landscape; and a local one, where the spaces produced between the volumes, generate high impact relations in the urban and school life. The building is one of the best examples of modern eco-architecture, in addition, due to its progressive architectural and engineering solution, as well as the characteristic aesthetics is the hallmark of the city. The school building is located on a difficult terrain and its volume, which combines rectangular and cylindrical shapes, contrasts with the environment. In addition, the school has a light exterior facades, which further accentuates the building – distinguishes it among the greenery of the park, next to which it is located [5].

Jean Moulin High School was built in 2016 in Revin, France. This is a project of the architectural firm «Duncan Lewis Scape Architecture». The project of the entire school complex was based on a strong and shared concern for the rebuilding of the relationship between the built and the natural environment, long before it had become a trend among the new generation of architects. The building had to develop a relationship with the landscape, one that would help merge them together. The ambition of the architect was to mimic the mountain silhouette and to redress the building as far as possible in vegetation. The new school closely follows the topography of the land, it literally sticks to the bedrock which it occupies, from the crest of the plateau all the way to the residential area that separates it from the river. The building is located on a territory with steep hills and gentle slopes, surrounded by forest. The educational elements of the program are distributed across two long, low buildings (referred to as ‘strips’). These buildings are arranged in terraces that provide all the classrooms wide panoramic views to the south west. Due to the stepped shape, the building repeats the shape of the slope, and green terraces «dissolve» it in its natural environment [6].

Figure 1. Interaction of architecture and landscape

An architect improves the setting to match the objectives and intended use of the building. The choices made have significant impact on arranging school complexes on challenging terrain. It can improve quality and efficacy of the learning process and knowledge and skills acquired.
The interaction of architecture and landscape directly forms the architectural, artistic and compositional principles and patterns. We can distinguish the principles «stylistic unity», «harmony with the setting», «universality of interior», «harmony of functions and forms», «content philosophy» and «including elements of exterior into interior». They affect the organization of premises and spaces of school complexes on difficult terrain.

«Stylistic unity» covers both exterior and interior decoration: finishing materials, colors, structural elements of a building used in all complexes to turn them into a showcase.

«Harmony with the setting» principle means making architectural object part of the environment based on contrast (contrasting architecture with the landscape with the focus on differences between the human – being and nature) or nuanced approaches (harmony of architecture with environment, blending of architecture with environment, unity of topography and buildings). Techniques engaged in accomplishing the goals are materials and colors as well as construction solutions: terraces, ramps- it all depends on the approach pursued. The principle is based on the proportion of architectural forms and setting, stylistic integration of forms and space, bioclimatology [7] (adaptation to the climate of the region, use of renewable sources of energy).

«Universality of interior» principle allows for the change, adjustment and space adaptation to respective needs. It enables open common space arrangement. To this end, it is necessary to use movable partitions and transformer furniture, use neutral colors for decoration. Open space zoning is accomplished by using different colors, lighting and difference in elevation of ceiling and floor.

Harmony of functions, form and functionality, unity of style in form and space are the techniques and methods of «harmony of functions and forms» principle. This is accomplished thanks to the construction materials, structural design, color scheme and decor.

Since school complexes on difficult terrain are developed for children, philosophy and artistic character play crucial role in finding best architectural solution when constructing educational establishment. That’s the core of «content philosophy» principle. Everything matters here: form, color, texture, theme, style and decor.

«Including elements of exterior into interior» is based on the interconnection of rooms and external space that blend, use of natural materials and beautification, glassed surfaces, «engaging the outside in».

Buildings architecture is of crucial importance for people’s perception and it shapes person’s attitude to the space. Scale relations, details, structural components, color, surface finish and, naturally, unity with the landscape around them are critical to developing harmonious impression.

Identified principle of architectural planning and artistic and structural organization are mandatory for developing school complexes on difficult terrain. They are applicable interchangeably and comprehensively, complementing each other.

5. Conclusions

Properly planned and well thought-through work of an architect ensures development of a comfortable environment and space for people tailored to their needs. In the course of working on the construction object it is necessary to take into account the setting of the construction object and its potential users. An architect shapes the respective character of buildings to be using relevant principles, techniques, location and planning, interior and exterior. Philosophy and design themes, choice of colors and decor play big role in creation of architectural objects. It is especially important for educational institutions, as children are more sensitive to the world around them.

One of the main tasks when designing school complexes is developing creative space enabling children personal development with the help of ergonomic, flexible, multifunctional interest-generating space. Ethical value of educational environment: lighting, colors, spatial relations, unity with nature are integral elements of the process.

Following the rules of architectural planning and artistic composition arrangements of school complexes on difficult terrain will ensure creation proper conditions to encourage learning process and assist children in their personal self-fulfillment and making informed decisions as to their future, thus, promoting smart integral communities.
In connection with the reform of education in Ukraine, the introduction of the program «New Ukrainian School» [8], there is a need for new architectural and construction solutions. Children need space and freedom of action both in school and indoors and outdoors. Freedom of action and space encourages development and does not restrain children in search of knowledge.

School complexes /centers on difficult terrain are technologically new educational institutions that have no analogues. They are designed not only to meet the functional and standardized needs and the generally accepted set of subjects provided by the reform of education in Ukraine, such educational complexes give children a choice and take into account their requests. School complexes on difficult terrain contribute to the formation and development of comprehensively developed individuals motivated by self-education and self-development, conscious, socially active citizens, patriots, able to ensure economic growth and cultural development of the country.

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