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УДК 72.04:004.92

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USE OF INTERACTIVE KINETIC FACADES TO GENERATE ENERGY AND AS A WAY OF VISUAL REHABILITATION OF THE DIPRESSIVE AREAS OF THE ARCHITECTURAL ENVIRONMENT

Formulation of the problem. Continuous growth of the world's population has led to an increase in urban infrastructure. Massive development of large areas with monotonous architecture negatively affects people living in such regions [1].

Relevance. Over the past few decades, kinetic facades have emerged as alternative building envelopes, designed to meet the increasing of varying and complex demands related to user comfort, energy consumption and cost efficiency [2]. One possible solution to the problem is the use of interactive facades, which can significantly increase the visual and aesthetic qualities of the architecture. The use of adaptive interactive kinetic facades will also allow performing functions such as: the use of alternative sources of energy generation, the introduction of adaptive synthetic and organic materials, interactive image projection technologies, lighting, thermoregulation, rotation of different building elements, ultraviolet protection (fig. 1).

Kinetic architecture is a concept through which buildings are designed to allow parts of the structure to move, without reducing overall structural integrity.

A building's capability for motion can be used just to: enhance its aesthetic qualities; respond to environmental conditions; and/or, perform functions that would be impossible for a static structure [3].

Only in the early 20th century that architects began to widely discuss the possibility for movement to be enabled for a significant portion of a buildings' superstructure. In the first third of the 20th century, interest in kinetic architect was one of the stands of thought emerging from the Futurism movement. Various papers and books included plans and drawings for moving buildings, a notable example being Chernikhov's 101 Architectural Fantasies (1933). For the first few decades of the 20th century kinetic architecture was almost entirely theoretical, but by the 1940s innovators such as Buckminster Fuller began experimenting with concrete implementations, though his early efforts in this direction are not regarded as totally successful [4].

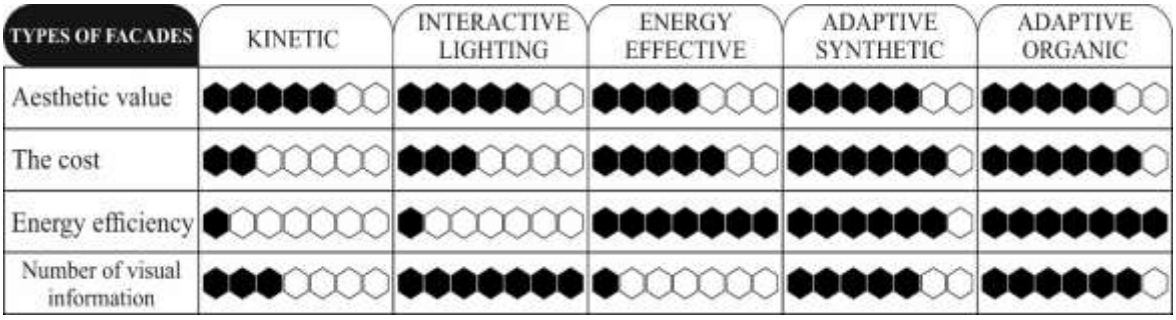

Fig. 1. Classification of different types of facades by parameters

Classification of facades

1. Static facade; Consists of the elements of the connecting panels. Panels can be made of various materials: aluminum, plastic, composite materials, as well as have any two-dimensional pattern or texture.

2. Kinetic: dynamic, rotating, moving facade panels. This type of facade uses wind energy for rotation.

To study the principles of work and fabrication of elements, I chose the 2D kinetic facade. This is one of the most inexpensive and available to date type of facade. Axial guides of the facade were made of steel, panels and a base of plywood and composite. Method of manufacturing: milling machine with numerical program control (fig. 2).

