Probabilistic analysis of hygrothermal conditions and mould growth potential in cold attics

Carl-Eric Hagentoft and Angela Sasic Kalagasidis
Research on cold attics

- **Started with**
  - Numerical model of an attic in HAM-Tools

- **Supported by**
  - Interest from building industry in different technical solutions for the prevention of mould growth

- **Closing phase**
  - Recommendations for different technical solutions based on the risk for mould growth
Probabilistic analysis

- Monte-Carlo simulations
  - 6 scenarios
  - 100 samples per scenario

- Two numerical models
  - Simple and complex
  - 25 sec or 120 sec per sample

For all 600 samples:
- 4.2 h or 20 h
Difference between the models

Simple  
(code in Matlab)

Complex  
(HAM-Tools)
Comparison of HM states in the attic

Air temperature in the attic

Relative humidity in the attic

Simple model
Complex model
Risk assessment based on criteria for mould growth

Mould growth potential
Definitely OK if $M < 1$

$$M = \frac{RH}{RH_{\text{crit}}}$$

Diagram showing the relationship between RH and temperature, indicating critical RH levels for mould growth.
Scenarios

2 ventilation flow rates: high and low

Leaky floor  Less tight floor  Tight floor

3 infiltration flow rates
Random variables and ranges

Ventilation flow rate (exterior air), 1/h

Low vent. = $N(2,1)$
High vent. = $N(7,5)$

Air infiltration (indoor air), 1/h

Leaky = $N(0.2,0.1)$
Less tight = $N(0.1,0.1)$
Tight = 0

Indoor moisture supply, kg/m$^3$

$\Delta v = N(0.004,0.002)$

Climate data 1971-1990 GBG

$year = random(0 - 30)$
Results – how long time MP >1

Low ventilation flow rate

- Leaky attic floor
- Less tight attic floor
- Tight attic floor

High ventilation flow rate

- Leaky attic floor
- Less tight attic floor
- Tight attic floor

- Simple model
- Complex model
Conclusions

• Reasonable good agreement between the results on MP

• Computational time saved with the simple model

• Further comparisons are required for more complex attic constructions and especially for variable air flow rates.