The effect of driving rain on the thermal insulations during the construction phase

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Driving rain is a definition used to describe heavy rain under windy conditions. Building construction times are usually long and typically the rainiest season in many countries, autumn, cannot be avoided. Insulation packages unprotected from rain on site, or already installed insulations left exposed to rain for longer periods, can unnecessarily increase structural moisture compared to using proper weather protection. Before the insulation materials on the walls are covered with weather protective façade layers they are frequently subjected to changing weather conditions, such as rain and altering temperature and humidity. If accumulated on the material, moisture could cause variations in the product performance of different kind of thermal insulations. [1]

In this paper we summarize the findings from numerical simulations conducted by VTT Technical Research Centre of Finland Ltd by Paroc's assignment during 2017 where a wooden frame wall of a single family house (height <10 m) was used as the model object. The wall consisted of the following layers: a 225 mm thick insulation layer (exterior side) attached to the PE-foil vapour barrier, a 45 mm thermal insulation layer and a 13 mm gypsum board. The structures were assumed to be protected from solar radiation. A cross-section example of the unsheltered wall is given in Figure 1 using heavy stone wool as thermal insulation.

In the simulation the exterior thermal insulation layers were subjected to occasional driving rain (simulating typical weather conditions) from the first of August to the end of November, i.e. during four months. Following the rain exposure phase, the materials were assumed to be covered by sheathing and the internal moisture conditions in the structure were simulated for a period of two years. The southern wall was selected to be studied due to the highest driving rain load. [2]

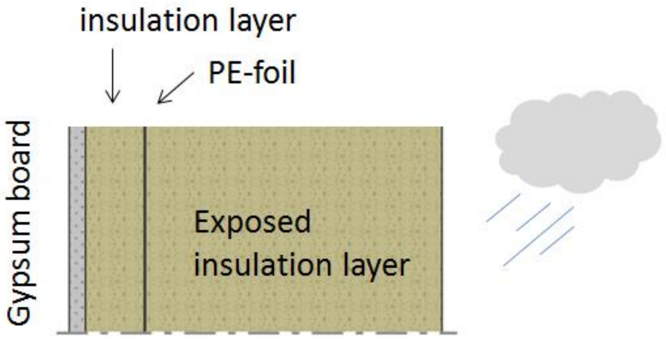

Figure 1. The unsheltered structure used in simulations using heavy stone wool as an example of a thermal insulation layer.

VTT utilized the WUFI 6.0[1] simulation model and the WUFI material library in this work. The structure was assumed to be ideally constructed, e.g. no liquid water or leakages were present. The study was conducted using northern climate conditions (Vantaa, Southern Finland). The thermal

[1] WUFI 6.0 = Wärme und Feuchte instationär – Transient Heat and Moisture Pro software. The Fraunhofer Institute for Building Physics IBP, 2016.

insulation materials selected for this study are presented in Table 1. The initial moisture content of the insulation materials at 80 % RH are given in Figure 2.

Table 1. Thermal insulation materials studied in the simulations. Density values from WUFI 6.0 material library. [2]

Abbreviation	Thermal insulation	Density [kg/m^3]
SW L	**Stone wool, low density**	**40**
SW H	**Stone wool, high density**	**97**
GW L	**Glass wool, low density**	**21**
GW H	**Glass wool, high density**	**115**
EPS	**Expanded polystyrene**	**30**
PU	**Polyurethane**	**40**

The reader is kindly reminded of the limitations in this numerical study. When analysing the results it should be kept in mind that there may be differences in the properties also within the material groups. In addition, the studied structure is a simplification of reality because no weather protecting layer was added on the exterior wall of the thermal insulation. Moreover, the ventilated wall structure used in the simulations is not the most common application for the studied thermal insulation materials. However, the study gives an idea of the wetting and drying process of a wall structure during the construction phase.

In real buildings, the driving rain can generate some risks for the unprotected insulation layer. This is mainly due to the non-idealities that are typical for material layer boundaries, such as the formation of damming water on the surface details and the hydraulic or wind pressure driven liquid flows into the structure. In this simulation, only the moisture absorption properties of the thermal insulation materials were investigated and compared. [2]

