The Use of Natural Materials in Environmental Architecture

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Abstract – This report analyzes the ecological use of natural materials in construction activity in a historical context. We discovered the concept of eco-style, ecological architecture and object eco-design. It is shown an outstanding contribution of contemporary architects in the development of ecostyle on the examples of their projects. We displayed the usage of secure ecological materials such as wood, stone, clay (bricks) in creation of outstanding masterpieces of world architecture in different epochs. It is shown advantages of eco materials and disadvantages of hazardous materials (in terms of building materials ecology) for use in modern construction and reconstruction and restoration of historical buildings.

Key words – ecological natural materials, wood, stone, clay, textiles, ecostyle ecological architecture

I. Introduction

The development of ecological mentality was a response to the sharp deterioration of the environment that characterized the second half of the XX century. The term "ecology" (the study of the relationship of plant and animal organisms with the environment) also touched upon the realm of architecture (ecostyle, ecodesign, ecological architecture, etc.).

The use of natural building materials and traditional techniques was the first manifestation of the ecological approach to design. As a result ecological architecture direction is based on the principles of materials and energy economy, organic interaction of man-made objects and natural environment.

The basic principles of ecological construction today is environmental friendliness of building materials during production and operation, taking into account climatic factors of the region building, alternative energy sources, matching the form and function facilities of region climatic conditions, proper disposal of waste and the use of closed recirculation systems, minimizing the negative building impact on the environment. The principles of ecological architecture are used in other areas: organic architecture, high-tech, eco skyscrapers construction and urban environmental planning [1–3, 19].

II. The use of natural materials in construction activity

The art of construction of buildings, architectural work, constructing - is one of the oldest professions on the Earth, which is inseparably linked with the history of human society. Architectural styles varied in the course of time, were improved methods of building, design solutions and architectural expressiveness and aesthetic structures, materials were diversified.

Architecture and construction always correspond to the level of technological progress and ideals of its time. It is worth to mention masterpieces of architecture from all over the world. Starting from the primitive dwellings, construction material [9, 10, 13] – wood, you can see it on Fig. 1, cane, clay, stone, leather, animal mats and bones), megalithic structures (stone), the Egyptian pyramids, temples and temple complexes at Karnak and Luxor of Ancient Egypt (stone, demonstrated on Fig. 3) ziggurat of Mesopotamia (raw brick, burnt brick, shown on Fig. 2). From the V century BC begins the development of another great civilization of the past – Ancient Greece (Athens Acropolis temples – the Parthenon (Fig. 4), the Erechtheion temple and the temple of the goddess Athena) (material – natural stone), and Ancient Rome (Pantheon, the Coliseum) (stone, brick, Roman concrete). In Byzantium architecture of the St Sophia's Cathedral in Constantinople were used natural stone, brick (plinfy) light tuffs (to ease the weight of the dome). Medieval Gothic skeleton construction of Gothic period – are Gothic churches (tracery of stone on Fig. 5) or half-timbered buildings of the medieval bridge (wooden frame and clay). The most famous architects of the Italian Renaissance – Donato Bramante, Michelangelo Buonarroti, Dzh.B.Vinola, A.Palladio, which are shown on Figs. 6, 7 and 8) used only environmentally friendly materials, such as – natural stone, brick, wood and mortar – smooth and textured lime-sand plaster.

In the history of architecture it is evident consistent use of traditional natural materials: wood (extensive list of conifers to hardwood, pine, cedar, oak, beech, etc.); rock (limestone, sandstone, tuff, marble, travertine, granite, basalt, etc.); clay (raw brick, brick, dried in the sun) and artificial natural material (burnt bricks); lime (for disinfection and aesthetic functions); herbal natural elements (tree branches, weeds, leaves, straw). Thus, the history of the building proves that modern construction and architecture – is a large space ideal for the implementtation of projects for people and their health [6–11, 17].

