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GREEN ROOFS AS AN ESSENTIAL ELEMENT OF MODERN URBAN ENVIRONMENT

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ABSTRACT

The need for the realization of green roof spaces has grown significantly in the last few decades, due to increasingly compacted urban spaces, which deprives urbanized territories of green areas. The positive sanitary and hygienic effect, the retention of dust particles and the improvement of the microclimate of roof gardens is a fact. This report presents comparative analyzes with selected european examples in the construction of green roofs. Suitable plant species and their requirements for this type of environment are described. Possibilities for a more tendentious integration of this type of landscaping in Bulgaria are presented.

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1. Introduction.

Modern green roof technology blossomed in the 1960s when Germany introduced a new, reliable technology that provided advanced irrigation and roof penetration protection. With its invention, Germany was able to establish this product on the market and develop the new green roof technology on a large scale like never before.

Green roofs have an advantage over standard roof spaces in terms of reducing the heat load of buildings, improving the microclimate, and improving the aesthetic condition of buildings [1].

This type of landscaped roof space is divided into two types: extensive and intensive, which differ in maintenance intensity, selection of vegetation, design elements, etc.

Historical development.

Green roofs date back thousands of years. In antiquity, green roof structures began as excavated roofs over caves, with "roofing" soil and plant life used for agricultural, residential, and ceremonial purposes. The downfall of these roofs was the lack of protection against burrowing animals and the lack of waterproofing ability. The first records of green roofs are seen in the "Hanging Gardens of Semiramis", which date from the period 800 - 600 BC and are one of the Seven Wonders of the Ancient World.

The industrialization of Europe over 100 years ago marked the beginning of densely concentrated buildings, in rapidly growing cities. An inexpensive type of roofing material from this time was tar. But it is dangerous because it is a flammable material. At this time a worker initiated a futuristic practice in the construction of landscaped roofs. He started the use of sandy material as the last layer on top of the impermeable layer of tar. These roofs are much more fire resistant than

typical roofs and in the sand layer some plant species begin to grow spontaneously. This marks the beginning of the history of green roofs in modern Europe. Some of these green roofs survived both world wars. In the early 1980s, 50 such buildings existed in Berlin alone, and they continue to be waterproof to this day [3].

2. Exhibition.

Roof landscaping is a proven positive for improving the technological qualities of buildings - prolongs the life of waterproofing, helps dust pollution, maintains their thermal regime. Depending on the type of roof garden (extensive or intensive), it manages to retain some of the rainwater, which in turn helps the drains to overcome intense rainfall without problems.

Preferred plants used to make extensive roofs are most often succulent species and herbaceous plants. Sedum, as a member of the Crassulaceae, is a popular, commonly used and highly suitable species for extensive roof accommodation. It has the ability to store water in its foliage and be resilient to harsh weather conditions. However, the main reason it is an extremely suitable species for this type of planting is that it does not need a deep soil layer. 2 - 3 cm is quite sufficient to satisfy the plant's needs. Its metabolism is modified - in the dark part of the day it absorbs carbon dioxide and the pores of the leaves are also opened only then, to minimize moisture loss during hot days.

The advantages of extensive roofs are that they accommodate vegetation that is less demanding and easier to grow, they allow moisture to evaporate and return to the atmosphere, and they cope better with the heat effect.

Intensive roofs provide an opportunity for design interventions as they have a wider choice of vegetation which can include lawns, shrubs and trees. These spaces can only exist if extremely well maintained. European design standards for such sites are lacking. The only source of information in this direction is the Guide for the Design, Implementation and Maintenance of Green Roofs, prepared by the German Research Institute for Landscaping - Forschungsgesellschaft Landschaftsentwicklung Landschaftsbau [7].

The minimum soil layer should be 20 cm. depending on the vegetation used (low, high shrubs, trees, etc.).

Components of a green roof [8].

Roof Deck.

The load capacity of the building's roof structure must be taken into account when considering the design and installation of a green roof. Green roof systems can vary in weight depending on the space's program and design, but typically weigh about 7 lbs per square foot per inch of growing media. For example, a 4" extensive green roof typically weighs 28 lbs per square foot and a 12" intensive system will weigh about 84 lbs per square foot.

Leak Detection.

It is recommended that the waterproof membrane be checked for leaks prior to adding additional layers. Leak detection systems are used on many green roof systems and typically consist of moisture sensors arranged in a grid fashion.

Waterproof membrane.

