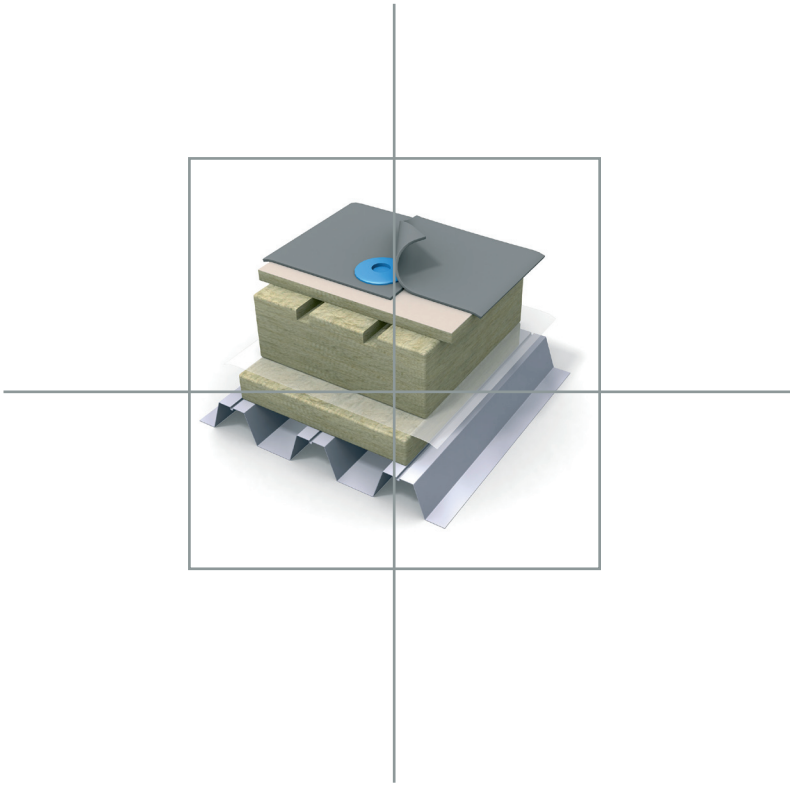
Ventilated roof
– Critical performance parameters

Research Report



Nieminen Jyri & Ojanen Tuomo.
''Ventilated Roof. Critical Performance
Parameters'' Espoo 2006,
VTT Research Report No VTT-R-03394-06.

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Ventilated roof
– Critical performance parameters

Main content of research report

Moisture in buildings causes....

- Moisture damages are one of the main cause bad indoor air qualities and they affect the occupants´ health and comfort.
- Moisture is the main cause of deterioration of building materials and structures.

VTT calculations, Report VTT-R-03394-06

- VTT has calculated the moisture load for typical buildings in 4 different cities: Moscow, Kiev, Bergen and Rovaniemi.
- The analysis represent yearly moisture balance (moisture in = moisture out).

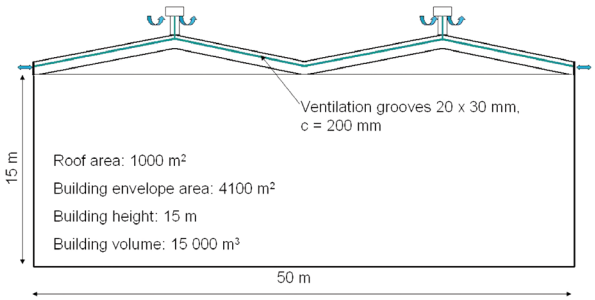

Figure 1.

Reasons for moisture leaking in

- There are, at least, 4 different ways for moisture to penetrate a roof:
  - Rain, snow
  - Diffusion
  - Air leaking in
  - Building moisture

Amount of moisture

- Rain has about 0,65 – 2,4 g/m²h, with 1 % of rain leaking in.
- Diffusion 0,002 g/m²h
- Air leakage from 0,036 g/m² to 5,20 g/m² depending on amount of leakage.
- Building moisture can vary between 0 – 0,300 g/m²h.

Better roofing work and materials

- As the roofing materials and quality of roofing work improves, water penetration through the roofing is rare and it may occur only locally.
- Poor air tightness can cause air leakages over the whole roof surface.

Air leakage

The report is talking about ideal, normal leaky and very leaky

- Ideal = as designed
- Non-ideal = as built
- Very leaky = bad installation

Types of building

The activity in the building is influencing. The study concentrated on following uses of the building:

- Pulp industry, Warm/high humidity
- School, Normal/dry
- Swim hall, Normal/high humidity

Function of the grooves

- Micro climate around the building is the main driving force for the groove ventilation. Air speed 0,01 – 0,10 m/s.
- The air flow direction in the grooves is not constant but changes according to changes in the pressure field.

Pressure difference

- A value on the safe side is to use 1.5 – 5.0 Pa as a pressure difference in calculations. Actual pressure might be higher but for the long term performance the above values are useful.
- The pressure difference is depending on:
  - Location of the building
  - Shape of the building
  - Height from ground to roof

Pressure differences to be used

Pressure difference Pa	Location of the building		
	Open or thinly-developed area	Dense-developed area	Windscreen by topography or forest
4 - 5	One-level roof with some obstructing structures	One-level roof without obstructing structures	Forest-high building, one-level roof without obstructing structures
3 - 4	One-level roof with obstructing structures	One-level roof with some obstructing structures	One-level roof without obstructing structures
2 - 3	Roof in two or more levels	One-level roof with obstructing structures	One-level roof with some obstructing structures
< 2	Roof in two or more levels with some obstructing structures	Roof in two or more levels	One-level roof with obstructing structures

Table 1. Pressure differences to be used for dimensioning of the roof ventilation. One-level roof refers to types of Figure 1.

