

Heat and moisture in wooden bearings of monumental buildings

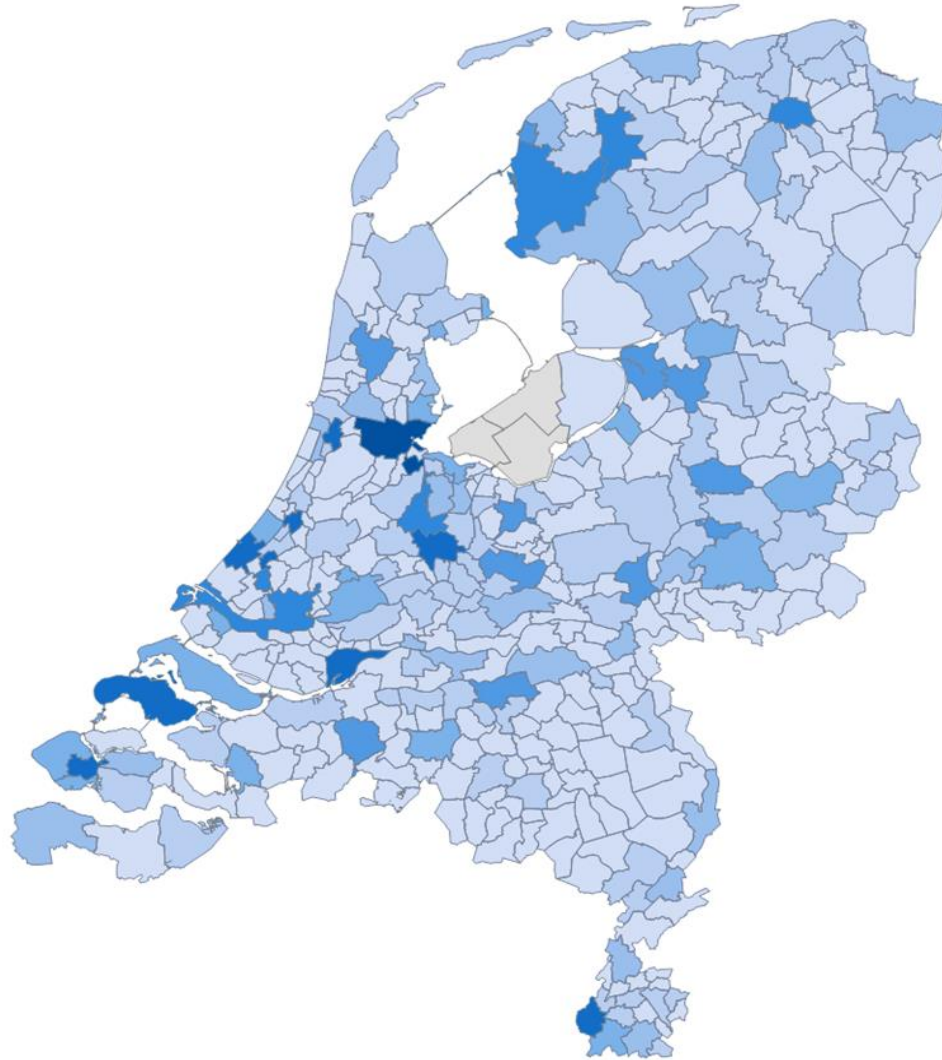
Henk Schellen TU/e
Jos van Schijndel TU/e
Menno Spierenburg DPA



Content

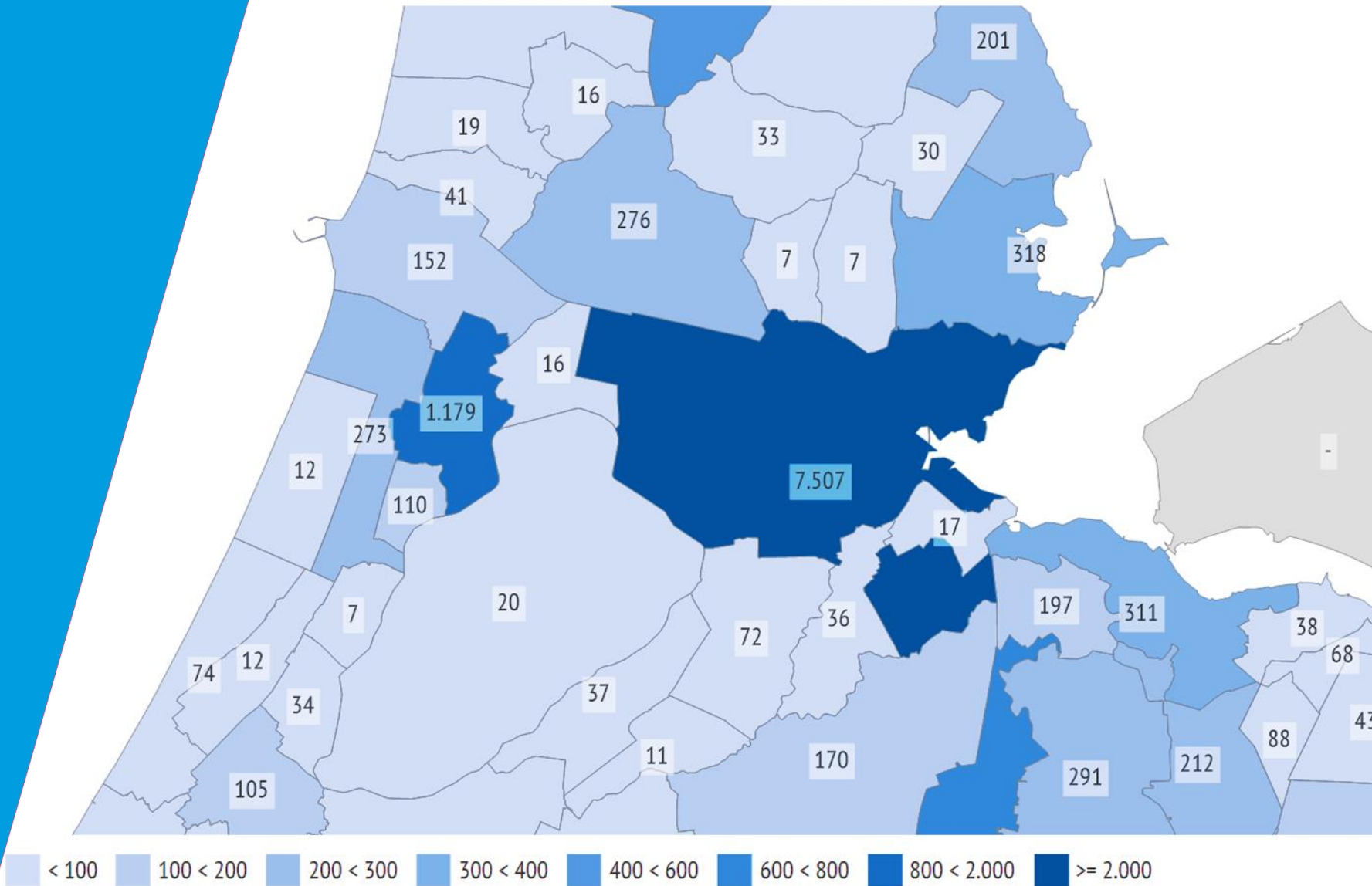
- Introduction
- HAM Simulations
 - Validation
- Case study
- Conclusion
- Recommendation

