ANALYSIS OF THE HUMIDITY OF THE GREEN ROOF DURING THE YEAR

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Abstract

The article deals with the analysis of moisture in the layers of a green roof. Climatic conditions change throughout the year and the amount of moisture in the composition of the green roof is related to them.

This article analyzes the data collected throughout the year. The expected output from the completed measurements should be an optimized maintenance plan for the extensive green roof. The current data serves as an informative sample of the amount of moisture depending on the weekly precipitation total.

Keywords

Extensive green roof, flat roof, humidity, maintenance, retention

1 INTRODUCTION

In the implementation, operation and maintenance of green roofs, we strive to achieve the highest possible efficiency in order to achieve the longest lifespan of the vegetation. Proper roof maintenance significantly influences vegetation development, as well as the frequency of maintenance.

With new green roofs, we encounter maintenance in the first years after implementation, but gradually the maintenance of green roofs is neglected, resulting in more frequent failures of the structure and the death of vegetation layers.

In the case of roofs that are maintained aesthetically inexpertly, the self-permeation is regularly insufficient and the green roof also ceases to fulfill its function.

By analyzing the condition of green roofs, we can optimize the maintenance process, set the correct service frequency for important roof components, and also propose suitable maintenance schedules. This is especially suitable in different seasons, when vegetation is dormant and there is no need to deal with roof drains and other risky areas.

Currently, the article serves as a case study of moisture measurement in different roof compositions. The measurements are conducted at two buildings in Brno. One green roof is located on a kindergarten building in Brno-Komín (Fig. 1), while the other is located on a multifunctional building in Brno-Bratislavská (Fig. 2). In both cases, the measurements follow a useful pattern developed for service and control interventions in roof structures.

2 PROCESS

Current status

Green roofs are engineered multi-layered structures with a vegetated upper surface, working in very shallow systems without connection to natural ground. Typical layers in green roofs include vegetation, growing medium – a blend of mineral material enriched with organic material that retains water and anchors vegetation – filter fabric, drainage layer (generally constituted of plastic profiled trays, in which water is stored, for plants sustainment during dry periods and for runoff and outflow peak attenuation) and root-resistant membrane. Water content in a green roof varies according to factors such as rainfall, evapotranspiration, runoff, and outflow [1].

According to the depth of the growing substrate layer, green roofs are commonly classified as extensive or intensive. Generally, a green roof with a substrate depth of less than 15 cm is classified as an extensive green roof and its vegetation consists of a shallow rooting, and drought-resistant plant. Rainwater falling on the green roof can be captured in the substrate or vegetation and eventually evaporated from the soil surface and released back into the atmosphere by the process of transpiration [2].

Contemporary bioretention design is highly empirical and often ignores the fact that different solutions to rain garden designs located in different climatic conditions produce different results [3].

The growth of sustainable design has occurred in last decades due to significant energy savings, reduced carbon emissions and decreased environmental footprint in the building sector, as reported in a wide range of papers in scientific literature [4]. The measurement of hydrological properties of green roofs and their criteria are extensively described in specialist literature [5], [6]. In particular, the thickness and composition of the substrate can significantly affect runoff ratios, as has been shown in several studies [7], [8], [9].

Roof samples

Before starting the measurement and research, an implementation phase was undertaken. In cooperation with the implementation company Greenvia, which deals with the implementation and maintenance of green roofs, two roof structures were selected and implemented in 2022. Based on this fact, control segments were additionally installed in these structures. In another case, a control segment was implemented on the roof of RedHat's administrative facility. This segment is left in place to observe material degradation over time.

Fig. 1 Green roof in Brno-Komin.

Fig. 2 Green roof in Brno-Bratislavská.

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Control segment

For the measurement of green roofs, a special control segment was produced (Fig. 3), comprising two basic parts. The first part serves as a base measuring 50×50 cm and is welded to a base made of rolled sheet metal. The second part consists of a removable basket made of rolled perforated sheet metal, which equipped with inspection eyes for attaching the lashings needed during measurement. The entire structure is provided with an anti-rust coating.

