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EUSBSR-Flagship Project

Research Results on Internal Insulation in Different Climates

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Baltic Sea Region Programme 2007-2013

Hamburg | Ministry of Culture

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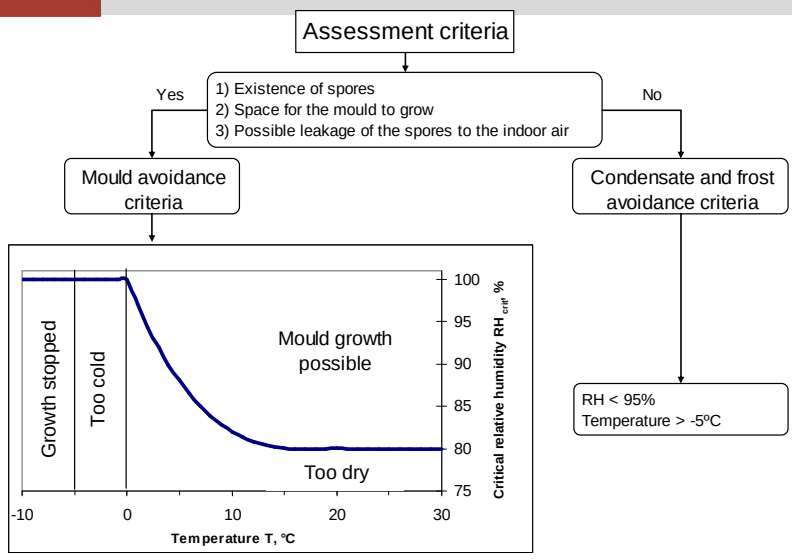

Künzel, H. M. 2011. 'Bauphysik der Innendämmung und Bewertungsverfahren', In Proc. of the 1. Internationaler Innendämmkongress. 2011
Viitanen H., Vinha J. 2010 'Moisture and biodeterioration of building materials and structures'. In Journal of Building Physics, 33 (3)

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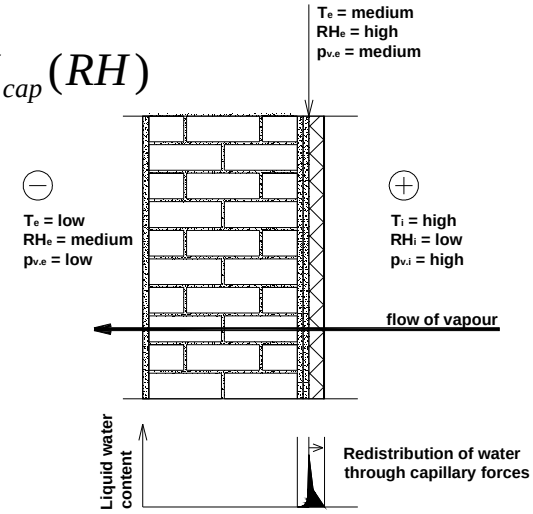
The principle of capillary active insulation

$$J = J_{diff}(p_v) + J_{cap}(RH)$$



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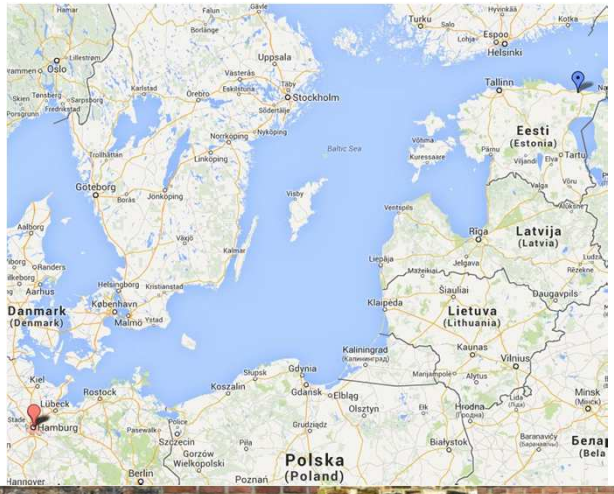
Interior insulation researches in Hamburg and Kohtla-Järve



