GREEN ROOFS: SUSTAINABLE BUILDING SOLUTIONS

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Abstract: *Green roofs perform a vital role in helping cities adapt to the effects of climate change by reducing the need for artificial cooling in hot weather and attenuating or capturing rainwater runoff, as well as providing a range of habitats for wildlife. However, green roofs can only provide these environmental benefits if designed and installed in a way that ensures that minimum performance criteria are met. This code therefore highlights the important green roof design, installation and maintenance considerations and provides guidelines as to how.*

Keywords: Green roofs, Building, Energy performance

1. Introduction

In the 1920s, Le Corbusier formulated five principles of new architecture. One of these principles is creating a flat terrace on the building's roof, where a small garden or a relaxation area could be set up.

Green roofs are building roofs that are partially or completely covered with green plants. In English, the term "green roofs" is used in connection with the trend of associating green with environmental trends in society. However, roofs with potted plants placed on them are not considered green roofs.

2. Methodology

Green technologies are trending in modern architecture. An advantage of green technologies is the creation of conditions for a healthy lifestyle, primarily thru dust absorption, noise reduction, and protecting building coverings from atmospheric influences. Thanks to the use of green building technologies, a significant effect is achieved by reducing heat loss thru the building's exterior envelope, which lowers the amount of thermal energy consumed. The comfort in the rooms increases due to the reduction in the intensity of radiant and convective heat transfer on the inner surface of the enclosure structures. Environmental pollution is reduced due to the decrease in emissions of harmful substances into the atmosphere. Green roofs are an effective way to increase green space in an urbanized environment and improve the microclimate of buildings (Figure 1).

Green roofs help mitigate the urban heat island effect thru shading, evaporative cooling, and thermal insulation. The use of green roofs flattens the heat island effect by leveling surface temperatures and can significantly reduce the average temperature of an entire city.

Figure 1. *Installing a green roof*

Green roofs play a vital role in helping cities adapt to the effects of climate change by reducing the need for artificial cooling in hot weather and mitigating or capturing rainwater runoff. However, green roofs can only provide these environmental benefits if they are designed and installed in a way that ensures they meet minimum performance criteria.

These advantages of green roofs have been repeatedly confirmed in practice. However, until recently, the design issues of green roofs were not regulated, which prevented the full utilization of the high energy, ecological, and economic potential of green roofs in different humidity and climatic zones.

Thus, two Codes of Practice for green buildings and neighborhoods have recently been developed in the Republic of Moldova, which contain some regulations in this regard. These regulatory documents will undoubtedly be useful to the broader professional community: architects, designers, engineers, developers, and urban planners. Generally, it is expected to stimulate the construction of green roof buildings. Implementing the recommendations of the Codes of Practice developed in the Republic of Moldova will make it possible to utilize the advantages of green roofs more fully in construction. Also, in the Russian Federation this year, GOST R 58875–2020 "Arrangement and Maintenance of Green Roofs of Buildings and Structures" came into effect. Technical and environmental requirements." This standard, for the first time, establishes the typological characteristics of green roofs. The environmental and technical requirements for their design are considered in detail, and the requirements for the production of works and the operation of structures are presented. The requirements for the typology of green and maintained roofs will make it possible to apply the type of landscaping more rationally in a specific climatic zone, which in the process of operation will make it possible to achieve the necessary economic effect. Establishing typological requirements for green roofs is also important when conducting technical and forensic construction examinations, as it will allow the expert to unequivocally determine the type and design of the roof and correctly answer the questions posed by the court. During the operation of green roofs, knowledge of technical and environmental requirements will allow for timely control of the structure's design characteristics, maintenance of the structure in working order, and the performance of routine and major repairs to the roofs.

3. Results and discussion

"Green" buildings.

Green roofs are designed to provide high-quality indoor air and environment. These require the use of special methods for calculating thermal characteristics, air insulation, and moisture resistance. However, there are no rules for designing thermal protection for green roofs in the developed Codes of Practice, nor in GOST R 58875–2020. This complicates the work of an engineer and slows down the introduction of new design solutions into the practice of building biopositive buildings.

Energy performance of buildings with green roofs. Calculating the energy characteristics of buildings is necessary to evaluate the effectiveness of the energy-saving measures provided in the project. The calculation of the energy characteristics of buildings with green roofs must be carried out taking into account the thermal characteristics of the enclosing elements.

Green roofs are generally utilized throughout the year. Therefore, the calculation of the energy characteristics of buildings containing green roofs should be performed on an annual cycle, with an assessment of the annual heat and energy consumption of the engineering systems. The energy demands of a building for heating and cooling must be calculated taking into account the heat flows due to heat transfer thru the external envelope. Due to the existence of different thermally inhomogeneous zones within the building, it is necessary to take into account the heat transfer across the boundaries of these zones. Heat savings from internal household sources and

solar radiation should also be considered. Where necessary, the need for heat or cold for treating the exhaust air and providing the heating medium must be considered.

The energy consumption calculation by engineering systems should be performed in a non-stationary thermal regime based on the daily variation of outdoor air temperature and solar radiation. This will allow for the best consideration of the performance properties of green roofs with high thermal inertia. The influence of wind speed affects the calculation results to a lesser extent, so this parameter can be taken based on monthly average values. Using methods to calculate the non-stationary thermal regime of individual rooms and the building as a whole requires the use of special software.

4. Conclusion

The results of the research conducted demonstrate that the aforementioned normative documents, both the Codes of Practice and GOST R 58875–2020 "Arrangement and Maintenance of Green Roofs of Buildings and Structures. Technical and environmental requirements," will certainly be useful to the broader professional community. Generally, they are expected to stimulate the construction of green roof buildings. Meeting their requirements will make it possible to utilize the advantages of green roofs more fully in construction. In this regard, it is necessary to develop rules for the design of thermal protection for green roofs and present them in current regulatory documents.

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