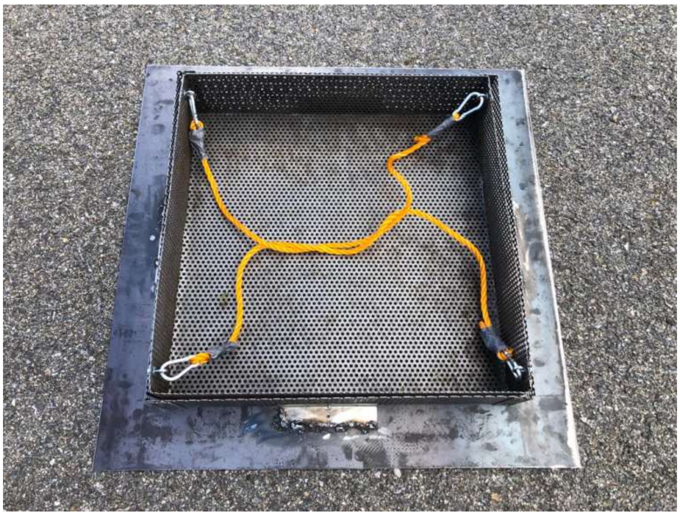

Fig. 3 Control segment.

Measurement cycle

When measuring the weight of the control segment with the composition of the green roof, the perimeter of the control segment is first cut through in order to break the ties between any vegetation roots. It is attached to the anchor points on the basket using a cable with staples.

Next, a segment is removed from the base. Subsequently, a steel tripod is used to fix the control segment (Fig. 4), which ensures accurate measurement without the deviation that could be caused by holding the segment in hand.

After the balance on the meter has stabilized, the given value is recorded in the diary and photo documentation of the roof‘s condition is taken. Such measurements take place every week.

Simultaneously with recording the weight of the segment, the amount of precipitation in the given period is also recorded.

Fig. 4 Segment tripod.

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3 RESULTS

The measured values were recorded in a table, which is regularly supplemented with additional data (Tab. 1). Rainfall records are obtained from meteorological stations of the Czech Hydrometeorological Institute and are recorded daily. The segments are measured once a week.

Tab. 1 The Sample od part of the measured data.

Day	**Rainfall Žabovřesky (mm)**	**Komin Segment weight (kg)**	**Rainfall Židenice (mm)**	**Bratislavská Segment weight (kg)**
01.01.2023	0.00	-	0.00	-
02.01.2023	0.00	-	0.00	-
03.01.2023	0.00	-	0.10	-
04.01.2023	0.60	-	0.70	-
05.01.2023	1.40	-	1.40	-
06.01.2023	0.60	-	0.60	-
07.01.2023	0.10	-	0.00	-
08.01.2023	0.50	-	0.60	-
09.01.2023	0.80	-	0.50	-
10.01.2023	0.00	25.42	0.00	24.45
11.01.2023	1.50	-	1.50	-
12.01.2023	0.60	-	0.50	-
13.01.2023	0.50	-	0.90	-
14.01.2023	0.60	-	0.40	-
15.01.2023	7.60	-	8.70	-
16.01.2023	2.60	-	2.00	-
17.01.2023	4.80	25.74	2.80	24.83

