



KATHOLIEKE UNIVERSITEIT
LEUVEN

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29 May – 2 June 2011
Tampere, Finland

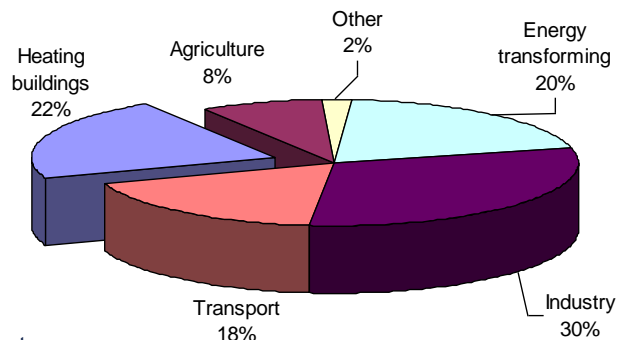


A NUMERICAL STUDY OF THE HYGROTHERMAL PERFORMANCE OF CAPILLARY ACTIVE INTERIOR INSULATION SYSTEMS

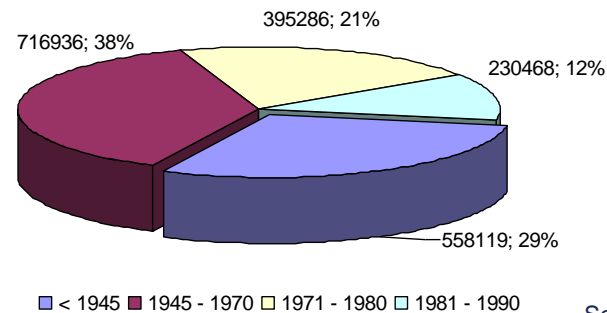
E. Vereecken, S. Roels
Building Physics Section
Department of Civil Engineering
K.U.Leuven

INTRODUCTION

■ CO₂-emission excesses



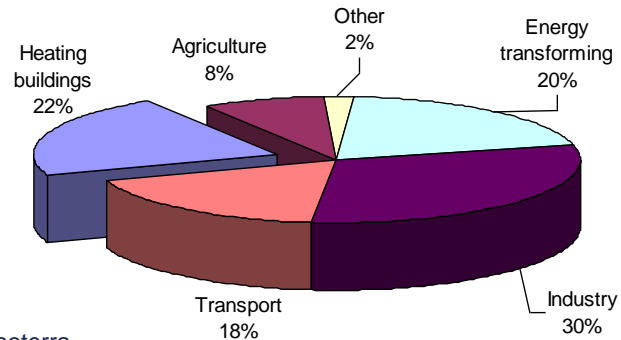
Source: Isoterra



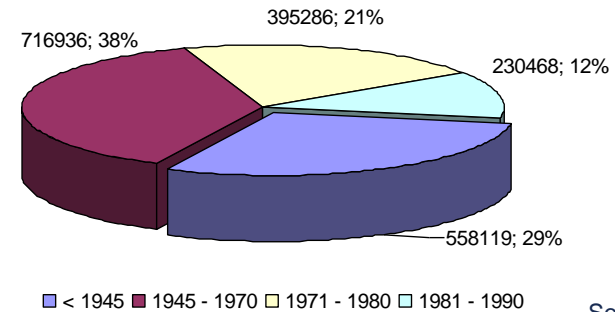
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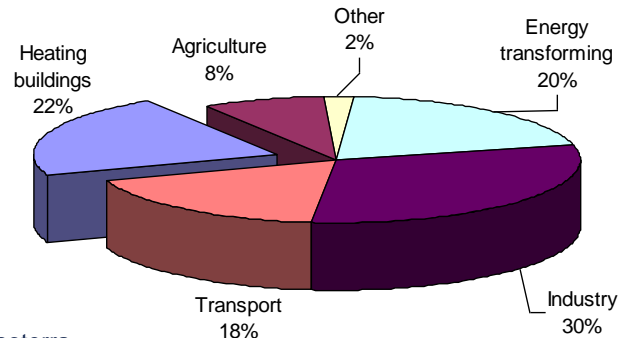


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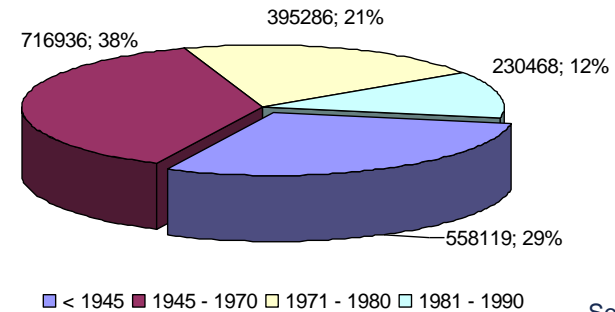
➔ Existing building stock (<1945)?

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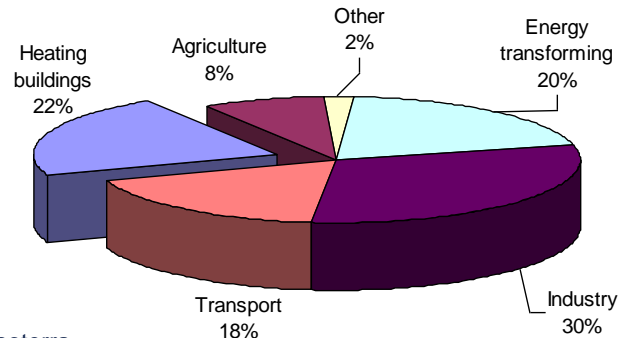
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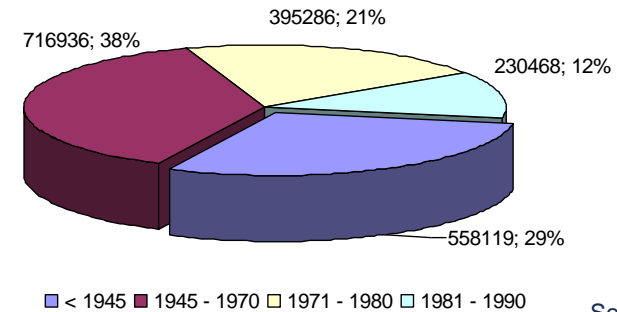
➔ Exterior or interior insulation

INTRODUCTION

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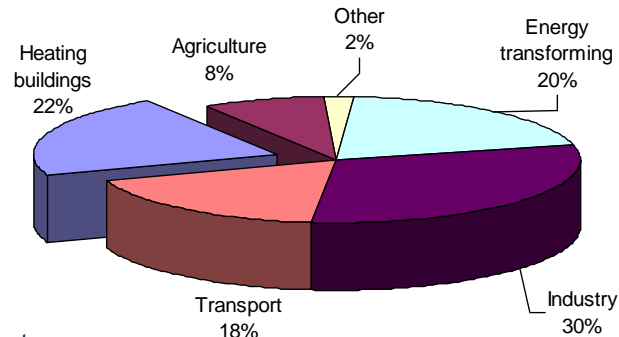
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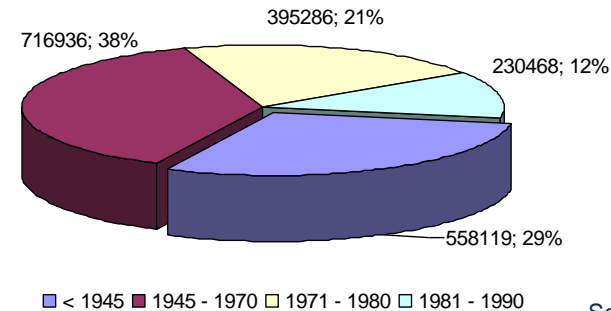
Interior insulation = most risky insulation technique
(Interstitial condensation, thermal bridges, frost damage, mould,...)

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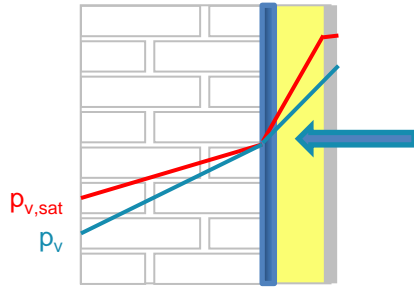
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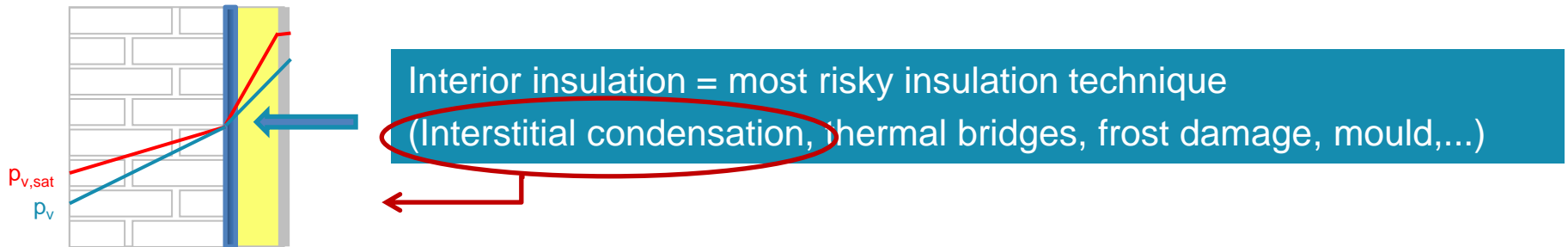
BUT: urban environment, historical buildings → Interior insulation

INTERSTITIAL CONDENSATION



Interior insulation = most risky insulation technique
(Interstitial condensation, thermal bridges, frost damage, mould,...)

INTERSTITIAL CONDENSATION

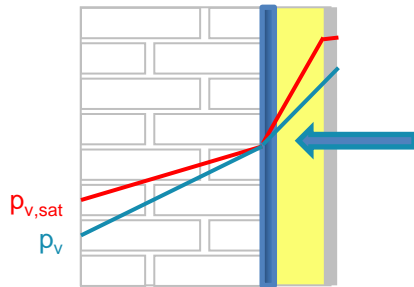


- 'Standard solution':

- vapour tight systems
(e.g. XPS, cellular glass, insulation + vapour retarder)

BUT: reduction drying rate of the masonry wall towards the inside

INTERSTITIAL CONDENSATION



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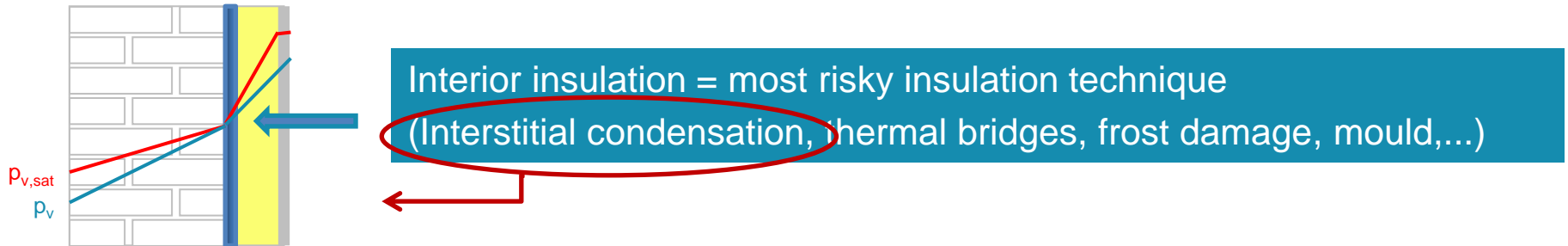
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- Recent innovative proposals:

- Smart vapour retarder
- Hydrophilic mineral wool
- Capillary active insulation

INTERSTITIAL CONDENSATION



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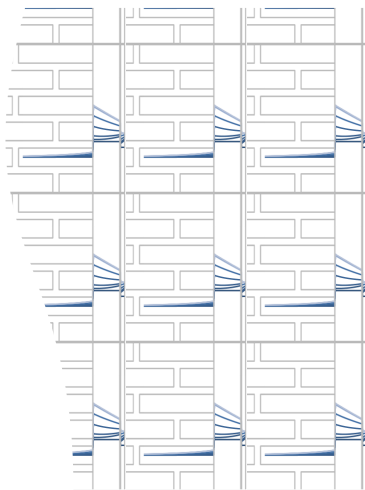
- Smart vapour retarder
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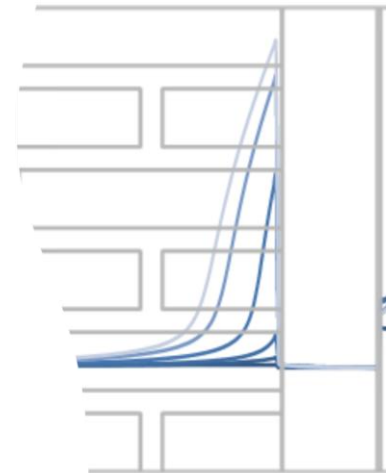
CAPILLARY ACTIVE SYSTEMS

