Internal insulation

Ayman Bishara, TUD
Jens Engel, REMMERS
Dagmar Exner, EURAC

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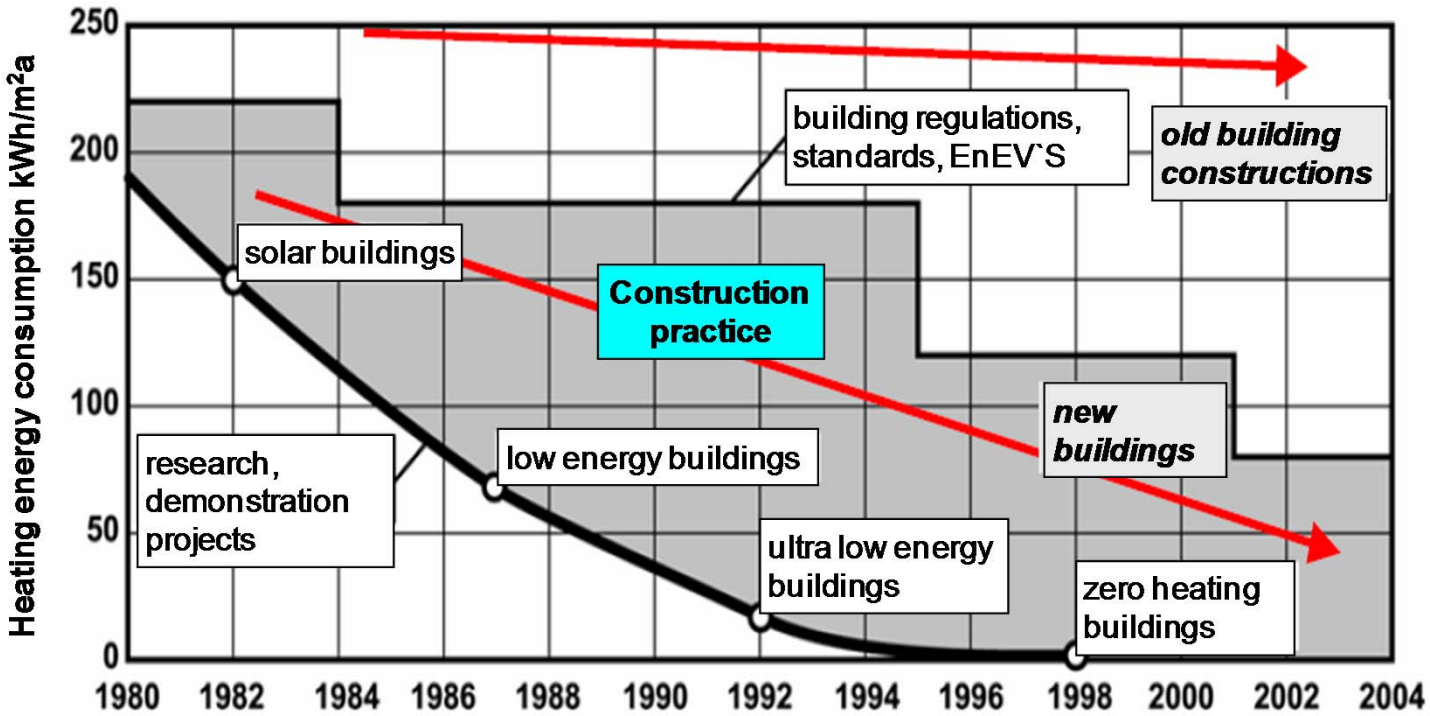
Internal insulation

Ayman Bishara

Why insulation?

Energy saving
Environmental protection, CO2- reduction
Reduction of cost of operation



How does an interior insulation system work?

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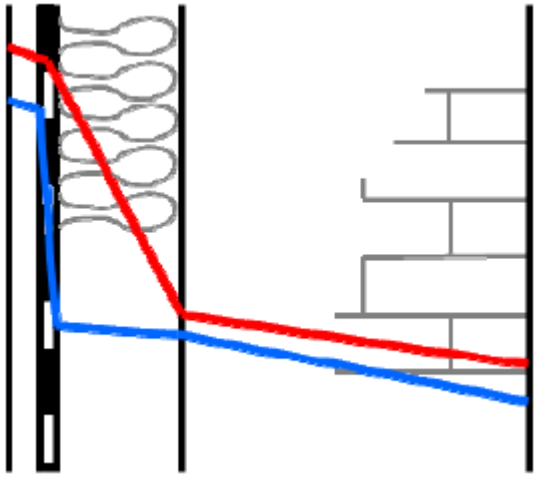
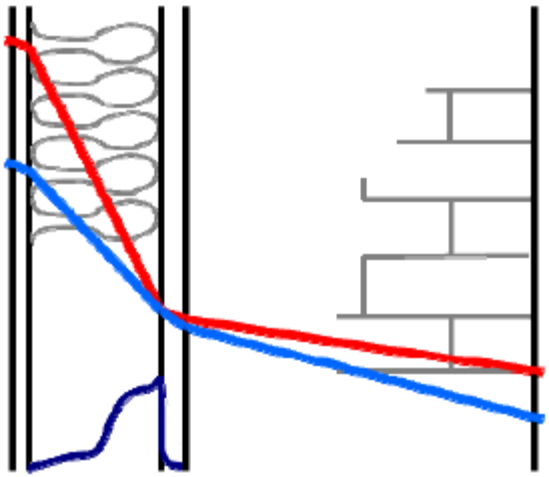
Operation of diffusion-tight interior insulation



No moisture accumulation,
no condensation,
hardly steam flow,
low drying potential

Course of
Temperature
and
Vapor pressure

Operation of diffusion open and capillary-active interior insulation



Moisture accumulation
→ steam flow
← water transport
high drying potential

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Different materials for internal insulation

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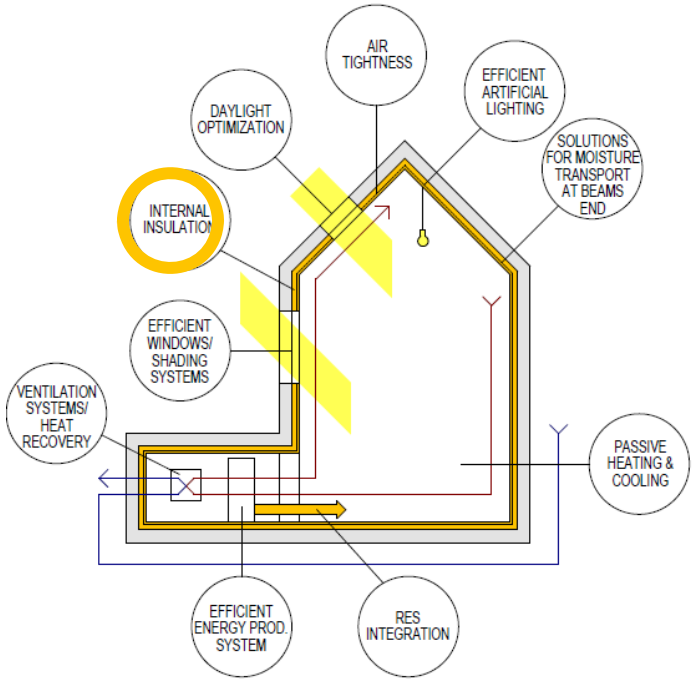