Amount of monuments - current state

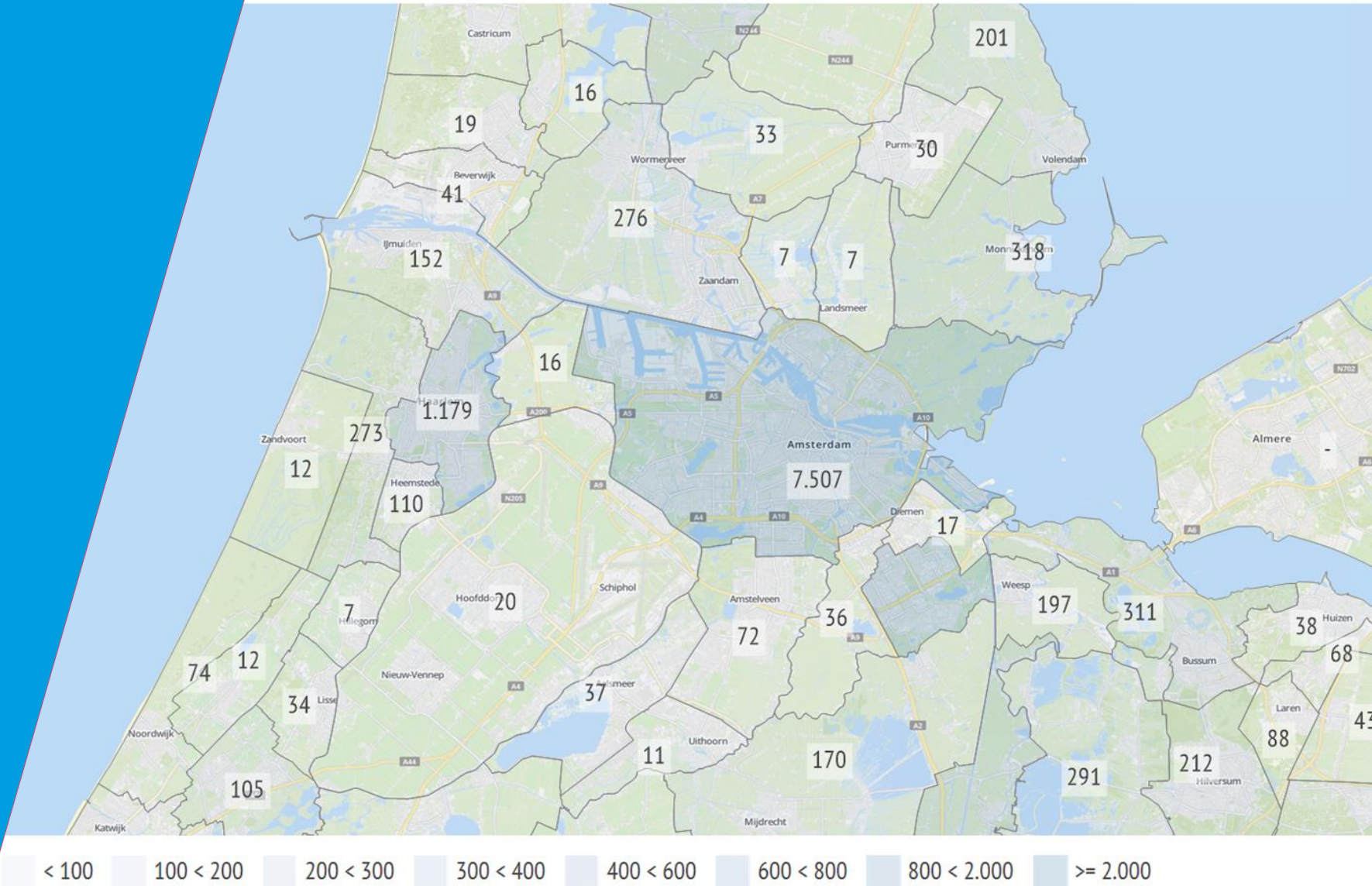


< 100 100 < 200 200 < 300 300 < 400 400 < 600 600 < 800 800 < 2.000 >= 2.000

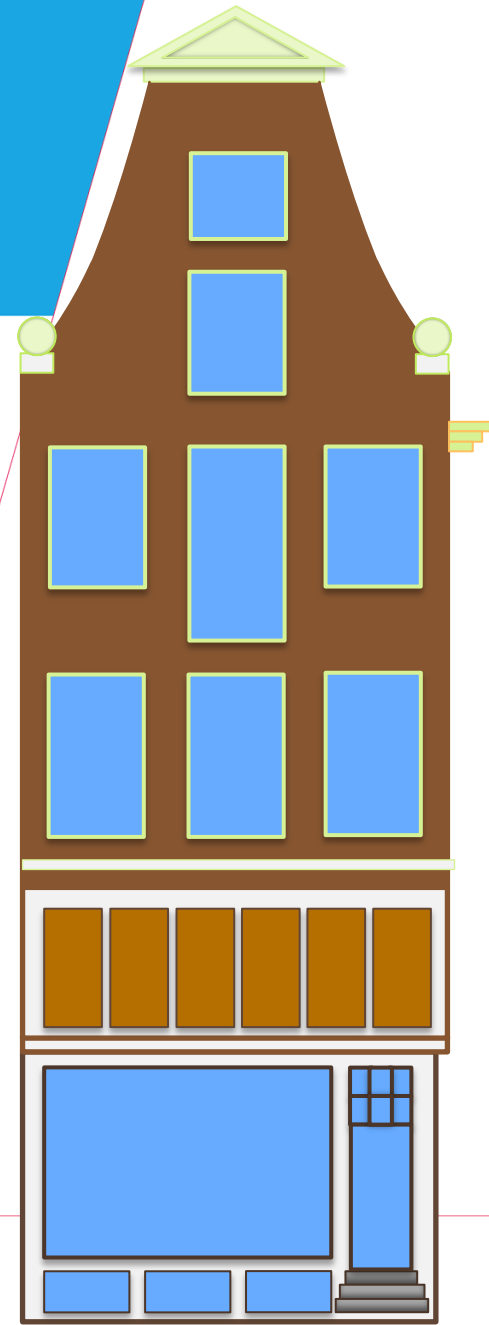
Amount of monuments - current state



Amount of monuments - current state



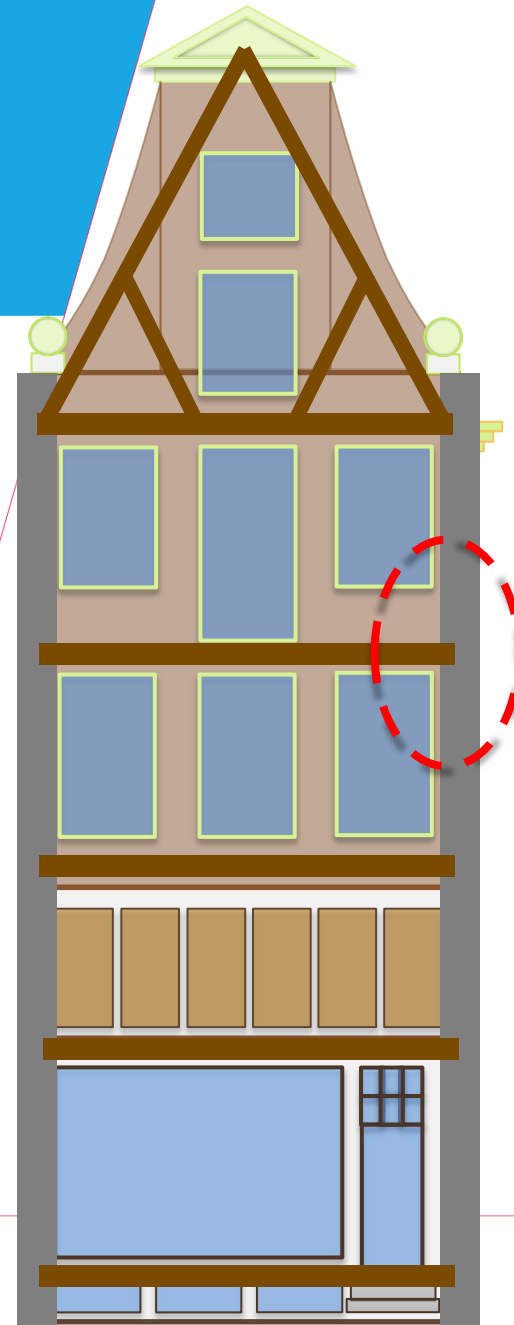




Wood in buildings

Typical construction

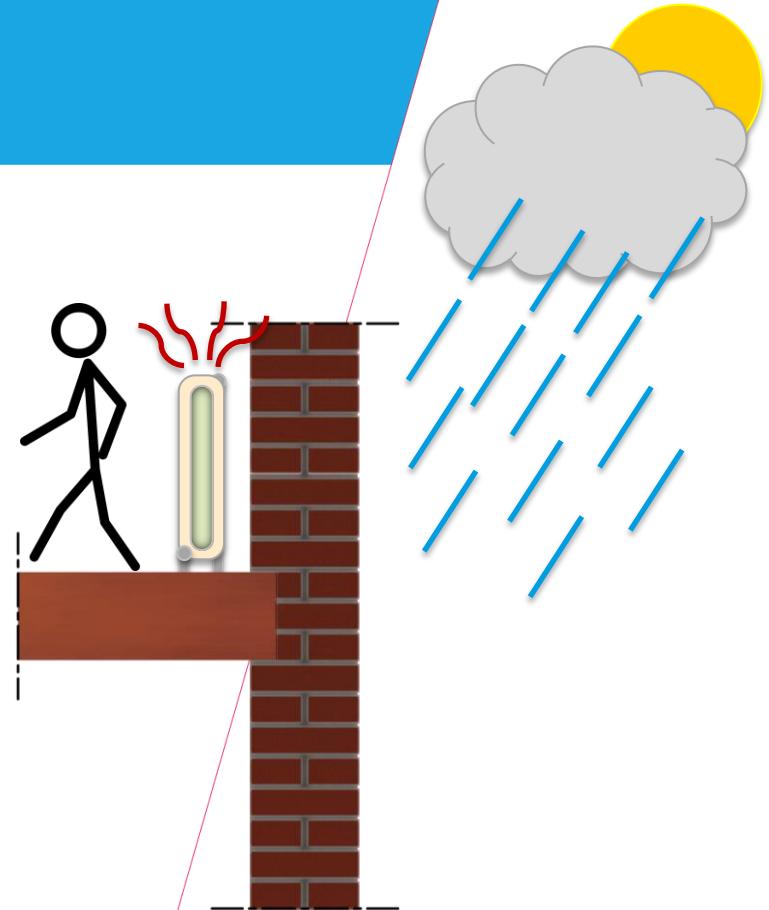
- Masonry walls
- Wooden floors
- Wooden truss



