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THE IMPACT OF GREEN SOLUTIONS ON SHAPING THE ARCHITECTURE OF BUILDINGS

WPŁYW ROZWIAZAŃ PROEKOLOGICZNYCH NA KSZTAŁTOWANIE ARCHITEKTURY BUDYNKÓW

Abstract

One of the basic guidelines of modern architecture is designing buildings in line with the rules of sustainable development. Architecture and sustainable development refer to the process of planning, programme, design, construction and management of the building throughout the time of its existence as well as its demolition carried out with respect for the natural environment. A building designed in compliance with the guidelines of sustainable architecture is consistent with green principles and uses green solutions. Green solutions contribute to the picture of the building, which apart from proper choice of materials and technologies, its strict inclusion in the context of the place and shaping of the interior space, should also be highly aesthetic in its body. The article analyses the impact of particular green solutions on the aesthetics and the body of buildings.

Keywords: sustainable development, energy efficient buildings

Streszczenie

Jedną z podstawowych wytycznych współczesnej architektury jest kształtowanie obiektów zgodnie z zasadami zrównoważonego rozwoju. Architektura i budownictwo zrównoważone odnoszą się do procesu planowania, programowania, projektowania, wznoszenia, zarządzania budynkiem przez cały czas jego istnienia, jak również jego rozbiórki, przebiegających z poszanowaniem środowiska naturalnego. Budynek zaprojektowany zgodnie z zasadami zrównoważonego rozwoju to taki, który spełnia założenia proekologiczne, z zastosowaniem rozwiązań proekologicznych. Rozwiązania proekologiczne składają się na obraz budynku, który oprócz stosownych rozwiązań materiałowych i technicznych, ścisłego wpisania w kontekst miejsca, ukształtowania przestrzeni wewnętrznej, powinien również cechować się bryłą o wysokich walorach estetycznych. W artykule przeanalizowany został wpływ poszczególnych rozwiązań proekologicznych na estetykę i bryłę obiektów.

Słowa kluczowe: rozwój zrównoważony, budynki efektywne energetycznie

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1. Introduction

Ecological context of architecture is now one of the design guidelines. The use of green solutions affect the respect for the environment, economic savings and the improvement of the buildings' utility. Endorsing ecological solutions in the design process has a significant impact on shaping the architecture of the buildings and leads to the construction of objects of characteristic spatial properties.

Green solutions in architecture are associated with an appropriate choice of:
– construction materials and technologies,
– installation

and with the shaping of the building structure consisting of the appropriate tasks such as:
– determining the relation of the building with its surroundings,
– distribution of functions and the internal space of the building,
– shaping the body of the building.

2. Construction materials and technologies

Selection of suitable building material has a significant impact on the primary energy content of the building, its energy consumption and utilization. The energy required to obtain raw materials, their processing, manufacturing, and transportation is referred to as the internal energy primary energy input [1]. Ecological materials are characterized by a low level of energy. The low energy content of the material is affected by the consumption of natural resources in the production process, the degree of processing of these raw materials, transportation, installation and durability of the material in relation to the period of the existence of the building.

An ecological building designer should include the use of low energy building materials in the design process. The use of local building materials (reduction of transport), the possibility of using recycled materials and traditional materials (low-processed) has a major impact. The impact of the production of construction material on the environment is also significant.

A design trend based on the use of traditional materials (low-processed) such as clay, wood, stone and the simplest technology can be observed in contemporary architecture. Low-tech architecture, also referred to as no-tech, is based on a conscious resignation from the achievements of modern technology (Paolo Soleri, Arcosanti, Arizona). A design trend of environmental humanism or environmental minimalism is characterized by the balanced use of traditional materials and innovative products. Combining local materials with industrialized ones such as brick, clay tiles, concrete, steel or glass can be observed in those trends (Gűnter Behnisch, Schaudt Architekten, OVO Grąbczewscy Architekci). High-tech and eco-tech architecture introduces highly developed technologies together with industrialized materials and high-performance materials such as composites, nanomaterials and smart materials with the ability to respond to changes in the environment (Norman Foster, Thomas Herzog, Gilles Perraudin). The eco-tech trend is based on the inclusion of active sustainable energy systems in the structure of the building [2].