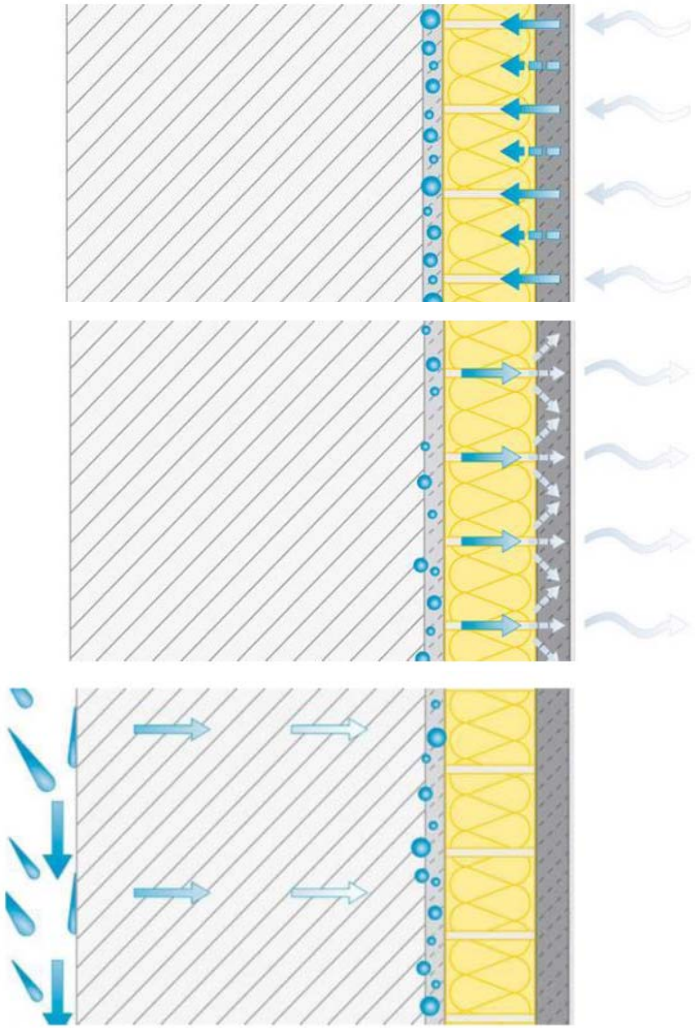


Perlite


Mineral fiber


Foam glass


Wood fiber


Mineral foam


Calcium silicate


Cellulose


PUR

REMMERS

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Case studies

Ayman Bishara
Dagmar Exner

CS6 - General description

Classicism building in Potsdam

Wilhelminian building in Dresden

Baroque building in Görlitz

Renaissance building in Freiberg

CS6 - Objective

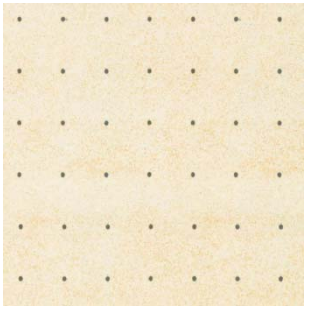
Objective: additional to evaluation of the energy efficiency, analysis and evaluation of planned insulation systems with focus on possible condensation and critical moisture contents in construction and the risk of mold growth

CS6 - Main intervention

Which insulation materials are used?

Potsdam	Dresden	Freiberg	Görlitz
Loam cork kieselguhr	IQ-Therm	Tec-Tem	Calciumsilicate

Loam cork
λ = 0.08 W/mK



PUR
λ = 0.028 W/mK

Perlite
λ = 0.045 W/mK

Calciumsilicate
λ = 0.065 W/mK

CS6 - Procedure for developing and planning of a suitable interior insulation system

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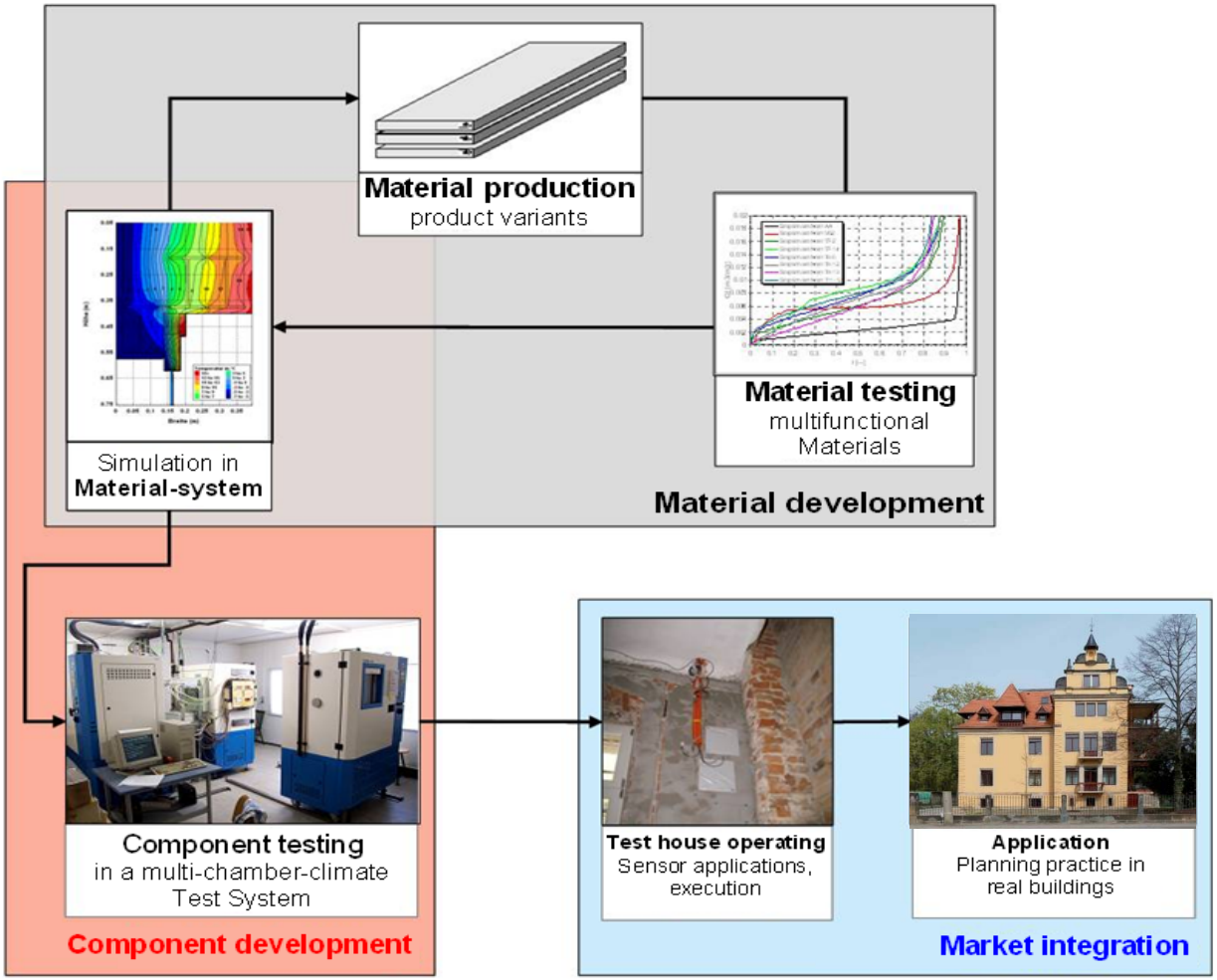