Wood in buildings

Risks typical construction

- High wind driven rain load
- Leakages
- Cracks



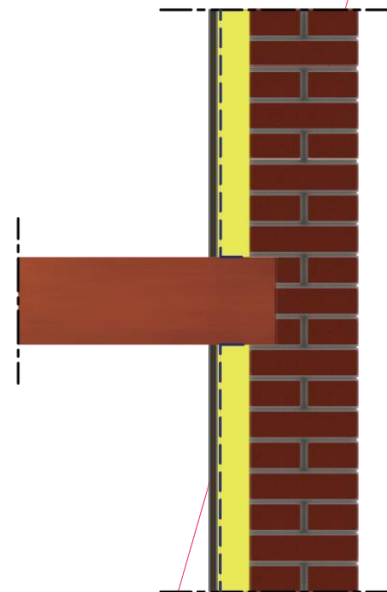
Wood in buildings

Interior insulation risks

- Moisture buildup in materials
- Mould growth
- Deterioration of wood

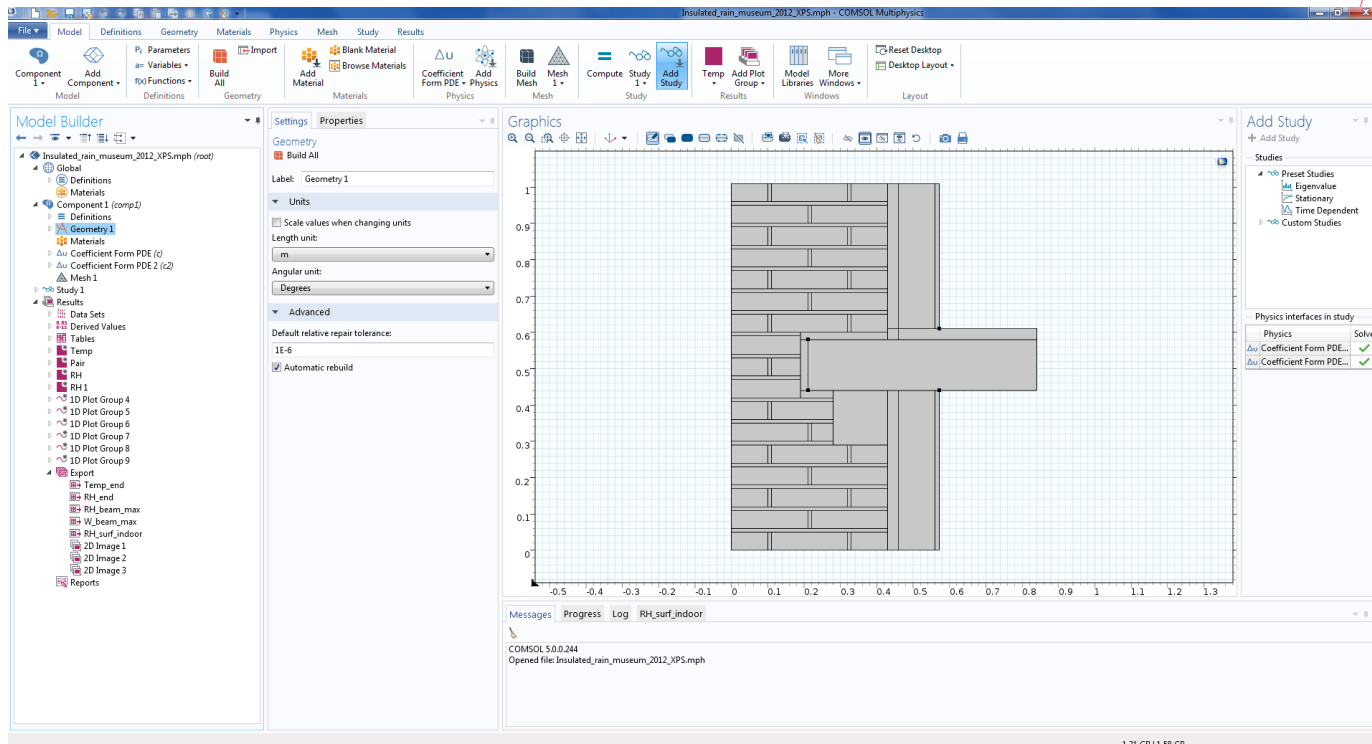
Area of concern

- Air permeability of construction
- Connection vapour barrier



