

Parametric Architecture in the Formation of Recreational Complexes

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Abstract. The architectural form of recreational complexes is inevitable without taking into account the structural skeleton, functional fullness and aesthetic perception of the object. The use of large-span structures plays a huge role in terms of the subsequent re-profiling of the recreational complex into a more modern facility that meets constantly changing modern requirements. Thus, in shaping, the role of modern design tools, computational design or parametrisation, taking into account BIM-technologies, is taken into account. Dynamics and transformation are important aspects of the parametric architecture in the design and construction of recreational facilities. Architectural shaping of the large-span structural shells makes it possible to change the enclosing skeleton of the building and change the functional zones depending on the class, level and profile of the recreational complex.

1. Introduction

The search for the ideal form in the architecture of recreational complexes and objects of leisure and tourism is carried out by the method of a combination of standard geometric forms. Geometry of forms is based on the introduction of additional information. At present, it seems possible to translate the surrounding reality into numbers and assign indices to space and architecture. Accordingly, decompose them by indexing in detail. In the design of recreational objects, we are dealing with a multitude of components. This may involve a number of Giant structural and architectural elements of a single multi-functional complex or group of separate volumes interconnected recreational functions. All these options and elements need to be properly organized. So, for example, in modern projects that are based on the computational design method, it may seem that all components are the same, but it is not so. In fact, the dimensions of each part or assembly are slightly different from each other in order to be able to arrange them in such a way that everyone can see the key dominant of the architectural structure. Taking into account such modern tools as Rhinoceros and Grasshopper, it became possible to facilitate the design and turn the search into a game of algorithmic search for form and function.

The purpose of this study - based on analysis of parametric design method of modern recreational facilities to develop the author's method for the design of recreation facilities and tourism.

2. Relevance of the topic

Parametric forms are one of the fundamentally important issues of architectural theory, education and practice. Architectural production is often accompanied by debates about the legitimacy of its design



approach, questioning the relationship between function and form, aesthetics and building systems, context and structure, user needs and construction costs in all possible configurations.

The concept of development of parametric architecture in the formation of recreational complexes is the formation of adaptive ability [1] without the subsequent loss of structural and architectural stability. It is important to understand that in the parametric design method the form affects the function and vice versa.

In recent years, innovative methods of searching for forms have been introduced in computing tools, allowing a new look at architectural design and subsequent production. Methods of searching for new non-linear forms for the design of recreational industry objects are generative design, algorithmic approach and parametric design. These methods are often described by such terms as "generative design", "parametric design" or "algorithmic design", and these are just some of them. They offer new ways of designing for architects, breaking with a predictable relationship between form and presentation in favor of computational complexity, which allows the development of new topologies. They shift the focus from the "form" to the "search form" [2].

The theoretical and design basis of the study included the positions of specialists and architects on the organization of recreational complexes in the following areas:

- Architectural and planning organization of recreational zones and shaping the architecture of recreational complexes [3], [4], [5], [6]
- Parametric approach in form plastic and function [7], [8], [9]
- On the plastic organization of the landscape [10], [11], [12]
- On the town-planning characteristics [13],[14],[15],[16]

At the same time, the issues of organization of recreational complexes by the method of parametric shaping remain poorly covered in scientific works and project implementations.

3. The objectives of the study are:

- Analysis of the plastic of the form of recreational complexes and the effect of form on the function, and the function on the shape
- Identification of the features of placement of complex parametric volumes and combined objects of a recreational environment
- Formation of basic principles of architectural and spatial organization of recreational complexes.

4. The theoretical part

4.1. General concept of parametric architecture in the design of recreational complexes

Critics of parametric project approaches argue that they disconnect the architectural output from their context and its users, and also lead to a decrease in spatial quality and integration of the building or volume in the urban environment. In addition, some argue that a fully computerized approach leads to a disconnect from physical modeling and development of methods. Consequently, the object risks losing tangible qualities, effects and properties. Nevertheless, various computational methods of determining the form existed in architecture long before the digital revolution. In the early twentieth century, many architects, engineers and designers, such as Frederick Kiesler [17], Frei Otto [18], and Le Corbusier [19], used design methods that were very similar to the modern computational approach. It seems that modern methods of computational design are not new. In order to better understand these processes, it is worthwhile to briefly review the various forms of philosophy that have dominated the architectural design for a long time and are widely used today.

