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GREEN-ROOF DOGHOUSE AND ITS SUSTAINABLE DESIGN POSSIBILITIES

The aim of this article is to show small green-roof features in little urban scale. Green roofs are on the agenda worldwide. It is caused by many challenges. Green roofs could be unique infrastructures of our cities. This article is about realized small green-roof on a little doghouse. Doghouse, its constructive solution and the most important - green top. Project of this doghouse is really largely symbolic when we compare it with standard big top of the building.

Keywords: construction, doghouse, green roof, medium, monitoring possibilities, plant

INTRODUCTION

The sense of giving back to the nature what we have inherited, putting plants and nature back into the hard and stark environment full of concrete, bituminous and unnatural surfaces touches something deep within us. It doesn't matter if the roof or wall is big or small, it is an act. An act full of symbolism and deep meaning.

Bringing nature into cities and urban dwellings has always been a very desirable amenity of urban planners and architects. Many masterplans with lots of green areas and free spaces were representing symbolic meaning of people owning land. Being close to nature, able to touch a tree, to walk barefoot on the grass has so deep meaning and idea for every human that it sets to zero all the negatives.

The act of greening a building, act of greening a bus stop or kiosk, placing a garden on an existing building makes a deep statement about the way we see, or we should see, the world. Buildings with green tops should become fascinating objects. Grass and vegetation have on earth their natural horizontal space. So why should it be a problem putting soil on top of a building and have things growing. There is something strange about it, more than ecological. This reconciles the humans with the nature [1].

The truth is that for most of us all this may seem very idealistic. To put a garden on our garage. Why not. But this is where it should start. Lots of joy, beautiful gardens, small domestic green roofs or sheds, garden offices, studios, bicycle sheds and other small structures. This article is about installing, constructing and planting a green roof on a little doghouse (Fig. 1), an opportunity to bring nature back to a place where it has been.



Fig. 1. Doghouse [own processing]

1. PLANTS

Plant specification marries up the expertise of growers, designers and horticulturists with the site specifications producing a list of plants creating a nice design of the site. Combined processes of bidding, purchasing, installing, establishing, ongoing maintenance etc. are all contingent on each plant specification, so special attention should be afforded to this phase of projecting extensive green roof [2].

Specification process should begin with functional and site-specific questions. Where is the location. What are the light conditions. Is the irrigation going to be necessary. What is the height of the roof. How much weight is the construction going to be able to carry. Is the roof near some river or lake. Is the projected roof on an exposed or sheltered place. What about storm water management. How should the color scheme of projected extensive green roof look like.

Installed vegetation *Sempervivum jovibarba allionii* (Fig. 2), *Sempervivum tectorum* (Fig. 3) and *Sedum spurium* (Fig. 4) was used because of two main reasons. Economical reason: all used plants were taken directly from nature, meaning cheap version of having plants for free. Low/no maintenance reason: used plants need low/no maintenance and no irrigation.



Fig. 2. *Sempervivum jovibarba allionii* [own processing]



Fig. 3. *Sempervivum tectorum* [own processing]



Fig. 4. *Sedum spurium* [own processing]

1.1. Hardy succulents

Hardy succulents are the workhorses of extensive roofs and the primary plants for systems using a medium of 10, or less, centimeters. They have unsurpassed ability to survive drought and wind conditions, store water in their leaves for extended periods and conserve water through a unique metabolic process. Hardy succulents like *Sempervivum jovibarba allionii*, *Sempervivum tectorum* and *Sedum spurium* are one of the choices for thin substrate, non-irrigated, extensive green gardens with the greatest survivability [2].

1.2. Plant establishment

Plant establishment is the key to green roof's longevity. If the establishment in the beginning is unsuccessful, time of the return of investments is going to be

lengthened. It is very important and also much cheaper to ensure the plant establishment in the beginning or even before the realization of the roof. The first weeks after installation are crucial. It is prudent to plant the plants early enough to allow them to root in before the first frost. Trials performed at Penn State University on plant establishment showed that well-established plants were much more likely to survive winter and drought than plants that were poorly established [3].