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CS6 - Baroque building in Görlitz

Building before and after renovation

Focus

- inside insulation facing to the street and EIFS facing to the backyard
- development and built of box-type windows with heat protection, glazing made of „solar glass“

CS6 - Görlitz
planned solutions

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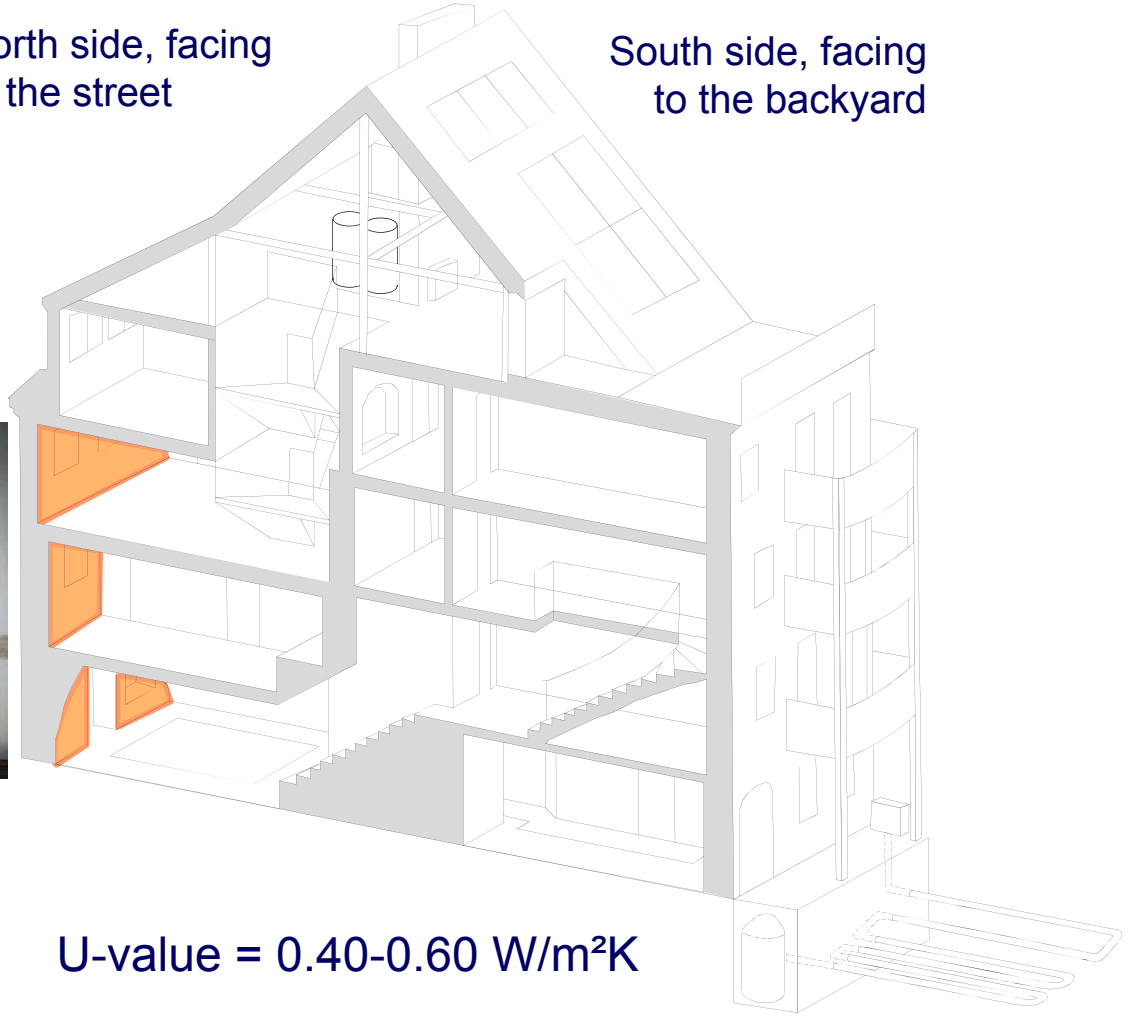
North side, facing to the street