The waterproof membrane protects the building from water infiltration and serves as the primary point of protection between the green roof system and interior building improvements.

Root Barrier.

The root barrier protects the waterproofing membrane from root intrusion. This product is typically composed of a Poly-Vinyl Chloride membrane that is field welded together.

Protection Layer.

The protection layer provides a uniform surface on top of the waterproofing membrane to protect the system from abrasion and penetration.

Drainage Layer.

The drainage layer may be either a lightweight granular media or a synthetic layer that is set beneath the planting media. The drainage layer provides a balance between water retention and root aeration.

Filter Fabric.

Filter fabric prevents fine soil particles from passing into the drainage layer of the green roof system.

Growing Medium.

The primary purpose of growing media is to support plant growth and provide storage for stormwater. Growing media is typically composed of expanded clay, shale or lava rock.

Wind Blanket.

The wind blanket provides temporary erosion control when placed over loose laid growing media to prevent materials from blowing or washing away. It typically bio or photo-degrades over a two year period.

Plants.

Ideally plants chosen should be drought resistant and require no watering after their initial establishment. Sedum species are the predominant plants used for extensive green roof systems. Semi-Intensive systems can begin to support a limited number of native prairie plants found in shallow soils above bedrock.

Ballast.

Ballast is used to provide a free draining path to roof drains, hold down waterproofing membranes and provide membrane coverage in areas that do not positively support vegetation.

Roof Drains.

Roof Drains are placed in low points to help remove excess stormwater that moves laterally through the drainage layers.

Irrigation System.

Some extensive green roof systems require permanent irrigation in order to comply with the manufacturer's warranty. Irrigation is not necessary if proper plants are selected.

Applications for stormwater management and pollutant removal [8].

Green roofs have historically been used across the United States to reduce stormwater runoff. In addition, other benefits include extending the lifetime of the roofing membrane, reducing cooling loads, mitigating the urban heat island effect, and providing habitat. Unlike conventional roofing, green roofs promote retention and evapotranspiration of precipitation. The plants, growing media, and drainage layers absorb and store stormwater, significantly reducing the release rate and volume over an extended period.

Examples of plant species suitable for green roofs - soil layer min. 10 cm.

Allium schoenoprasm 'Chives'

Sedum spurium'John Creech'

Sedum acre 'Aureum'

Sedum spurium 'Roseum Superbum'

Sedum album 'Coral Carpet'

Sedum reflexum 'Green spruce'

Sedum sexangulare

Sedum spurium 'Vodoo'

Sedum spurium 'Fuldaglut'

Green roofs with a soil layer of up to 10 cm require plant species that are resistant to dry and windy weather, have low soil requirements and are small or medium-sized. These plants are hardy and can adapt to green roof conditions while providing ornamentation and functionality in spaces.

Delosperma nubgineum 'Basutoland'

Echinacea purpurea 'Purple Coneflower'

Sporobolus heterolepis 'Prairie Dropseed'

Opuntia humifusa 'Eastern Prickly Pear'

Bouteloua curtipendula 'Side Oats Grama'

Talinum calycinum 'Flameflower'

Sempervivum 'Silverine' Hen and Chicks

Examples of plant species suitable for green roofs - soil layer min 20 cm.

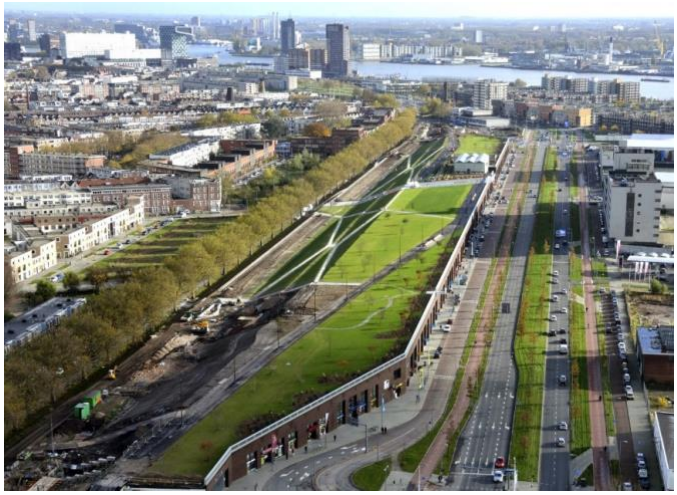
Green roofs with up to 20 centimetres of topsoil offer more vegetation choices. It is important to bear in mind that plants must be drought resistant, have shallow roots and be able to withstand extreme conditions such as winds, lots of sun and heat.