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Research in Tallinn/Kohtla-Järve, Estonia

- Built: 1938-1939 (brick building) as a school
- Monument since 1998
- Current use:
  - Centre for work exercise
  - Hostel
  - Sports hall

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Objectives of the study

- Analysis of the hygrothermal performance of an internally insulated exterior brick wall
- Comparison of four different insulation materials in terms of hygrothermal performance
- Calibration of computational model (Delphin 5.8.1)
- Finding suitable solutions for interior insulation which are safe and easier to implement

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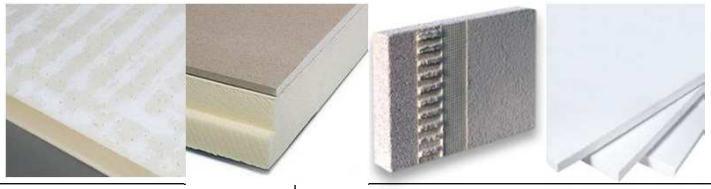
Used insulation materials



Property	Material			
	PIR	IQ-T	AAC	CaSi
Thickness of used layer, mm	30	50	60	50
Thermal conductivity λ, W/(mK)	0.027	0.031	0.047	0.063
Vapor diffusion resistance coefficient μ, -	100	27	2	4.6
Water absorption coefficient A_w, kg/(m^2 h$^{0.5}$)	1.0·10^{-7}	0.01	0.1	1.17

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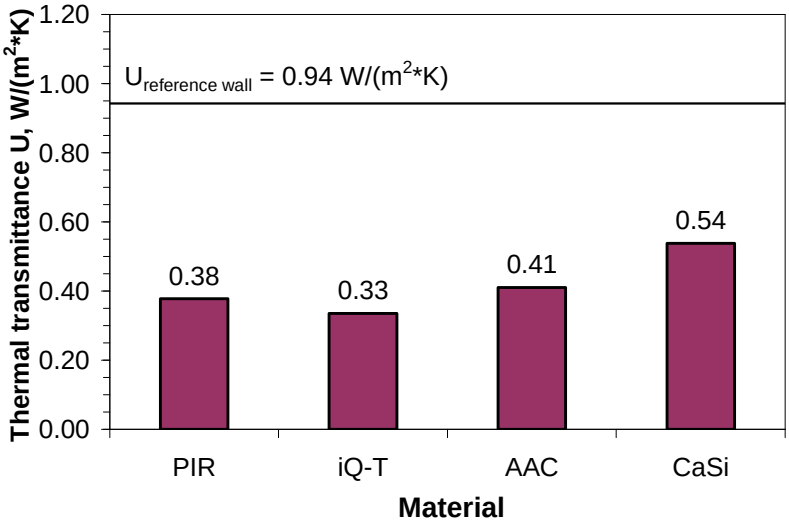
Measured thermal transmittances of the wall sections