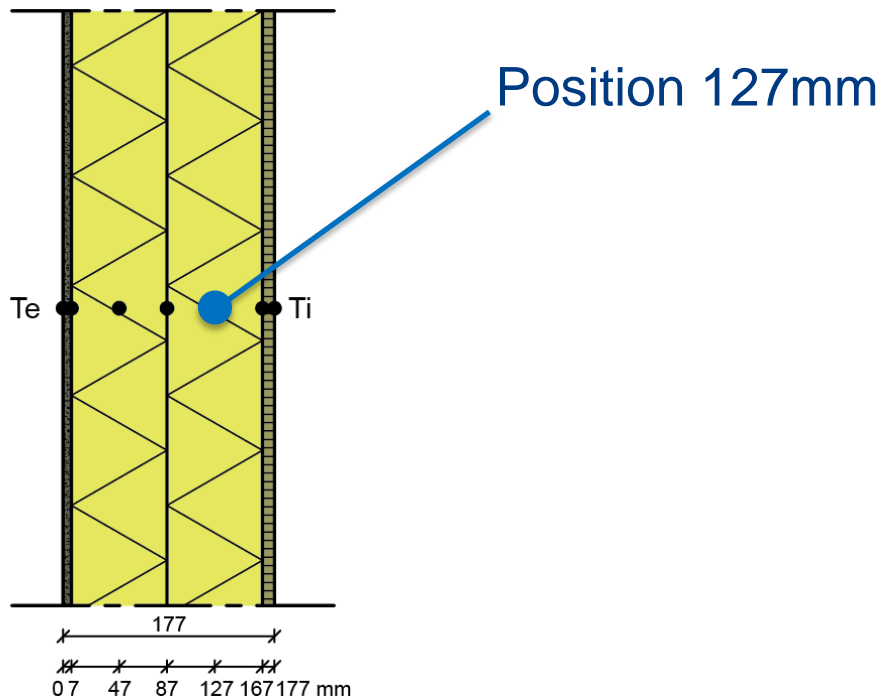
HAM Simulations

Heat, Air and Moisture

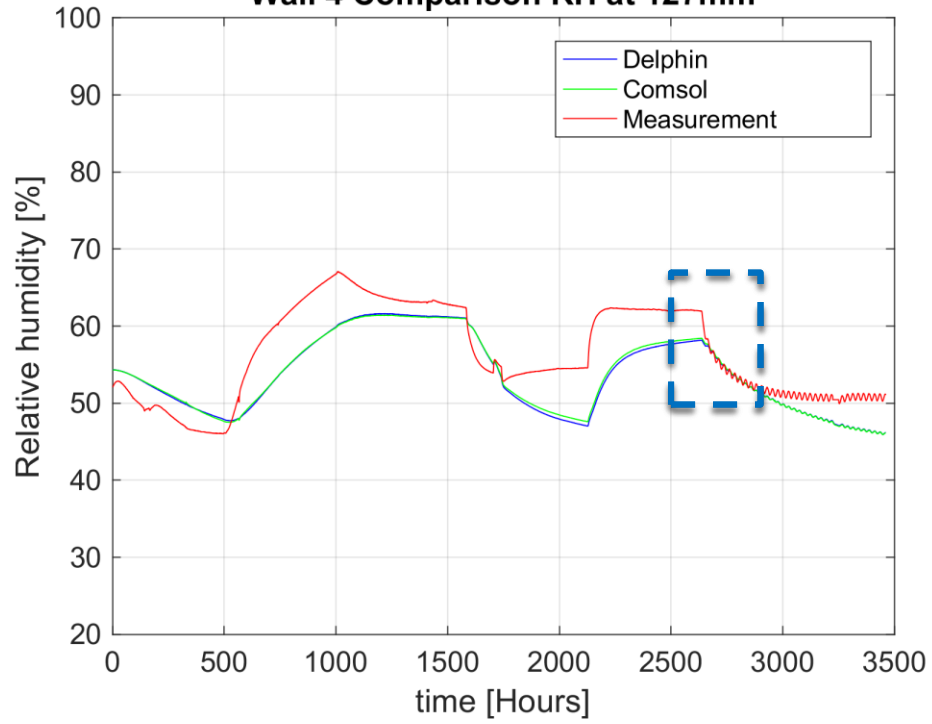


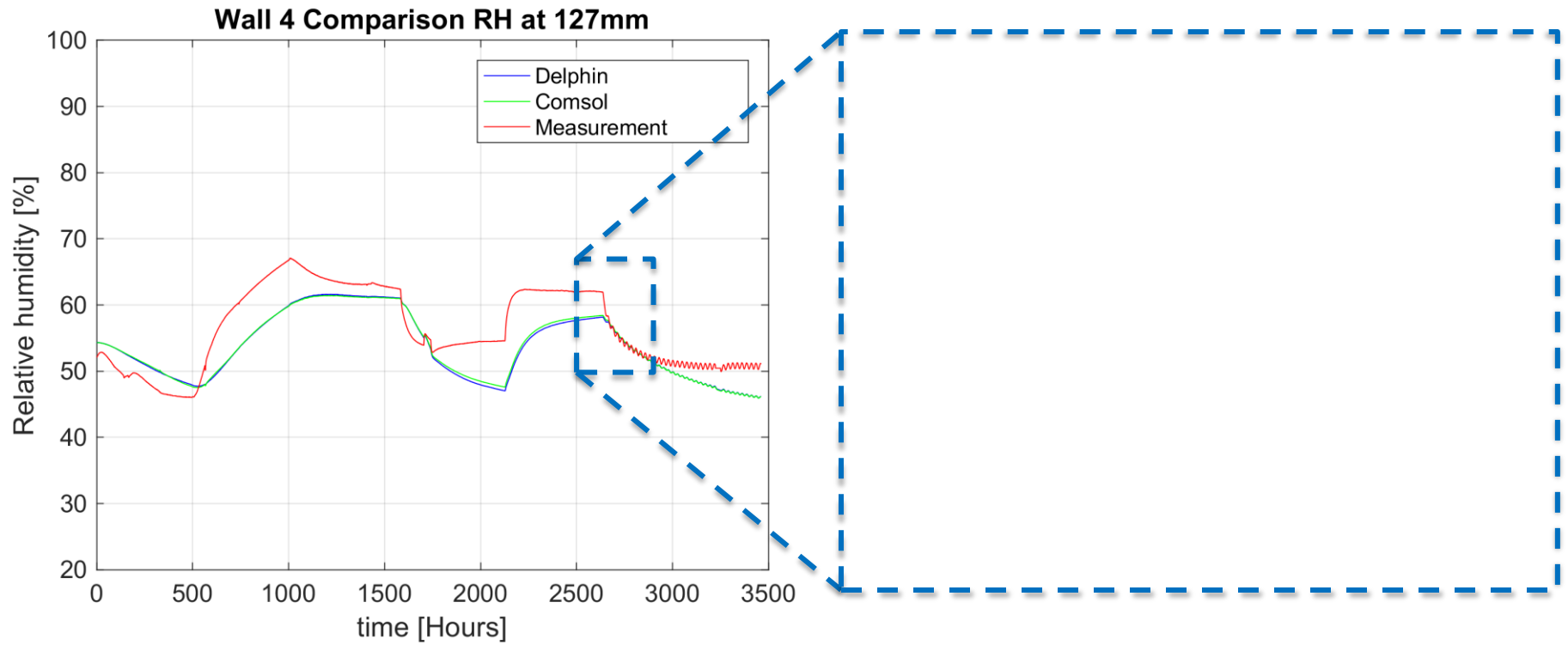
Comparison with Delphin

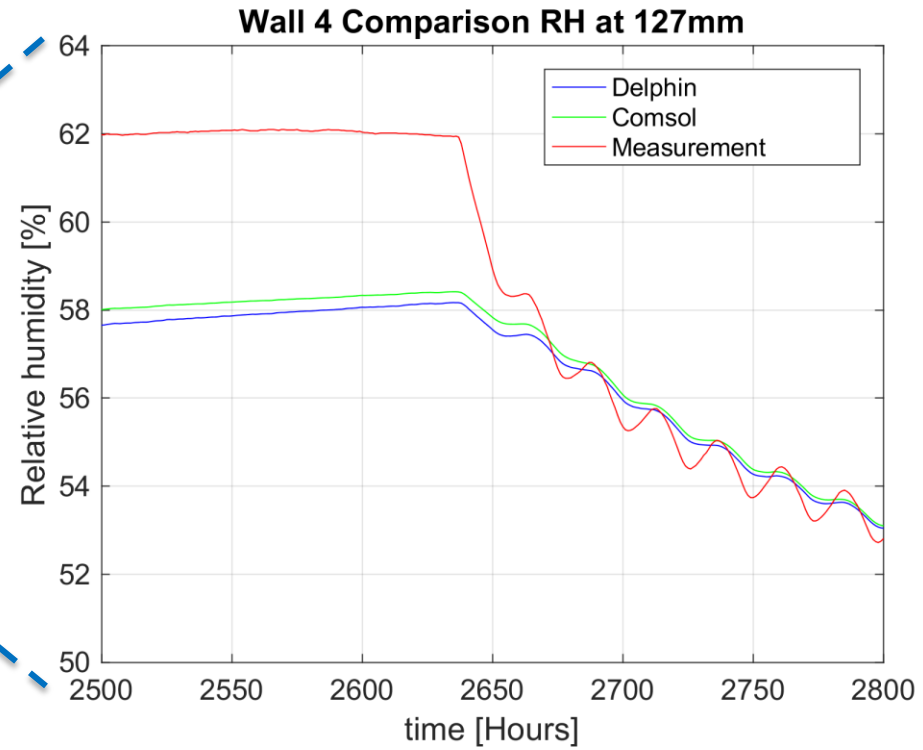
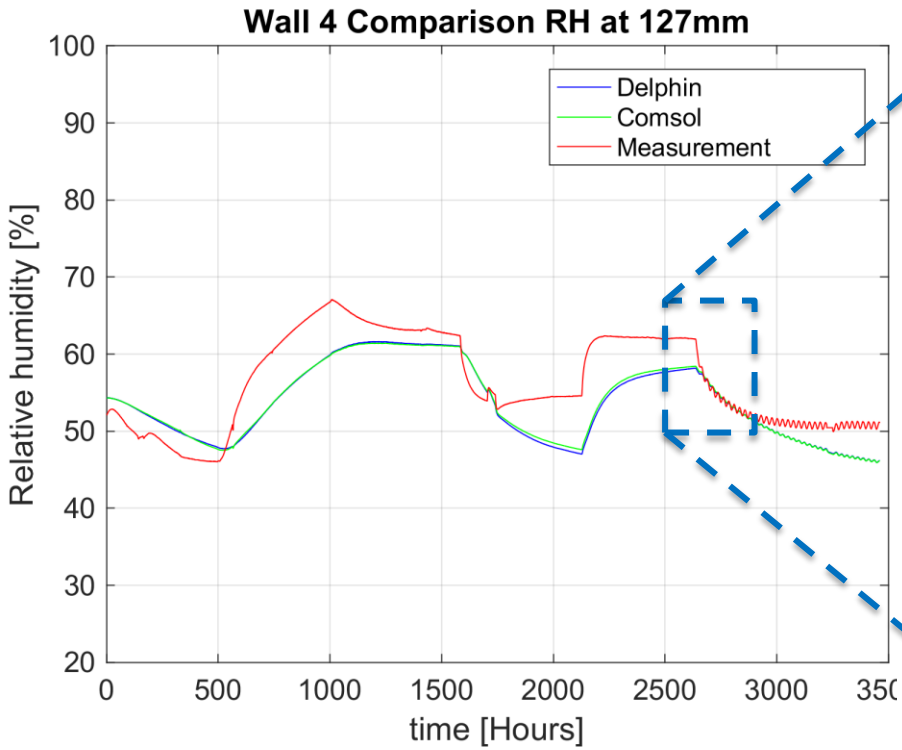
- Materials from Delphin
- Boundary conditions [Rafidiarison, et al. 2015]
- Comsol model based at Goesten, S. [2016]



