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PASSIVE IRRIGATION SYSTEM FOR GREEN ROOFS

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Abstract

This paper present an innovative system for green roof irrigation. This is based on natural flow of water through plants witch mean capillarity. The system work in two directions: collecting the rain water in suspended tanks on the top of the building, under growing substrate and then transporting the water through capillary conductor, watering the substrate. This solution can be applied on large scale for all constructions witch wont to convert their roofs to green roofs.

***Key words*:** *capillary, green roof, irrigation*

INTRODUCTION

Given the current problems facing humanity: changing the temperature of the planet, the emergence of fluctuating weather events, desertification of large areas of land, finding technical solutions to meet the climate change it has lately become a priority.

In Romania in recent years they have found major climate changes manifested by extreme weather events: summer, prolonged drought, flooding caused by heavy rains, and winter is characterized by abundant short snowfall and followed by long periods in which rainfall missing.

The study presented in this paper is an original technical solution that emulated the current trend of green rooftops adapted to the new conditions imposed by climate change.

Even if green rooftops are not new, the fact that modern society is trying to implement on a large scale to existing buildings are also an indication that this technique is a standard in terms of adaptation to climate change. The best example is the impact in minimizing heat island effect in urban areas.

Although, valuing the green roofs was limited long time in Romania by local conservatism in construction but in recent years climate change is forcing the adoption of such solutions. However the benefits related to limiting the heat island effect and private companies have appeared to us that by this method provides an alternative to air conditioners.

The proposed solution comes to help those who want to have green roof thermal protector of his own construction.

A not insignificant factor is the action it has urban ecosystems around it. Expanding Green rooftops can successfully counterbalance the negative effect that has on urban biodiversity. The figure below shows the three types of substrate types characteristic of cultivated plants types.

Fig. 1. Different substrate depths (6, 12, and 20 cm) used to create various vegetation forms as a basis for the colonization of diverse fauna on the roof [1].

A green roof is a roof that has media and vegetation planted above a roofing system. The different components and wide variety of benefits is dependent on the type and complexity of the green roof system. There are two types of green roofs; intensive and

extensive. Living roofs have a wide variety of environmental and financial benefits [5].

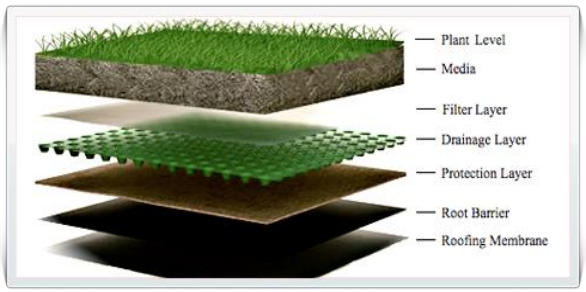

Fig. 2. Layers of a green roof
Source: http://godfreyroofing.com/commercial/education/roofing-articles/introduction-to-green-roofing/

Complete Built-Up System — In a built-up system all of the elements of the green roof system are built in order to support vegetation and growth. These systems provide flexibility in substrate depth and vegetation requirements.

Root Barrier: The root barrier acts as a protection obstruction, which prevents the roofing system from being damaged by roots.

Protection Layer: The protection layer is a puncture resistant membrane that prevents the root barrier from being damaged when the green roof is installed. Certain protection layers also can absorb water and nutrients.

Drainage Layer: The primary function of the drainage layer is to allow excess water to run off, and is often constructed with lightweight materials.

Filter Layer: The filter layer segregates the plant and media from the drainage layer. The filter layer prevents the drainage layer from becoming clogged as well as retains important organic materials in the media that are needed for plant growth.

Growth Media: The growing media is the substrate that sustains growth in the green roof. It is a mixture of inorganic (crushed clay, expanded slate) and soil with organic and mineral additives (humus, sand, lava, peat). The media must provide nutrient, water, and air supply to the vegetation as well as resist frost, wind, and maintain a specific pH-value. The composition of growing media can vary in order to help reach a specific goal, such as water retention, fire retardant, or insulation value[4,5]

Plant level: The plant level contains different varieties of vegetation that are dependent upon the specific green roof project and location [2,3,5].

MATERIALS AND METHODS

Passive irrigation system comprises: a supply tank of the roof, drainage tubes, capillary conductors and water tank at the base of the building.

Greened roof supply tank is located on top of the building, below the topsoil and replace virtually standard draining system. It has a parallelepipedic shape and has a length equal to the length of the roof. Container volume calculation is based on irrigation needs: roof or roof surfaces or hedges and underlying building. Also the area where the building is located has a great importance in average and maximum amounts of precipitation.

In the figure below (fig. 3.) is presented cross section of the top rain water tank for passive irrigation.

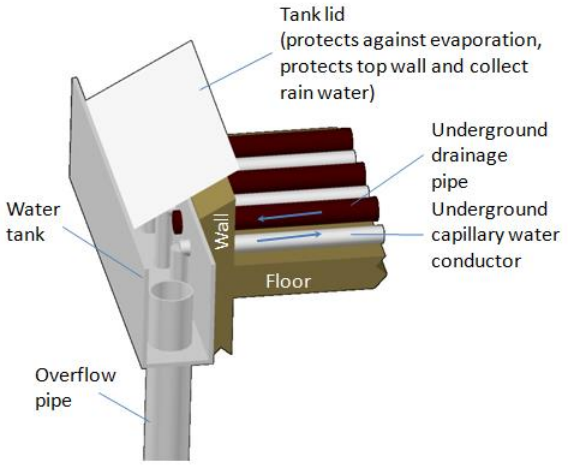

Fig. 3. Cross section of the top rain water tank for passive irrigation (original)

Given that the tank reaches the maximum loading capacity at one tooth heads is equipped with an overflow, a pipe located upright which has opening superior to the maximum water level in the reservoir and the bottom is connected to a reservoir at the base of the building .

