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TYPES OF INFRASTRUCTURE USED FOR GROWING PLANTS IN GREENHOUSES LOCATED ON THE ROOFS OF BUILDINGS

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Abstract: *The paper refers to the benefits of building green roofs and greenhouses located on the roofs of buildings in the context of increased greenhouse effect and continued growth of pollution on our entire planet. The idea of setting up greenhouses on the roofs of apartment buildings, businesses and educational institutions is expanding more and more in the world, this arrangement being not only an oasis of tranquillity, but also a way to reduce pollution, noise, the amount of dust and carbon dioxide in the atmosphere.*
Keyword: *green roof, greenhouse roof, legislation, pollution*

1. INTRODUCTION

In the context of increased greenhouse effect and continued growth of pollution throughout our planet, the concept of '*green city*' is increasingly heard.
In this context, the development of green roofs or buildings on which to plant lawn and greenhouses where flowers or vegetables can be grown gains more adepts. Using green roofs in urban farming projects can also create a local food system for the entirely community.

2. TYPES OF GREEN ROOFS

"An idea springs up in cities everywhere, where acres of landscaping potential rises above our heads." (Verlyn Klinkenborg - American writer and editor)
Figure 1 shows an example of fitting small plant growing on the roof of St. Luke's International Hospital in Akashi, Tokyo (Photo: Ian Muttoo on Flick), and in Figure 2 is shown a roof of 120 m^2 from Shaoxing in east China's Zhejiang province where rice was successfully cultivated [1], [2].

Figure 1: The roof of a hospital from Tokyo [1]

Figure 2: The rising of rice on a roof in Shaoxing [2]

The possibility of developing crops directly in the ground on the roof surface is now possible thanks to the emergence in recent times a variety of new intelligent materials.
The growing of plants out of greenhouses can be done on low depth infrastructures that can generally be used to plant grass, medium depth that is suitable for the cultivation of flowers and the deep depth, for shrubs and trees. Such structures, marketed by Carlisle Syntec US company can be seen in Figure 3 [3].

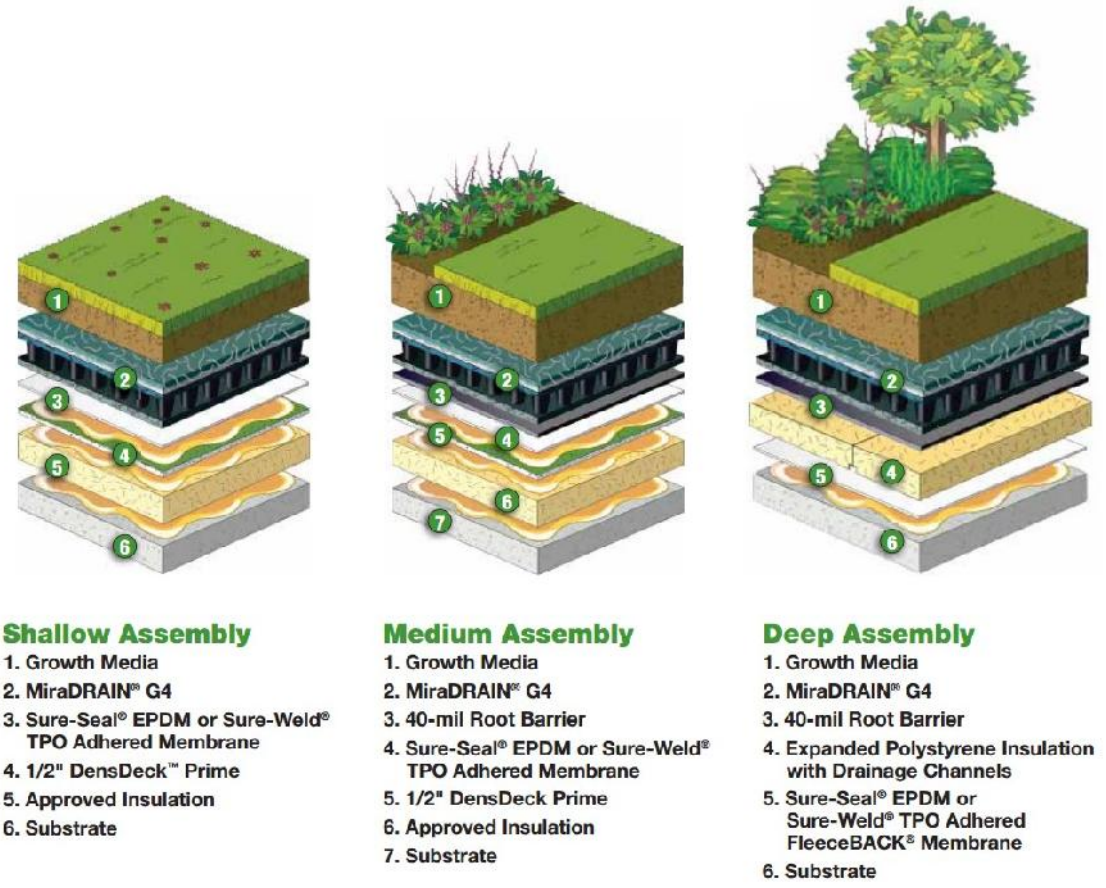

Figure 3: Materiales marketed by Carlisle SynTec. US for the plants growing on roofs []

An '*eco roof*' reduces the influence of climatic factors (wind, rain, sun), it is a good sound insulator and last but not least, it is a way to use this space for recreation and relaxation.

