Pressure Difference Across a Wall Did Not Affect Moisture Content in Pores of Wall Structures

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Abstract

Unexpectedly, the indoor-outdoor pressure difference did not affect significantly the moisture content in different layers of two outer walls but the moisture content depended more strongly on the moisture content in outdoor.

Materials and Methods

The outer walls of a large (102 000 m^3) four-floor building were repaired by making the cavities within the walls broader and by increasing the slope of the window edge (Figure 1) in order to decrease moisture content in the main walls. The repair was conducted in two phases, the first repair period included only the outer walls in the side of outer yard. During the second phase the outer walls in the side of inner yards were also repaired. The National standards advice to maintain depressurization of the building by adjusting the supply air flow to be 10%–20 % less than exhaust air flow in order to avoid the possible condensation of the moisture in structures due to indoor air. The aim of this study was to investigate how the moisture content in the wall structure depends on pressure difference across the wall in conditions without additional moisture sources.

The measurements of the humidity and the temperature were conducted by continuous measuring devices (Vaisala HMP 233, HMP 143A and HMP 44L and Grant 1000 Series Squirrel) for a year in three layers of the outer walls: brick, insulation and concrete element layers. The pressure differences across the walls were also followed continuously by pressure transducers (Setra 264). (Figure 1)

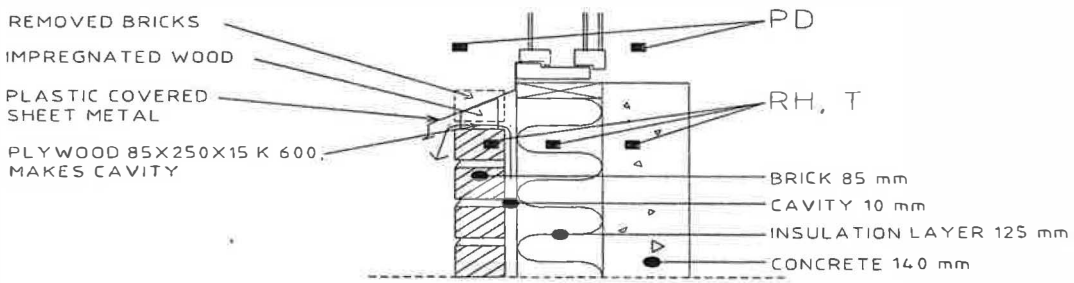

Figure 1. The repaired construction of the outer wall in detail and measurement points of relative humidity (RH, %), temperature (T, °C) and pressure differences (PD, Pa).

Results

According to the regression analysis, the indoor-outdoor pressure difference did not explain the moisture content in inner surfaces of two outer walls located at the opposite sides of the building (Table 1). The rooms on both sides of the building were depressurized in average of 2.3 and 3.2 Pascals (Table 1), however, there also existed periods of positive indoor pressure.

The moisture content in different layers of the wall depended on the moisture content in outdoor air generally (Figures 2–5). Making the ventilation cavities broader and increasing the slope of window edge also in the wall on the side of the inner yard increased the correlation between the moisture content in different layers of the wall and the moisture content in outdoor air (Table 2).

Table 1. The mean values for moisture content (g/m^3) and temperature (°C) in different layers of the outer wall measured at the same time during six months. The dependence (R^2) of the moisture content in inner surface of the walls on pressure difference across the walls. R^2 was analyzed by regression analysis.

The relative humidity and corresponding values in indoor and outdoor air were RH=25.3%, v=5.2g/m^3 , T=23.0°C and RH=81.8%, v=5.7g/m^3, T=3.4°C, respectively.
outer yard: indoor-outdoor pressure difference: mean –2.3 Pa (from -24.9 to +19.2 Pa)
inner yard: indoor-outdoor pressure difference: mean –3.2 Pa (from -14.5 to +7.7 Pa).

Structure	Moisture content (g/m^3) inner yard/outer yard	Correlation R^2 inner yard/outer yard	Temperature (°C) inner yard/outer yard
Outer surface	6.2/5.5	no correlation	5.9/7.6
Insulation	6.0/5.6	no correlation	11.9/11.3
Inner surface	6.1/5.2	0.002/0.094	20.5/20.5

Table 2. The dependence (R^2) of the moisture content in different layers of the walls on outdoor air during eleven months. The walls were located both on the side of outer and inner yards. R^2 was analyzed by regression analysis.

Inner yard/outer yard	The whole period 4.6.98 - 26.4.99 inner yard/outer yard	Before the repair 4.6.98 - 31.8.98 inner yard/outer yard	After the repair 1.9.98 - 26.4.99 inner yard/outer yard
Outer surface	0.90/0.86	0.35/0.45	0.94/0.82
Insulation	0.91/0.95	0.49/0.86	0.92/0.93
Inner surface	0.58/0.67	0.13/0.14	0.54/0.74