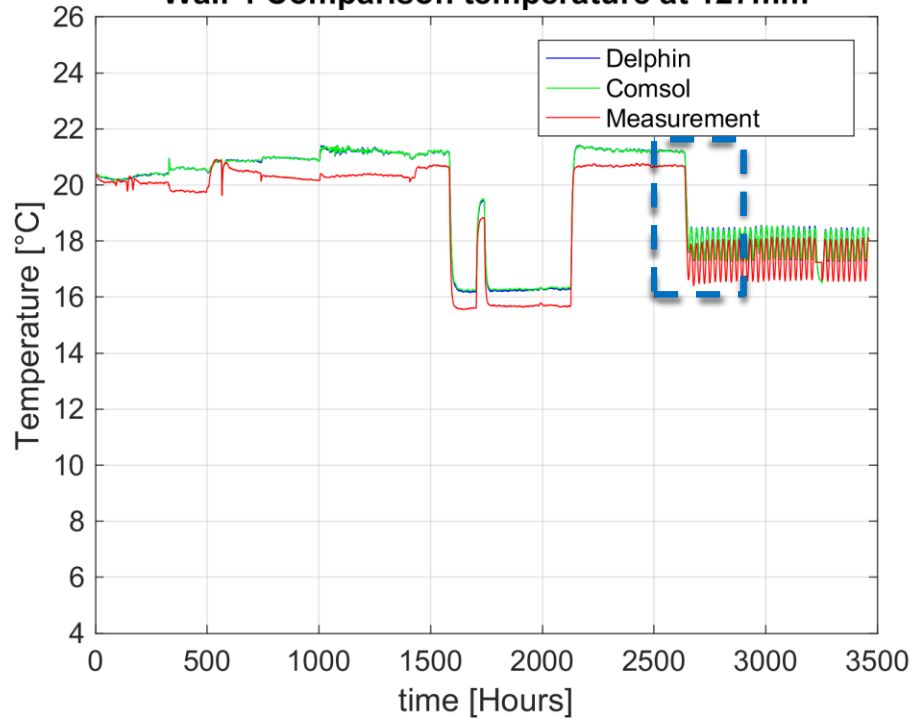
Wall 4 Comparison RH at 127mm



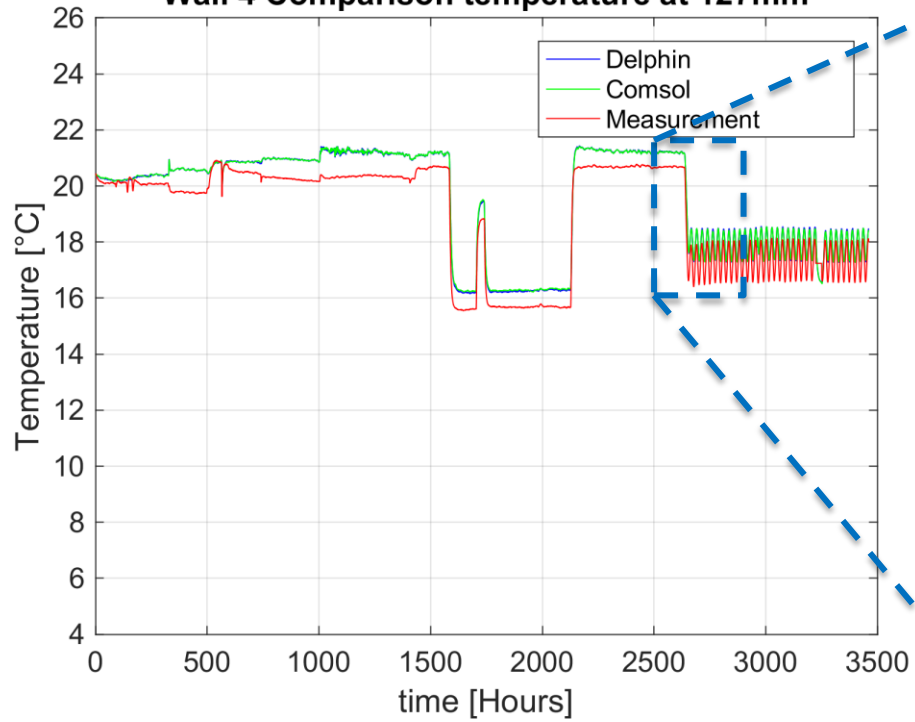


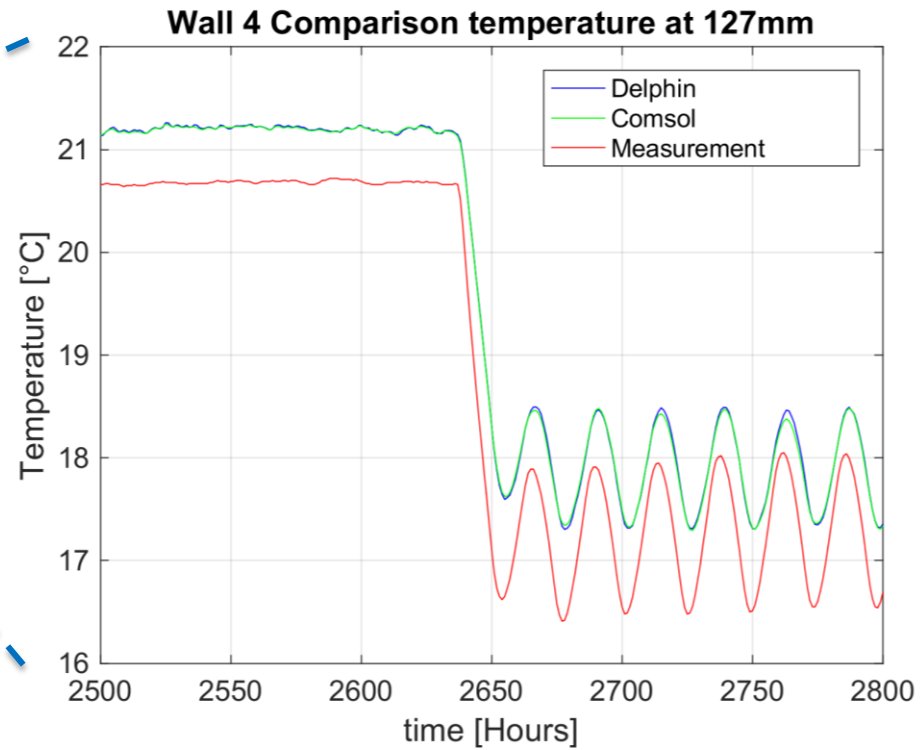
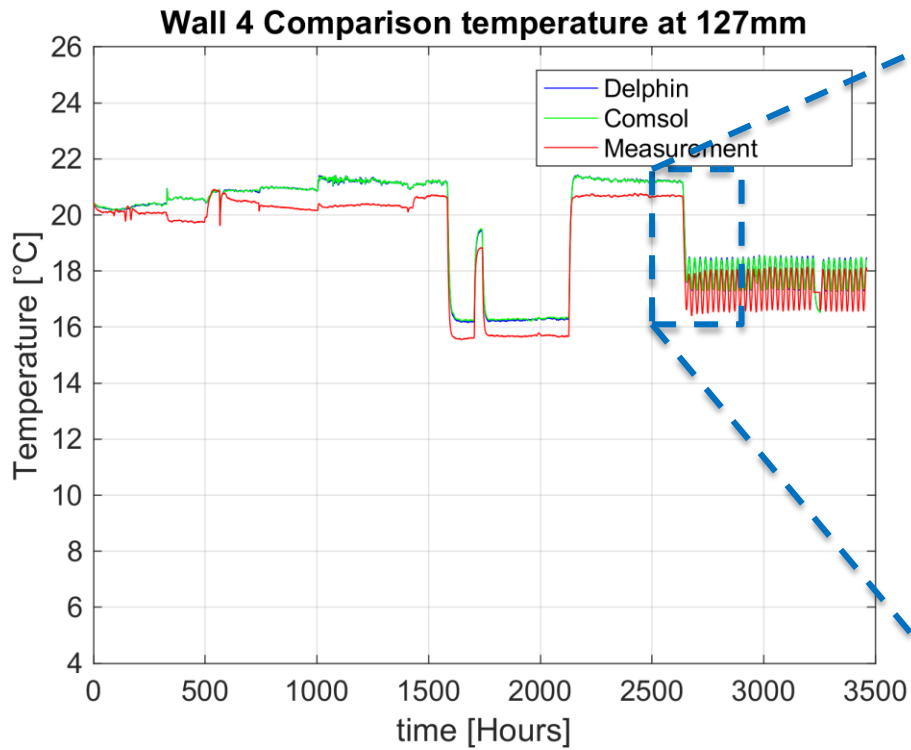


Wall 4 Comparison temperature at 127mm



Wall 4 Comparison temperature at 127mm

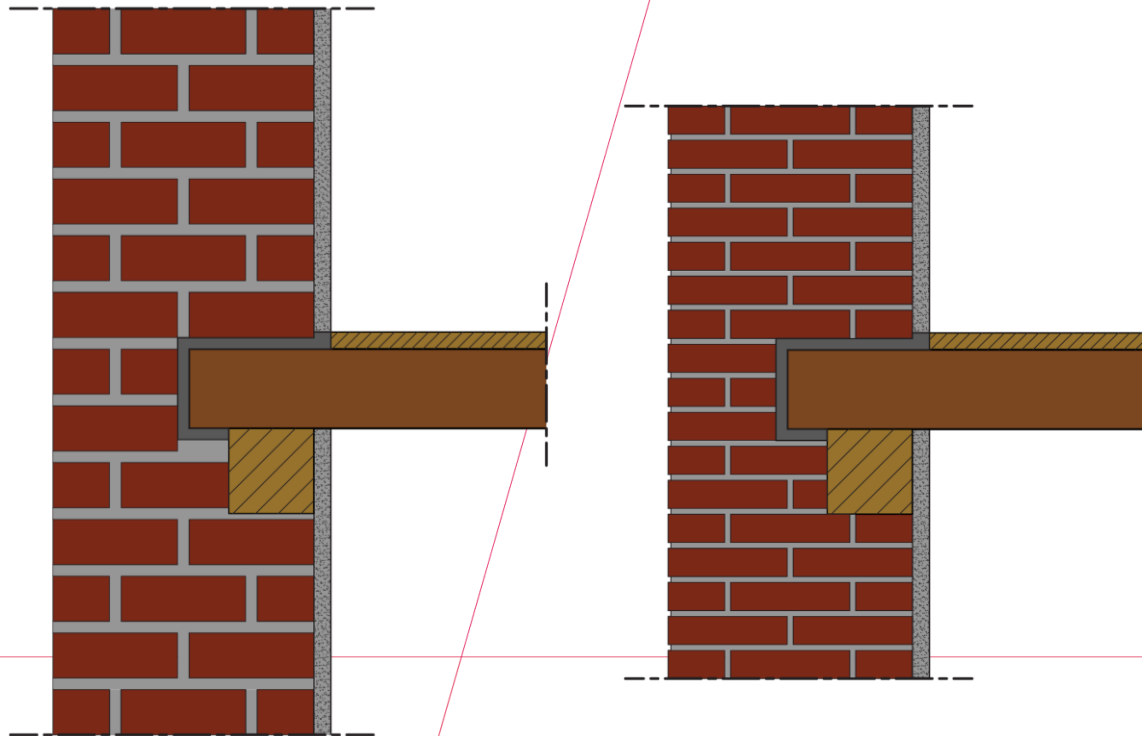




Case study

Harrestrup, M. [2016]