The choice of material has a major impact on the appearance of the façade and the body of the building, especially when they are placed in the finish of the façade and internal partitions.

The use of natural materials in the building partitions often serves to emphasize the ecological nature of architecture. Highly industrialized materials (photovoltaic cells, solar panels, transparent thermal insulation) also bring about ecological associations. A major challenge for designers is also combining traditional materials with highly industrialized technologies.

The choice of material and construction has a major influence on the thermal capacity of the building structure. Materials of high heat capacity (e.g. brick, concrete, stone, clay) serve as a thermal mass. An important issue is the distribution of accumulation layers in relation to the functional layout of the building. An accumulation layer system should in due course allow for the free flow of the obtained thermal energy to the relevant rooms.

3. Installations

The dynamic technological development in the architecture of the twentieth century contributed to the introduction of installations that were to improve the comfort of the facilities. As a result, increasingly more complex installation systems (excessive use of air conditioning and artificial lighting of buildings) led to the development of disease symptoms of the so called "sick building syndrome" among the users. Today green installation solutions are based on environmentally friendly solutions (energy coming from renewable sources, energy recovery from internal systems), elimination of harmful phenomena associated with the operation of installations and limiting their impact on users (increase in the hygienic standard of installation e.g., the use of filters or silver additives in installation pipes) as well as an increase in device efficiency (optimizing the functioning of the installation, integration of internal systems, the introduction of operational control systems and the control systems themselves).

Ecological systems affect the architecture of the building (e.g., equipping a single-family building with mechanical ventilation instead of a gravity one requires more space for the passage of wires, which results in an increase in the amount of stories – and thus has a major impact on the body of the building). It is also necessary to design space for the components of the system. Particular devices, which are integral parts of the system, may be located in the buffer zones designed from the north or in the central part of the building. A large heat storage location has a major impact on the body of the building and the structure of the building`s functions.

4. Building surroundings

The design of green buildings cannot take place without their integration with the environment. Each building is unique because of the different location, climatic conditions and the surrounding urban infrastructure. There is the exchange and flow of energy between the environment and the building. An environmentally friendly building design concept requires a thorough analysis of the environmental conditions including: the type, shape and development of land, technical infrastructure, availability of media and renewable energy sources, sunlight, prevailing winds and the outside air temperature. The architectural consequences of green building design in relation to the environment are reflected in the formation of objects with a compact block (reducing heat loss by penetration) and with a longer south elevation (increased exposure in the direction of the most favorable insolation).

There may be some deviations from this rule due to the shape of the plot, adjacent buildings, communication system and the surrounding infrastructure. Design constraints dictated by urban circumstances do not disqualify ecological solutions. However, with the increasing urbanization of the land, designing optimal green solutions becomes more difficult and requires customized solutions.

A green building is in harmony with the environment. The area surrounding the building is not just a plane on which the building is constructed, but it is also a natural extension of the interior space of the building. Therefore, the development of the area surrounding the building conforms to the rules of inner space design. Zoning of outer spaces is carried out in a similar way as is the internal space (a buffer zone on the north side, i.e., parking lots, technical areas). The relation of the building with the surrounding area occurs also through the merging of inner and outer spaces: use of conservatories, opening of elevation in the direction of green areas and facing the south, eye contact with the environment, the introduction of greenery on roofs and facades of buildings. In the area surrounding the green building there may appear different infrastructural elements connected with the functioning of the building such as: air intakes, short-term reservoirs of heat, elements of the solar panels or photovoltaic panel installation unrelated to the body of the building.

5. The functional layout. The interior of the building

The configuration of the function and the distribution of internal partitions in an environment-friendly building is extremely important due to the fact that the interior space of the building should allow for the free flow of air, natural light and heat obtained from solar radiation. This space is not only designed to meet all the functional and aesthetic requirements, but it is also used for obtaining, storing, circulating and recovering energy. It becomes essential to form it skillfully in terms of building physics, the use of natural phenomena such as the greenhouse effect, convection (solar chimneys) and absorption or heat transmission.