Inside the upper reservoir open mouths water outlet of drainage tubes. Also, there are sandwiched capillary water conductors that

connect the interior of the tank base and the farthest point calculated water transport in soil.

Drainage tubes are plastic, they are perforated to allow the passage of water from the soil into the tube and transverse cross the soil volume of green surface from the building.

Capillary water conductors have in their composition of high density fabrics and are coated with a waterproof plastic sheath. According to the needs wetting, calculate distances where the insulation is removed. In those places the water will return to the soil.

Tank cap has an inclination of 30 °. From the edge of the outer wall of the tank is punctured to drain rainwater accumulated on it in the tank inner edge covering the top of the wall protecting.

The reservoir at the base of the building accumulate excess rain water from the upper tank. It will irrigate adjacent spaces of the building.

RESULTS AND DISCUSSIONS

The irrigation system presented is calculated depending on the needs of the irrigation of cultivated plant species, their density, soil thickness, soil composition and total area of irrigation.

The water cycle involves two stages: collecting water in rain and water supplies in drought conditions.

In rain water evenly distributed over the entire surface of the roof traverses the ground layer and accumulates at its base. Existing drainage pipes makes the water to penetrate through their holes and move to the side tanks where it accumulates. Also, a collecting area above the tank is not negligible. Due inclination covers, water flows outward and falls through a series of slots in the tank.

If the rainfall exceeds the capacity of the collection system, the water level reaching critical level, horizontal pipe whose opening is at this level will evacuate the excess to a reservoir at the base of the building.

After the termination of rain because the drainage system is rapidly reduce moisture in the soil to plant the needed parameters.

Plants certainly continue to draw water from the soil and will initiate the drought system regime.

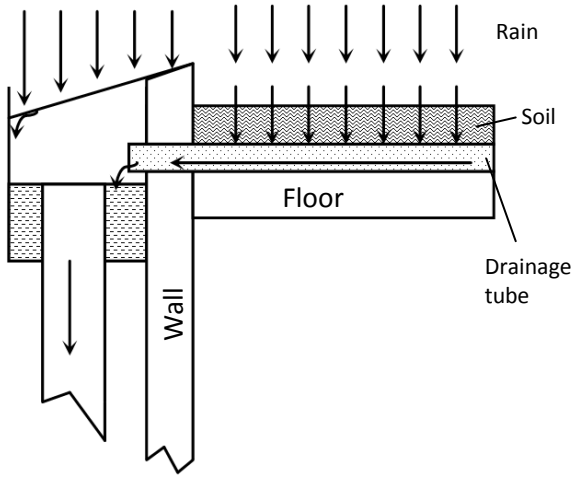

Fig. 3. Water flow on rain conditions (original)

In drought conditions, the conductors penetrating the capillary to the bottom of the tank will carry water through effect of capillarization distributing it evenly over the entire surface of the roof. At equal distances, water insulation surrounding the wires is interrupted, a place where the soil has contact with the core conductor. Distances between conductors are also calculated according cultivated plant species, their density, soil thickness, soil composition and total area of irrigation. Distances between areas where insulation is opened and distances between watering conductive matrix form.

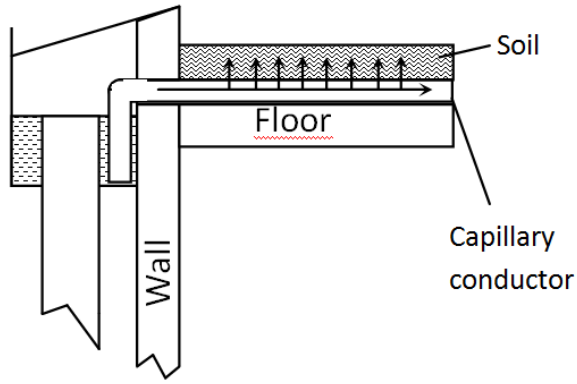

Fig. 3. Water flow on drought conditions (original)

Plants use capillary action to bring water up the roots and stems to the rest of the plant. The molecules of the water (the liquid) are attracted to the molecules of the inside of the stem (the solid). This attraction is used to help

force the water up from the ground and disperse throughout the plant [6]. The same process is involved in capillary conductor where capillaries are created by the internal structure of dense textiles.

A big advantage of positioning the tank near the green roof is to eliminate energy consumption for pumping water vertically from the base of the building.

The base of the tank offers the possibility of shading windows under it, reducing the room temperature inside the building in summer.

From an economic perspective, equipping a building with such a system brings higher costs of production and assembly than in a classic green roof. While return on investment is substantial due to lower water consumption for irrigation and also electricity consumption due to air-conditioning systems during the summer. In winter, both the layer of earth conductors and textile capillary substantially improve heat transfer coefficient also leading to saving of thermal energy.

CONCLUSIONS

The proposed concept can be applied in any green rooftop, small or large surfaces.

Unlike sprinkler systems when some of the water dissipated in the form of droplets is coached by air currents, where the proposed system remains in ground plants needed water.

Water flow is natural under gravity or capillarization effect.

Positioning the supply tank to the roof level can fuel successful green wall under it.

Even if the proposed solution requires a higher initial investment, due to tanks and capillary conductors, amortization, in current climate conditions specific to Romania is fast.

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