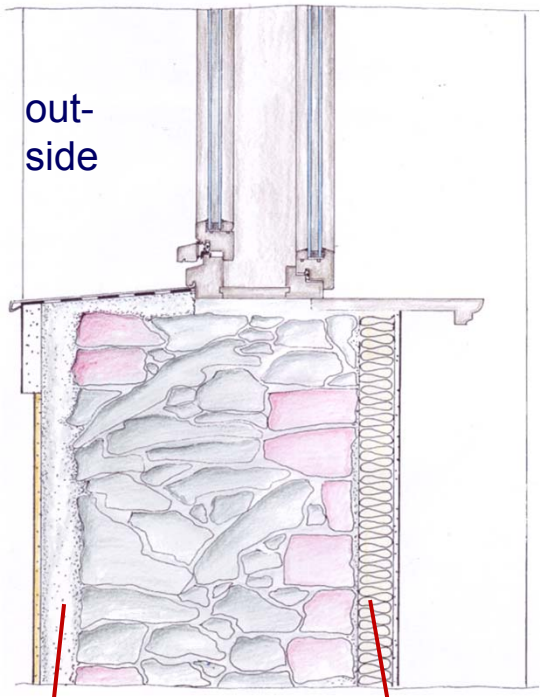
South side, facing to the backyard

calcium silicate



U-value = 0.40-0.60 W/m²K

- inside insulation facing to the street



thermal insulation plaster

calcium silicate

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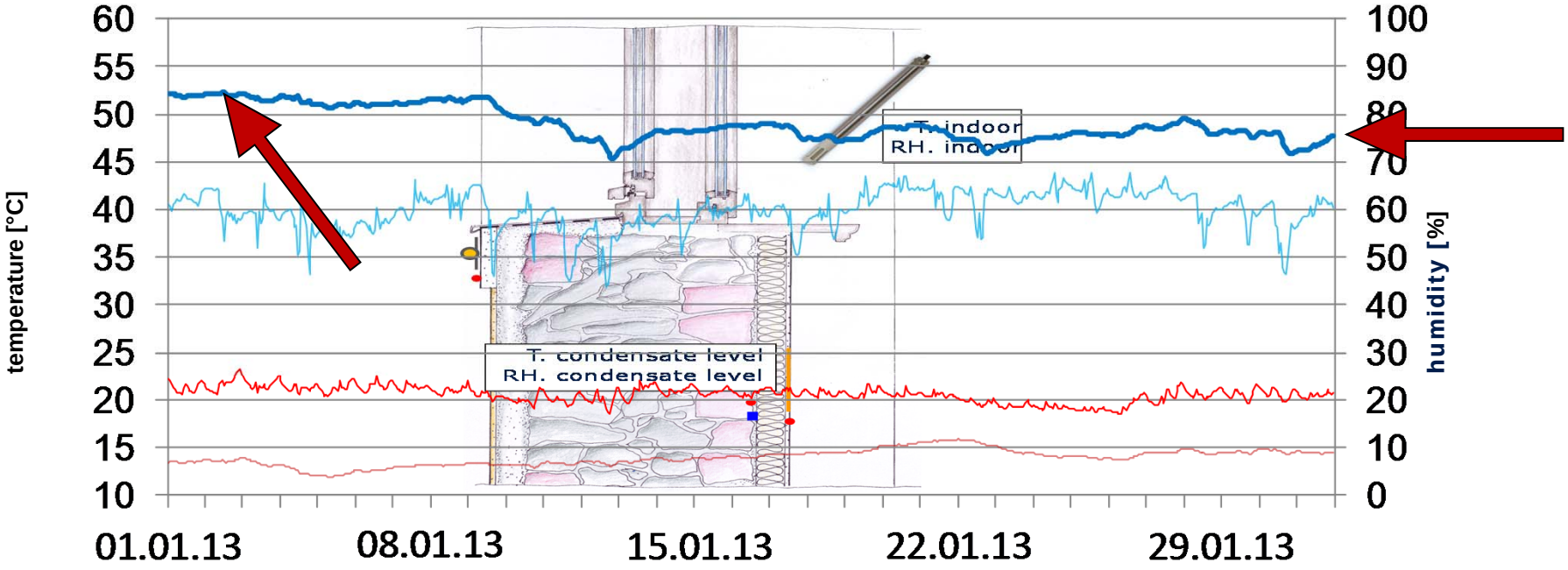
CS6 - Görlitz – discussion of the results



T. condensate level in [°C]

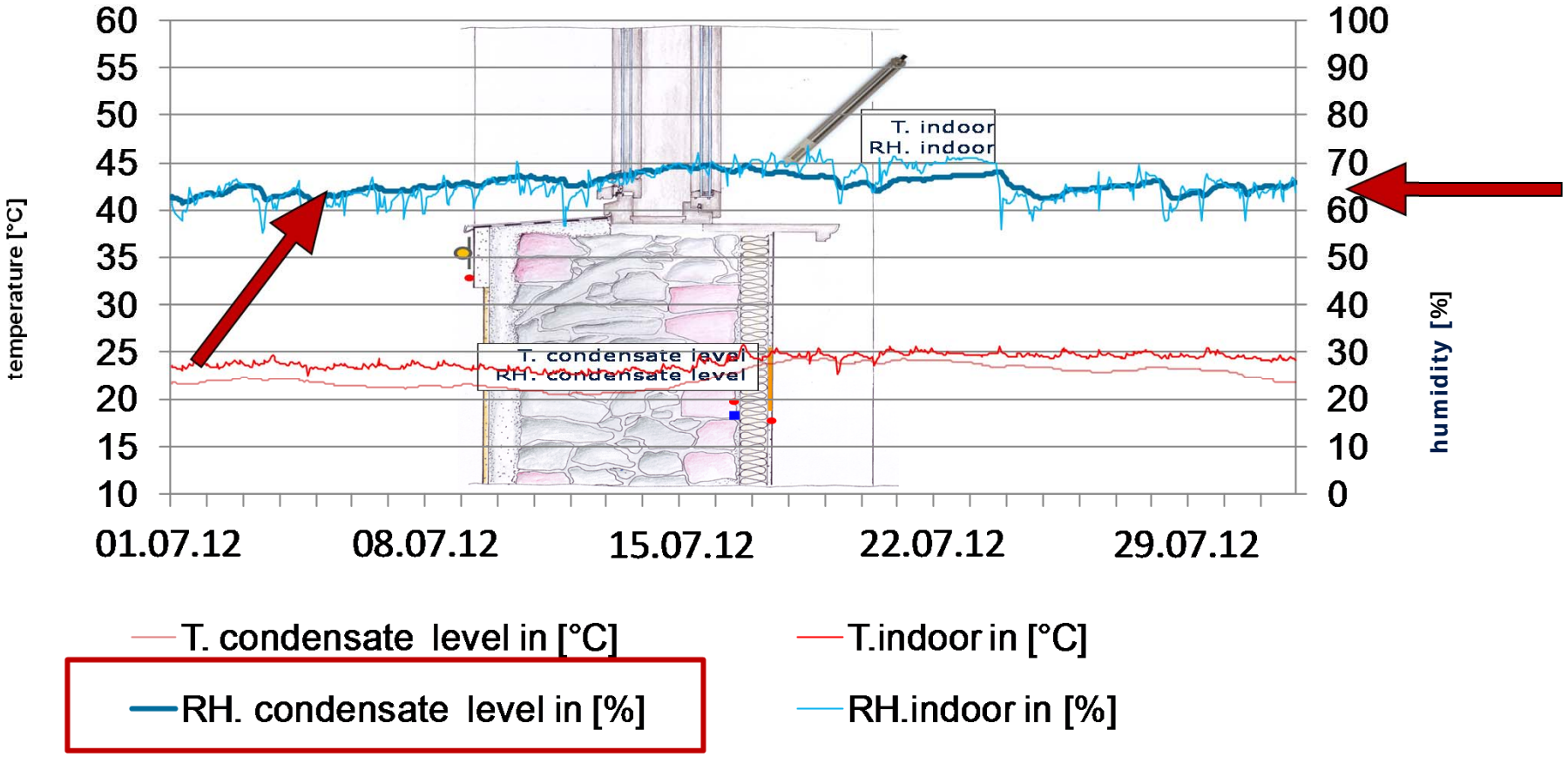
T.indoor in [°C]

RH. condensate level in [%]

RH.indoor in [%]

Kitchen on the 2nd floor, temperature and humidity of the indoor climate and humidity and temperature conditions in the wall, January

CS6 - Görlitz – discussion of the results



Kitchen on the 2nd floor, temperature and humidity of the indoor climate and humidity and temperature conditions in the wall