- Vapour open + high capillary pores (e.g. Calcium silicate, wood fibre board)
 - ➔ redistribution of liquid moisture
 - ➔ avoidance of interstitial condensation

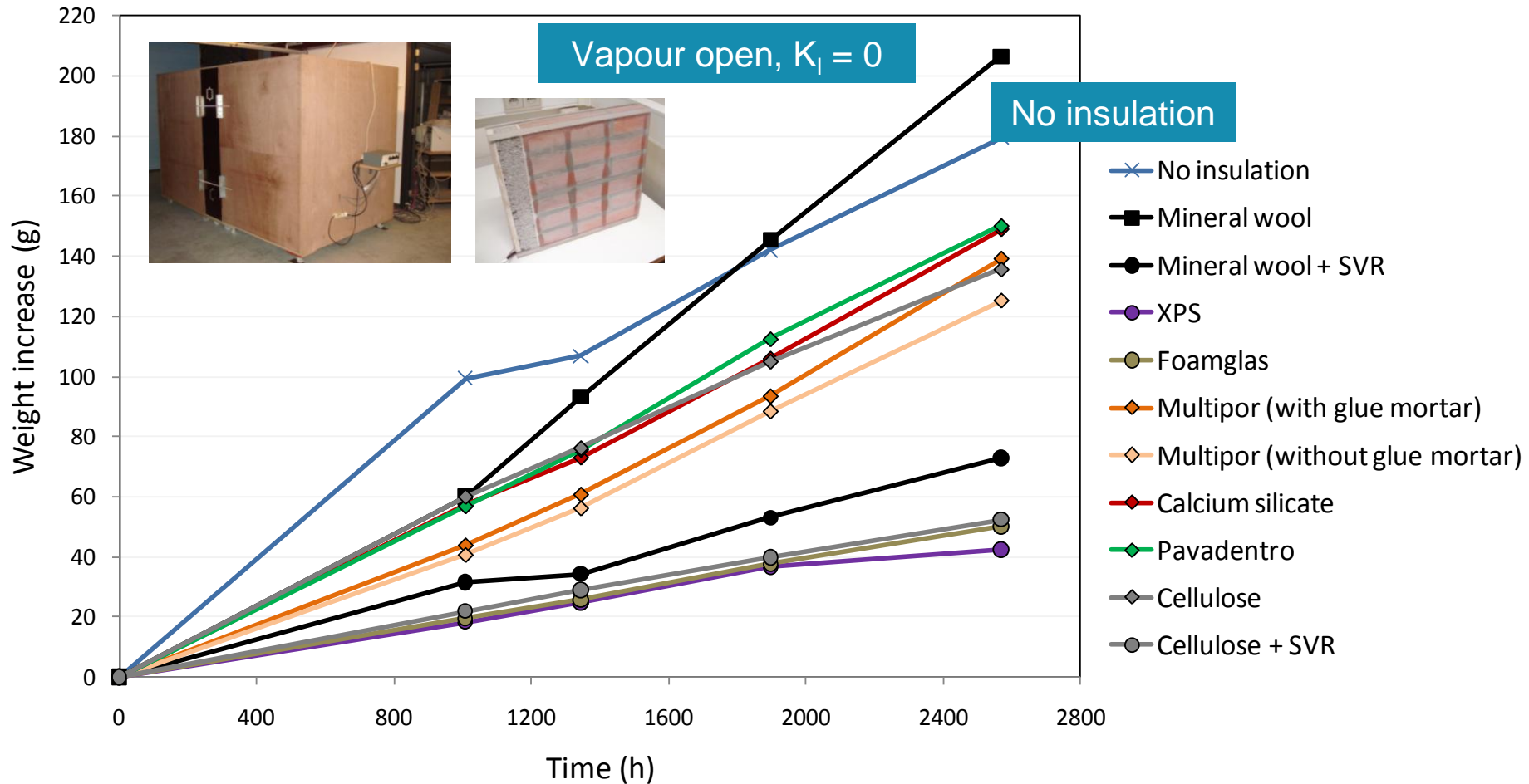
Capillary active insulation



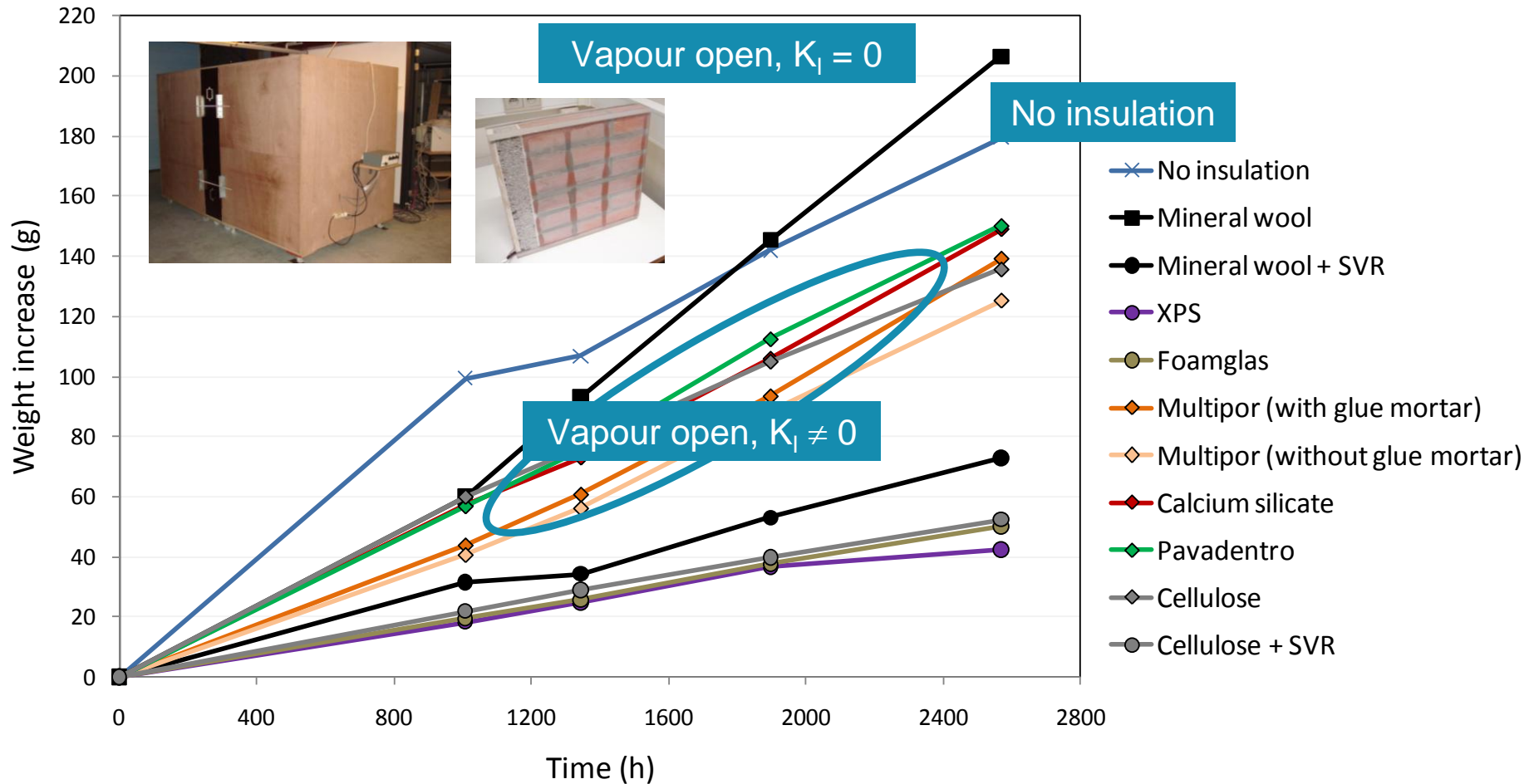
Non capillary active insulation



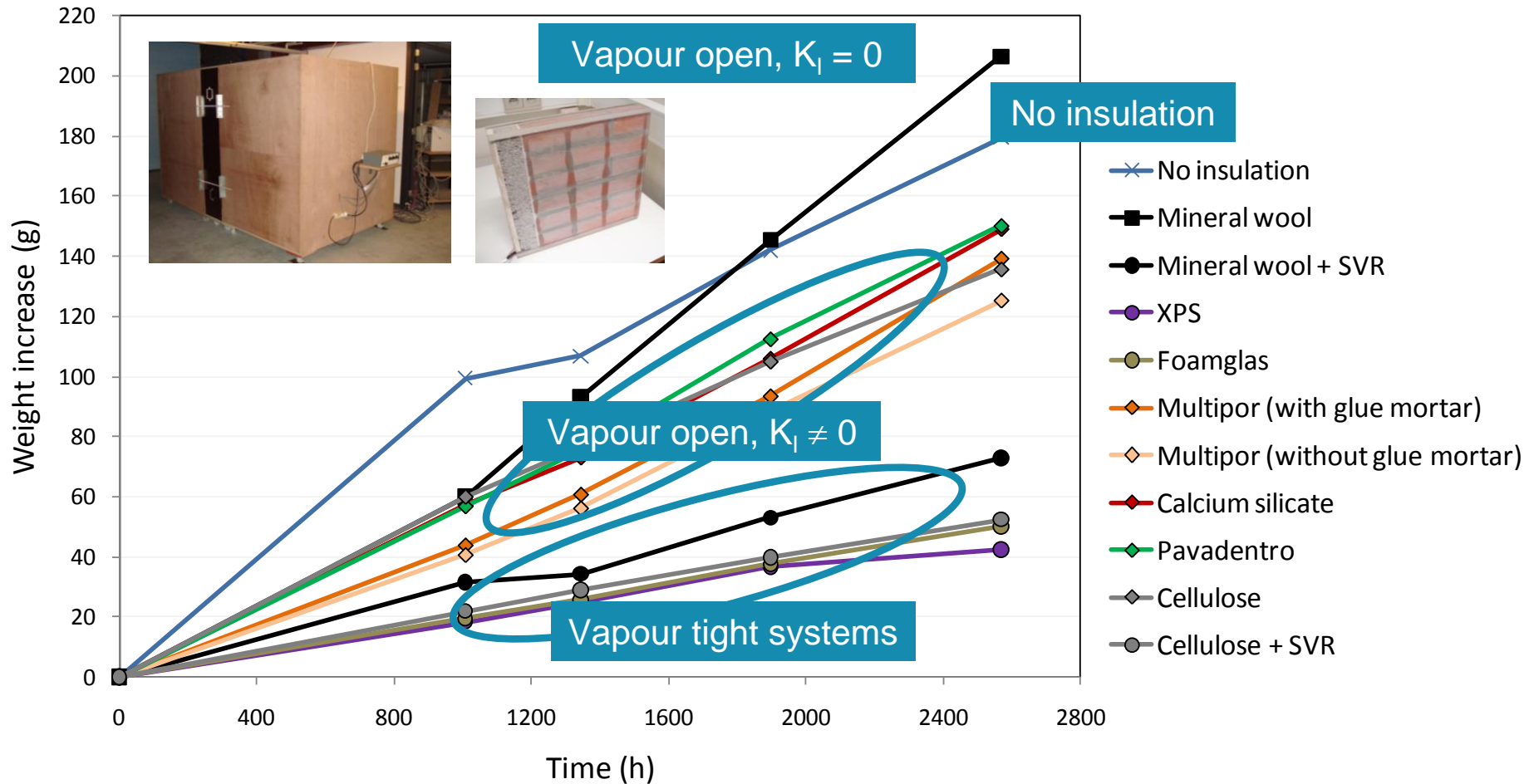
HOT BOX – COLD BOX EXPERIMENT



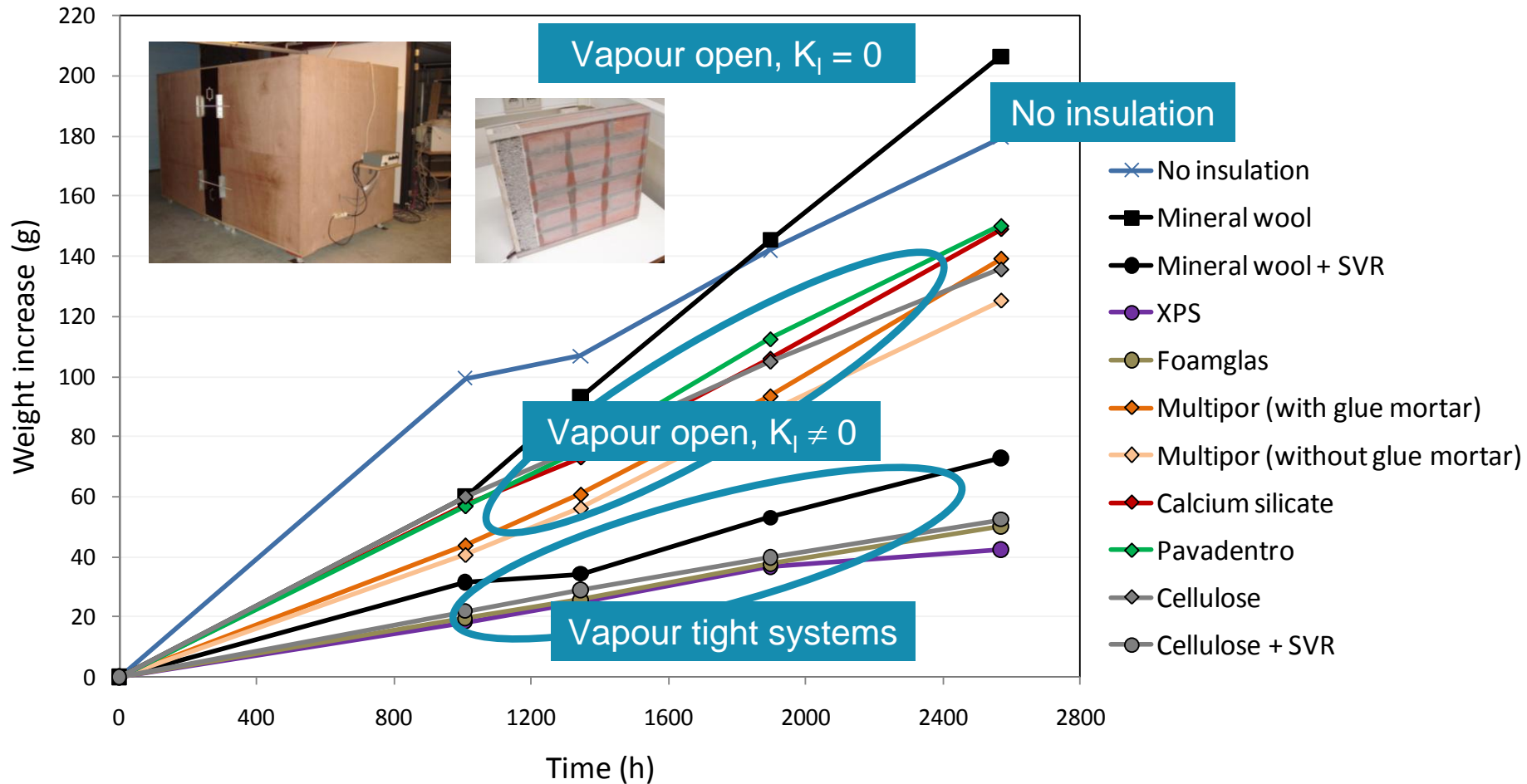