Fig. 1. Zrub in the USA [19]

Fig. 2. Ziggurat [19]

Fig. 3. Karnak & Luxor Temple Complex [19]

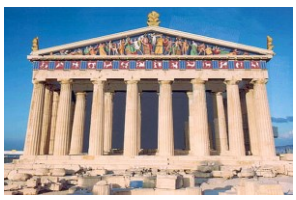

Fig. 4. Parthenon [19]

Fig. 5. Tracery (gothic) [19]

Fig. 6. Donato BramanteSt. Peter's in Rome [19]

Fig. 9. "Chair of texture". Designer Tjep [19]

Fig. 10. Florian Schmid "Made from concrete" [19]

Fig. 7. Dzh.B.Vinola Church of the Gesù [19]

Fig. 8. Church of the Gesù [19] Basilica in Rome [19]

Fig. 11. Javier Senosiain. Bio Architecture [19]

Fig. 12. Chair for resting. Biodesign [19]

III. Ecological style in architecture and design

Ecostyle is one of the most popular modern styles nowadays. Naturalness in everything – that is the principle of Ecostyle. Therefore, no plastic, metal and particle board should be used. The interior in the style of "eco" is made from natural materials and in harmony with the environment, gives a sense of freshness and unity with nature. Any habits and preferences can be displayed in the created interior as a form determined by the content. In decoration and objective environment basic colors are most used – white in contrast with dark wood, beige, brown and natural hues of nature. The relevance of ecostyle is associated with the desire of the civilized world to live consciously, rationally and responsibly using natural resources and for maintaining clean environment. Ecostyle principles in furniture design – particularly, the use of waste wood, metal, textiles, enabled the production of various products, each of which is unique. As an example, one can cite "Chair of texture", what observed on Fig. 9, by designer Tjep. The innovative material is used by German designer Florian Schmid in the manufacture of furniture for sitting with a series of "made from concrete". It is demonstrated on Fig. 10. Very close to ecostyle is biodesign (Fig. 11) (bimorph architecture) – its main difference is simulating natural feature of natural forms. Ideology is the style unity of man with primeval world. Object biodesign is most developed in designing furniture for sitting and relaxation, and fixtures are shown on Fig. 12. The main objective in designing techniques of biodesign include: pastiche certain aspects of natural prototype, sculptural interpretation of forms, parametric design, use of natural raw materials and industrial waste [12, 14–15].

IV. Prominent architects and their eco-projects

We also want to consider more the contribution to the development of talented architects to Ecostyle. After all, these people want to change our routine.

The biggest ecological building in the world is the California Academy in San Francisco in the "Golden Gate" park, designed by Renzo Piano (Fig. 13). The building is almost a hectare of living space, covered with soil. Museum of Natural is opened in the building; it is functionally and visually connected with the natural environment. On the roof of the Academy is arranged with the windows that opens and closes using temperature monitors, providing natural ventilation and thermal insulation through soil 150 mm.

Symmetrical correct and at the same time complicated shape in planning is «Earth House», built by Jolson Architecture Interiors in Victoria, Australia (Fig. 14). The house covers 465 m² and 97 acres integrated with a garden maze.

Prices villa designed by Bart Prina is secluded housing on the Pacific Ocean. The building is harmoniously integrated into environment like growing up out of rocks and waves repeating lines. Another object of this architect is High Residence, which was initially planned as a country residence. In the process of building into a real environment, it was integrated into nature, which implemented all customer requirements (Soil architecture).

Emilio Ambash built a large cultural center in Fukuoka (Japan), 15 – storey complex with a lot of exhibition space, conference rooms, museums and thus saved the "lungs of the city". You can find it on Fig. 15.