CS6 - Renaissance building in Freiberg

Building before and after reconstruction

Focus

- zero energy consumption without destroying the historic appearance of the building
- evaluate the energy reduction potential and economics to give guidance for future projects
- create attractive living space in the historic city center

CS6 - Freiberg planned solutions

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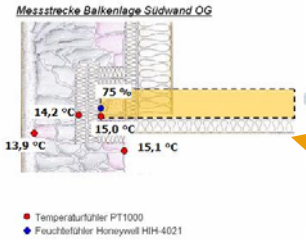
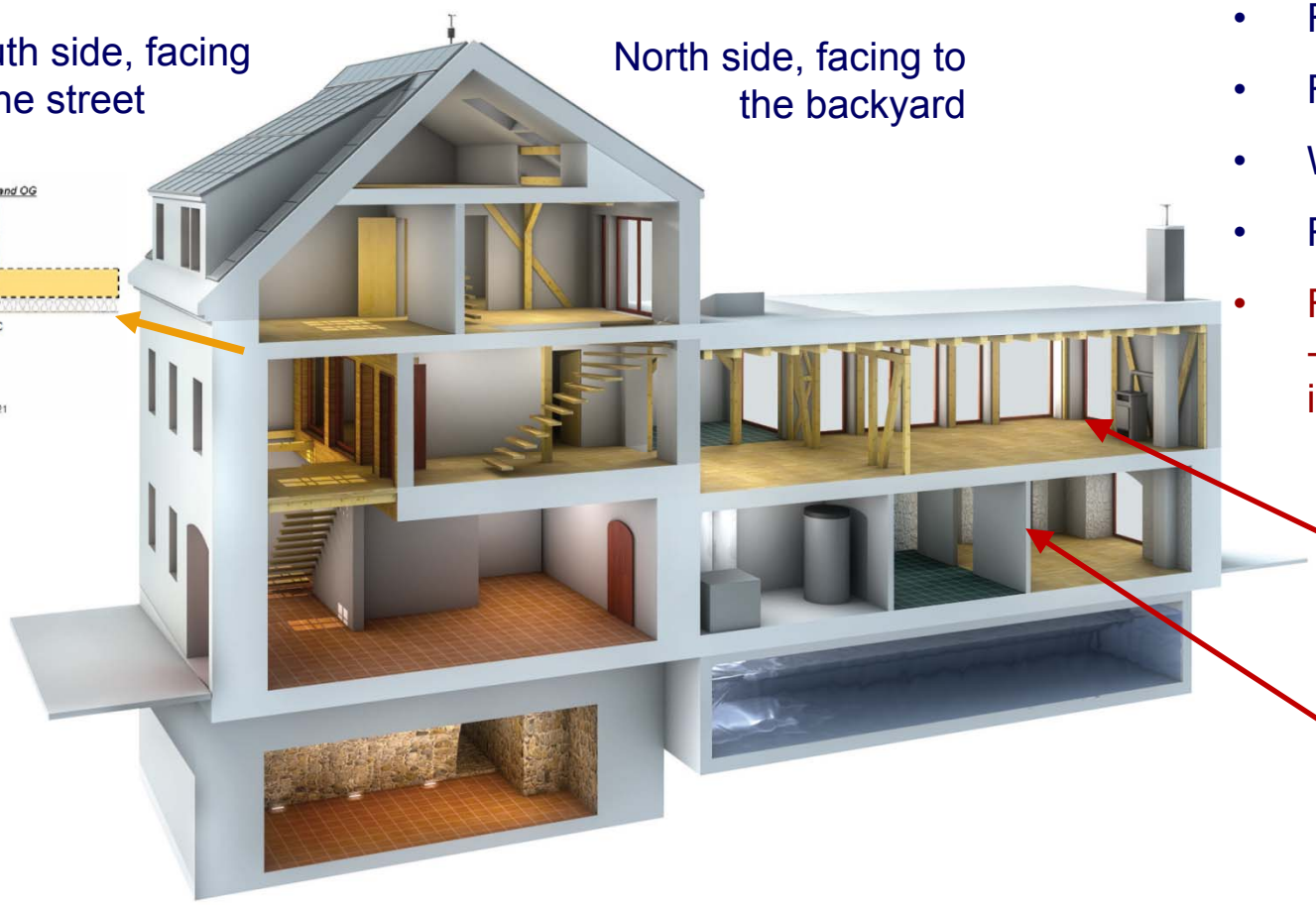
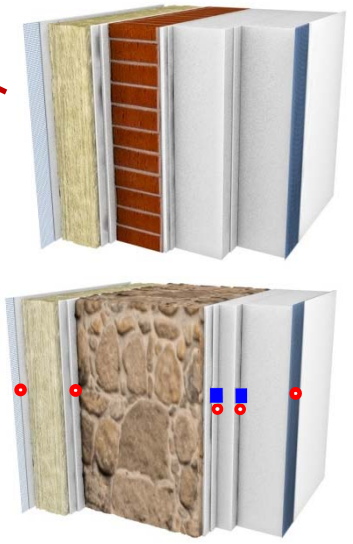
South side, facing to the street

North side, facing to the backyard





- Facing to the street
- Fire wall
- Windows
- Roof
- Facing to the backyard - EIFS and internal wall insulation



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CS6 - Freiberg – discussion of the results

