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Microclimate measurements in ventilated air gaps – instrumentation and first results

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Microclimate measurements in ventilated air gaps – instrumentation and first results

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Abstract. To achieve energy efficient buildings, the requirements for air tightness in Norway were strengthened in the recent years. Thus, the use of tape for tightening connections and overlaps in the wind barrier and vapour barrier layer has become more and more common. Since these products are covered by a façade cladding and hence difficult to access, they need to maintain their performance level over many years, usually 25 to 30 years. To design test methods to ensure the performance of tapes and other products used in the ventilated air gap, more knowledge on the climatic conditions, especially temperature conditions, is needed. The recently finished ZEB Lab building in Trondheim, Norway, has been instrumented with thermocouples to monitor the temperature conditions in the air gap. This study presents the instrumentation set up and first findings from the start of the experiment in summer 2020. First results show temperature levels up to 76 °C in the upper part of the roof construction.

1. Introduction

Ventilated façade constructions are a much-used solution in the Nordic countries (1). The façade is constructed as a two-step tightening, where the façade cladding acts as a rain screen. Placed behind the façade cladding there is an air cavity to ventilate the air gap and drain excess moisture. The air gap is followed by an exterior air barrier layer, that can both consist of a rigid material or a membrane. To achieve energy efficient buildings, the requirements for air tightness in Norway were strengthened in the recent years. Thus, the use of tape for tightening connections and overlaps in the wind barrier and vapor barrier layer has become more and more common. Since these products are covered by a façade cladding and hence difficult to access, they need to maintain their performance level over many years, usually 25 to 30 years. To design test methods to ensure the performance of tapes and other products used in the ventilated air cavity, more knowledge on the climatic conditions is needed (2). The recently finished ZEB Laboratory (3) building in Trondheim (N 63°24'51", E 10°24'27"), Norway, has been instrumented with thermocouples to monitor the temperature conditions in the air gap.

2. The Research Building

The building used in this study is located in Trondheim, Norway and serves as a research infrastructure for the Norwegian University of Science and Technology (NTNU) and the research foundation SINTEF, see Figure 1 (see www.zeblab.no for pictures and further information on the building). The building footprint is rectangular with the main facades facing south, north, east, and west. The roof is inclined by 32° facing south. The wall and roof consist of a wooden frame structure with a wind and rain tight layer (exterior air barrier membrane on the walls and asphalt roof cover), where tape is used for tightening of the exterior air barrier around windows, ducts, and overlaps. The façade cladding consists of BIPV modules mounted in plastic frames on a substructure of cross-layed battens.

On most of the north façade and part of the east and west façade, vertical black wooden cladding is used. The air gap width is continuous on both the façade, 109 mm (36 mm + 73 mm) and the roof, 127 mm (98 mm + 29 mm), which allows free vertical air flow.

The instrumentation took place during the construction phase of the building in the period November 2019 to February 2020, and the data logging began in August 2020. The air gap of the walls was instrumented with thermocouples (type T) and measured using a Campbell Scientific CR1000 (accuracy ±0.5 °C and a range of -40 °C to 85 °C). At each location (see Figure 1), the temperature is measured at three different positions of the air cavity: on the surface of the exterior air barrier (façade) or the surface of the asphalt roof cover (roof), in the middle of the air gap, and on the rear face of the cladding or solar panel.

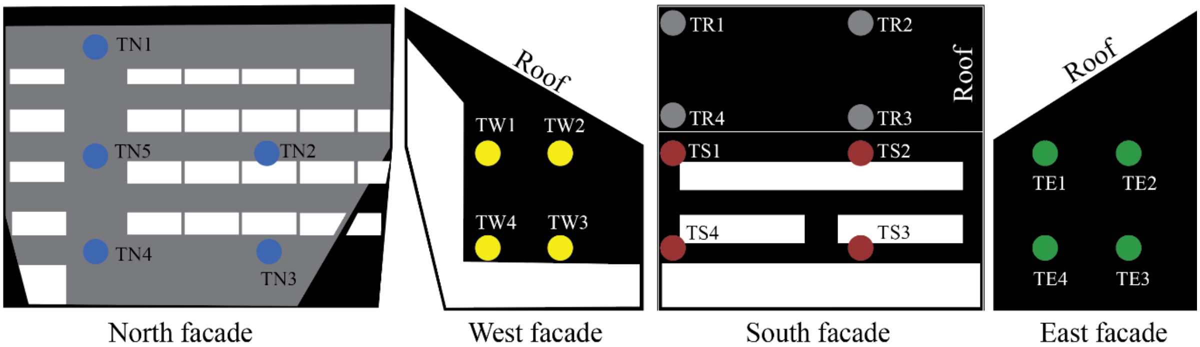

Figure 1 Drawing of test building. Coloured dots indicate locations of thermocouples. Grey areas indicate wooden cladding, black areas BIPV modules, white areas windows.

