



RESEARCH ON THE CONSTRUCTION OF GREENHOUSES LOCATED ON THE ROOFS OF BUILDINGS

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Abstract: *The paper refers to the benefits of building of green roofs and greenhouses located on the buildings' roofs in the context of increased greenhouse effect and continued growth pollution on our entire planet. In this sense, a trend that is continue growing is the creation of green roofs or buildings which can be used not only for pitch, but also for flowers or vegetable, creating very real organic greenhouses. There are also presented some of the research conducted around the world in order to improve the infrastructure of this kind of constructions.*

Keyword: *green city, greenhouse roof, legislation, pollution*

1. INTRODUCTION

The concept of *green city* is increasingly used in the context of rapidly increased of the greenhouse effect and the continuous increase of the level of pollution throughout our planet.

In a green city can be found the features that make urban living healthier, more pleasant and friendlier with surrounding ecosystems.

Green cities widely use renewable energy, host many companies which use clean technologies, promote an ecological way of life and had adopted rules for the protection of the environment, but also innovative strategies to promote new environmental concerns. Among the concerns which raise an increasingly interest is the creation of green roofs or buildings on which can be grown not only pitch but also flowers or vegetable, prosing really organic greenhouses.

By growing flowers or vegetables on rooftops we actually render to the nature a part of the area which is occupied by the construction of such buildings. Until recently, the idea of setting up greenhouses on the roofs of apartment buildings, businesses, and educational institutions was considered an utopia. Nowadays, this idea gets more adepts, the arrangement being not only an oasis of tranquillity, but also a way to reduce pollution, noise, and the amount of dust and carbon dioxide in the atmosphere.

2. THE CONCEPT OF GREEN CITY AND ECOLOGICAL ROOFS

Due to the emergence of a multitude of smart materials it is possible the directly crops' establishment on the soil laid on the roof surface.

But must be taken into account the structure of the building, the possibility of draining of the excess precipitation, and the compensation of their absence, as appropriate. Also, must be selected plants whose dynamics could match such a project, which can be viable for a long time and can be easily replaced with another similar.

An example of fitting the grows of small plants on the roof of buildings is shown in Figure 1. In this figure can be see that over concrete slab sits an antiroot membrane, a decking drainage geotextile and then a layer of soil can be put [1].

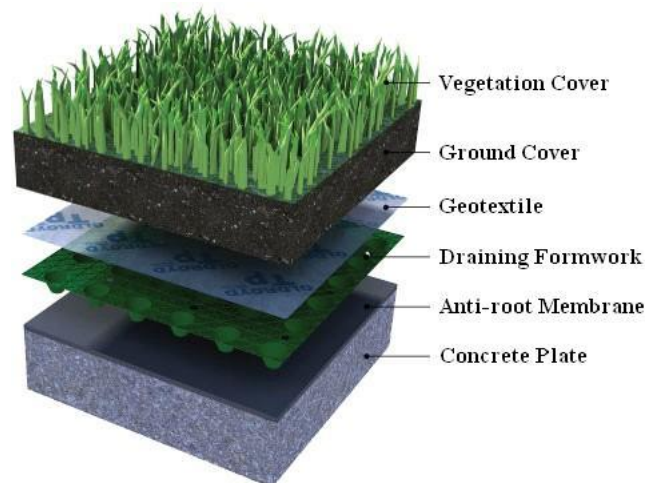


Figure 1: Materials used for small plants' growing on roofs []

Toronto is the first city in the world which has passed the legislation that require for new buildings to have 'eco' roofs. *Eco-roofs* program is launched by the city's authorities who were receptive to alarming signals over global warming and have decided to take this measure. The distribution of green roofs in Toronto is shown in Figure 2.

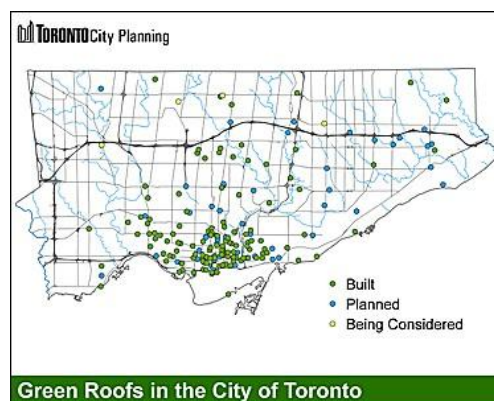


Figure 2: The repartition plan of green roofs in Toronto [2]

In Tokyo, the largest metropolis in the world, green spaces are few and the massive use of air conditioning apparatus worsens the hot weather during the summer time. For several years, all new skyscrapers in Tokyo should have mandatory a garden on their roof. This requirement is difficult to meet because of earthquake prevention regulations which limit the maximum authorized load for roofs and walls.