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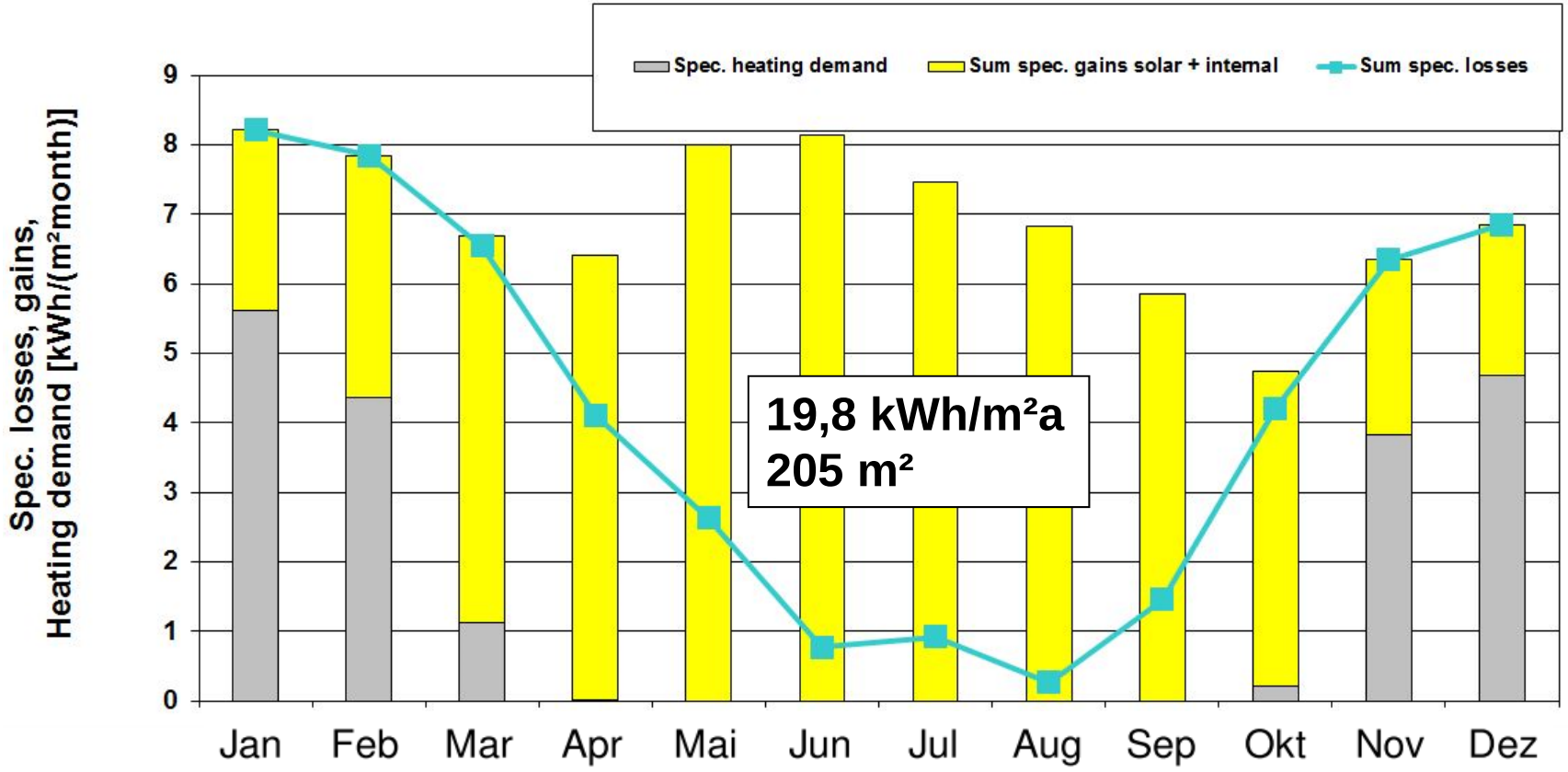
Energy heat consumption



Annual heat consumption for floor heating of 4,140 kWh/a (19.7 kWh/m²a) plus 2,226 kWh/a for hot water.

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CS6 - Classicism building in Potsdam

Building before and after reconstruction

Focus

- analyze the internal insulation planned with a focus on possible condensation and critical moisture
- critical moisture content in wood construction and the risk of mold growth
- driving rain protection, hydrophobic impregnation

CS6 - Classicism building in Potsdam

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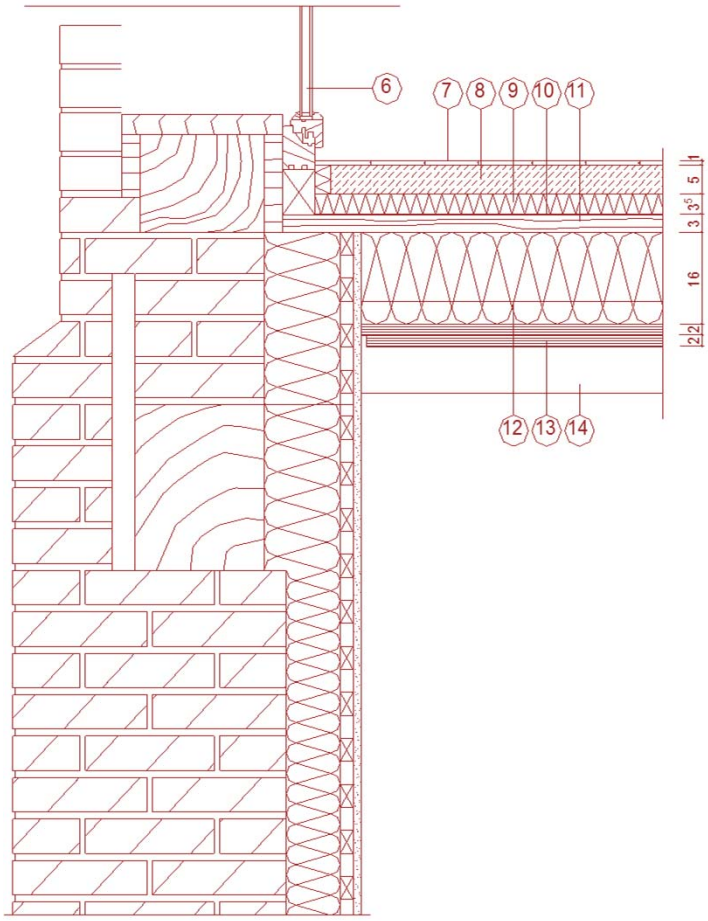
Schinkel magazine 3

timber-framed construction, inner wall



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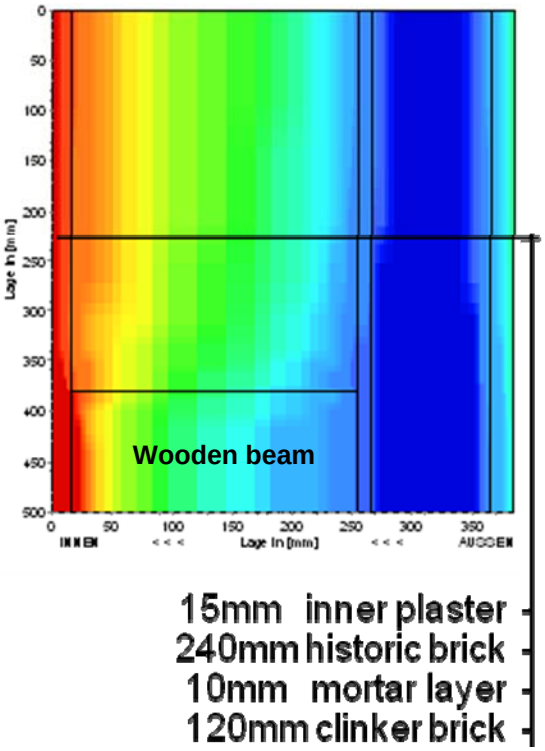
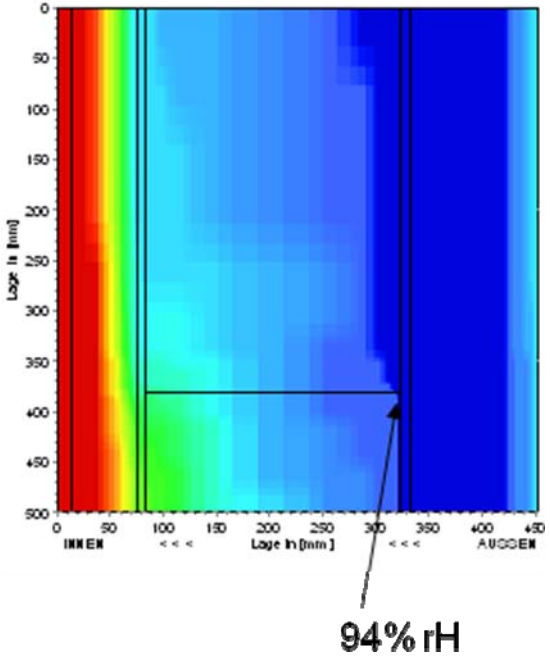
CS& - Potsdam – discussion of the results