3. Results and Discussion

Figure 2 shows temperature measurements during two days in August 2020. The figure shows values for the surface of the wind sheathing (wall) and roof cover. Air temperature and horizontal solar radiation are measured by a meteorological station located 60 m east from the ZEB Laboratory.

While the air temperature during the two days is quite alike (average air temperature august 21st: 20.3 °C; August 22nd 19.9 °C), the temperatures in the air cavity are significantly different for the two days, especially for the south façade and roof locations, which corresponds with the solar radiation load.

The thermocouples at the east façade show a rise in temperature at sunrise (the solar radiation measurement device is in the shadow at this point of time), the temperature rises at a maximum of 57 °C. The highest temperature is measured at 13:24 on August 21st, in the upper part of the roof (TR2): 76 °C on the back of the PV panel, 50 °C on the middle of the air cavity, and 52 °C on the surface of the roof cover. At the same point in time the measured air temperature at the meteorological station is 25.5 °C, i.e., the difference is up to 50 °C.

The results show that the temperature in the air cavity of the wall follows the solar radiation load measured at the meteorological station. The temperatures measured in locations on the north façade (in the shadow) correspond with the measured air temperature at the meteorological station.

The measured temperatures in the air cavity at locations exposed to solar radiation, show a significantly higher temperature in all measurement points of the air cavity, with a maximum at the back of the cladding material (either PV panels or black wooden cladding). The highest values are reached on top of the roof and façade pointing South.

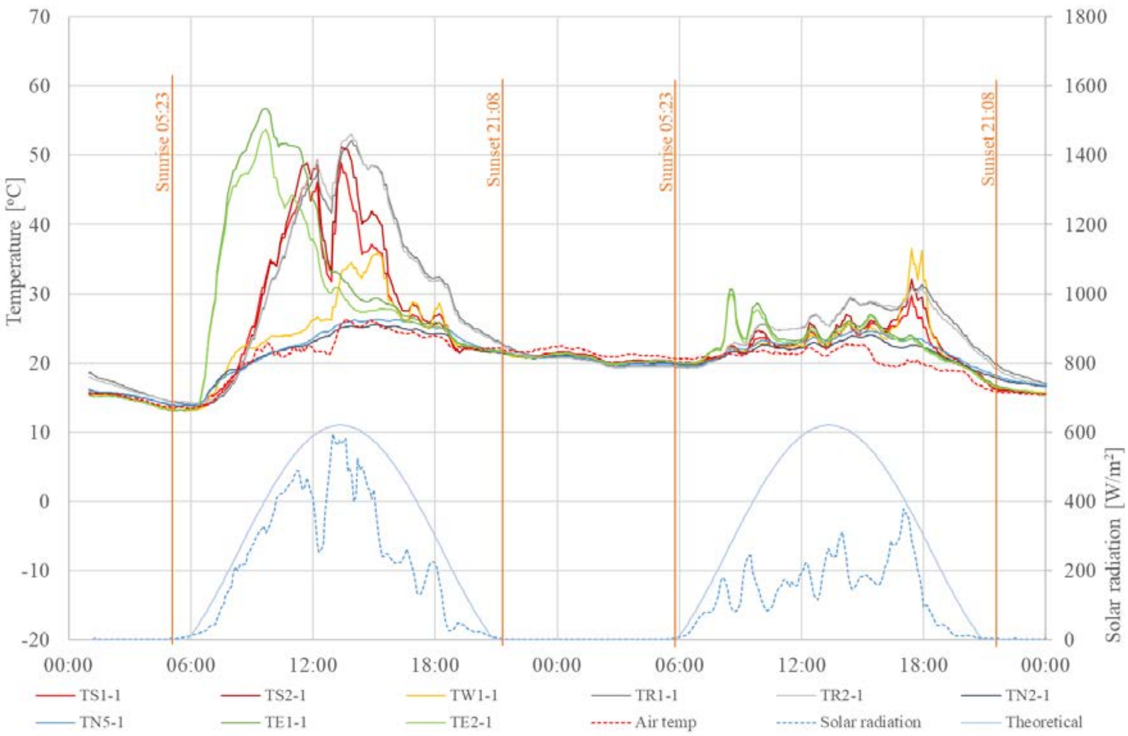

Figure 2 Temperatures measured two days in August 2020, air temperature and solar radiation from meteorological station.

4. Conclusions and further work

The intention of the measurement campaign is to gain knowledge about the microclimate conditions of the air gap of a ventilated façade and roof. This will provide valuable insight in the in-use conditions of materials and products used in this location. These results will be used as input in the design of accelerated ageing tests.

Furthermore, the results will be studied regarding the hygrothermal conditions, especially wetting and drying. In the same location wireless hygrothermal measurement devices have been placed, and the results from these measurements will be compared with the ones from this study and the results of hygrothermal simulations.

Acknowledgement

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