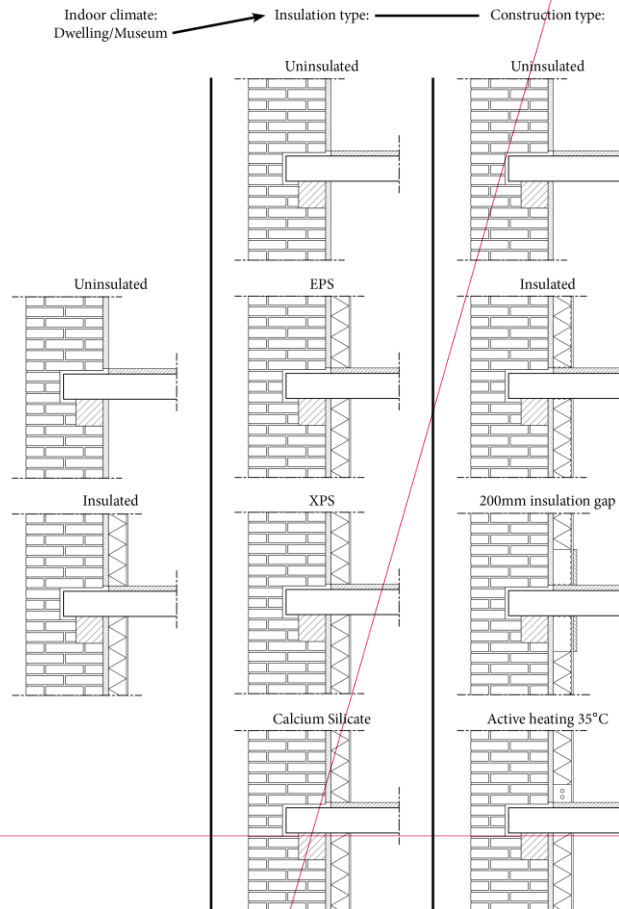
- Reproduction with COMSOL
- Adapted to Dutch sizes
- Usage of Dutch climate
- Year 2012 (average)



Case study

Different categories

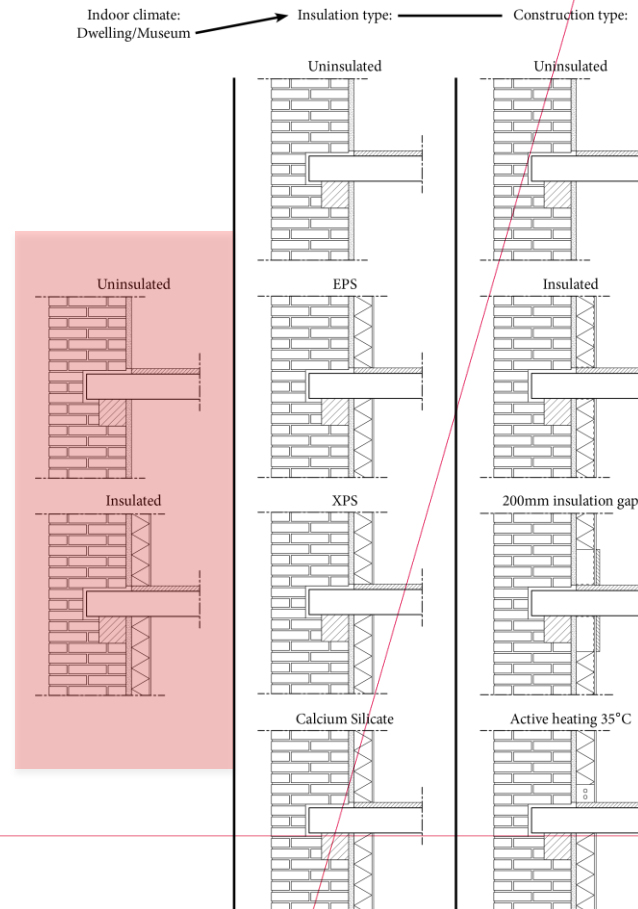
- Indoor climate
- Insulation type
- Construction type



Case study

Different categories

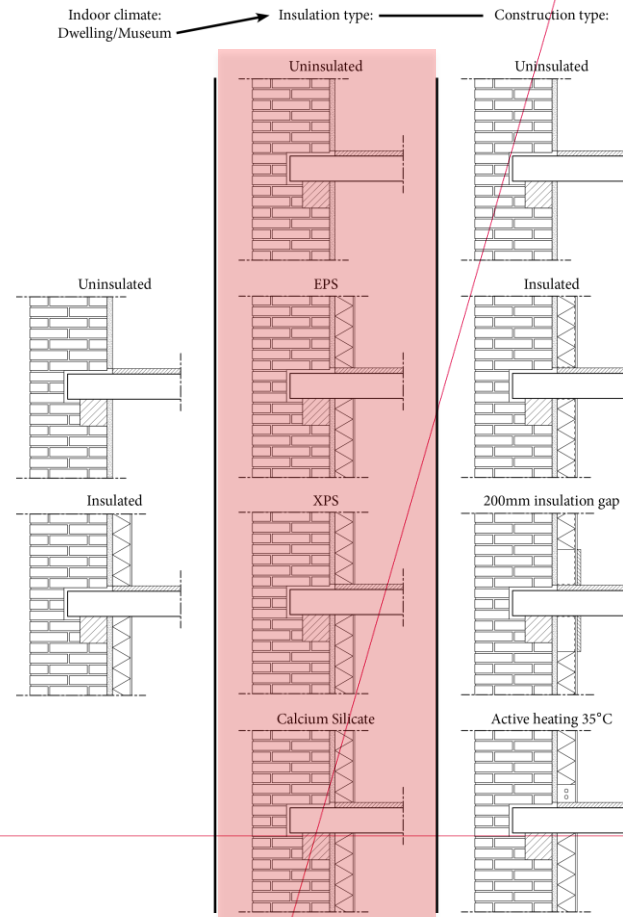
- Indoor climate
- Insulation type
- Construction type



Case study

Different categories

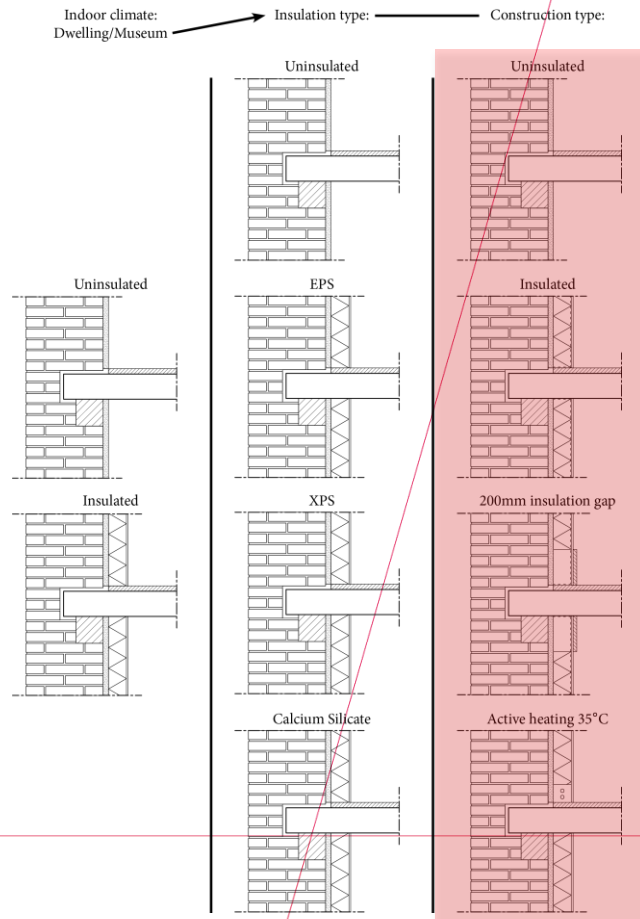
- Indoor climate
- **Insulation type**
- Construction type