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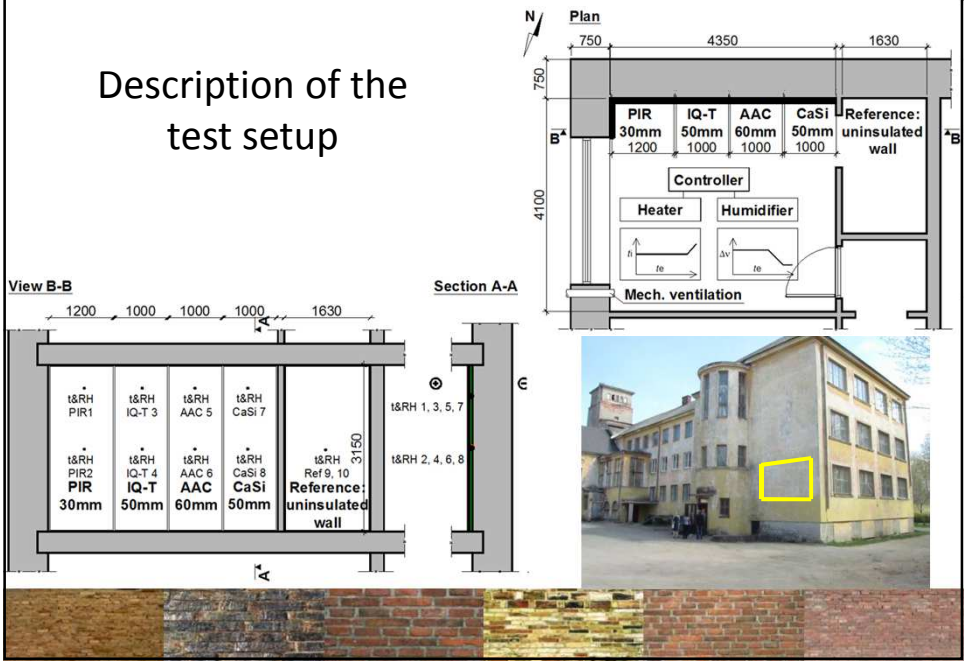
Description of the test setup



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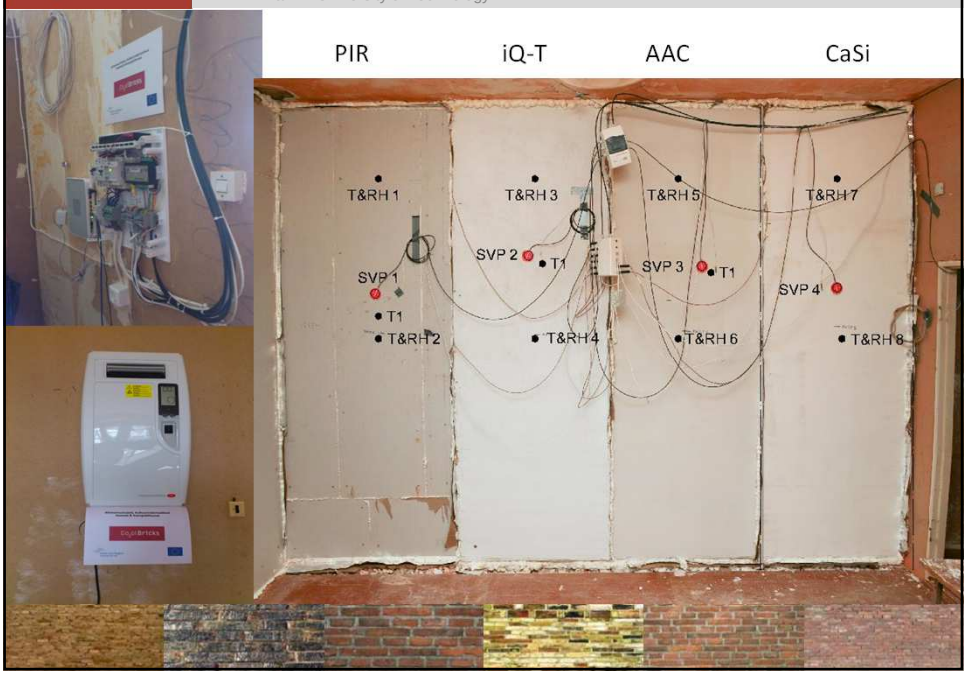

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Conditions

- Estonian moisture reference years (for mould and condensate avoidance) were used
- Moisture loads:
  - $\Delta\nu$ +2 g/m^3 – school or office
  - $\Delta\nu$ +4 g/m^3 – dwelling with low moisture load
  - $\Delta\nu$ +6 g/m^3 – dwelling with high moisture load

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Results

1D simulation results of Kohtla-Järve wall

- PIR: not suitable for dwellings in its current form
- iQ-T: compatible with all simulated cases
- AAC: possible failure under high moisture loads in dwellings
- CaSi: compatible with all simulated cases