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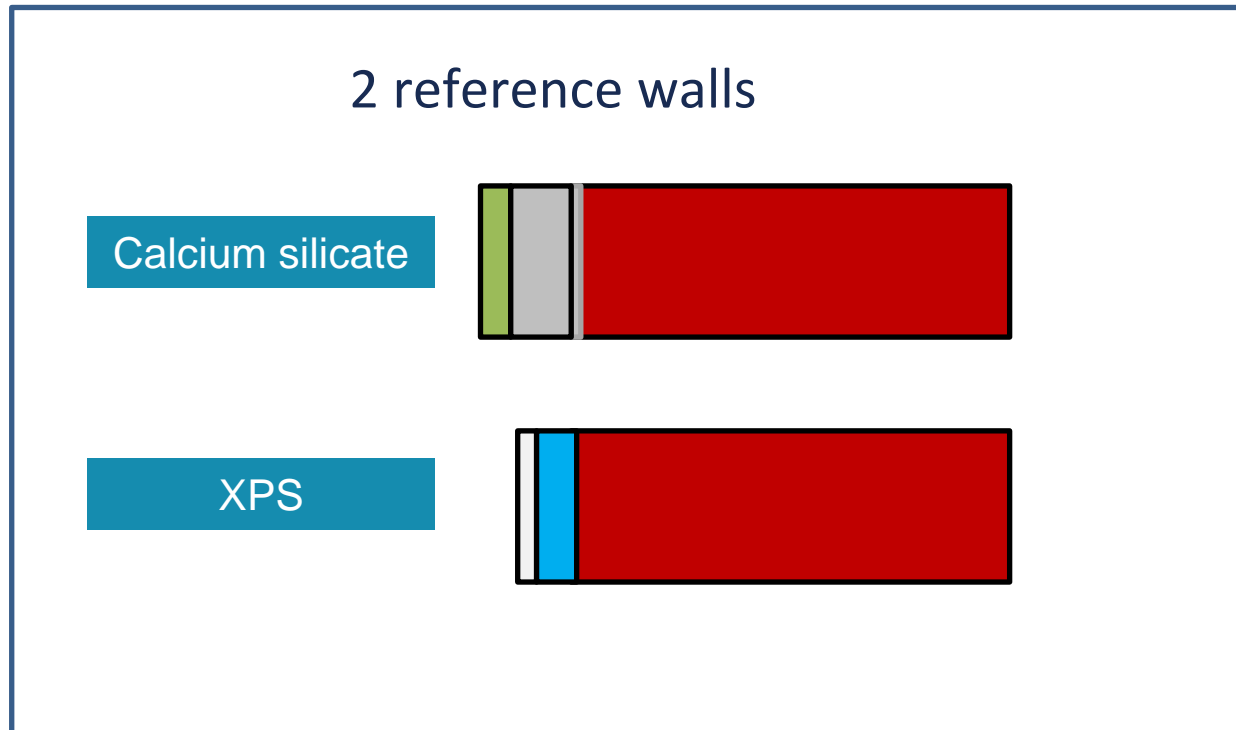


Do capillary active systems always perform better?

???

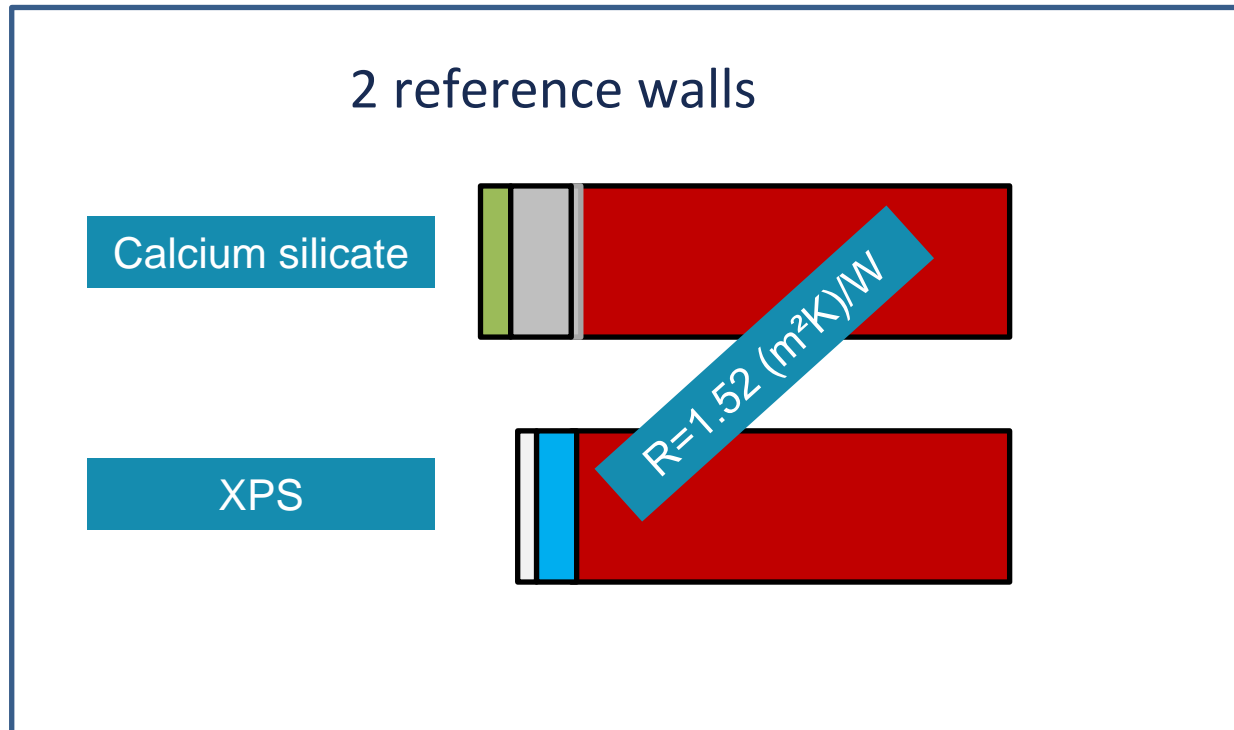
REFERENCE WALL

- Capillary ↔ Vapour tight insulation system



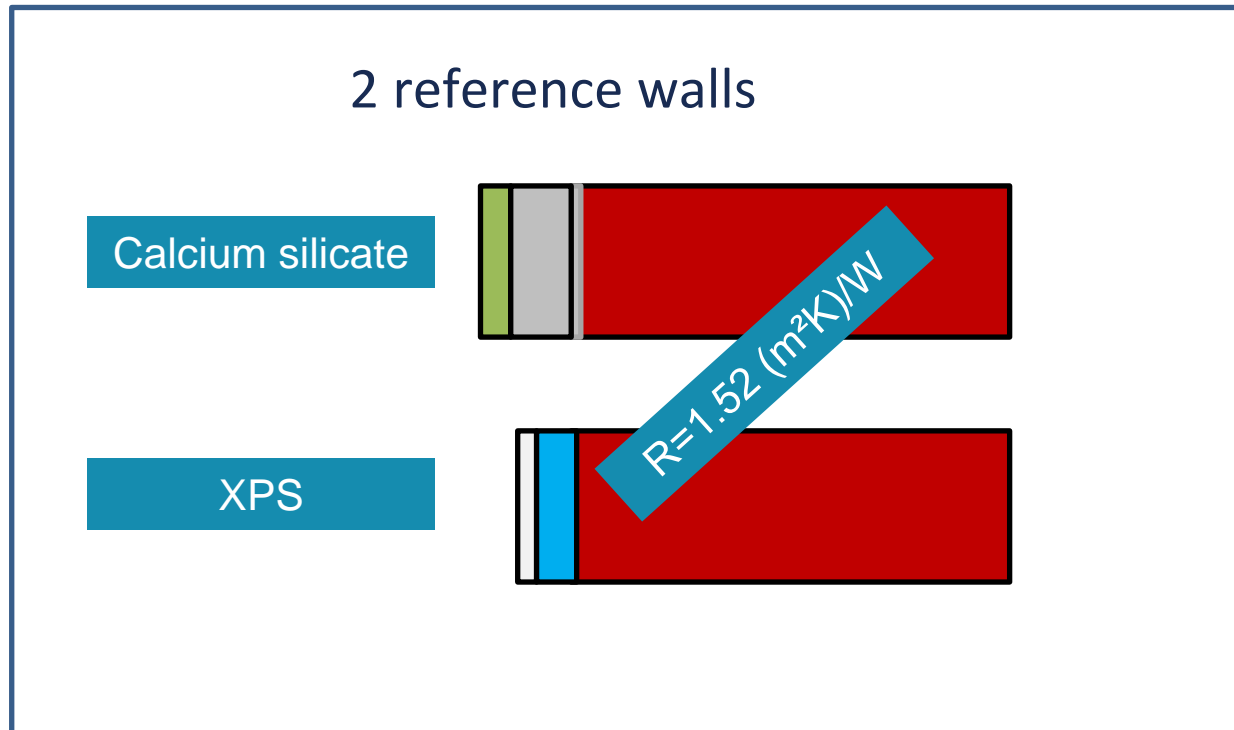
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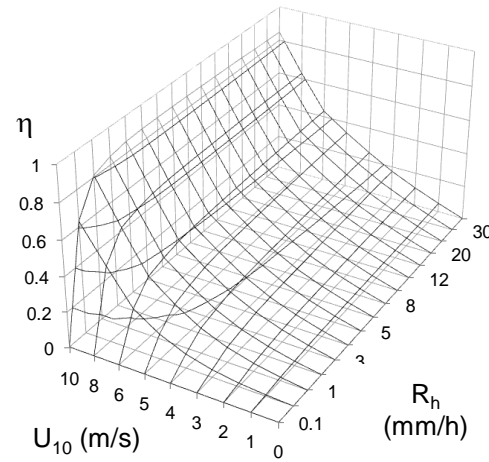
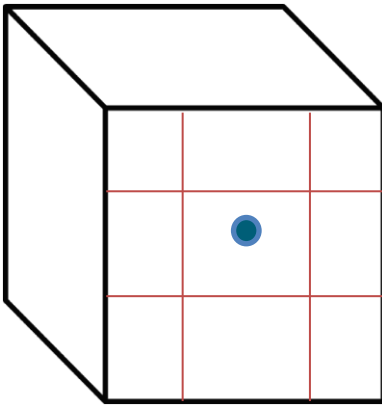
Heat and moisture transport: HAMFEM