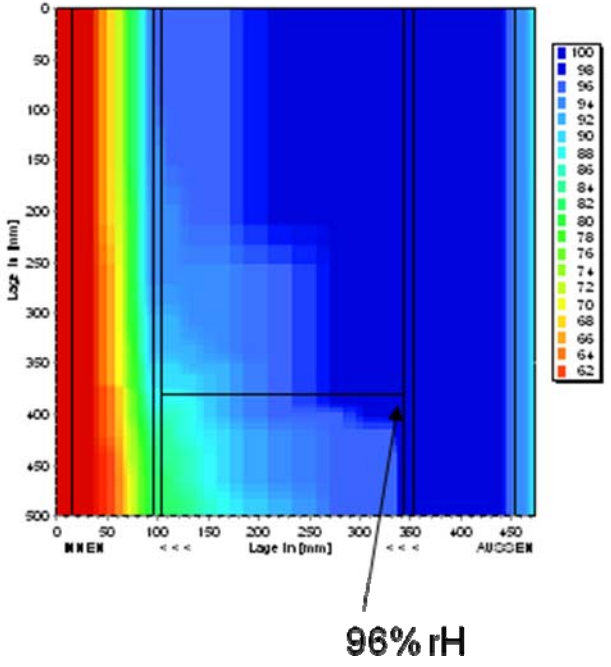
not insulated



60mm loam-cork insulation



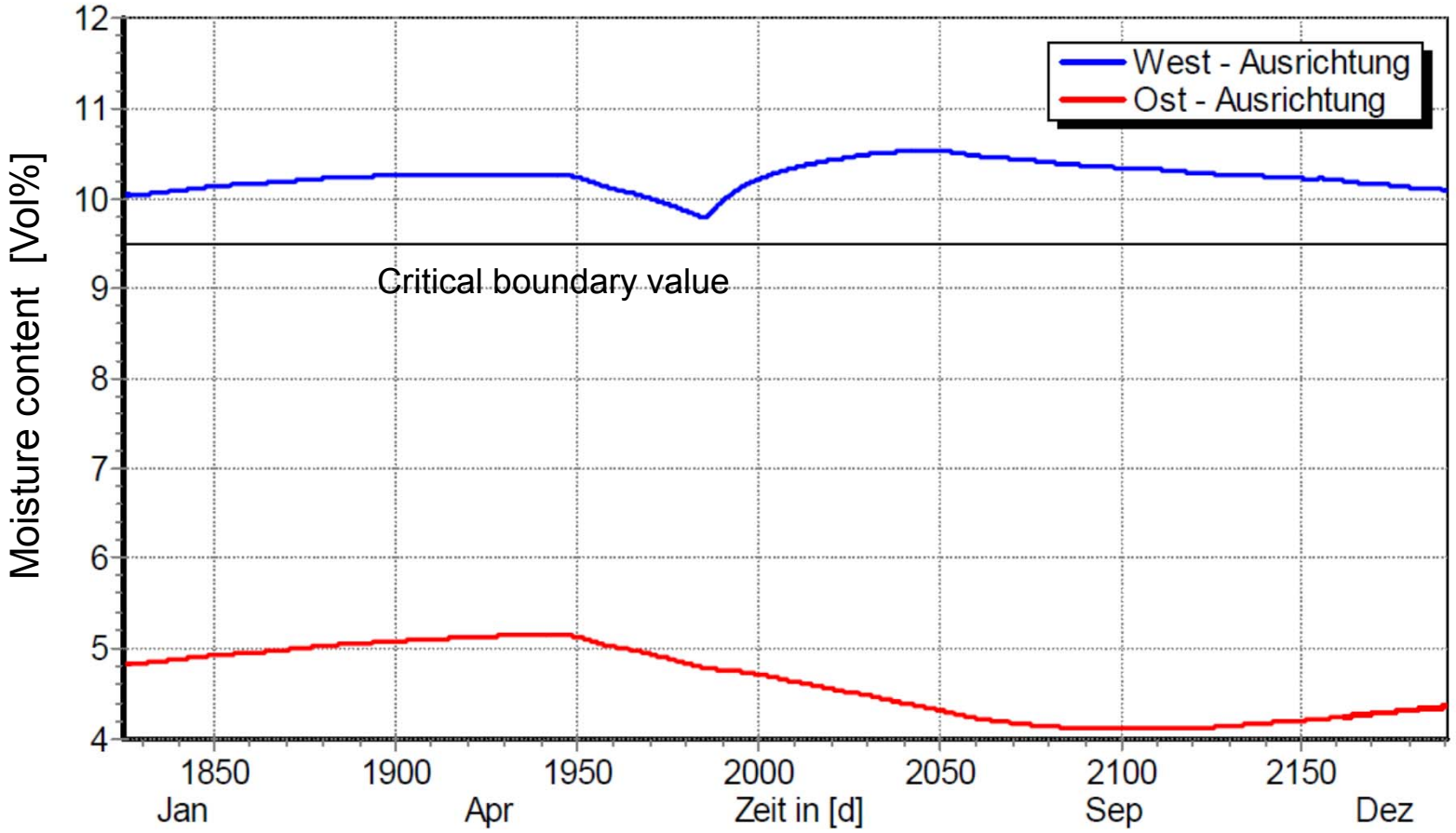
80mm loam-cork insulation



Range of relative humidity at the time of maximum moisture load (Delphin-simulation)

CS& - Potsdam – discussion of the results

Moisture content of the wooden beam [Vol%]