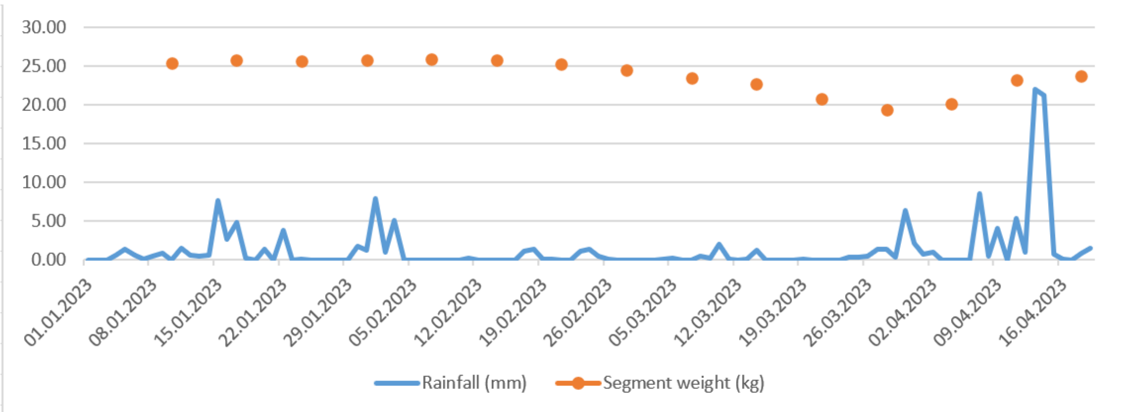

Fig. 5 Measuring data January–April in Brno-Komin.

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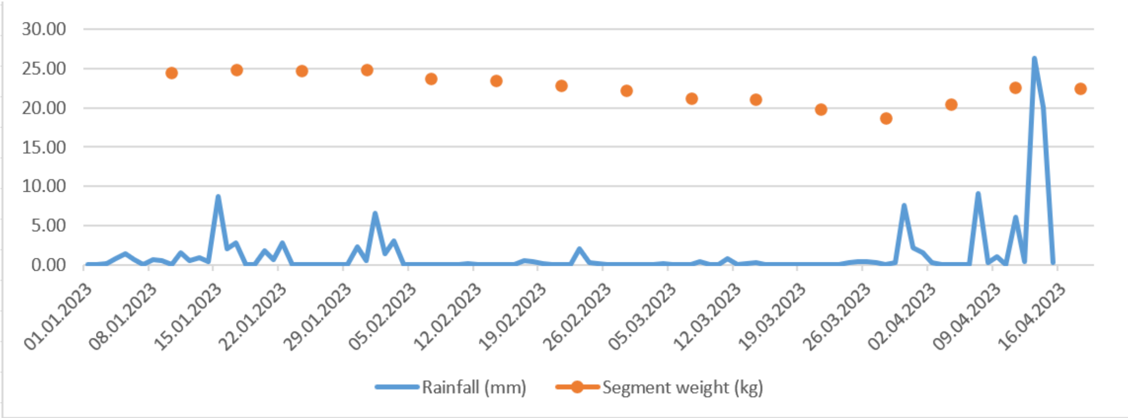

Fig. 6 Measuring data January–April in Brno-Bratislavská.

The values plotted on the graph are more meaningful in terms of recorded data over a longer period of time. From these data, we can read the dependence of the amount of rainfall on the weight of the control segment (Fig. 5), (Fig. 6).

4 DISCUSSION

According to the measured values of rainfall and weight, we can read from the graphs that during the spring months of March and April, larger amounts of rainfall were recorded, leading to an increase in the weight of the control segments. We can therefore assume that during these months there will be a greater occurrence of washouts and the associated washed-out substrate on the roofs. Consequently, it would be appropriate to carry out the first maintenance of green roofs after winter during the spring months. Vegetation changes also occur during these months, with plants beginning to flower and grow more abundantly. Other complications may arise, such as clogged roof drains and limited drainage of large amounts of water.

We assume that the rainfall in these months can represent the state within the entire republic, as we are located within one climate zone and there are no major weather fluctuations with regard to the size of the country's territory.

5 CONCLUSION

The measurements conducted so far have fulfilled their intended purpose. Based on these measurements, we can set up timely maintenance schedules for the green roof at the beginning of the growing season and thus prevent the risk of damage arising from inadequate or neglected maintenance. From the results, we can determine the approximate timing for maintenance during the spring months.

Through further gradual measurements, we should find out the optimal timing for maintenance on green roofs during the autumn months.

From the measured values during the summer months, we observe that in these months there is the least amount of precipitation on the roofs, so roof maintenance mainly consists of watering the roof and any gardening work such as removing weeds, fertilizing and adjusting vegetation.

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