METHODOLOGY

- Interaction with building zone

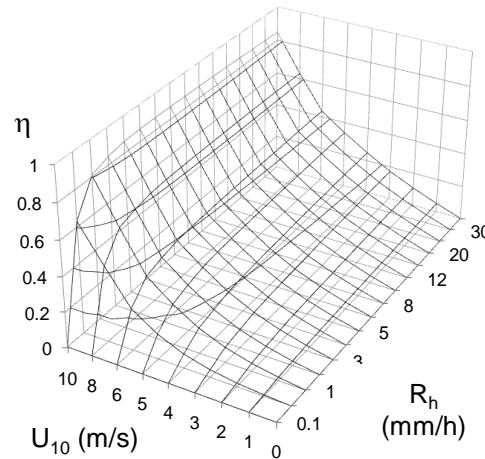
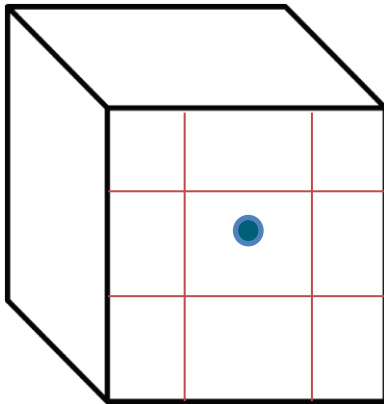
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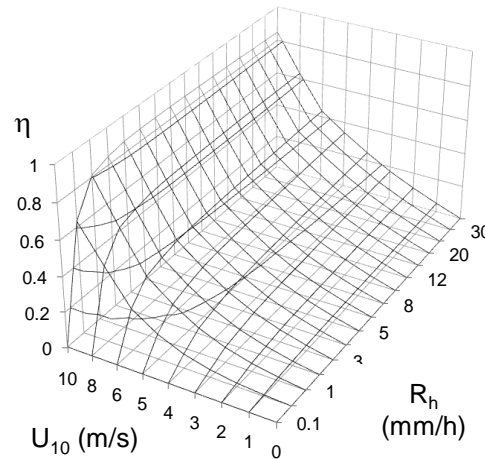
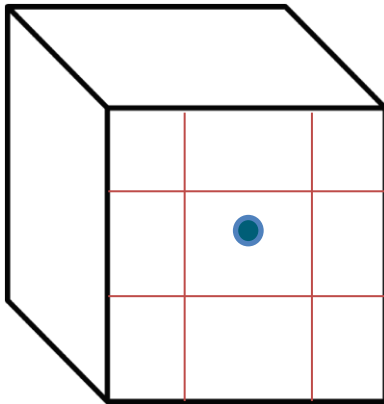


$$\frac{V}{R_v T_i} \cdot \frac{\partial p_{vi}}{\partial t} = (p_{ve} - p_{vi}) \cdot \frac{nV}{3600 R_v T_i} + G_{vp} - G_{buf/c}$$