- Computational model was validated and calibrated
- It is now possible to simulate the performance of 2D details, other wall types and moisture loads

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Prospective Actions

- Simulations of different wall types
- Simulations of 2D details
  - Exterior wall corner
  - Exterior wall – interior wall intersection
  - Exterior wall – wooden beam
  - Exterior wall – concrete floor

- Possible studies
  - Measurement of wooden beams
  - Converting basements for living (thermal insulation, waterproofing)

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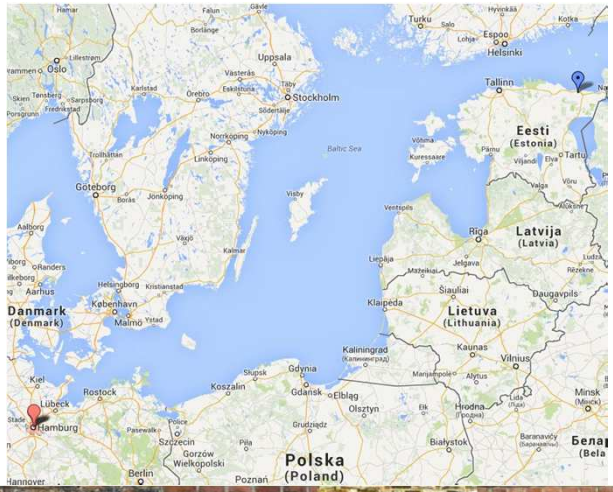
Interior insulation researches in Hamburg and Kohtla-Järve



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Research project in Hamburg

Primary energy consumption:
438 kWh/sqm/a (calculated)
Final energy consumption:
181 kWh/sqm/a

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Objectives of the study

- Difference between calculated and measured U-Value of the wall
- Influence of the humidity of the wall on the U-Value
- (Does the wall heating help to increase the U-Value of the wall?)

Parameter	Symbol	Outer layer (Red clay brick)	Inner layer (Sand lime brick)
Dry gross density	r	1.788 kg/m³	1.704 kg/m³
Thermal conductivity	l_{dry}	0,811 W/sqmK	1,188 W/sqmK
Specific thermal capacity	c	800 J/kgK	891 J/kgK
Porosity	O_{Por}	0,325 m³/m³	0,357 m³/m³
Capillary Saturation	O_{cap}	0,106 m³/m³	0,177 m³/m³
Water vapour diffusion resistance	m_{dry}	28,0	18,65
Water intake coefficient	a_w	0,0312 kg/m²s$^{0.5}$	0,3109 kg/m²s$^{0.5}$

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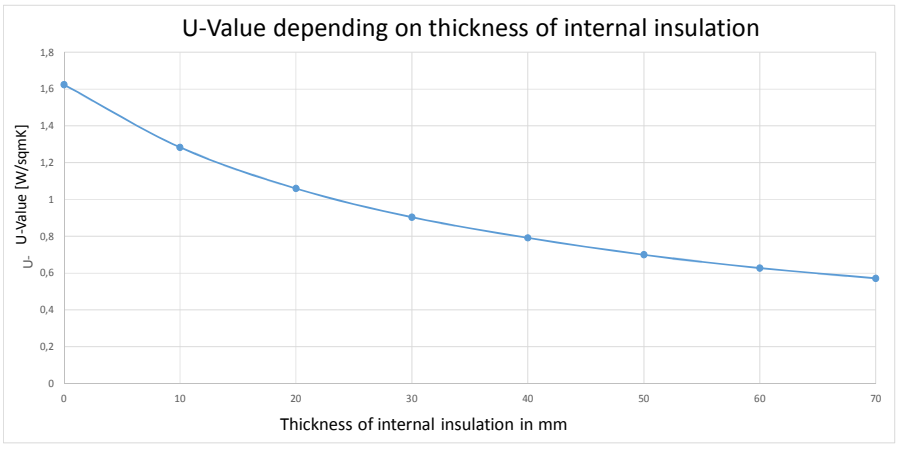