Thus, the zoning of the premises on the basis of their usable temperatures becomes crucial. Technical and economic premises, communication zones, and auxiliary facilities are located on the north side, creating buffer zones. On the southern side there are rooms for which thermal energy from solar radiation is recommended due to their high demand for thermal energy: living rooms, offices, dining rooms. A characteristic of the ecological building floor plan formation (and hence, the body of the building) are additional profit zones (buffers located to the south side of the building), greenhouses and conservatories integrated with the body of the building. In addition to the aesthetic advantage of the opening to the building being on the south side, this zone has the task of extracting heat energy during the heating season. Thermal zoning of rooms occurs also vertically and is dependent on the density of the surrounding buildings and obstruction by surrounding elements (a zone with the greatest demand for heating energy should be in the most advantageous position in terms of insolation e.g., in the case of a single family building with a high density of the surrounding buildings, the location of the living room may be more favourable on the upper floors and not on the ground floor).

The formation of functions and the interior of the ecological building should allow for the use of natural lighting, ventilation, cooling and heating of the building in an optimal way. It becomes reasonable to create clear functional systems with narrow tracts in order to provide

better access to light and to group rooms with the same demand for internal microclimate parameters. Deep building tracts necessitate the use of courtyards and solar chimneys.

6. The body of the building

The ecological structure of the building should be characterized by its compact form due to the reduction in heat loss by penetration through the building envelope. However, an ecologically friendly building is characterized by its close connection with the surrounding area and its adjustment to the parameters of the external environment. Therefore, the body of the building fitting naturally with the surrounding landscape can be characterized by fragmentation, low building height, an extensive area of the ground floor and other individual spatial characteristics.

A characteristic of a building gaining energy from solar radiation is an adjustment of the solutions of the body of the building to the external climate. For this reason, an ecological building is characterized by the presence of spatial elements in the form of: conservatories, glazed or open courtyards, atriums, solar chimneys, moving facade elements that enable adjustment of solar profits. The body of the ecological building is very often characterized by elevation variability depending on the time of day and year (adjustable movable sun visors, interactive elevations and intelligent elevations). The outer shell of the body of the building also gains a different importance as it is not only to protect it from the elements, but also above all, to let the factors influencing the improvement of the microclimate into the interior and to keep the climate worsening factors out. The use of an external facade sunshade system gives rise to the "multi-layered" partition effect and the ambiguity of the external borders of the building.

A green building is characterized by the opening to the south (large amount of glazing) and the reduction of glazing on the north side i.e., differentiation of the glazing on the basis of the orientation of the facade in relation to the cardinal directions. Due to the formation of the details of the facade preventing the occurrence of thermal bridges, the body of the building is usually devoid of elements which would break its continuity. On the south side of the building, there may be additional visors in the form of balconies, galleries or bays, which also enable functional opening outdoors. A green building envelope can be actively integrated with components of the system acquiring renewable energy. These elements are properly exposed with respect to the cardinal directions – in a southern direction.

The architectural consequence of the use of ecological solutions in the facades of buildings is to increase the thickness of the external walls in order to achieve the desired heat transfer coefficient. This may result in the apparent sturdiness of the body of the building and reduced visibility through the windows. The choice of materials used in green building facades may be based on traditional or modern solutions. It is also possible to combine both of these trends.

7. Conclusions

Ecological building is a system of closely interrelated solutions, the choice of which is dictated by taking consideration of the external environment and the intended use and function of the building, with particular emphasis on solutions which promote respect for the

environment. Energy management is the priority in the design of such buildings. Distribution of functions, the use of appropriate building materials, technology, construction, installation, shaping of the body of the building is done on the basis of an analysis of a number of environmental conditions; it cannot be considered in isolation from them, as well as from other building elements included in the eco-friendly building. The use of green solutions in architecture involves the creation of objects with characteristic spatial features which serve to achieve an adequate comfort of the building.

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