Plant establishment on the doghouse roof was ensured before the roof realization. Three types of used vegetation, *Sempervivum jovibarba allionii*, *Sempervivum tectorum* and *Sedum spurium*, were prepared for being planted on the roof. One half of *Sempervivum jovibarba allionii* and *Sempervivum tectorum* was planted in containers one week before being planted on the roof of the doghouse. After moving these plants out of the container (one week period), newly established root system of these plants was noticed. Another half of *Sempervivum jovibarba allionii* and *Sempervivum tectorum* was planted on the roof directly after being removed out of the soil it was growing in. *Sedum spurium* was planted on the roof directly after being removed out of the soil it was growing in. The roof is exposed to the west, because of the plant choice.

After plant establishment, a few minutes after finishing planting vegetation heavy rain came. To ensure that rain would not wash out the soil and freshly planted vegetation, the roof was covered with plastic foil. When the rain was soft, plastic foil was removed and the roof was naturally watered with rainwater.

Proper care during establishment will provide achieving coverage in earlier date. Planting requires regular irrigation. If planting occurs in areas with natural rainfall that is regular, irrigation may not be needed. On many installations on US East Coast, plants require no supplemental irrigation at all, not even upon planting. On the other hand, parts in the North require care and everyday irrigation. Irrigation can be achieved through several methods: built-in irrigation systems, lawn sprinklers, garden hoses. Irrigation need should be ascertained and used for the specific plants, location and time of year when the roof is being installed [2].

2. MEDIUM

Medium depth and its greater depth means more diversity of used plants because of more options for growing roots of used plants. Composition of the underlying medium influences load of soil. This also means influencing plant specification in terms of weight, water absorption capacity, drainage rates etc. The ideal medium is lightweight, retaining water well, also porous and freely draining. The more water the medium retains, the more weight is being added to the roof. The medium supplies and absorbs nutrients, anchors the plants, provides enough weight to avoid floating when wet and avoids being flown off during establishment [1].

Medium depth used on the doghouse roof is constant 6 cm. This was effected by two main reasons. Plant specification reason: used plants do not require deeper

substrate depth. Construction reason: the doghouse was designed as a simple construction to support low load of soil. Before plants were installed, all engineer and protective works on the roof were completed to ensure avoiding potential damage to the plants. When the roof was ready for the planting, the medium was spread to the specific depth and thoroughly moistened. Plastic film was not to be laid over the substrate, because it could have caused overheating of the medium and later affect the planted plants.

Generally, extensive green roof medium is a blend of sandy or granular materials that balances water absorption with adequate porous surface. A variety of natural and synthetic materials can be used to achieve balance. Lelite, pumice, diatomaceous earth, sand, expanded and active clays, expanded shale, gravel, bricks and tiles. And vermiculite or perlite can be used in conjunction with other materials [2]. But we need to face the fact that using these kinds of materials the green roof is going to be less environmental and more expensive than purely natural medium.

Medium used on the doghouse is purely organic with no artificial materials. Soil composition was designed for mostly economical reasons. In future, this green roof may be compared with another green roof with different roof layers. Medium is surrounded with layer of gravel. This layer is designed for winter season when soil expansion is possible. Gravel border is also making the roof look more fashionable and well designed.

More organic medium, more planting options are available. Predominantly organic medium is not recommended for extensive green roofs. Because of decreasing of pore space, higher water retention and increasing nutrient loading, reducing medium depth over time may be caused. Changing of medium depth may cause change of the designed roof, adding the substrate and changing environment of planted vegetation. Depth of medium should be constant over a long period of time and highly organic medium makes it impossible.