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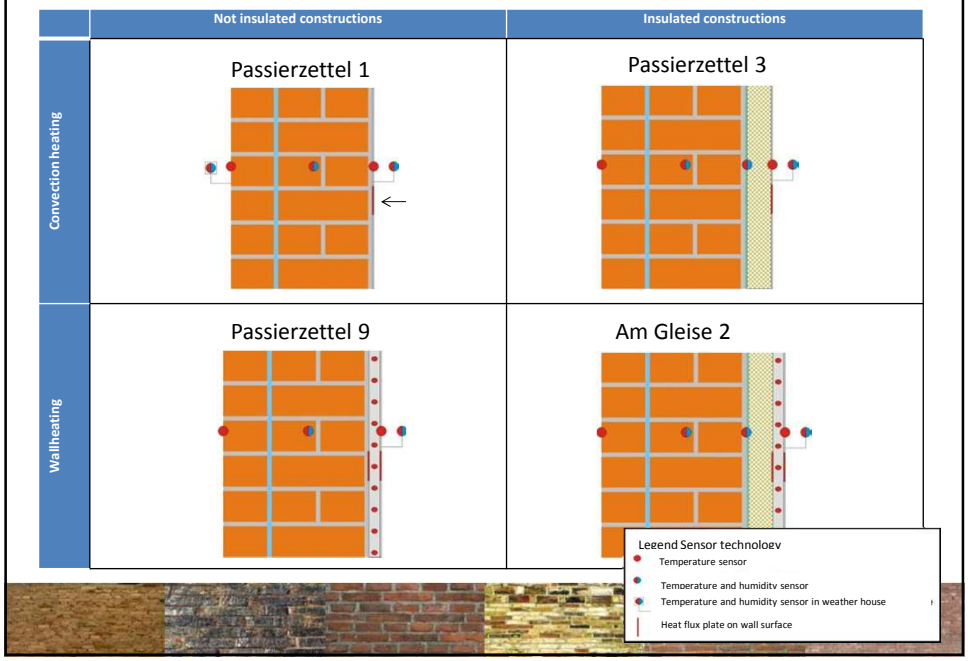

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Wall heating on outer wall with 50mm capillary active internal insulation

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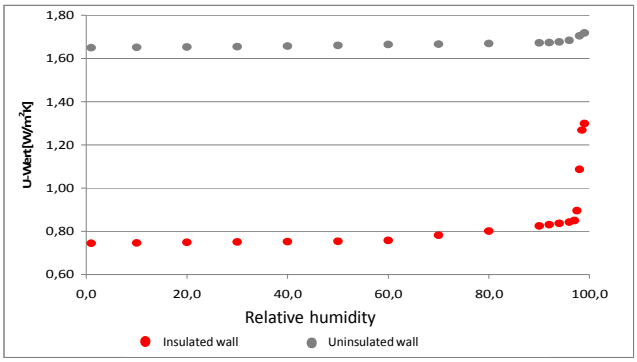
Results



- Humidity in not insulated walls has marginal influence on the U-value: 4%

- Humidity above 60% in walls insulated with calcium silicate increases the U-value rapidly: 0.74 W/m²K to 1.3 W/m²K for humidity of 99 % (76 % increase)

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Results

- Difference U-Value of the uninsulated wall:
  - Calculated by energy auditor: 1.89 W/sqmK
  - Calculated by simulation : 1.65 W/sqmK
  - => 13% difference
- Insulated wall (5cm calcium silicate) calculated by simulation: 0.74 W/sqmK

- Influence of the humidity of the wall on the U-Value:
  - Uninsulated wall: < 90% RH almost no influence(ca 1%)
    - > 90% little influence (max. 4%)
  - Insulated wall: below 60%: marginal influence (incr. max. 3%)
    - Between 60% and 97%: some influence (incr. max. 15%)
    - Above 97%: big influence (increase by 76%)

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Thank you very much for your attention!

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