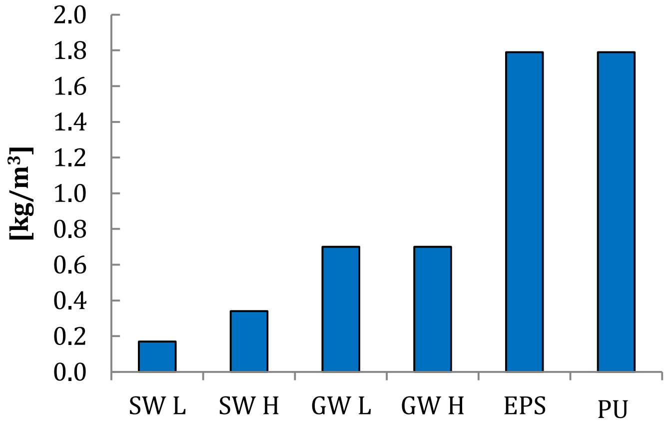

Figure 2. Initial moisture content at 80 % RH for the thermal insulation materials in the simulations. [2]

Total mass of moisture, expressed as kg/m^2, in the structure during the four months of rain exposure followed by two years after the sheathing is plotted in the Figure 3. The small difference between the insulation materials both in the total mass of moisture and the average moisture content of the outer thermal insulation layer depended on the sorption curves of the materials given in WUFI (Figure 4). In addition, the initial moisture content under 80 % RH relative humidity conditions was different depending on the material as shown in Figure 2.

As can be noted from Figures 3 and 4 the thermal insulation layers are not affected by the driving rain, indicating good weather resistances. Polyurethane and polystyrene had a higher moisture content during the unprotected period (see Figure 2), but after the sheathing their moisture content decreased to the level of normal seasonal variations. The moisture content of the stone and glass wool was not influenced by rain at all during the simulated two and a half years test period regardless of the exposure to the rain.

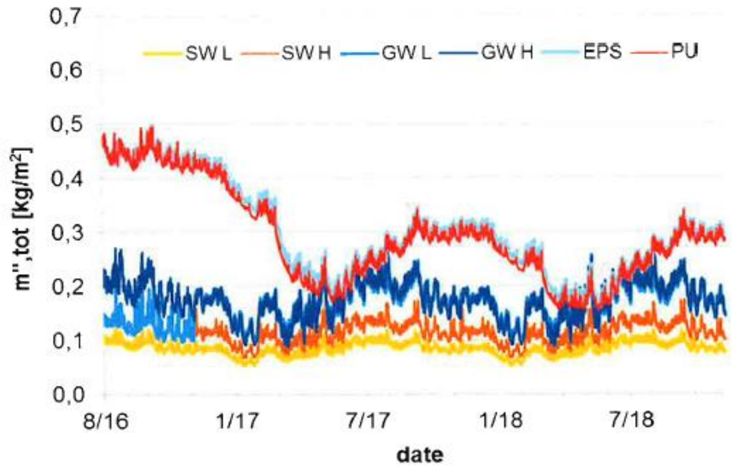

Figure 3. Total mass of moisture in the structure shown during the four months of exposure to the rain and two years after the sheathing. The graph is sourced from [2].

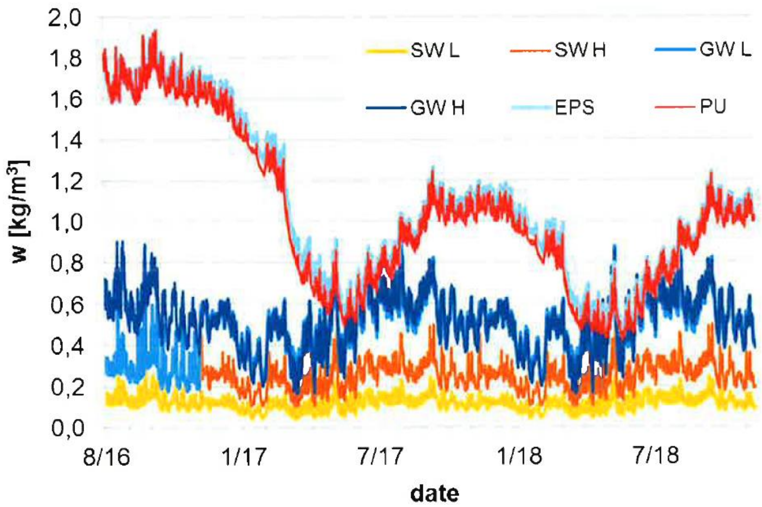

Figure 4. Average moisture content of the insulation material exterior layer (225 mm) shown during the four months of exposing to the rain and two years after the sheathing. The graph is sourced from [2].

References

[1] H.-P. Mattila, ”Moisture Behavior of Building Insulation Materials and Good Building practices,” Paroc Group Oy, 2017.

[2] T. Ojanen, ”VTT-R-04783-17: Moisture performance of stone wool insulation products,” VTT Technical Research Centre of Finland Ltd, Espoo, 2017.