THERMAL CONDUCTIVITY OF THATCHED (REED) ROOF IN COMPOSITE CEILING

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ABSTRACT

The aim of the study is to determine the thermal conductivity of reed roof in composite ceilings of civil houses, which are in use. The thermal conductivity of houses in use depends on the inside microclimate conditions and outdoor climate (cover of snow on the roof, blast of wind, radiation of frost, solar energy etc). Up to now the thermal conductivity of reed was identified in laboratory conditions without consideration of the outdoor climate conditions for roofs. Measuring thermal flow and temperature inside and outside of the reed roof in composite ceiling allows calculating the coefficient of heat conductivity (λ, W / mK), what is necessary for thermal calculations of the named buildings. Analysis of measuring thermal conductivity of reed roofs of six living houses during the heating period gives medium arithmetic for λ 0,11 W/mK for reed in composite ceiling with snow-cover (thickness 150 … 300 mm).

Key words: thermal conductivity, reed roof, composite ceiling, climatic conditions, radiation of frost

INTRODUCTION

The thermal conductivity of reed is determined and the coefficient of thermal conductivity (λ, W / mK) is calculated depending on water consistent 0,050 … 0,058 W/mK (Rekomendatsii po primeneniju…, 1988) p.9,10 and for reed mats 0,059 … 0,078 W/mK. For reed mats another reference material is present (SNiP II-3-79…, 1982) p. 27 0,06 … 0,07 W/mK. But the submitted coefficients do not consider the outdoor climate conditions (especially radiation of frost) and specificity of composite ceiling with reed roof. Consequently, it is necessary to determine the coefficient of thermal conductivity for reed in composite ceiling for houses in use experimentally. It is needed for calculating the heat cost to engineer and reconstruct the buildings with composite reed roofs in similar climate conditions as the Estonian Republic. Up to now there are 2982 buildings with thatched roofs in use (Konks , 2011). On Figure 1 there are two of them as examples.

EXPERIMENTAL INVESTIGATION

The study was carried out in six houses, where people lived year-round.

In five houses the measurements were done during one winter day with a thermo gauge sonde probe and thermovisior thermovisor because these houses are too far from the research centre in Tartu. In one house near Tartu the study was carried out during the heating period. Figure 1. The house is built using ecological building materials: wood, stone, saw-dust and reed. The composite ceiling consists of the following layers:

- reed 300 mm
- paper
- saw-dust between the raffers 50x150 mm, in the distance 1000mm
- boarding 18 mm.

The following methods for the determination of the thermal conductivity of composite reed roof were used:

- measuring with thermo-camera Therma CAM B2 inside rooms
- measuring with temperature gages TMC 1-HD, TMC 6 – HD, TMC 20 – HD and TMC 50 – HD in connection with the data carrier logger HOBU U12 – 006 and HOBU U12 [4] in all layers of insulated roof;
- measuring with heat flow plates FQ90119 in two positions in the house near Tartu;
- measuring with a thermo-gauge in all layers of insulated roof-ceiling on five buildings;
- calculation method, equation 1 [4]

$$\lambda = \frac{qd}{T_1 - T_2} \qquad (1)$$

q – thermal conductivity, W/m^2
d – ply (thickness) of the material, m
T_1 – temperature of the warm side layer, ^{0}K
T_2 – temperature of the cold side layer, ^{0}K

The thermal conductivity of reed roof was determined under various climate conditions outside:

- cover of snow on the roof;
- blast of wind
- radiation of frost (sky radiation temperature -70^{0}C)
- solar energy etc.

Figure 1. Houses with thatched roof in the Estonian Republic.

Figure 2. The house nearby Tartu in Ihaste built of ecological building materials.

The microclimate inside the house was investigated in the same living house where people were living all the year round.
The analysis of measuring gives the following coefficient of heat conductivity

- near Tartu – λ=0,10 W/mK
- Hiiu I – λ=0,12 W/mK
- Hiiu II – λ=0,106 W/mK
- Hiiu III – λ=0,118 W/mK
- Otepää – λ=0,115 W/mK
- Puhja – λ=0,107 W/mK

Medium arithmetic for λ is 0,111 W/mK.
The investigation of using air-barrier in the layer between saw-dust and reed shows that air-barrier is useful, Figure 3. The radiation of frost during the night decreases the temperature of snow on the roof, Figure 4. The frost radiation is especially harmful when the snow is in ice, then the capacity of frost is considerable in snow.

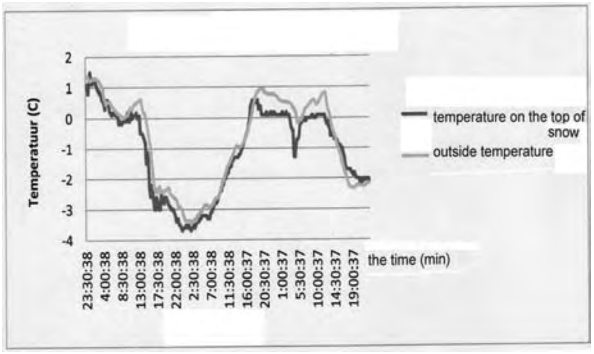

Figure 4. Radiation of frost decreases the temperature on the top of snow on the roof (11.01.2011 … 13.01.2011).

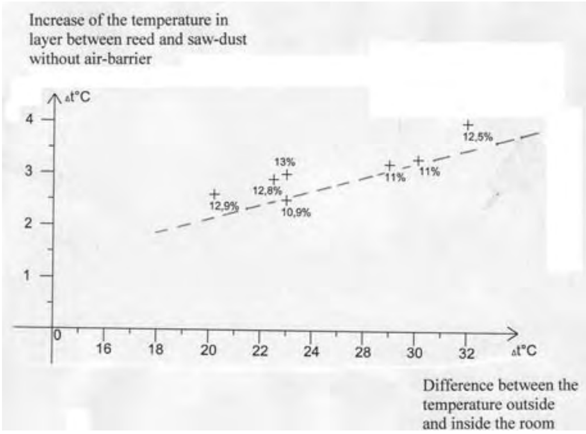

Figure 3. Decrease of thermal resistance of saw-dust without air-barrier (10,9 % … 13 %).

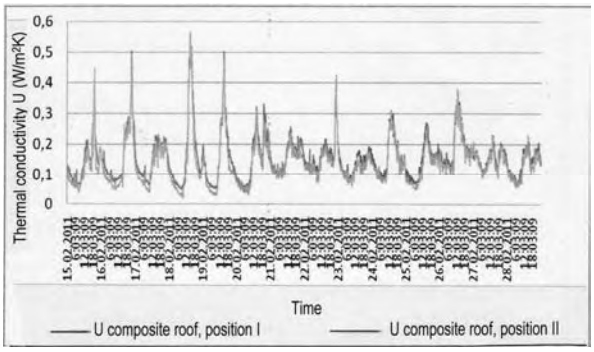

Figure 5. Thermal conductivity of reed in composite ceiling with snow-cover is changing quite a lot.

The thermal conductivity of reed in composite ceiling is increasing up to five times in clear up (cloudless) nights when it is influenced by frost radiation from the sky, Figure 5.

CONCLUSIONS

Based on the test results and numerical analysis:

- the thermal conductivity of reed in composite ceiling is increasing up to five times in cloudless night by the reason of frost radiation from the sky.
- the coefficient of thermal conductivity λ (W/mK) for reed in composite ceiling with a

snow cover for houses in use in the climate conditions of the Estonian Republic is 0,11 W/mK.

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