3. CONSTRUCTION

The construction is simple. The doghouse disposition: vestibule and the dog's room. The construction consists of a floor, five walls and a roof. Entry to the dog's room is inside the doghouse from the vestibule, under the roof. The roof is an aisle with 220° slope. Floor dimension is 800 x 800 mm. Roof dimension is 1000 x 1000 mm. The roof overhangs the floor 100 mm on each side. Height of the wall with the entrance is 450 mm, opposite wall height is 750 mm. Signature element of this roof is horizontal division into three parts. The division has aesthetical reasons but the main reason is to avoid soil slide. There are holes in the bottom construction parts dividing the roof into three parts. These holes are ensuring water runoff during storm rainfall. Construction of the doghouse is made of 15 mm thick OSB boards. The dog's room is insulated with thermal insulation. Construction of the roof is described in Table 1.

Table 1. Construction of the roof [own processing]

Vegetation	–
Soil	60 mm
300 g filter fabric	1.5 mm
Water holding drainage layer	10 mm
Waterproof membrane	0.1 mm
Waterproof coating	2 coats of paint
OSB board	15 mm

4. MONITORING POSSIBILITIES

Process to track can be: storm water retention, temperature, water quality and plant performance. Energy savings can not be monitored because of the building use as a doghouse. Water retention can be monitored. Kept liters out of the city sewer system can be monitored. Water quality. The green roof should not add any nitrogen to the runoff. Water quality testing should show that the water runoff contains fewer pollutants than typical water runoff. Most significantly, the roof should be reducing the amount of nitrogen entering the watershed. Temperature differences. The green roof should be cooler than conventional black roofs on neighborhood buildings. Temperature differences should be the greatest on the hottest days. Temperature differences are a result of plants evaporation [4].

Small green roofs, when we talk about small green roofs in a small urban scale, are very important for every city, every street, every district. When we compare them with standard black roof, their features are incomparable. What they do to air, water, people, psychology, aesthetic of the place. Physical, ecological, water runoff aspects are very significant. There are many green roofs features: lowering surrounding air temperature through water evaporation, lowering the presence of allergens, cleaning air, forming oxygen, capturing CO₂, absorbing light smog, creating new environment, aesthetic factor of the green roof, psychological effects, lowering surrounding air and creating new living space, visions of wood, meadow, creating new living space, water retention, unloading surface drainage, green roof aroma, modern city design.

CONCLUSION

Ecological design is still very much in its infancy. More compact mixed-used neighbourhoods full of streets crossed with parks providing livable and healthy habitat for all living things in it. Totally green building or totally green city does not exist yet. There is so much theoretical work, technical research, environmental studies etc. that have to be done and tested before we can say that we have a green building or dwelling. On the other hand, ecological design as we know it today,

offers enormous potential to transform our buildings into products, systems. Urban roof like this is a very challenging place. Lofty ideas of potential acres of green spaces that lie above our cities. Roofs as lifeless place of bituminous surface, violent temperature contrasts, bitter wind and antipathy to water. As it has been proved, they can be changed into non asphalt wasteland. When we go to the rooftops in cities, we usually look out for a view. Positive change happens in case like this, when you don't have to look for a view, because it is in front of you. Unexpected green and blue grasses, pink and yellow flowers, roses and little trees in the middle of concrete, glass and steel.

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ZIELONY DACH I MOŻLIWOŚCI JEGO ZRÓWNOWAŻONEGO PROJEKTOWANIA

Przedmiotem opracowania jest pokazanie możliwości zrównoważonego projektowania zielonych dachów. Zielone dachy są konstrukcją popularnie wykonywaną na całym świecie. Mogą być również unikalną częścią naszych miast. W artykule przedstawiono realizację zielonego dachu usytuowanego na domku dla psa. Projekt tego obiektu z zielonym dachem jest właściwie symbolicznym odniesieniem do możliwości tworzenia takich przekryć na innych obiektach budowlanych.

Słowa kluczowe: konstrukcja, zielony dach, zrównoważone projektowanie, rośliny