4.2. The processes of designing recreational complexes and recreation and tourism objects, conditioned by nature

Architecture based on nature is still found today. The City of Arts and Sciences of Santiago Calatrava in Valencia (1996 - 2006) and the concept of recreational architecture, designed and built by Zaha Hadid bureau on the shores of Novorossiysk, where nine perpendicular to the sea buildings will appear, from which the visitors will have an impressive panoramic view, is a prime example. In this complex will be located hotels, public spaces and places for international conferences, fairs and business congresses. The project also provides for the creation of a park zone, a fishing port and a marina. The buildings, different in height and shape, will be arranged in ascending order in height, which will give the dynamism to the complex as a whole. The architectural features of each building are determined by its function. Although each of these two projects used different tools, they all mimicked the intellectual processes of living organisms or natural phenomena, translating them into architecture, rather than simply using them as inspiration for form and appearance.

4.3. The processes of designing recreational complexes and their objects, based on the geometry of the natural landscape

A striking example is the mansion "CAPITAL HILL REZIDENSE", located in the Moscow region in the village of Barvikha. While working on the project, Zaha Hadid proceeded from topographical features of the terrain and relief. The main volume of the building is partially inscribed in the depth of the hill and the object as if grows out of the ground. The surrounding landscape is immersed inward and creates a special landscape, in which the boundaries of the outer and inner spaces seem to be missing. A separate dominant, located at an altitude of 22 meters, opens the view points to the surrounding forests and the horizon. The connecting link between the components of the mansion are three concrete supports, forming a tower. CAPITAL HILL REZIDENSE refers the viewer to the traditions of the Russian avant-garde, including El Lisitsky's "Horizontal Skyscrapers" [20].

4.4. Context-Driven Design Processes

Using architects morphological and typological elements as an approach to design solutions, form a constructive movement. The theoretical basis of contextual design was the theory of "fold", which became the driving force for nonlinear architecture. Architecture, which is at the intersection of sciences, responds to the adoption of new paradigms. The architectural space becomes even more dynamic, and the forms are more free and closer to nature. The interdisciplinary approach has made the language of architectural shaping more vivid and rich. The "fold theory" and the idea of a topological change in the object became the basis of nonlinearity and deviated from the standard understanding of the architectural form. This greatly expanded the worldview of designers. There was an interlacing of architecture and environment. [21].

4.5. Processes for designing due to performance

In contrast to the above, a number of architects and engineers practiced a completely different method of determining the form. They focused on the smallest possible form, based on the structural characteristics and properties of the material. The link of the building with its context plays only a secondary role. The search for the ideal form in the architecture of recreational complexes and harmonious proportions is carried out by a combination of typical and standard forms saturated with additional information. At present, it is possible to translate the surrounding reality into figures, assign indices to space and architecture, respectively, decompose them by indexing every detail. In architectural design, we are dealing with a variety of components. It can be a huge amount of constructive and architectural elements, and all these units must be properly organized. For example, in modern projects that are based on the computational design method, it may seem that all components are the same, but it is not. In fact, the dimensions of each part or assembly are slightly different from each other so that you can arrange them in such a way that everyone can see the key dominant of the architectural structure. Taking into account such modern tools as Rhinoceros and Grasshopper, it became possible to facilitate the design and turn the search into a game of algorithmic search for form and function.

At present, the question of the need for a holistic relationship between a recreational complex and a town-planning solution is very relevant. Parametric recreational objects are found only as combined volumes separately located in the existing recreation and tourism environment. There is a certain limited inclusion of resort buildings in the natural landscape from the point of view of the design processes caused by the formation. Accordingly, it seems possible to identify holistic recreational parametric complexes and combined ones. It is therefore important to take into account the method of shaping on the basis of various combinations. [13].

In the architecture of modern recreational complexes, we are dealing with a lot of form-building components, we can talk about an infinite number of elements, hence all this must be organized. The opinion that they are all the same is wrong. Their dimensions have long been determined by infinitesimal differences. This is due to the use of higher mathematics algorithms for production and design. Higher mathematics is the science of curves. Even a straight line in higher mathematics by definition is a curve, just this curve without inflection. A new understanding of the form can be implemented in all objects related to recreation and recreation. In this way, you can view the parametric design method with a pre-programmed form [22-24].