$$G_{buf/c} = \sum_k \beta_k \cdot A_k \cdot (p_{vi} - p_{vs/sat,k})$$

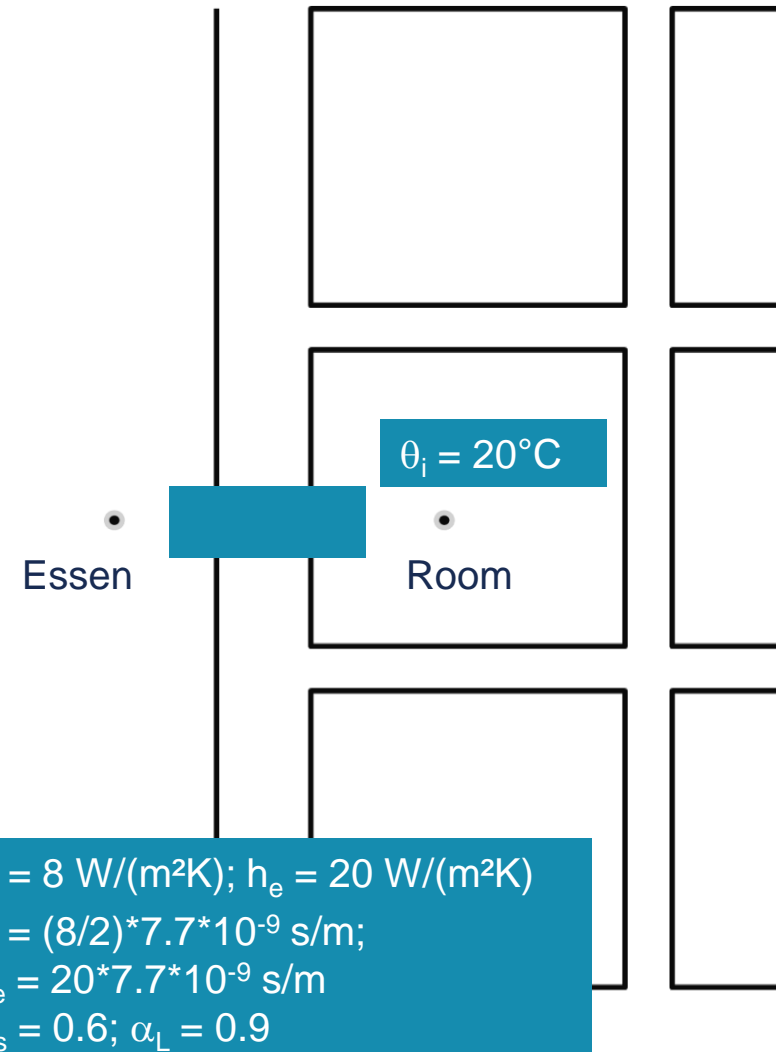
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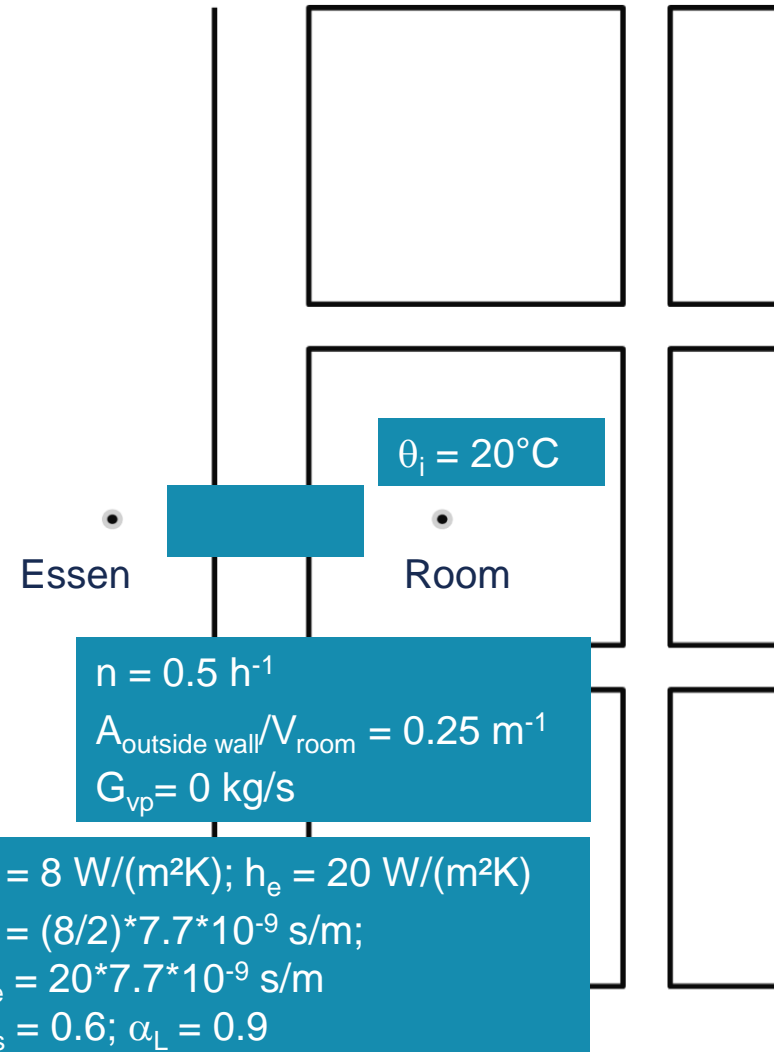
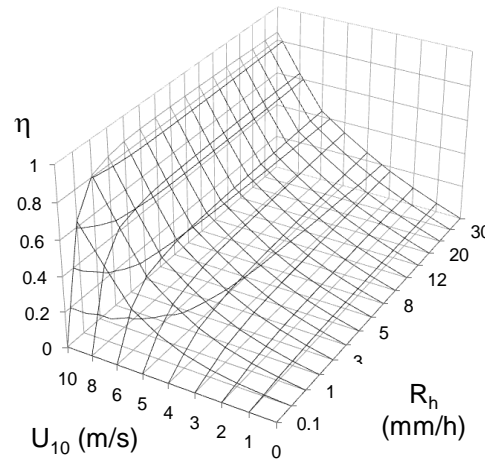
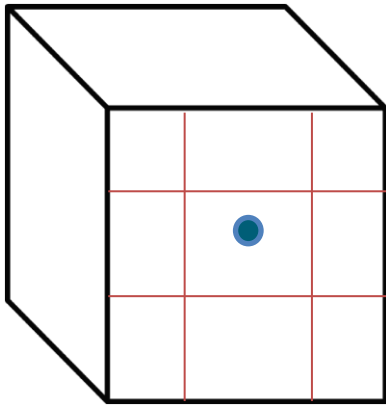
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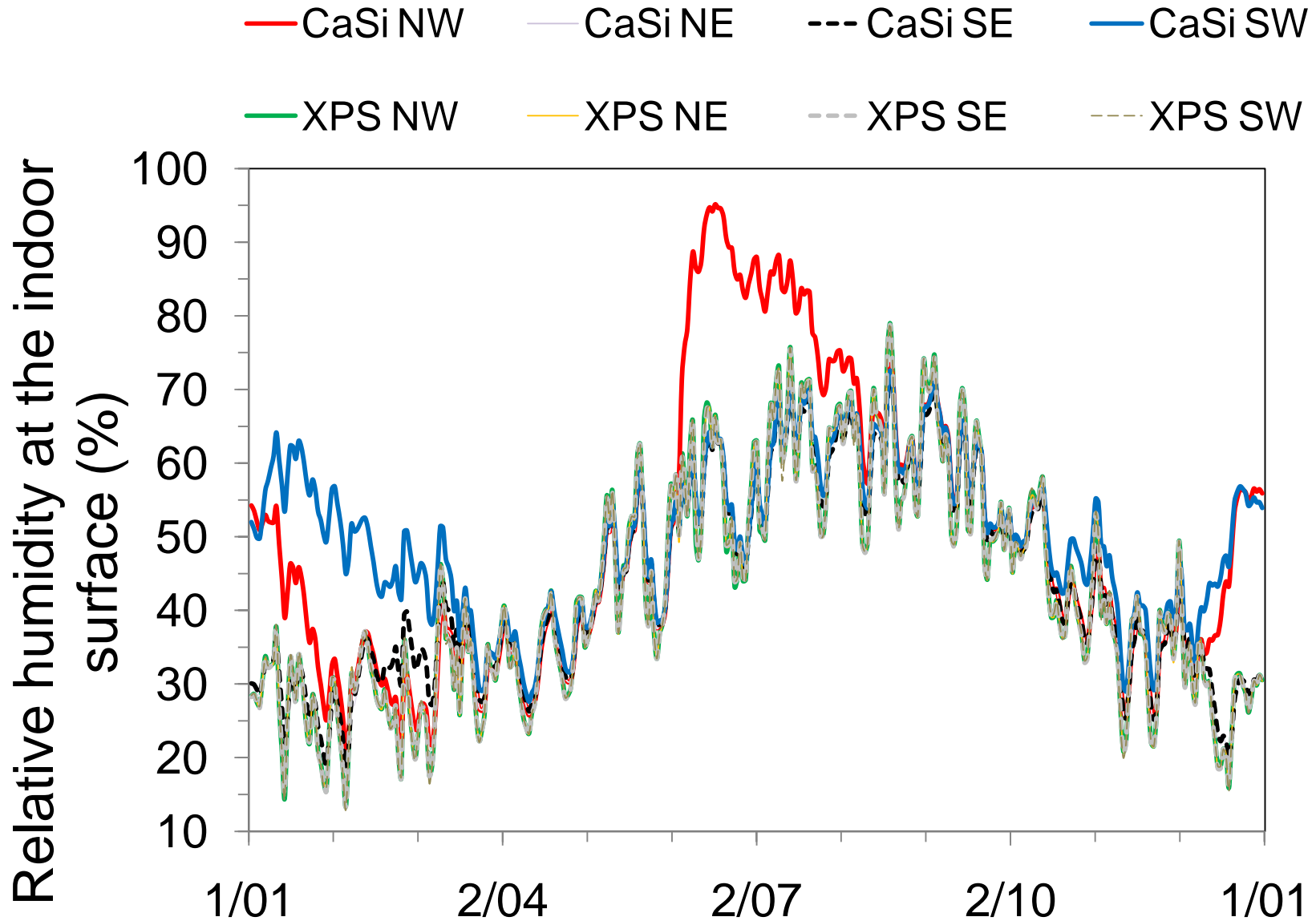
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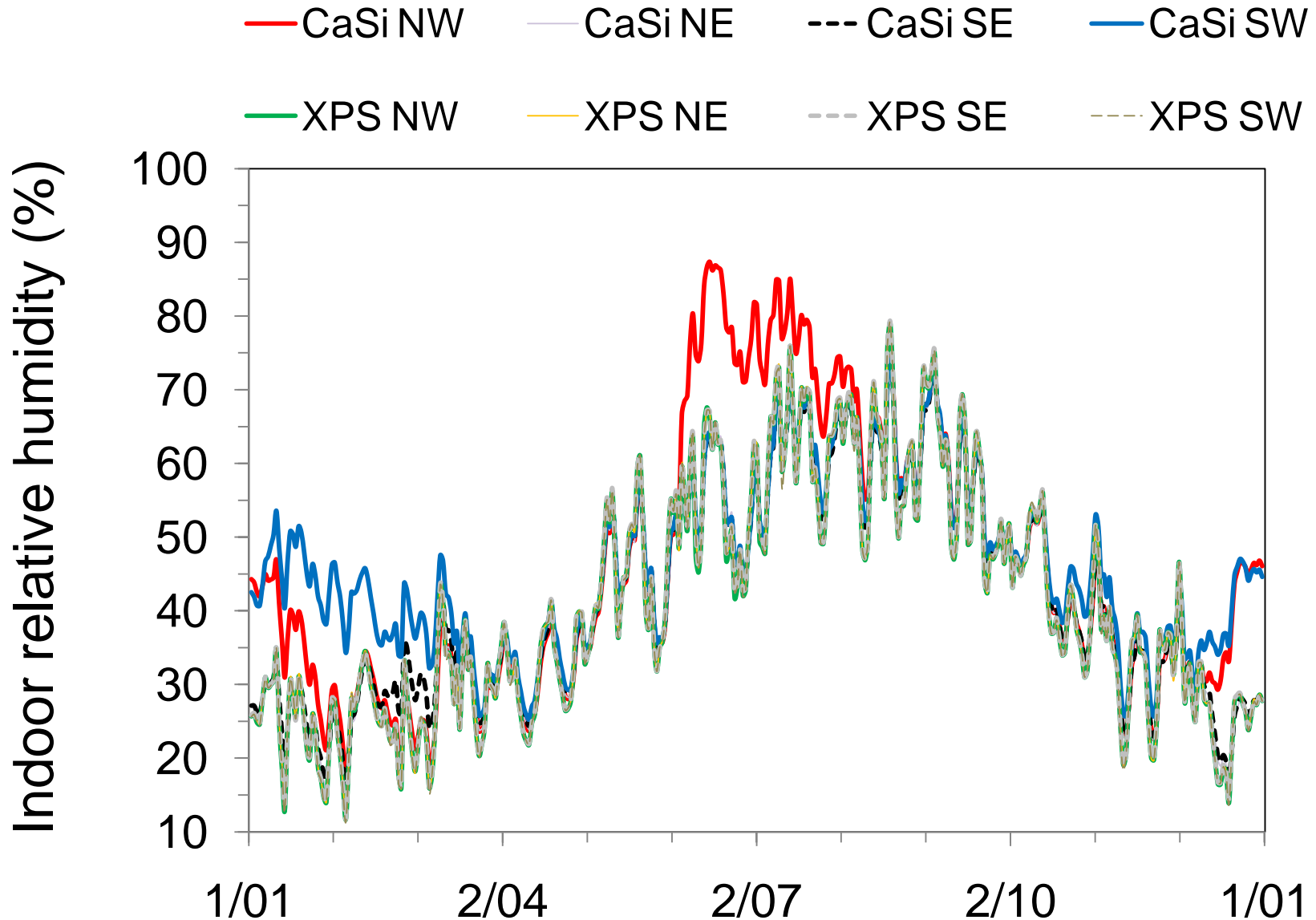
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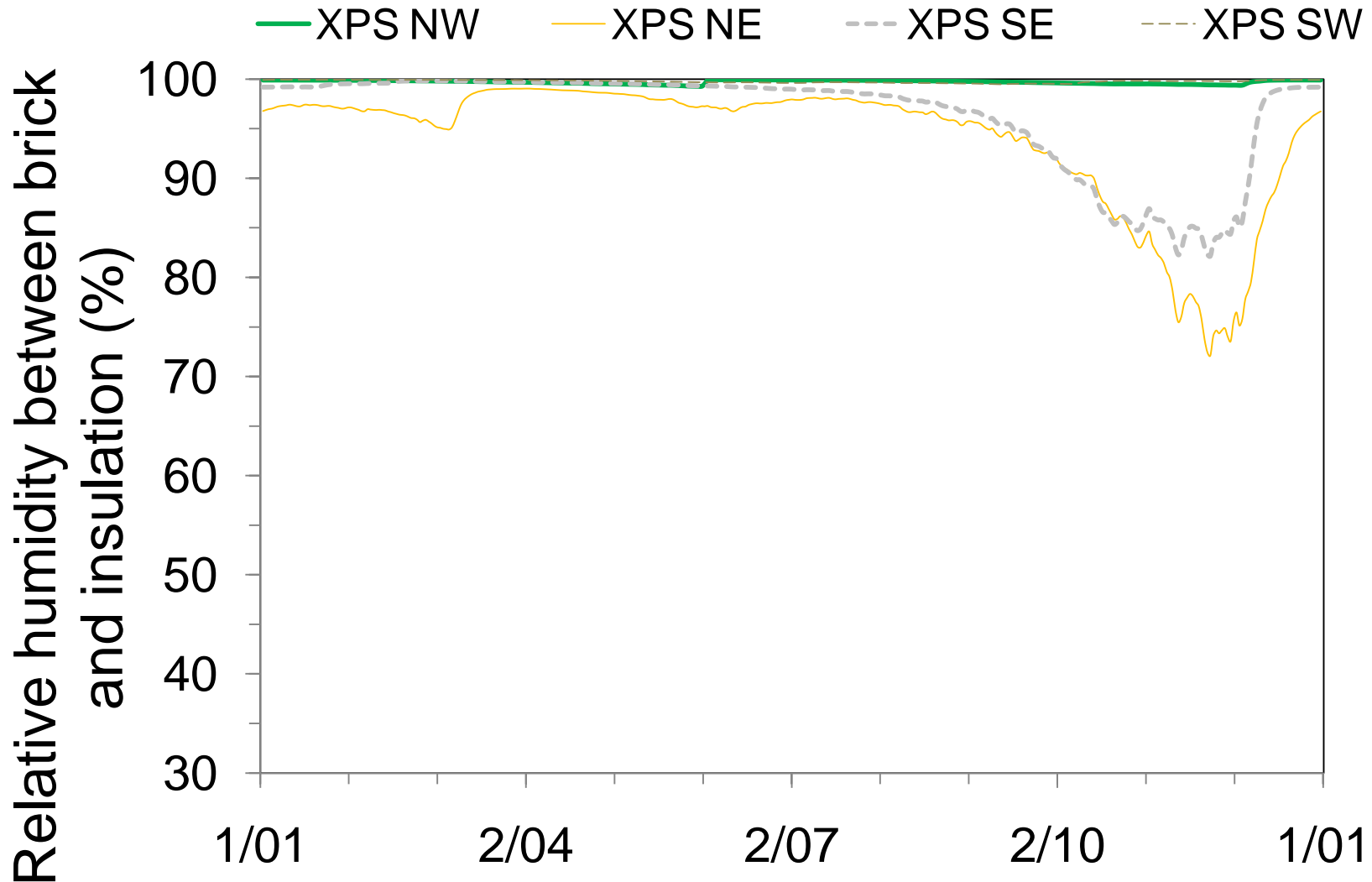
ORIENTATION