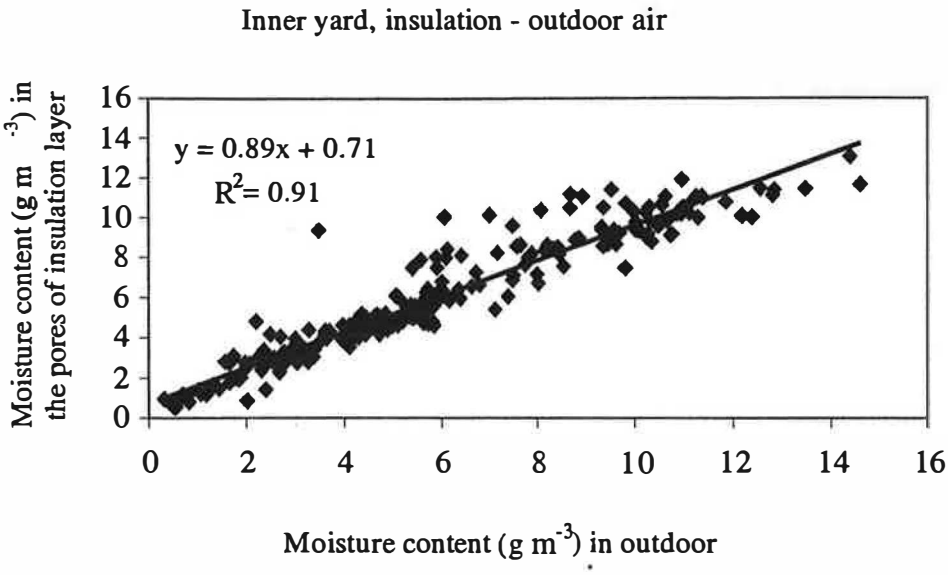

Figure 2. Moisture content (g/m^3) in pores of insulation layer of the outer wall in the side of inner yard and in outdoor air during eleven months.

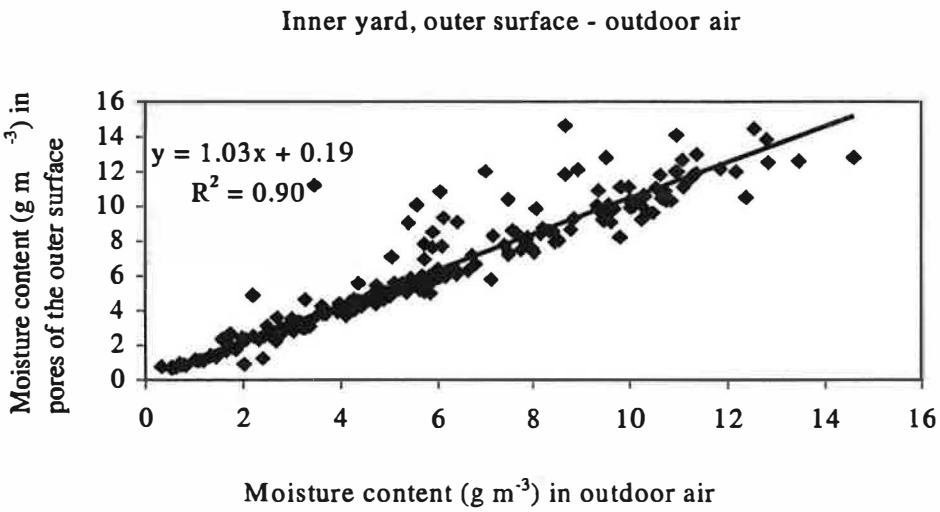

Figure 3. Moisture content (g/m^3) in pores of the outer surface of the outer wall in the side of inner yard and in outdoor air during eleven months.

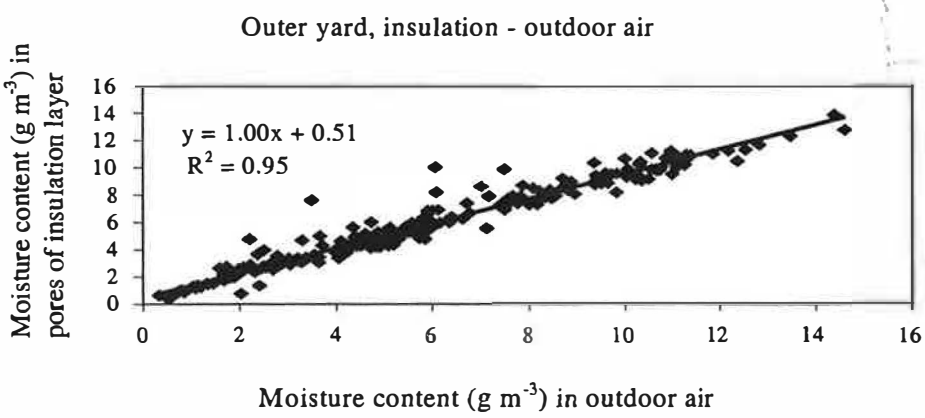

Figure 4. Moisture content (g/m^3) in pores of insulation layer of the outer wall in the side of outer yard and in outdoor air during eleven months.

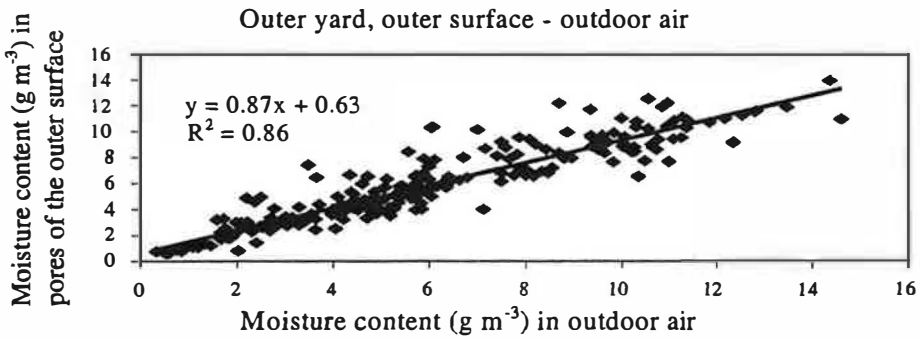

Figure 5. Moisture content (g/m^3) in pores of the outer surface in the outer wall in the side of outer yard and in outdoor air during eleven months.

Conclusions

The moisture content in the pores of the different layers in the wall did not depend on pressure difference across the wall. Only the moisture content of the inner surface of the wall depended very slightly on pressure difference although the inner surfaces of the walls were exposed to positive pressure occasionally. On the other hand, the ventilation cavity in the wall was observed to be highly beneficial in prevention of moisture condensation in the wall.