Influence of local weather conditions on ventilation of a pitched wooden roof

Nora Bunkholt, M.Sc student [1]; Lars Gullbrekken, PhD [2]; Tore Kvande, professor [1]

[1] Department of Civil and Environmental Engineering – NTNU, Norway
[2] SINTEF Building and Infrastructure, Norway

Summary

This paper investigates the influence of temperature and wind conditions on ventilation of the air cavity beneath the roofing in a full-scale pitched wooden roof construction. The relevant roof construction is equipped with instrumentation for temperature and air velocity measurements. The findings show distinct periods of below-ambient temperature and positive condensation potential in the ventilated air cavity of the roof. The measurements imply that the materials in the roof regulate the humidity in the air cavity. Large negative peaks in the condensation potential indicate dry-out of the construction.

Key words: Pitched roof; Wood construction; Air cavity; Ventilation; Condensation

1. Introduction

The Norwegian climate is characterized by extreme variations and large geographical and seasonal differences, which put large demands on Norwegian building envelopes. Pitched wooden roofs, widely used in Norway, are constructed with ventilation beneath the roofing in order to 1) remove excessive moisture from the roof construction, and 2) remove heat in order to prevent melting of snow on the roof and subsequent formation of ice. This paper is a continuation of a study performed by Gullbrekken et al. in 2017. The aim is to study the influence of temperature and wind conditions on ventilation of the air cavity in a full-scale wooden roof construction. Key issues are to investigate how the temperature in the air cavity depends on the outdoor climate and to examine the condensation potential (CP_i) that follows below-ambient temperature periods in the air cavity.

2. Methods

The study was carried out on a full-scale experimental laboratory building situated in Trondheim, Norway. The building has a wooden roof construction with eaves-to-eaves ventilated air cavities beneath the roofing. The structure of the roof is described in Figure 1. The air cavities are equipped with instrumentation for temperature and air velocity measurements. Outdoor temperature and wind exposure are recorded at a weather station located above the ridge of the roof. Four air cavities, two at the northern and two at the southern side of the roof, were studied during five different periods in 2016-2018.

3. Results and discussion

The measurements demonstrated long intervals of below-ambient temperature in the ventilated air cavity, ranging from 6% to 97% of the time for the different periods studied. Lowest values were found in summer and in winter if snow was covering the roof. Highest values were found in winter when snow was not covering the roof. Low outdoor temperatures and days with clear sky may have contributed to large cooling of the roof in the latter winter period. Differences in CP_i was found when comparing the southern and the northern side of the roof. This is illustrated in Figure 2, which shows variations in CP_i during a period in March 2016. Longer intervals of positive CP_i and smaller negative peaks in CP_i at the northern side of the roof imply higher risk of condensation at this side. A higher CP_i was also seen for the rear side of the roofing than for the middle of the air cavity. In general, the observations showed that CP_i in the air cavity was very dependent on the temperature and radiation conditions present. A relationship between variation in wind and variation in CP_i was also observed. It was found that wind speeds were very low, i.e. < 1m/s, during most of time when the CP_i was positive. This implies that wind speed is of importance for the condensation situation in the air cavity. The periods of below-ambient temperature in the air cavity were larger than the periods of positive CP_i. This indicates that the oriented strand board (OSB) at the rear side of the roofing was absorbing condensate due to its hygroscopic properties, reducing the risk of visible condensate. Due to the large negative peaks in CP_i, the surface will experience dry-out. Hence there is little concern that moisture absorbed will lead to damages in the OSB.

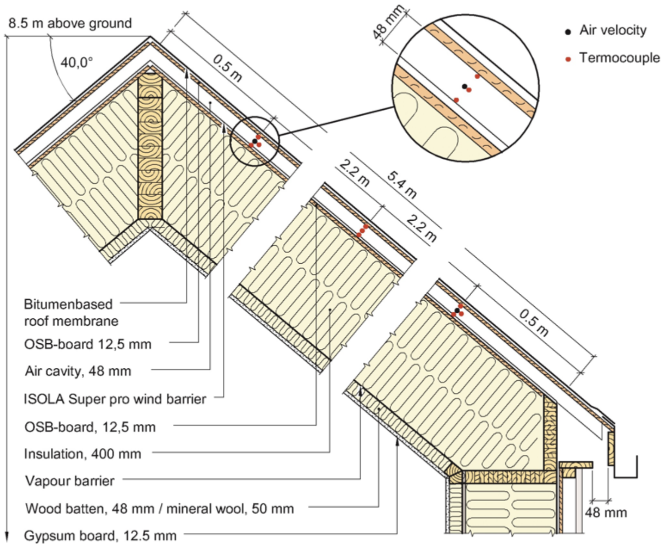

Figure 1 The roof structure at ZEB Test Cell Laboratory.

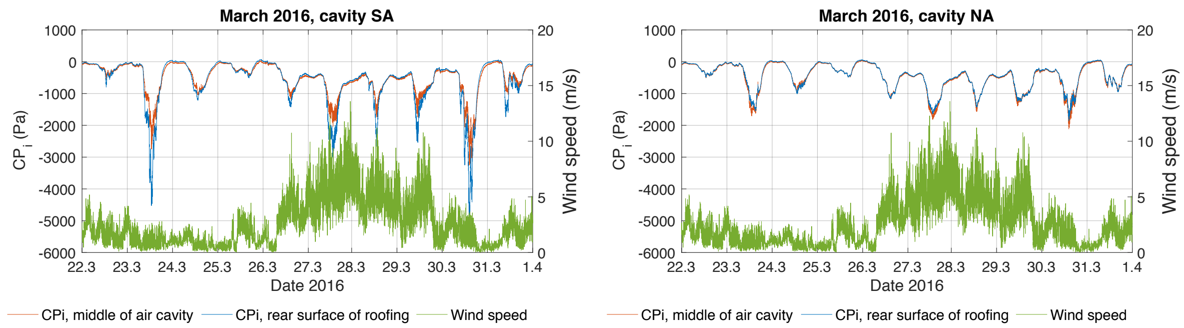

Figure 2 Variation in CP_i (for two different cavities) and wind speed in March 2016.

4. Conclusions

The study of the roof on the ZEB Test Cell Laboratory shows distinct periods with below-ambient temperature in the ventilated air cavity. Positive CP_i is measured during long periods, especially in spring, autumn and winter without snow. Large proportions of the periods with positive CP_i have wind speeds less than 1m/s. The periods with below-ambient temperature in the air cavity are larger than the periods with positive CP_i. This implies that the materials in the roof absorb moisture and regulate the humidity in the air cavity. However, large negative peaks in CP_i indicate dry-out of the construction.

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