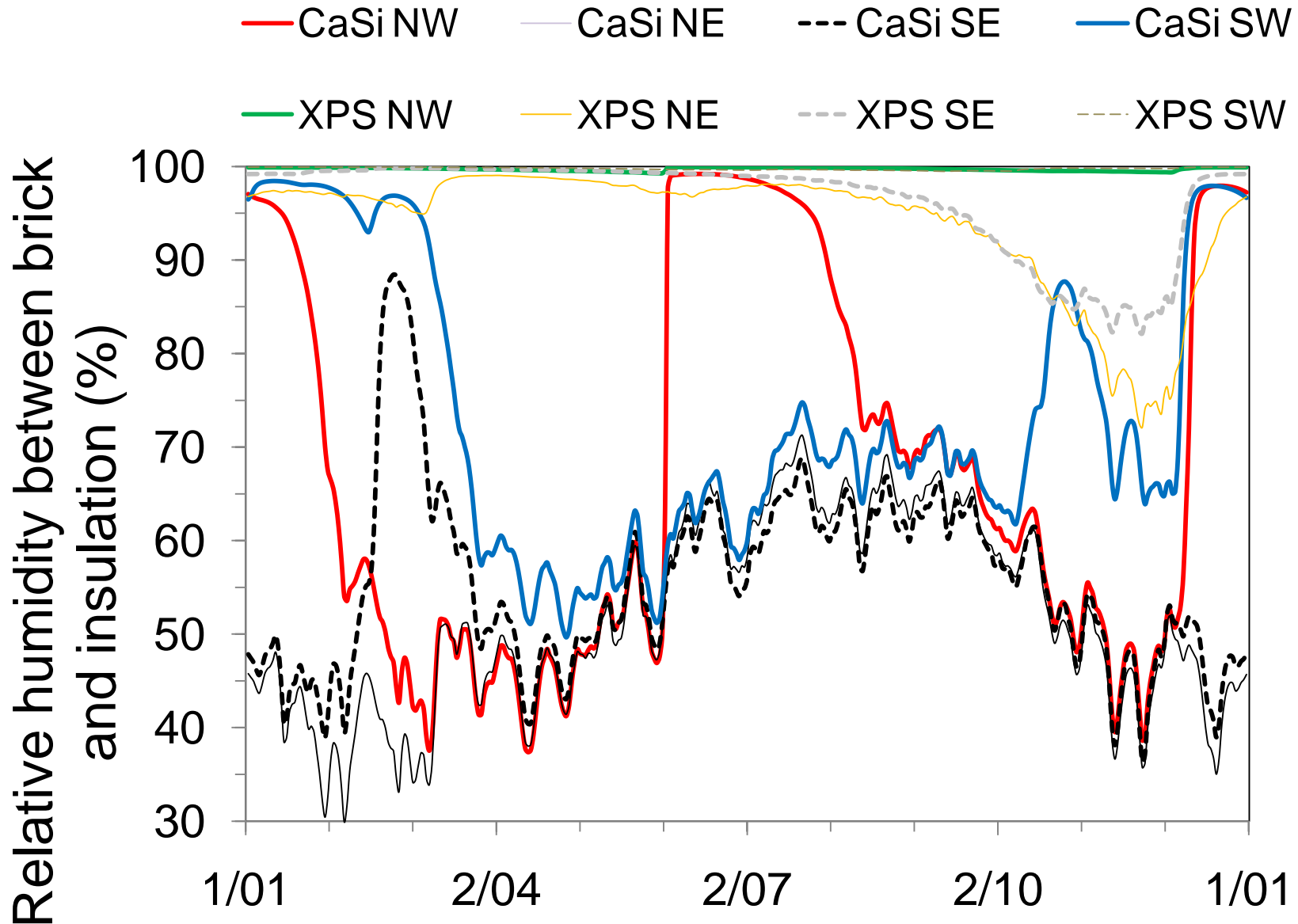
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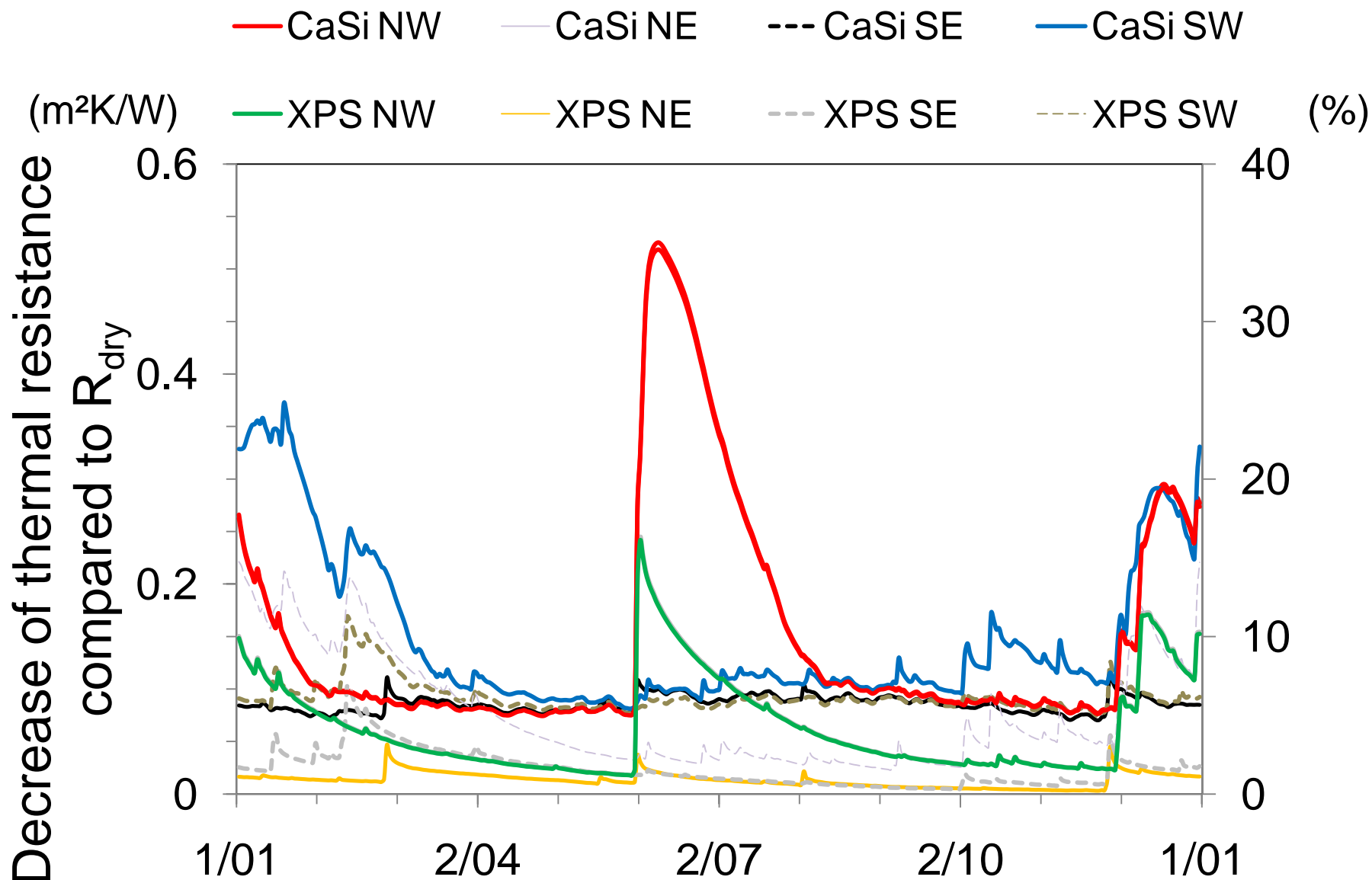
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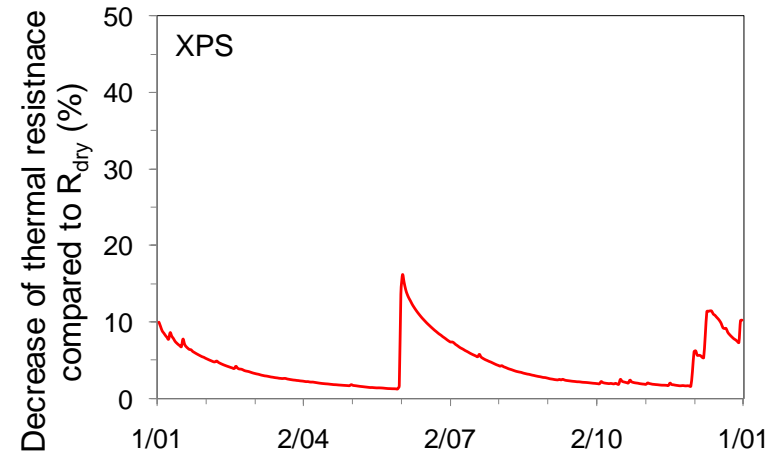
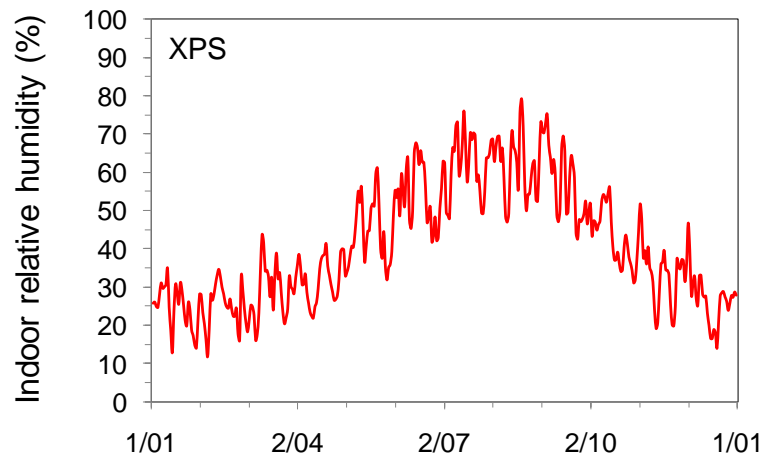
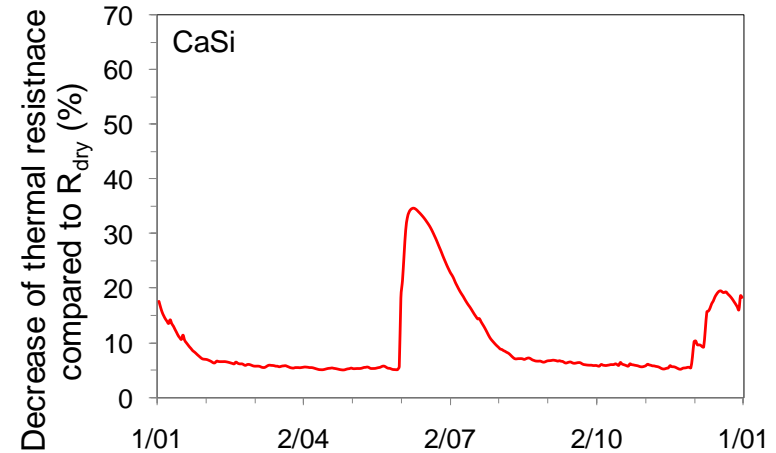
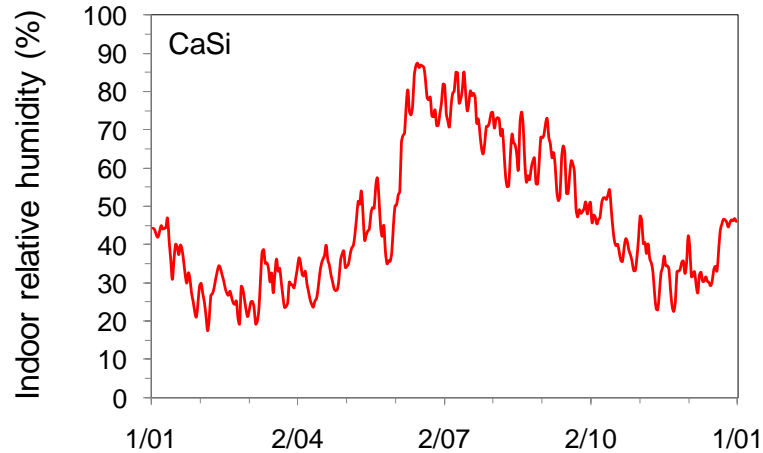


ORIENTATION



POSITION

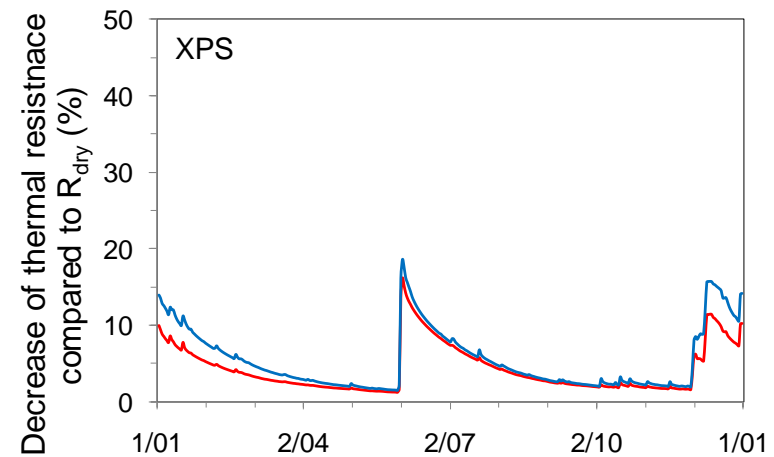
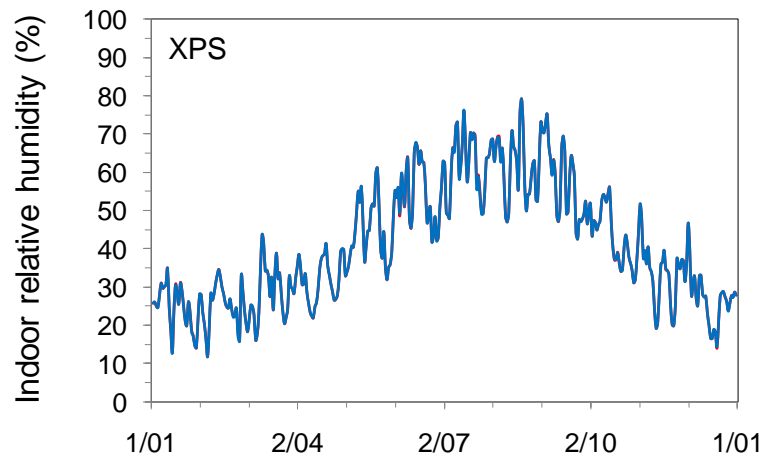
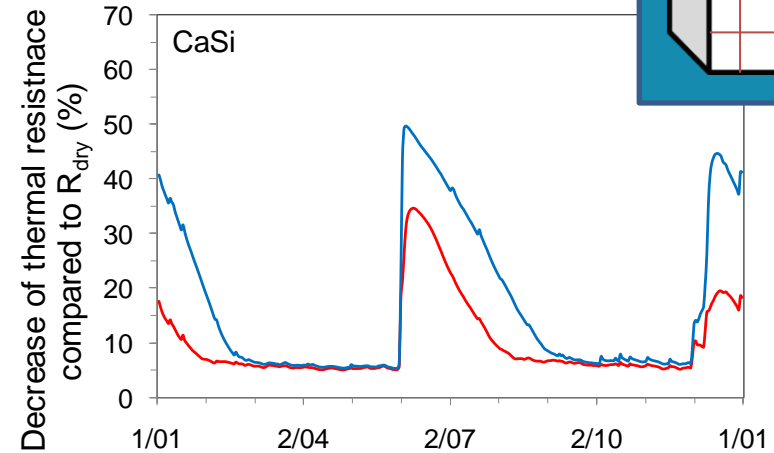
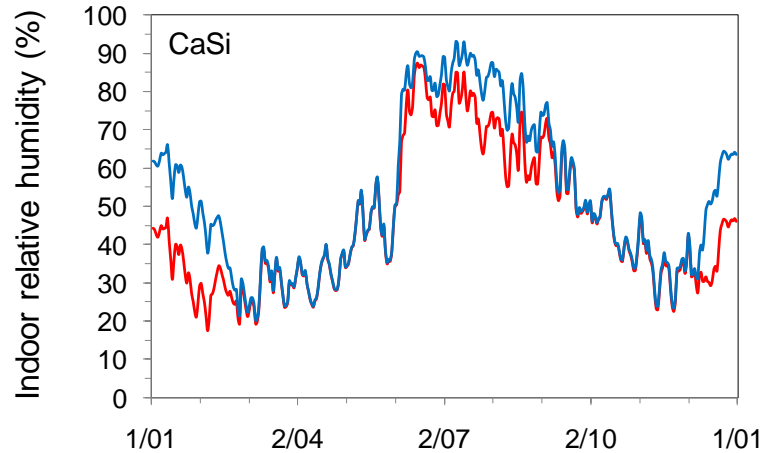
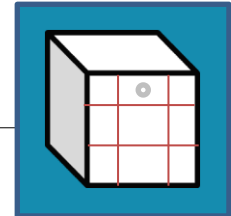
— Reference wall