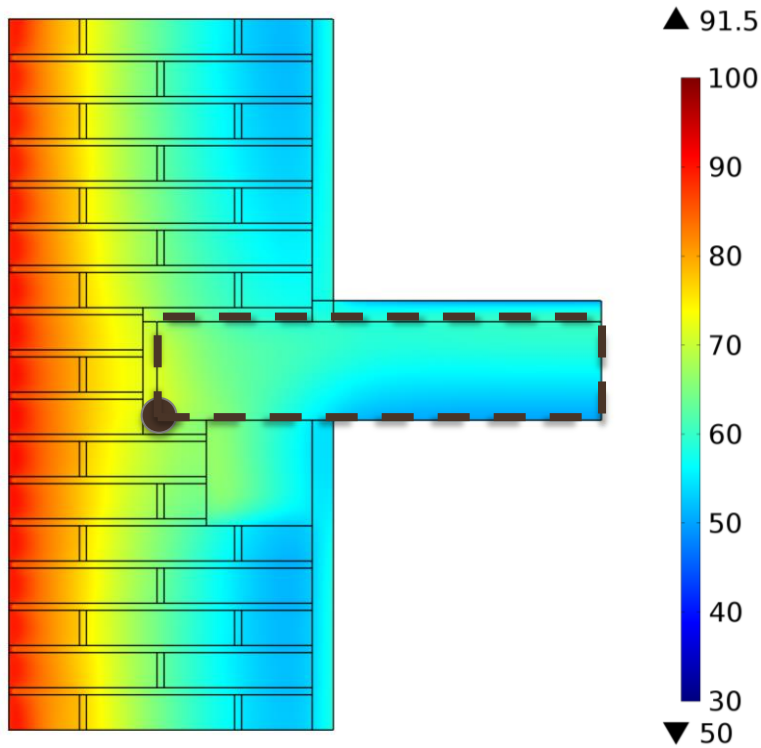
Case study

Different categories

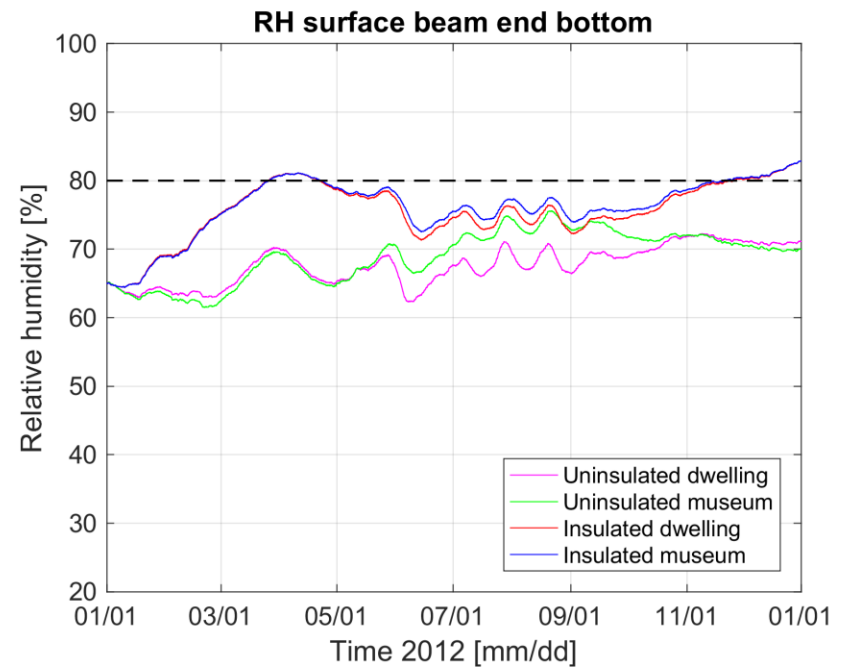
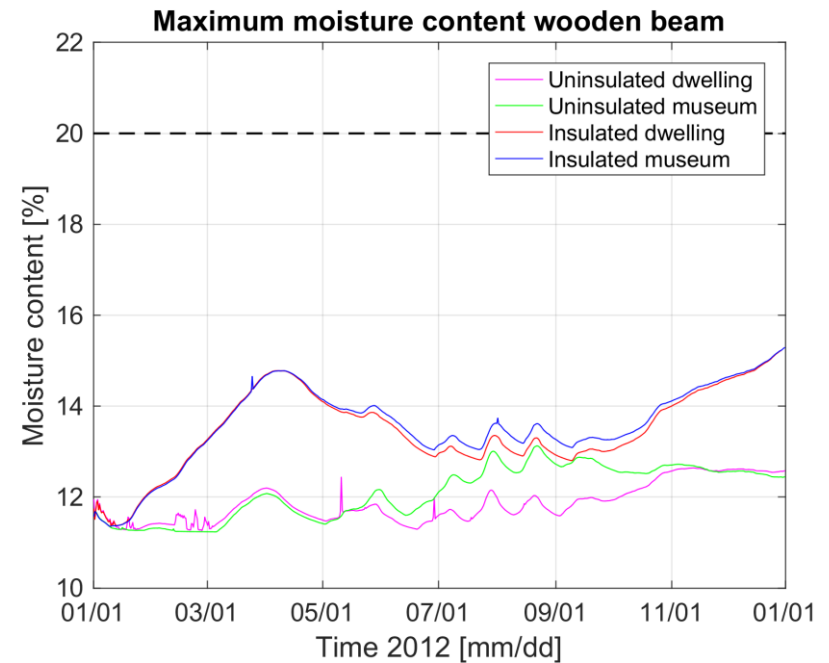
- Indoor climate
- Insulation type
- **Construction type**



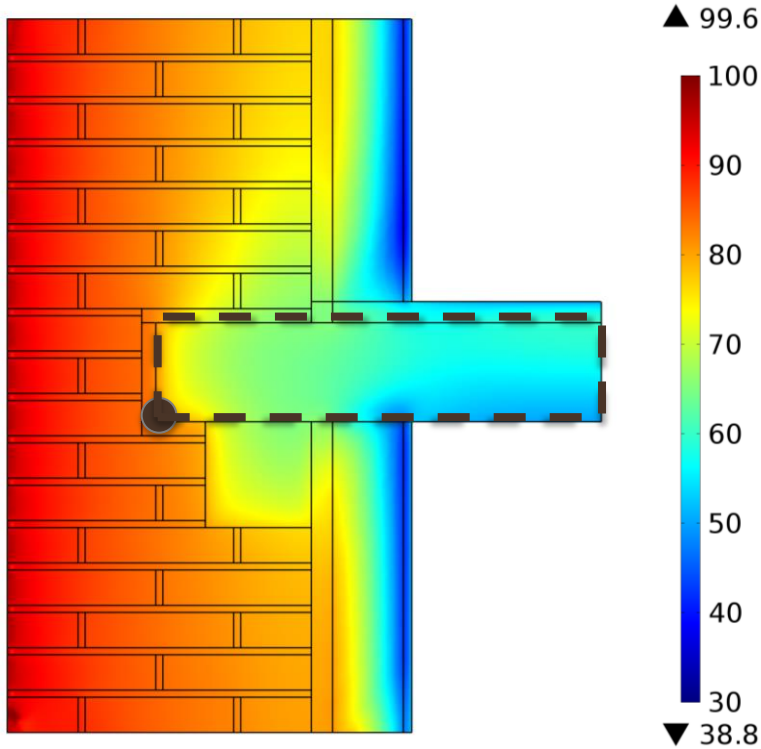
Indoor climate:



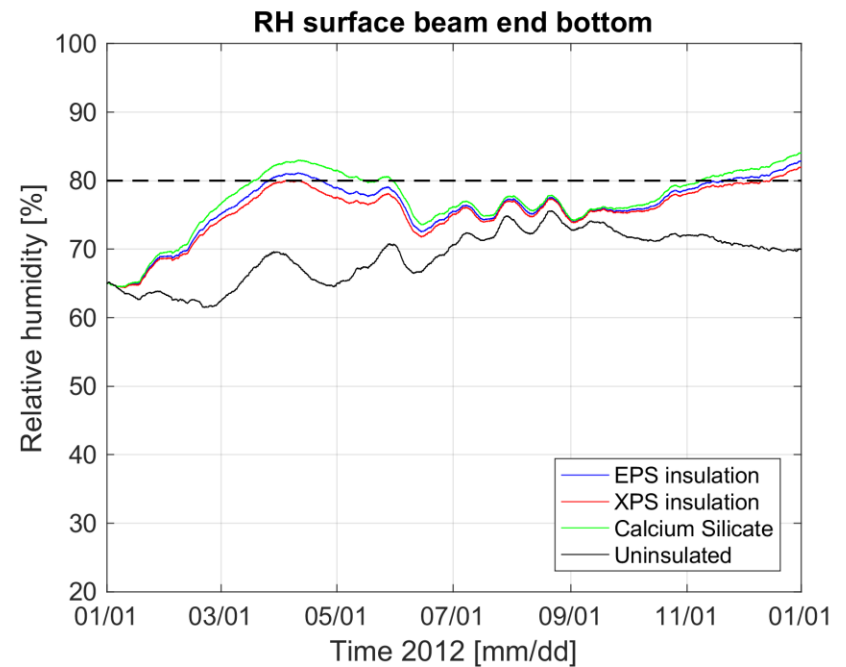
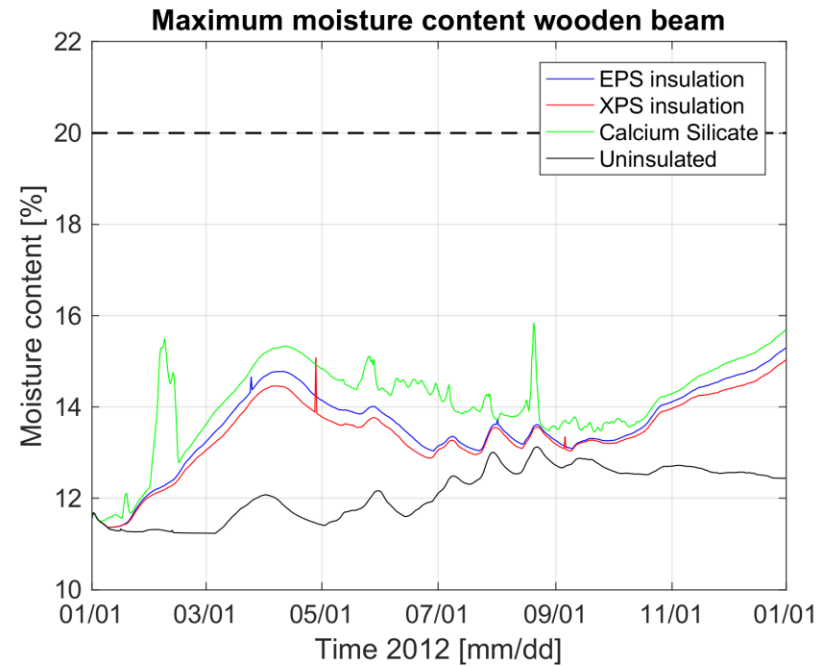
RH at 30-12-2012