Parameters as input for dimensioning

- Length of ventilation channel from eaves to ventilation openings
- Thickness of the thermal insulation 150 – 300 mm
- Indoor conditions: air and diffusion tightness for ceiling
- Climate: Temperature, humidity and rain
- Wind velocities and available pressure for ventilation

Example

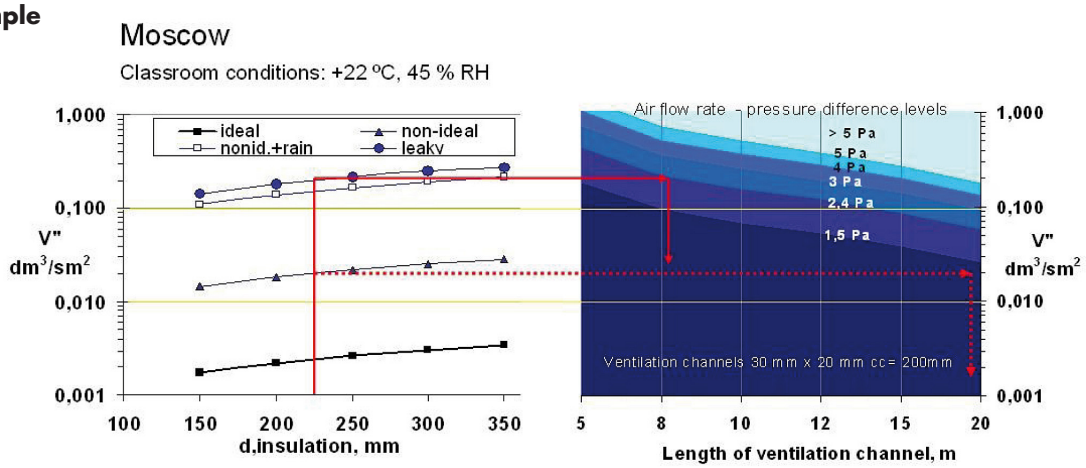

Figure 2.

Conclusion:

- Every roof takes moisture in and because of that:

"Every roof in every situation needs to be ventilated"

Conclusions/suggestions

- Moisture can be calculated
- Air leakage is the main problem
- Average ventilation guarantee drying
- Dimensioning based on required air flow rate
- Maximum length is set depending on available wind pressure

Solar radiation

- Safe estimate does not include sun.
- Roof ventilation dries out 0,05 liter m^2/day.
- During 40-80 sunny days a total of 2-4 kg/m^2 can dry out.
- Consider: How much is yearly coming in???

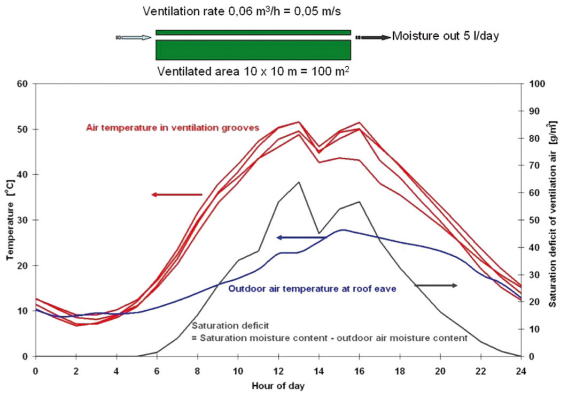

Figure 3.

Functions everywhere

- Analysis show that the ventilated roof performs everywhere in Northern Europe.
- One significant difference:
  "The higher insulation level the higher ventilation rate the shorter the length of ventilation channel"

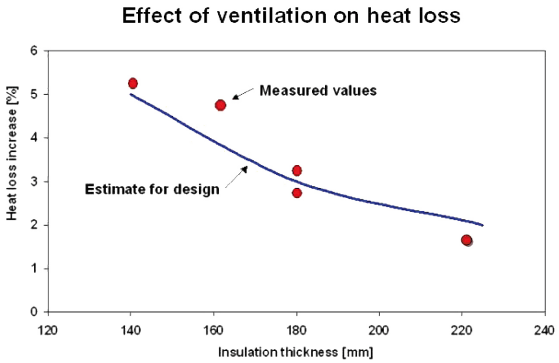

Figure 4.

Suggested length of ventilated area

Indoor climate type	Examples of buildings	Roof characteristics	Suggested length of ventilated area, m			
			Open area		Sheltered area	
			No solar	Solar	No solar	Solar
Dry	Waehouse	Large roof area, one level roof	20	20	20	20
Low humidity	Shopping centre	Large roof area, roof in several levels	20	20	15	15 - 20
Average humidity	Housing	Small roof area, one level roof	15 - 20	20	15	20
	Office, school	Moderate roof area, roof in several levels	15 - 20	20	10 - 15	15 - 20
High humidity	Process industry	Large roof area, high building volume *)	10 - 15	15 -20	< 10	10 - 15
Extreme humidity	Swimming hall, pulp industry	Large roof area, high building volume *)	< 10	10 - 15	< 10	10 - 15

*) Building type and location typically allow solar radiation on the roof.

Table 2. Suggested length of ventilated area for different building types. The suggestions include assumptions, that no rain penetration is possible and roof air tightness is good.

Should a roof be ventilated?

- Time factor crucial, slow deterioration of roof layers may occur without any noticeable moisture damages. This deterioration may include corrosion mould growth or softening of insulation materials.
- Built in moisture and air leakages may cause moisture risks in the long time run.

The result shows that a ventilated roof maintains dry.

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