POSITION

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— Position 2



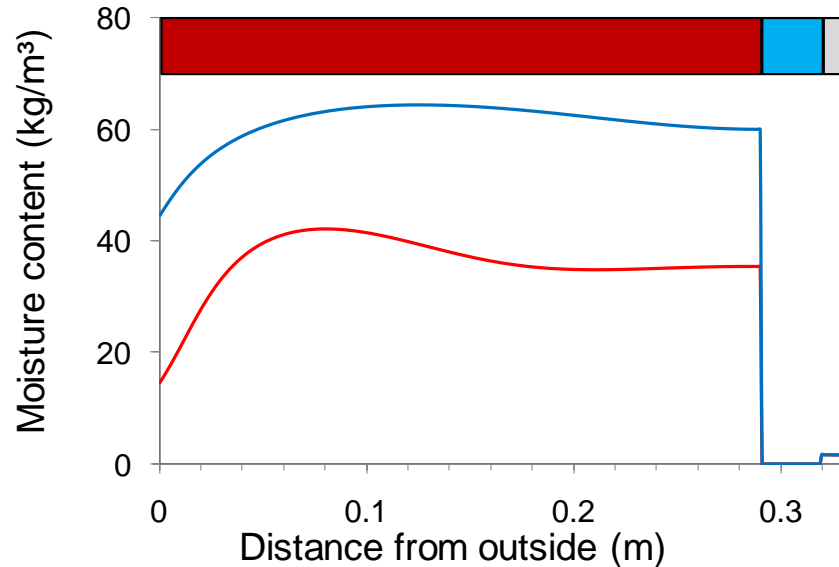
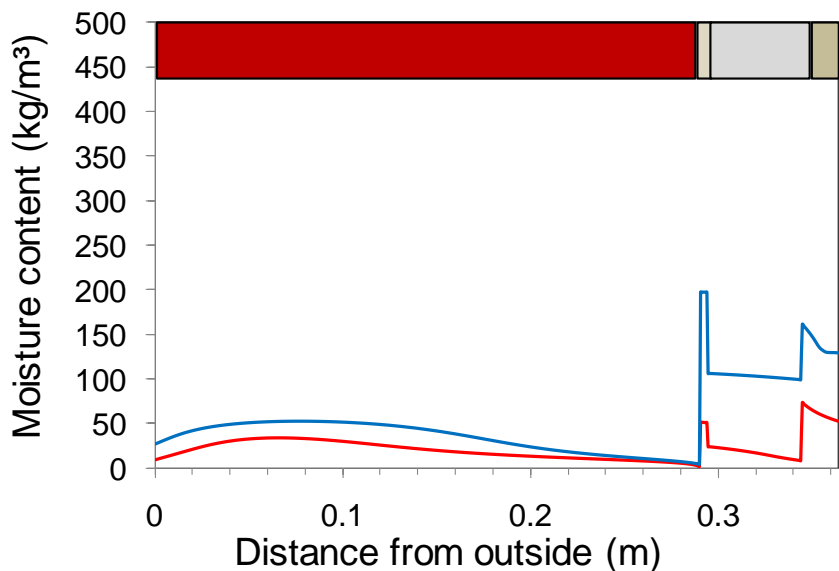
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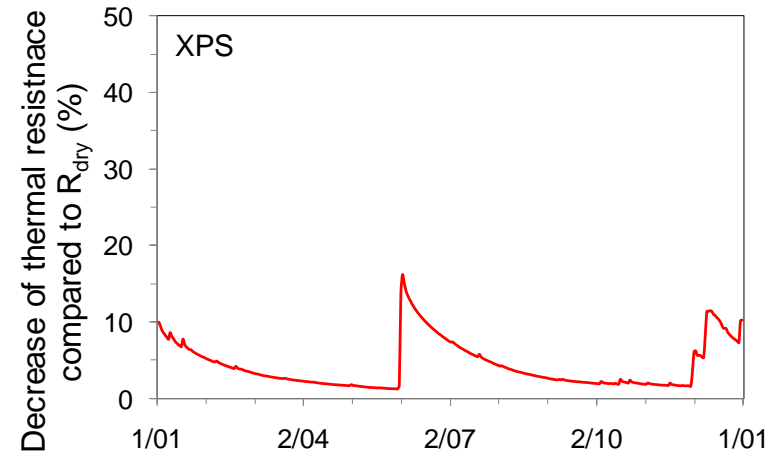
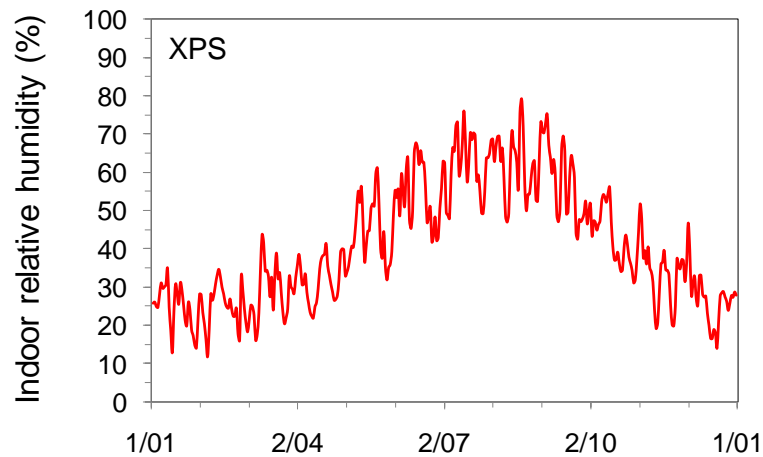
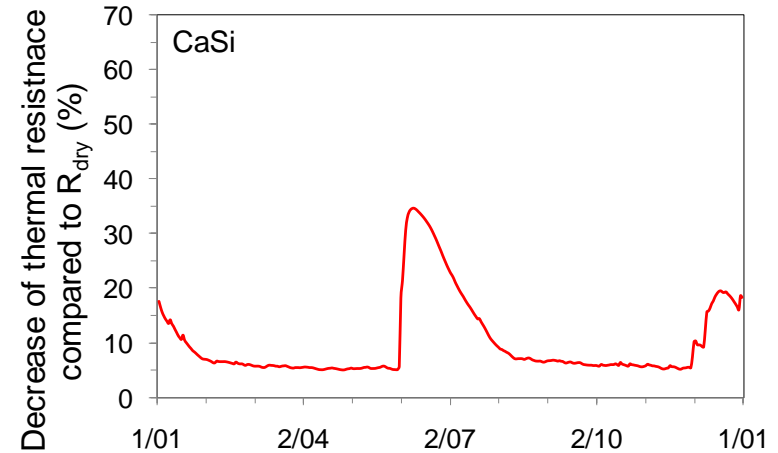
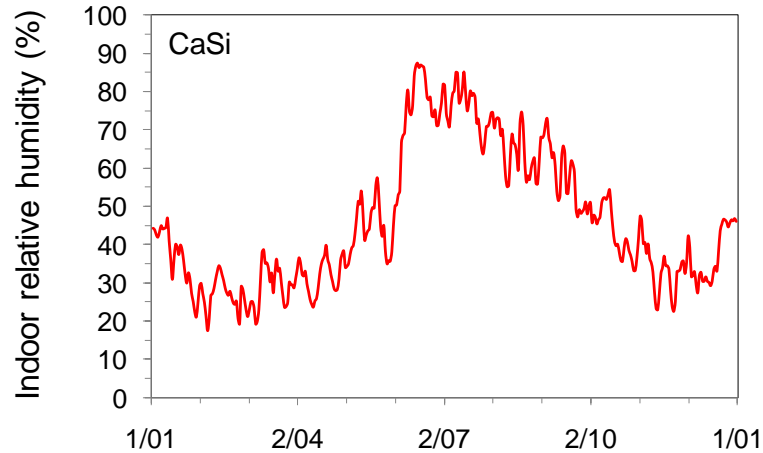
Calcium silicate

XPS



POSITION

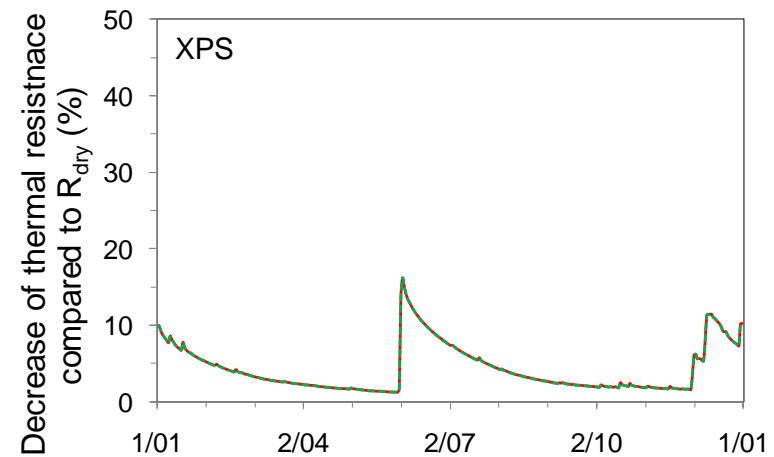
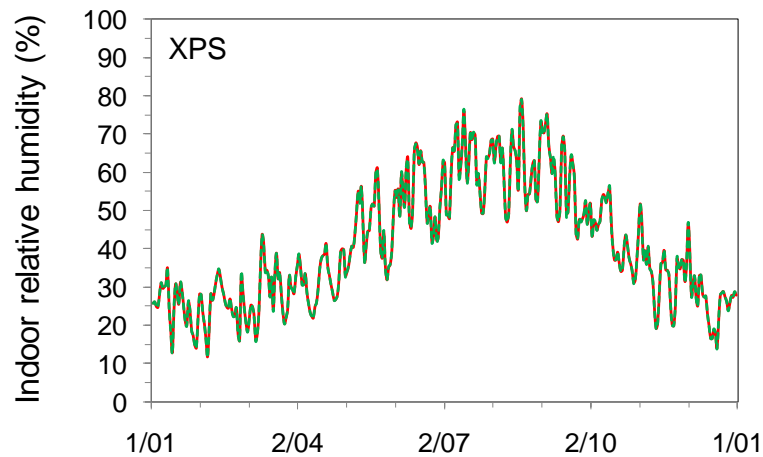
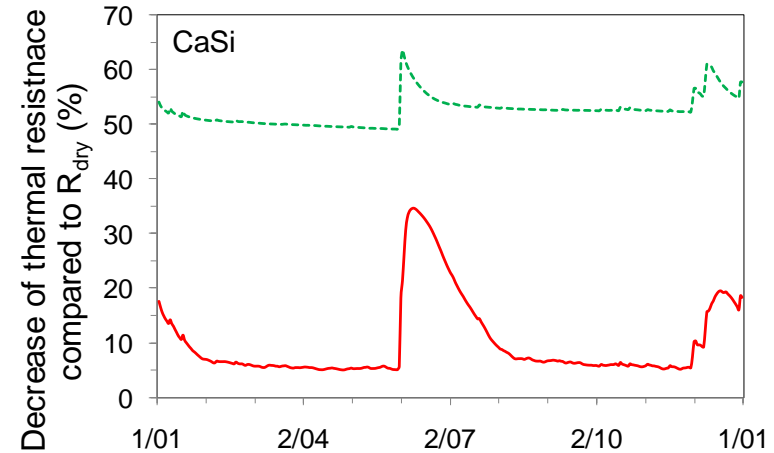
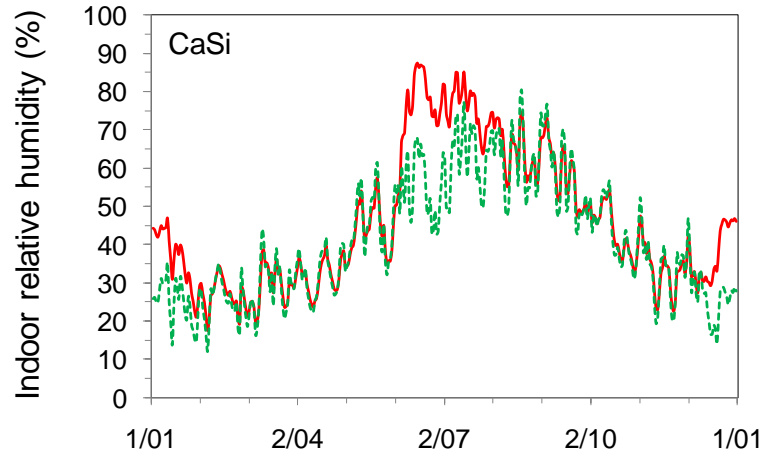
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POSITION