Vierhavenstrip Roof Park [9].

Location : Rotterdam, Netherlands
Year of design : 2002-2007
Year of realisation : 2015
Nophadrain intensive green roof system

Designer : Buro Sant & Co en dS+
Employer : City of Rotterdam
Realisation : Dura Vermeer in cooperation with Mostert de Winter
Nophadrain Intensive Green Roof System - inverted roof
Area: 80 000 m²
Budget : €12.6 million

The project at Vierhavenstrip in Rotterdam is unique and the largest of its kind. The plants were created on the site of a former railway station, under a green roof park. It is the largest rooftop park in Europe. It opened in the summer of 2015 [2] The park is striking thanks to its enormous size and design. This is attractive and well maintained park that has enormous benefits for the local population. Richly landscaped, it is easily accessible from the neighbourhood, with community facilities, themed gardens and facilities for children. There are a variety of approaches into the park, including stair groups and lifts. The largest part of the roof park has been created using the Nophadrain intensive green roof system.



The underlying roof surface is protected by the inverted roof principle (with insulation above the roof covering, not below it). This waterproof insulation also has sufficient compressive strength to withstand the load of the roof park components above it.

The cleared alley network structures the space within its water, traffic and urban development conditioned environment. A long row of plane trees lines the park on the side of the g. Paths, diagonal alleys provide less steep access. At the top is a panoramic view of the city and harbor. Security, the desire of many residents, can be found in three themed gardens. Other features include a conservatory restaurant and a children's playground.

Building flood defences is not an everyday task - piling is impossible, for example. And the park's one-metre-thick earth layer requires an additional strong building structure. This sloping neighborhood park shows how intensive use of space can go hand in hand with effective urban landscaping [3].

Technical University of Delft [11].

Location:Delft, Netherlands
Designer: Mecanoo
Area: 15000 m²
Year of design: 1998

The fascinating 1960s site for the new library on the Delft University of Technology campus is overshadowed by a large, brutalist concrete building by Van den Broek & Bakema. The university needed a campus atmosphere: lawns with flowers and trees where students and faculty meet informally on wide staircases. A modern library that is served by computers, most of the books stored in basements. This is a building where technology is displayed. Then the idea of a modernist library building for the school was born, complete with a large green roof. Thanks to it, the building is energy efficient. The grass roof has an insulating effect and reduces large temperature changes. The vegetation retains rainwater and the slow condensation of this water creates natural cooling in summer. It also provides excellent noise reduction.

There are no cooling machines on the roof. Their activity is replaced by groundwater. They keep the building cool or warm, depending on the need. The technology is energy saving.

The grass is raised in one corner and supported by columns. The central hall, which is created by this effect, has glass facades. The slope is interrupted by shallow steps leading up to the main entrance. A huge cone snakes through the grass roof, providing space for circular and introverted learning spaces and symbolising technology.

3. Conclusion.

In conclusion, green roofs have numerous advantages and are an increasingly popular solution to urban development challenges. They offer a range of environmental, social and economic benefits including stormwater management, reduction of the urban heat island effect, air quality improvement and energy efficiency.

In countries such as Germany, Austria, Switzerland, etc., the idea of energy efficiency is an argument for the construction and perfect maintenance of roof gardens.

In Austria, for example, every tenth flat roof is built as a green roof. Austrian substrate manufacturers produced 62,554 tons of certified substrates in 2018. The market for waterproofing related to green roofs grew by an average of 4.67% between 2014 and 2018 (compound annual growth rate) [13].

In Germany, a total of 7,217,720 square meters of green roofs were constructed in 2019. They are classified into 6,024,421 sq m (83.5%) extensive green roofs and 1,193,299 sq m (16.5%) intensive green roofs [14].

Green roofs also provide space for recreation, promote biodiversity and contribute to the overall aesthetic appeal of buildings. Although initial installation costs may be higher, the long-term benefits and savings make green roofs a wise investment for any building owner or developer looking to create a more sustainable and resilient built environment. The effectiveness of building landscaped roofs has become clear, and the need is coming on fast. The trendiness in this regard should be making bolder inroads in our country, which could not stand out with a long-established practice in the direction of landscaping the many flat (and not only) roofs in the country. Building this type of landscaped spaces is one of the most important steps on the road to establishing ecological neutrality in Bulgaria.

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