3. ANALYSIS ON GREENHOUSES LOCATED ON THE ROOFS

When designing the greenhouses located on the roofs of the buildings must comply with certain specific construction requirements such as:

- framing the cityscape;
- increased strength, this condition is required to withstand specific conditions they may face, especially strong winds;
- the weight of the entire structure must be reduced in order not to overload the ceiling of buildings where are located.

Placing a greenhouse on the roof of a building in Romania is subject to Law that regulates the construction of a building roof, the main documents required are the following [4]:

- technical expertise required to verify that the new building does not affect the loading time of building construction;
- certificate of Urbanism;
- certificate of Street Nomenclature;
- certified Survey and Topographical Lifting;
- notice of the Environment;
- notice of Sanitation;

- notice of the State Construction Inspectorate.

As shown, to build a greenhouse on the roof of a building there are needed a lot of acts and notices, as also noticed the constructors from other countries.

A world-renowned company, among others, for the construction of greenhouses located on the roof is Nexus Corporation in the United States [5]. A project completed by the company at Arbor House, New York is shown in Figure 4.

Figure 4: Greenhouse developed by the Nexus Corporation company in New York, US []

The material used for the resistance structure is extruded aluminium and for coating acrylic glass is used. The growing of plants in greenhouse is made mainly in hydroponic system. The most common materials used as greenhouse roofs include glass, polyethylene film, double-layered panels of polycarbonate or acrylic, and fiberglass panels or sheeting. Each of these materials has benefits and drawbacks, and one may be more suited to a particular type of greenhouse than another. Each greenhouse roof material has one very important characteristic in common: It is a clear or semi-clear, light-permeable material that will allow the plants inside the greenhouse to receive the light and heat they need to grow.

The most traditional and permanent solution for a greenhouse roof is glass. It is the clearest, most light-permeable material available, and can be quite long-lasting when installed correctly. Glass is often the best choice for permanent greenhouses, or solariums. Tempered glass, which can be up to five times as thick as regular glass, poses the least risk of cracking or shattering. A greenhouse roof made of tempered glass may be the only roofing material that can hold very heavy, wet snow for long periods without collapsing.

Glass roofing does have its drawbacks, though. It generally requires the highest up front cost, not only due to the cost of the glass, but also because it requires strong, sturdy framing materials to support it. Care must be taken to carefully construct and seal glass greenhouse roofs, as those not sealed properly have a high probability of leaking. Glass also carries a higher risk of breakability than some other materials, and it is not the best insulator.

Fiberglass sheets or panels are a long-lasting, less expensive alternative to glass and may be used in permanent greenhouse structures for 15 years or more. This material is much lighter than glass, so it does not require heavy-duty framing the same way that glass roofing does. Fiberglass is durable enough to withstand many types of weather and other outside elements.

Double-layered polycarbonate or acrylic greenhouse roofing, which is generally constructed with equally spaced "webs" between the two layers, retains heat very well. It may be the best roofing material where energy costs or cold temperatures are concerned. It is stronger and more durable than film, and may be flexible enough for use on curved roofs. It is reasonably long-lasting, sometimes up to 10 years [6].

In order to achieve the resistance structure of greenhouses located on the roofs aluminium is mainly used due to low weight, good mechanical strength and high resistance to corrosion.

An example of using extruded aluminium profiles for connecting two panels of polycarbonate, with rubber gasket for sealing is shown in Figure 5 [7].

Figure 5: The sealed aluminum profile used for the roof construction []

The large farms in urban and peri-urban roof is a commercially viable way to feed cities, and offer fresh local produce artisan responsible for the urban population.

4. CONCLUSION

From the general study conducted on "green roofs" can be drawn the following conclusions:
- the idea of setting up greenhouses on the roofs of apartment buildings, businesses and educational institutions, is expanding more and more in the world, this arrangement being not only an oasis of tranquillity, but also a way to reduce pollution, the amount of dust and carbon dioxide in the atmosphere, but also the level of noise;
- the possibility of developing crops directly in the ground on the roof surface is now possible thanks to the emergence in recent times a variety of new intelligent materials;
- when designing greenhouses located on the roofs of buildings there must be met certain specific structural requirements such as compliance with the planning, increased mechanical strength and reduced weight of the materials used.

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