Green Park, which was located on the ground, continues to rise across steppe south facade of the building, turning it into a terraced garden of Babylon. Patrick Blanc became famous due to biological decor called "vertical gardens" (Fig. 16). This is not just ivy or vines but many beautiful plants that are able to keep upright life, with a minimum of feeding and artificial lighting. Plants that form the garden should not just get along with each other, but have the harmony of color, size and texture of the leaves, creating a unique pattern, color transitions and relief composition. Frydensrayh Hundertwasser – is bright, bold and unique artist (Fig. 17). One of his memorable creations - building in the German city of Darmstadt, built in 2000 in his bimorph ecostyle. This creation is still discussed. The opinions are polar: from "the horror!"To" I want to live this way! ". There are no straight lines or correct angles. Line facade, facade graphics resemble the very nature of creation than of human hands.

Architect Ken Young engaged successfully more than 40 years in projects, which are called "green", he is known as the inventor of the bioclimatic approach in the design of high-rise buildings and is considered one of the world's leading experts in the field of environmental and energy-saving design. It is observed on Fig. 18 [7–8, 18].

Young studies and uses in his practice methods by which buildings are functioning like in natural ecosystems. This approach is based on the use of environmental principles, passive energy saving techniques and promotes the creation of structures that interact with the environment, economic construction and use, and provide a higher level of comfort inside buildings. The "green" architecture has the following trends: a) planting shrubs, trees and grass on the balconies; b) vertical garden; c) greening the roof (often flat).

Landmorpfing. One of the most prominent representatives considered with Landmorpfing – is Charles Jenks – American landscape architect and designer who developed many projects related with the movement of large volumes of earth to create volumetric-spatial compositions. Example is garden "Goddess of the North", created on the site of the industrial area of coal mining. The relief of the park creates a gigantic sculpture of the goddess of Earth with height 34 m and length of about 400 m [4–5].

Fig. 13. Renzo Piano. Academy of Sciences in California [19]

Fig. 14. Earth House. Jolson Architecture Interiors [19]

Fig. 15. Emilio Ambash. Cultural centre.Fukuoka [19]

Fig. 16. Patrick Blanc. "Vertical gardens" [19]

Fig. 17. Architecture of Frydensrayh Hundertwasser [19]

Fig. 18. K. Young. «Green architecture» [19]

V. Modern materials in the design of architectural environment

Safe materials are traditional and produced on a natural basis: brick, stone, concrete, decorative materials on the basis of plaster, wood (Fig. 19) and glass. Dangerous building materials in terms of ecology are materials with a high number of polymers consisting of: various kinds of plastic, linoleum, roofing materials, and most hazards are varnishes, paints and materials based on phenol and formaldehyde. The latter can make unfavorable effect on human health. Linoleum or laminate, even when heated by sunlight produce a whole range of organic and toxic substances (Fig. 20). Low-quality paints and varnishes, and can eventually cause allergies or asthma. One way of solving environmental problems of building materials is the use of new high quality materials (eg. products of the roofing material). Some progress has been made in this regard, particularly with regard to, for example, sound facilities.

Fig. 19. Ecological material: wood [19]

Fig. 20. Harmful material: linoleum [19]

Conclusion

Tradition of widespread use of ecological natural materials to create attractions of world architecture in different eras confirms the importance and indispensability sustainability of their use in various cultures.

We outlined the place and importance of natural environmental materials to the concept of ecostyle, ecological architecture and ecodesign objective. It is shown the contribution of the prominent architects in the development of ecostyle on the example of their projects.

Nowadays integrated environmental system has successfully been developed and implemented, new technologies connected with energy supply use solar power and wind, closed-type buildings and zero energy balance and biotic cycle, buildings using the integrated systems of complex automation of all life support systems, centralized management and monitoring. Yet I want to suggest, to some extent, to return to the old methods of construction, particularly, to use and process only ecomaterials. For example, in the reconstruction of historical monuments, as well as in designing of individual apartments should be used only environmentally friendly materials. The example of private housing is green roof-terrace two-storey Meera House in Singapore, designed by architectural firm Guz Architects. Architects tried to create the impression of the indivisibility of human and land, which is on the second floor.


Figs. 21 and 22. Ecostyle Interior [19]

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