Green roof in module of climate chamber

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Abstract

The submitted article is devoted to the research of the green roofs located at Faculty of civil engineering of Technical University of Kosice. The aim of this research work is to improve the quality of integrated research of advanced building constructions with focusing on intelligent buildings and indoor technologies with respect on design and evaluation of design elements for the progressive buildings.

Key words: green roof, climate chamber

1 Introduction

The mentioned article is elaborated in two main sections. The first section of analysis subsists measurement of roof structure in climate cell, where the only disparity in the roof construction was the addition of a vapor barrier to part of the S2 roof arrangement. We came to the closure after evaluating and examining the result, that the roof construction has to be improved, as a result of summer, the temperatures on the waterproofing layer were high. We modernized the roof structure by installing a green roof layer module on the S2 roof structure (Figure 1). By this specified roof structure model, we are trying to reach elimination of expanding surface temperature on waterproofing layer in summer period, which is mentioned in second section of this article.

Figure 1: Situation of test chambers measure

After evaluating the measurements of the vegetation roof on the S2 roof structure, we have come to the conclusion that the vegetation roof with a 45 ° slope oriented to the south side needs irreparable irrigation during the summer months, which we have taken into account when designing the module of the vegetation roof for the roof structure S1 by adding it to the supporting structure of the vegetation roof gutter for storing water directly in the roof structure. / Figure 3).

bitumen belts with upper spread
 4,5 (mm)
 thermobase thermal insulation with overpoled belt
 80 (mm)
 prominent anchoring system with microventilation
 4 (mm)
 OSB board, laquered
 15 (mm)
 wood beam
 125 (mm)
 thermal insulation Nobasil
 125 (mm)
 vapour barrier Jutafol
 1 (mm)
 plasterboard low ceiling
 12,5 (mm)

soil, thermal insulation along the edges
 80 (mm)
 drainage layer
 bitumen belts with upper spread
 4,5 (mm)
 thermobase insulation with overpoled belt
 80 (mm)
 prominent anchoring system with microventilation
 4 (mm)
 OSB board, laquered
 15 (mm)
 wood beam
 125 (mm)
 thermal insulation Nobasil
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 1 (mm)
 plasterboard low ceiling
 2,5 (mm)

Figure 2: Roof layers' composition Figure 3: Current roof layers' composition

Distribution and type of sensor in the test sample roof cover.

Figure 4: Deployment of sensors

Measurement of the heat transfer coefficient through the roof construction

Subject to measurement was continuous implementation of testing measurement of the constructions' thermal parameters and factor during a winter season. The heat transfer coefficient (U-value) measurements were made as the first ones. They were made by the measuring device Testo 635 with a probe for U-value (the heat transfer coefficient) determination and subsequent comparison to calculations **Chyba! Nenašiel sa žiaden zdroj odkazov..** The Testo 635 device measures only in a presumption that the difference between the internal and external temperature is at minimum 20(°C) along with keeping all procedures during the measurement. The emphasis was on the objected measurements. The procedure by itself is not described in the publication. The measurement's results are described in the charts and in the graphs. The measurements of the construction S2 are displayed by a yellow color in the graphs. A single length of the measurements (one-minute interval during 15minutes measurements, two-minute interval during one-hour measurement) is displayed on the X axis and the actually measured values expressed in (W/(m²K)) are displayed on the Y axis. **Chyba! Nenašiel sa žiaden zdroj odkazov..**

2 Measurement results of the climatic chamber module

The calculated value of the heat transfer coefficient through the construction from the calculating program is referred in the following table 1. **Chyba! Nenašiel sa žiaden zdroj odkazov..**

Table 1: The roof composition from interior side

Number	Name	D [m]	L [W/m.K]	C [J/kg.K]	Ro [kg/m ³]	Mi [-]	Ma [kg/m ²]
1	Plasterboard	0.0100	0.2200	1060.0	750.0	9.0	0.0000
2	Jutafol N	0.0001	0.3800	1700.0	640.0	65000.0	0.0000
3	Isover	0.1250	0.0390	880.0	50.0	1.4	0.0000
4	OSB boards	0.0120	0.1300	1700.0	650.0	50.0	0.0000
5	MikroventSR	0.0042	0.2100	1470.0	1286.0	17113.0	0.0000
6	Polyurethane	0.0800	0.0320	1500.0	35.0	220.0	0.0000
7	Icopal	0.0042	0.2100	1470.0	1100.0	50000.0	0.0000
8	Draining layer	0.0040	0.5000	1880.0	140.0	3.0	0.0000
9	Volcanic soil	0.0800	0.6000	500.0	1600.0	1.5	0.0000
10	Vegetating grid	0.0400	0.1100	1200.0	2000.0	4.0	0.0000

Boundary conditions are referred in the table 2:

Table 2: Calculation boundary conditions

Thermal resistance during the heat transfer in the interior R_{si} :	0.10 ((m ² K)/W)
Ditto for calculation of condensation and surface temperatures R_{si} :	0.13 ((m ² K)/W)
Thermal resistance during the heat transfer in the exterior R_{se} :	0.04 ((m ² K)/W)
Ditto for calculation of condensation and surface temperatures R_{se} :	0.04 ((m ² K)/W)

Requirements on the thermal resistance and the heat transfer coefficient, together with the calculated values of the thermal resistance and the heat transfer coefficient through the construction are referred in the table 3. **Chyba! Nenašiel sa žiaden zdroj odkazov..**

Table 3: Requirements on the thermal resistance and the heat transfer coefficient and their calculated values

Requirement: R_n =	4.90 ((m ² K)/W)
Calculated value: R =	6.97 ((m ² K)/W)
Requirement: U_n =	0.20 (W/(m ² K))
Calculated value: U =	0.14 (W/m²K))

Total comparison of the measurements with the calculated values was made as the measurements of the sample S2. Subsequently, an arithmetical sum of the given partial values was made. These values were arithmetical averaged and compared to the calculated value. The values are referred in the table 4. **Chyba! Nenašiel sa žiaden zdroj odkazov. Chyba! Nenašiel sa žiaden zdroj odkazov. Chyba! Nenašiel sa žiaden zdroj odkazov..**

Table 4: Comparison of the calculated and measured value of the heat transfer coefficient

Measurement		Calculated value
1	0.144 (W/(m ² K))	0.14 (W/(m ² K))
2	0.145 (W/(m ² K))	
3	0.147 (W/(m ² K))	
4	0.150 (W/(m ² K))	
5	0.146 (W/(m ² K))	
6	0.145 (W/(m ² K))	
($\bar{x}$)	0.146 (W/(m ² K))	0.14 (W/(m ² K))

3 Conclusion

The measured samples of the roof constructions S1 and S2 in the climate chamber module have no signs of an unprofessional assembly or infringement of working procedures during building phase. All procedures specified by a producer were kept during the single measurement and afterwards, it is possible to state that difference between the measured and

calculated values of the heat transfer coefficient is $0.0060 \text{ W}/(\text{m}^2\text{K})$. This difference possibly may be caused by:

- Measuring device Testo 365 with an accuracy $\pm 0.005 \text{ W}/(\text{m}^2\text{K})$,
- Measuring probe for measuring the heat transfer coefficient with an accuracy $\pm 0.003 \text{ W}/(\text{m}^2\text{K})$,
- The values were counted for three decimal places in averaging (0.000).

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