Consequently, it can be noted that modern digital design tools have influenced such tasks as:

- structure and shape of the shell, which is appropriate to apply in recreational facilities
- parameters of the internal comfort of recreational architecture, in particular the multifunctional complexes themselves

The form of a recreational complex or a separate structure for recreation and tourism in the modern non-linear context is subordinated to the transformation of the simplest geometric bodies and is organized by applying complex mathematical algorithms that react to changes in curvature. The given form parameter defines silhouette outlines while forming the internal space of the architectural object. The structure of the shell of the complex is accordingly subordinated to the general form, but is designed in such a way that affects the overall image of the architectural object. The structure of the shell is in close relationship with the functional purpose of the internal form and corresponds to comfortable conditions. The parameters of the building, in addition to the aesthetic properties and the structure of the shell, determine the design features of the object and are in interrelation with it.

Functionality corrects the appearance and structure of the shell. An important aspect is the insolation of recreational facilities. The shape, structure and location of functions are directly dependent on the sun's rays. The architect uses the CAD and BIM drawing tools of computer systems in terms of space, shape, material and structural elements, and computer editors of 3D visualization, modeling and programming are often involved in formalizing architectural tools. These tools make it possible to apply the algorithmic design process, thereby dividing it at the stage of working with the form and structure of the architectural object. Algorithms can be step-by-step and logical:

- The step-by-step algorithm mimics the shaping process directly affecting the constructive part.
- The logical algorithm makes it possible to translate the information of their various data sources into parameters that are necessary to control the process of shaping.

Architectural shaping of the large-span structural shells makes it possible to change the enclosing skeleton of the building and change the functional zones depending on the class, level and profile of the recreational complex. The level of comfort of recreational complexes is differentiated depending on the season, the contingent of vacationers, the duration and short duration of rest. At full or partial change of a functional or a category of a complex the big spans give a constructive opportunity to reformatting and transformation of the zones intended for sports, rest and residing.

In the architecture of recreational complex objects, the use of a computational paradigm helps to derive the concept of an object from very abstract things. The architect needs to conduct a large-scale study of the territory and create algorithms that will best meet the project requirements. An integral part of the modern architectural design is variability. This is the creation of a variety of options and the choice of the most suitable. With BIM technology, changing and adjusting parameters at any design stage reduces the number of errors and makes the final result according to pre-defined conditions.

When applying the parametric modeling method for the creation of recreational complexes, five directions of design:

- Form parameters
- Parameters of topography, environment
- Parameters of the shell structure that creates the multifunctionality of the recreational complex
- Digital Prototyping
- Interactive Environment

All these five parameters for designing recreational complex objects should always be considered together. Thus, it is possible to single out the following principles for the formation of recreational complexes with the help of parametric design:

- Principle of form-building actions
- Principle of prototyping and context

5. The practical significance

Parametric modeling of recreational complexes should be implemented in modern design through comprehensive study and analysis of the territory, a clear gradation of the function of the volumes and facilities needed for recreation and tourism. It is advisable to continue scientific research and justification for an integrated or combined approach in the field of computational design and parametric design. An important task is the introduction of design on the basis of mathematical algorithms in the educational processes of architectural institutes, with the aim of mastering new skills in designing, modeling, and the ability to combine architectural shaping with mathematical analysis.

6. Conclusions

The form of the recreational complex can be subordinated to the transforming actions of simple geometric bodies. Formation should be organized by complex algorithms that allow to respond to the context. The shape of the recreational complex determines the overall silhouette of the object while limiting and forms the inner space of the complex.

The structure of the shell of the recreational complex and the parameters of the shell are subject to the shaping properties of the general shape of the object. The shell project affects the final image of the object. The shell structure reacts to the functional purpose of the building inside and corresponds to the required comfort conditions.

The functional purpose of the recreational complex is the parameter that determines and corrects the appearance and structure of the shell. Depending on the effective location of functions within the complex, it is advisable to place them.

The insulation parameters or the orientation of the object in space are an important basis for the form and location of the functions.

The parameters of internal comfort are associated with the shape and structure of the shell of the complex, functional purpose and insulation.

All these forms and structures can change at the design stage using BIM technology and parametric design.

In the process of operation, the functional purpose of the complex may change, and the form and the shell remain unchanged. Architectural shaping of the large-span structural shells makes it possible to change the enclosing skeleton of the building and change the functional zones depending on the class, level and profile of the recreational complex.

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