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- - - Latex paint

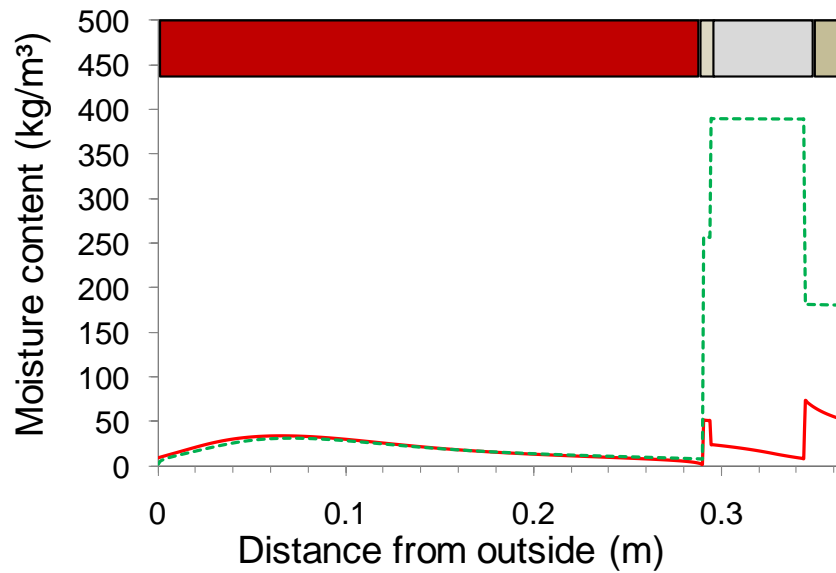


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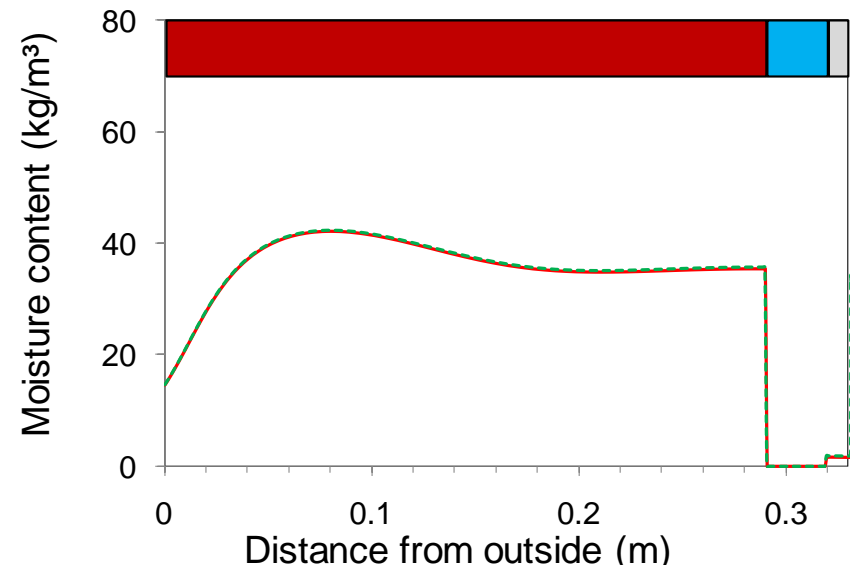
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CONCLUSIONS

- Sensitivity capillary active insulation system
(WDR, finishing layer, thickness masonry wall, orientation, etc.)
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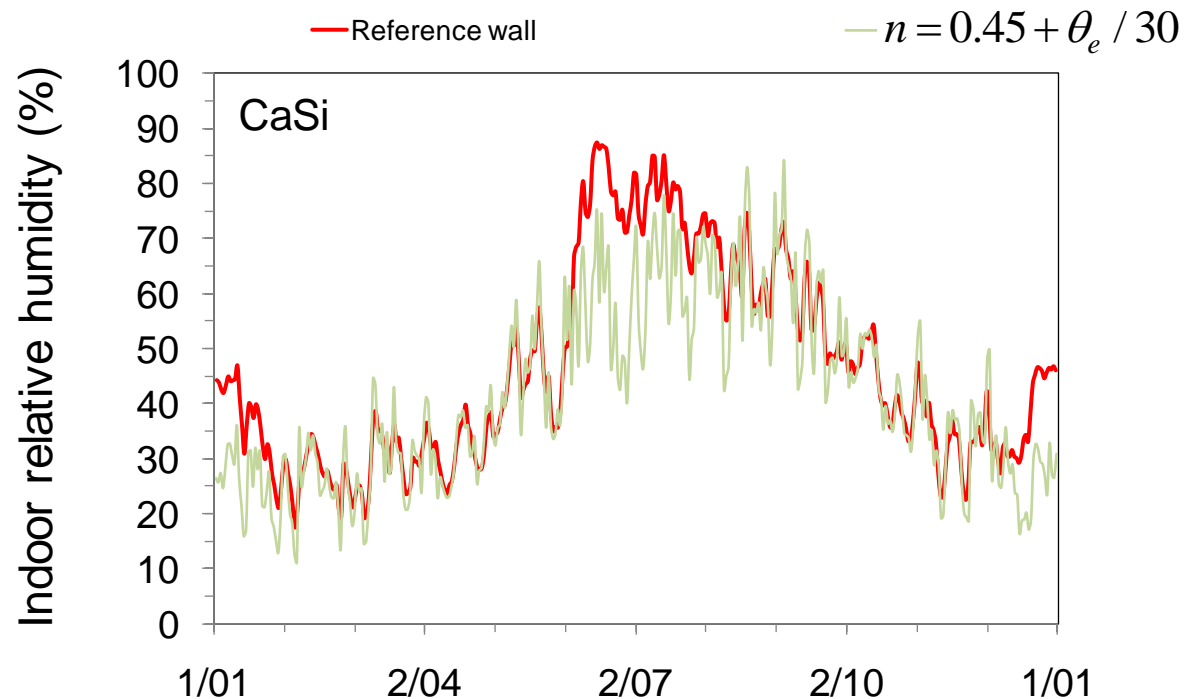
E.g. damage wooden beam ends?



Thank you for your attention!

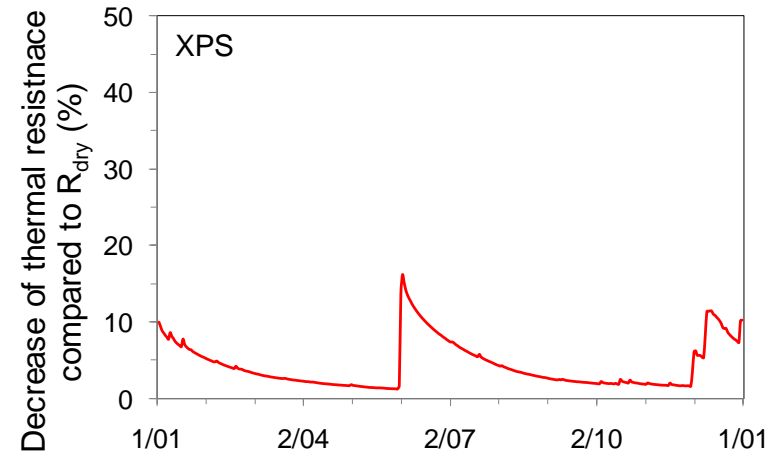
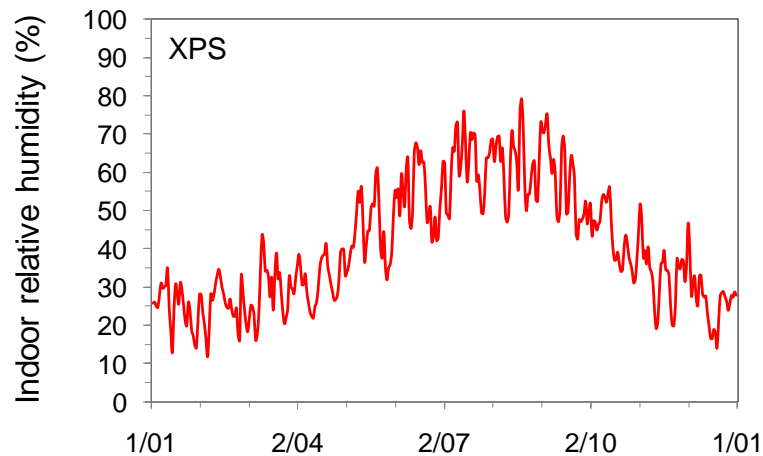
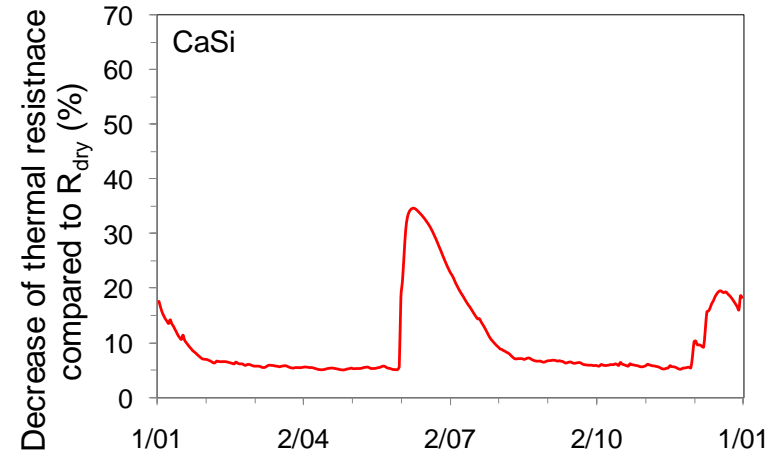
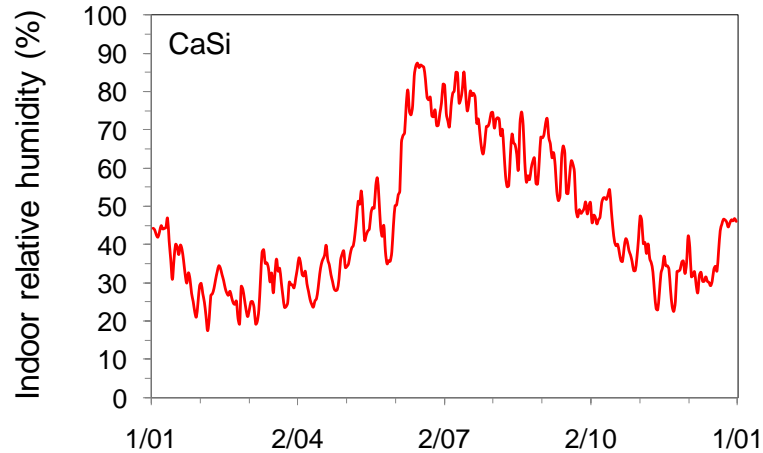
REMARKS

- First investigation
 - No vapour production
 - No contact resistance
 - Surface Area / Volume
 - $n = 0.5 \text{ h}^{-1} \Leftrightarrow \text{E.g. } n = 0.45 + \frac{\theta_e}{30}$



THICKNESS MASONRY WALL

— Reference wall



THICKNESS MASONRY WALL

— Reference wall - - 19 cm masonry wall