Insulation material:



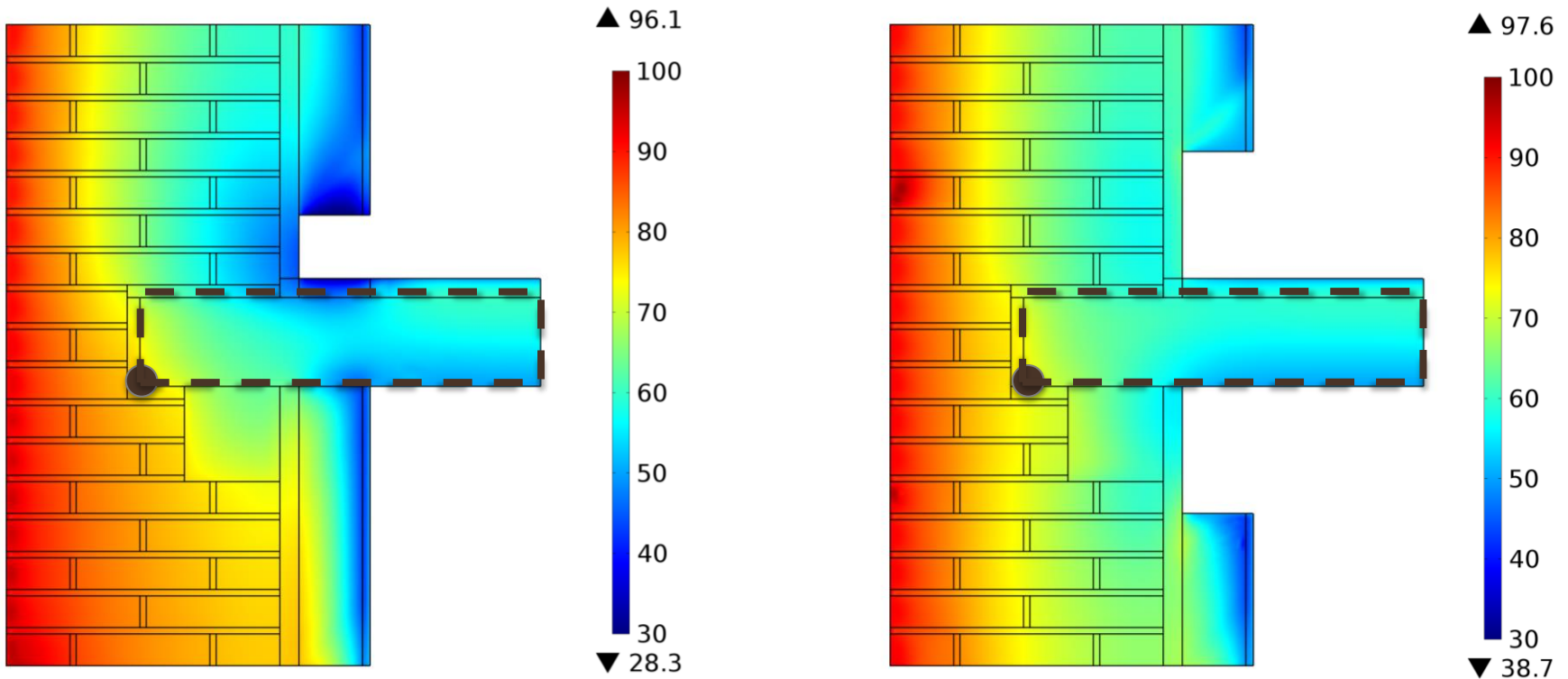
RH at 30-12-2012



Construction:

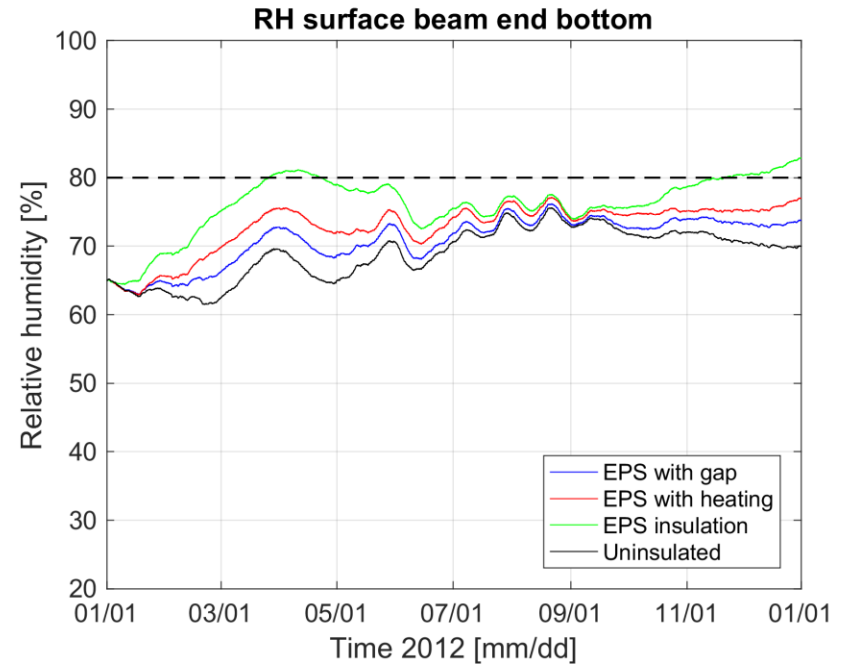
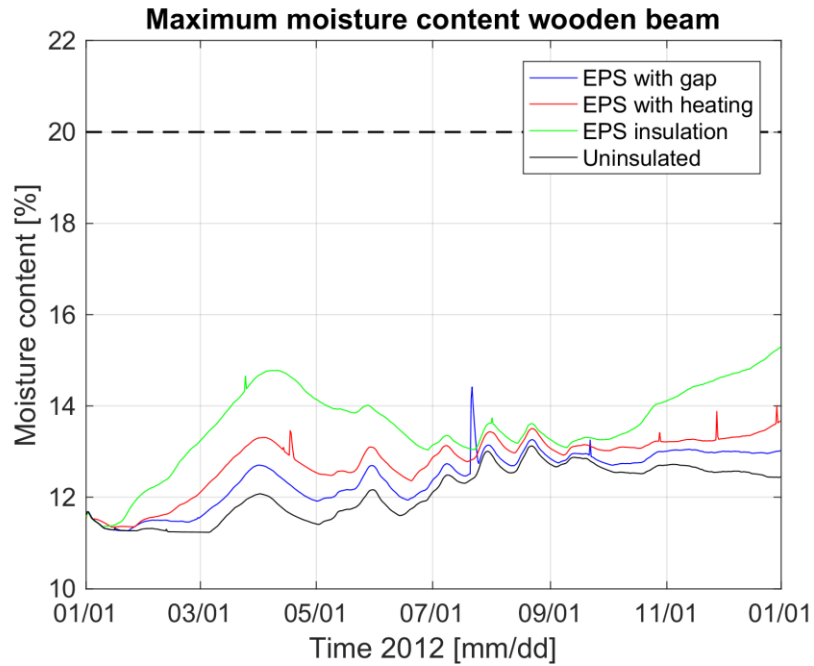
Active heating 35°C

200 mm gap



RH at 30-12-2012

Construction:



Conclusion

Interior insulation possible

- Museum indoor climate (worst case)
- Moisture buildup
- Risk of mould growth at surface

Effective measures

- Active heating
- Insulation gap of 200mm

Recommendations

Improvement simulation model

- Solar radiation
- Wind/rain climate (measured or with CFD)
- Simulation multiple years
- 3D models

Questions