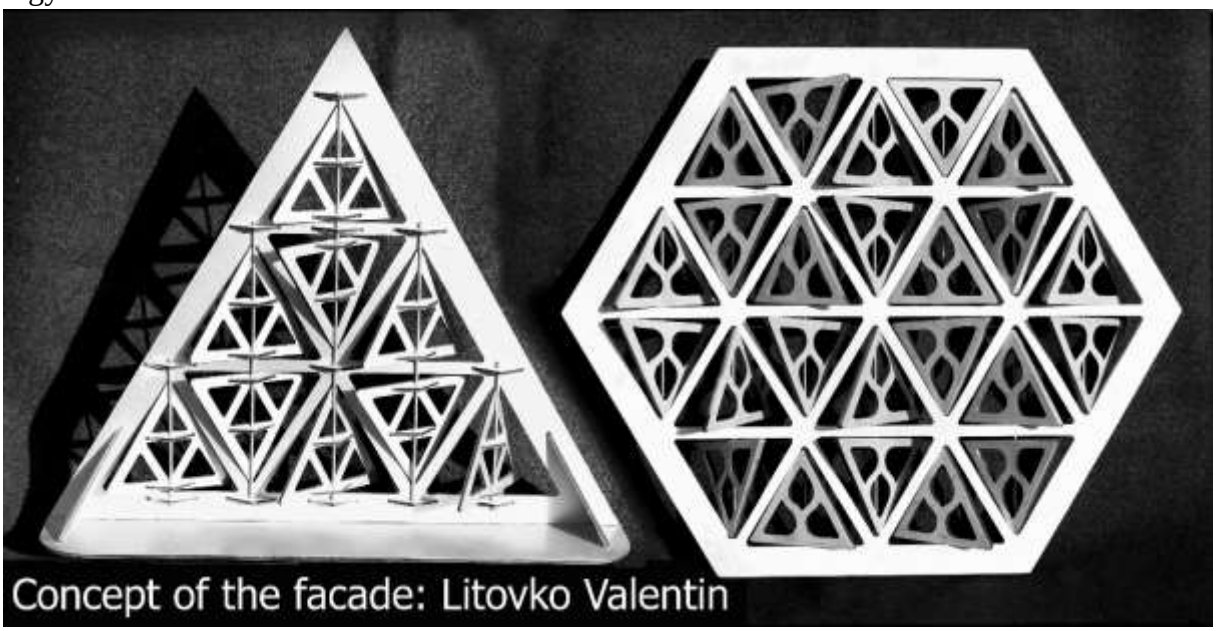

Fig. 2. Prototype element of the kinetic facade. By: Litovko V.S.

3. Interactive light facades: the possibility of lighting both the street and the interior space of the room, ICE, projected facades, the ability to transfer images to the facade with the help of light elements.

One of the interesting examples the «Crystal Mesh» facade of the Iluma Shopping Center in Singapore was designed by Berlin firm realities:united. The tessellated plastic, embedded with lamps, envelops the convex sides of the edifice.

The crystal media façade is a three dimensional canvas on which media artists, art students and even the public can apply fast moving, legible images, text and graphics and architectural treatments, all at the scale of a city block. Iluma has the new and exciting potential to give ordinary citizens the opportunity to impact their surroundings at an urban scale [5].

4. Energy-efficient facades: using alternative energy sources, wind generators, solar panels.

5. Adaptive synthetic facades: using adaptive technologies 4d printing, innovative adaptive materials, the use of flexible composite materials, materials with memory. The use of active sensors responding to changes from outside and adjusting the facade to these changes. Soma‘s “One Ocean” thematic pavilion the biomimetic approach of the kinetic facade further tries to link the building to its context. The facade has a total length of 140 meters and has a variable height between 3 and 13 meters. 108 kinetic lamellas make up the surface and supported at the top and bottom edges of the facade. The lamellas are composed of glass fibre reinforced polymers which gives them a high tensile strength, low bending stiffness and allows for large reversible elastic deformations. The kinetic facade was developed together with Knippers Helbig Engineers. The goal was to create a seamlessly integrated and continuous skin. A biomimetic approach was chosen to achieve the smooth movement desired [6].

6. Adaptive organic facades: using adaptive technologies of 4d printing, organic cells, innovative adaptive materials. Smart Material Concept: Smart Material Houses exemplify a new prototype of buildings that combine adaptable structural design with smart technologies and building materials. The state of art bioreactor façade is pointing the way ahead for the future of the façade and low energy engineering for Green Buildings. The conversion of light to heat is a well-known physical process used in solar thermal design. In contrast, the conversion of light to biomass is a biochemical process facilitated by microscopically small algae, called microalgae. Microalgae-like vegetables use sunlight for the photosynthetic process and this is linked to the process of conversion of CO2 to organic matter. This fact leads to a new opportunity of reducing CO2 emissions through building façades.

Energy Concept: The basic idea behind the energy concept is the combination of different energy sources so that they will work together. The energy concept is thus capable of bringing together, in one circuit, solar energy, geothermal energy, a condensing boiler, district heating, and the production of biomass in the bioreactor facade. [7]

7. Mixed type of facade. Each of the above facades can simultaneously combine several types of facades performing more functions. Combinations of technologies can be different: energy efficient and interactive; Kinetic and adaptive; Kinetic and energy efficient.

Conclusions. A kinetic façade can be used to manage light, air, energy, and even information. They can act to reduce solar gain as well as allowing the passage of fresh air into the building, helping to alter the interior environment. The moving elements of the façade can be programmed to respond to climatic or other environmental factors, time, levels and type of occupancy and so on to improve performance and efficiency.

With advances in sensors, materials and building management technology, designers are increasingly able to consider kinetic components as design solutions.

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