Japanese company Suntory has introduced an artificial type of soil, more porous, stronger and lighter than the ground soil, which can be applied on the roofs and walls of buildings to plant vegetation on and thus to refresh the temperature in major cities.

According to the Japanese company, a sample of 450 grams of artificial soil called 'Pafcal' (a new urethane foam material based on urethane, specially developed by Suntory), can absorb water as much as a kilo of ground soil. Applied on the roof of a house, it allows the grow of the grass and deciduous plants, which significantly reduces the temperature inside the building.

The concerning for the development of green roofs appeared also in Romania thus, for several years lectures deal with this topic. The purpose of these courses is to assist architects, manufacturers and solution providers to understand the design principles of green roofs, the options available and the needed steps.

According to studies conducted by the manufacturer of additives and building materials, green roofs can reduce the cost of heating or air conditioning in homes by up to 26%, providing excellent thermal insulation during all the year.

Currently, the level of promotion and implementation of 'green' roofs is growing worldwide. At the present time, in Germany, 10% of the roofs are green and in Switzerland the legislative regulations require that any newly constructed covering with an area greater than 500 square meters to be produced using such a system.

Throughout the world there have imagined many futuristic projects, a significant example being shown in Figure 3.



Figure 3: The ‘eco’ construction project

One of the greatest manufacturers of greenhouses is the North American company Nexus Corporation. Among other things, this company produces greenhouses designed to be located on the roofs of the building (Figure 4) for over 10 years [4].



Figure 4: Types of greenhouses produced by Nexus Corporation USA

One such project, shown in Figure 5, was designed for Florida State University. Following the calls, greenhouses were also placed on other structures, such as Arkansas State University, University of California, Centralia Community College etc.



Figure 5: Greenhouses placed on the roof of the Florida State University [4]

The material used for the structure is extruded aluminum and acrylic glass was used for coating. The plants' growing in greenhouses is done mainly in hydroponic system. In Figure 6 is shown a crop developed on a rooftop greenhouse at Gotham Greens, Greenpoint, New York, USA.



Figure 6: Greenhouse developed on a rooftop at Gotham Greens-Greenpoint, New York, SUA [8].

Another example of a greenhouse placed on the roof is shown in Fig. 7. This is located on the roof of a warehouse in Montreal, Canada and has a total area of 3,000 m². It is used for the growing of tomatoes, eggplants, carrots, arugula, and other herbs and vegetables in hydroponic system [5].

In the context of the importance of growing plants in greenhouses located on roofs, significant is that, at least for now, the paid price for the rent of the roof is modest.



Figure 7: Greenhouse in Montreal, Canada (Lufa Farms) [5]

A greenhouse made of polycarbonate lightweight structure, located on the roof of a parking (garage) in Tucson, USA, can be seen in Figure 8.



Figure 8: Greenhouse in Tucson, Arizona

A greenhouse made of polycarbonate on lightweight structure, located on the roof of a parking (garage) in Tucson, USA can be seen in Figure 8. UrbanFarmers AG company from Switzerland launched in 2013 a pilot greenhouse (UF001 LokDepot) with an area of 250 m², located on the roof of a warehouse in Basel (Figure 9) [6].

This was done for commercially purposes, can produce up to 5 tons of vegetables a year and has been tested by the Swiss company together with a team from the University of Applied Sciences (ZHAW), in order to verify the functionality, robustness and quality of production.



Figure 9: UF001 LokDepot farm from Basel, Switzerland [6]

A futuristic micro model, intended to be located on the roof (Globe / Hedron), and designed by Italian architect Antonio Scarponi along with UrbanFarmers will be made on the structure of bamboo and will be commercialized in the near future.



Figure 10: Globe/ Hedron farm [7]

The greenhouse shown in Figure 10 may provide the necessary of herbs and vegetables for 4 families of 4 people throughout the year [7].

3. CONCLUSION

By the analysis performed on the importance of green roofs and roof-mounted greenhouses, we can draw the following conclusions:

- *green cities* widely use renewable energy, host many companies which use clean technologies, promote an ecological way of life and had adopted rules for the protection of the environment, but also innovative strategies to promote new environmental concerns;
- among the concerns which raise an increasingly interest is the creation of green roofs or buildings on which can be grown not only pitch but also flowers or vegetable, prosing really organic greenhouses;
- due to the emergence of a multitude of smart materials it is possible the directly crops' establishment on the soil laid on the roof surface;
- green roofs can reduce the cost of heating or air conditioning in homes by up to 26%, providing excellent thermal insulation during all the year;
- the idea of developing greenhouses on the roofs of apartment buildings, businesses and educational institutions, get more importance, this arrangement being not only an oasis of tranquility, but also a way to reduce pollution, the degree of noise, the quantity of dust and carbon dioxide from the atmosphere;

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