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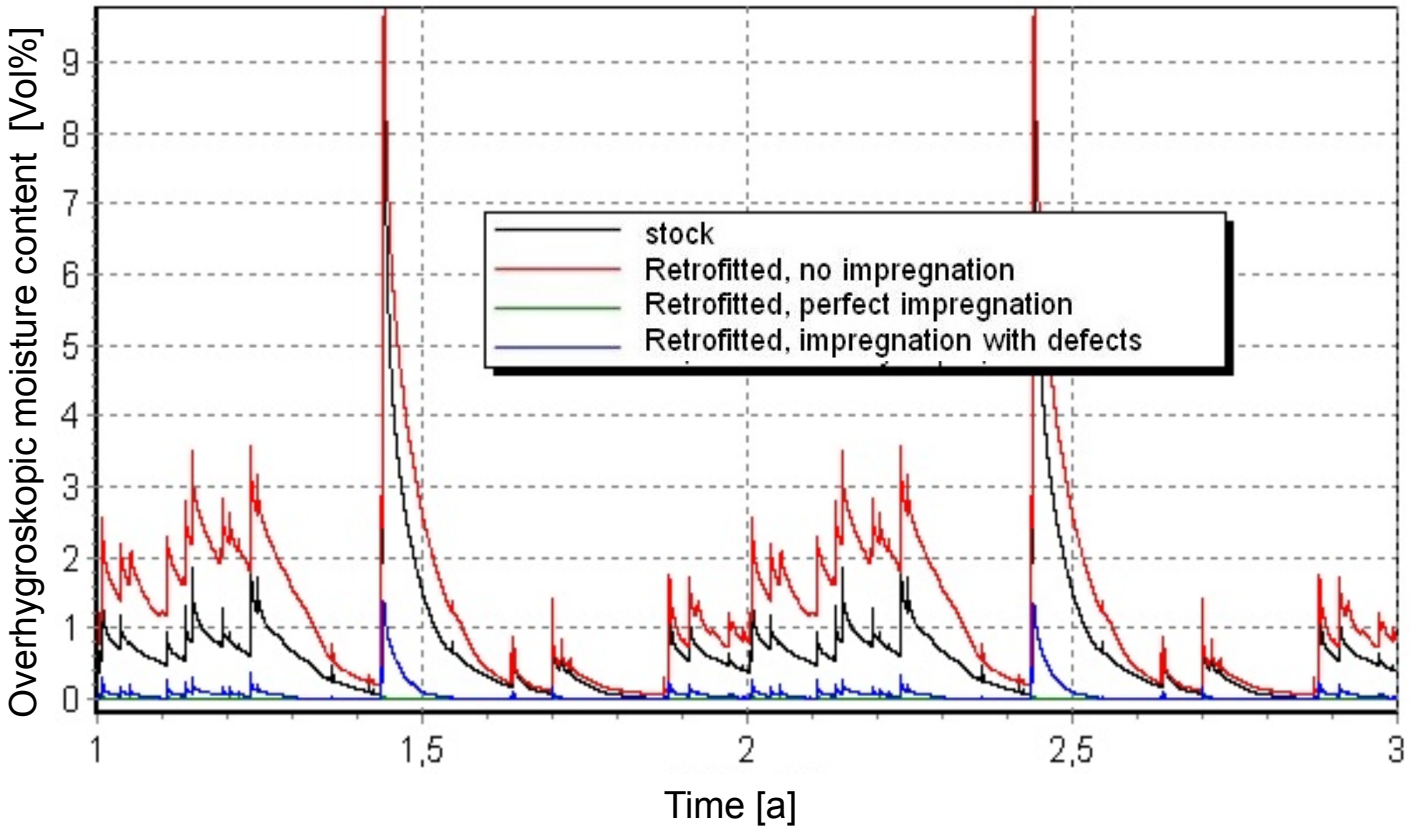
Over hygroskopic moisture content in the construction [Vol%]



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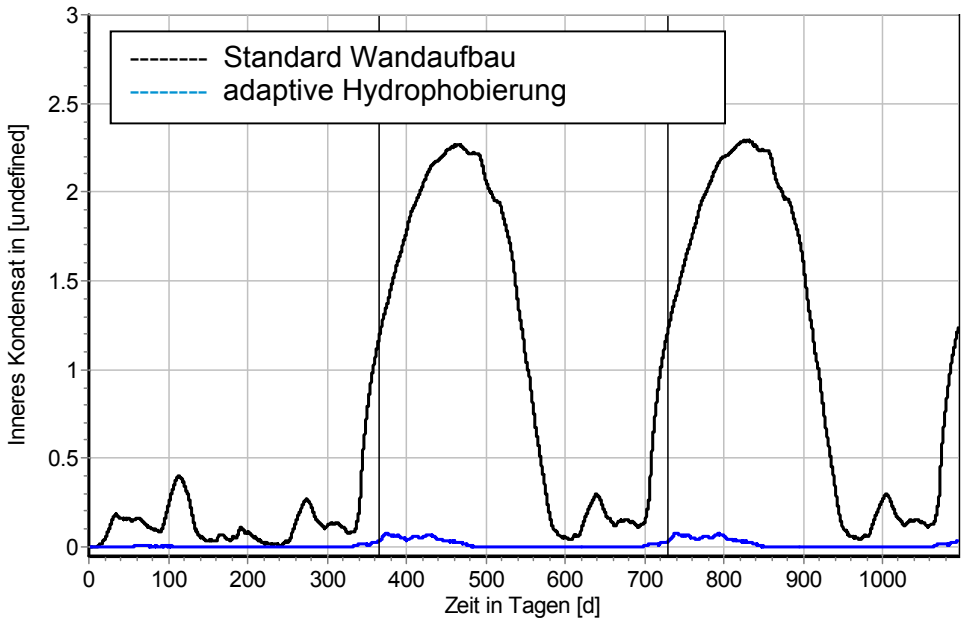

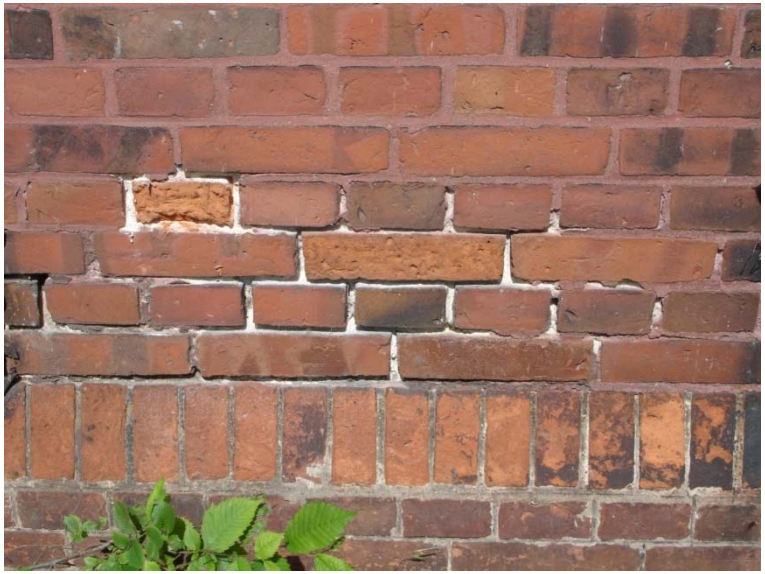

Adaptive hydrophobic impregnation

- functionality and durability of driving rain protection
- homogeneous penetration up to 15mm depth
- applicable on moist undergrounds → emulsions cream
- keeping drying potential
- unchanged optical impression after application

CS& - Potsdam – discussion of the results

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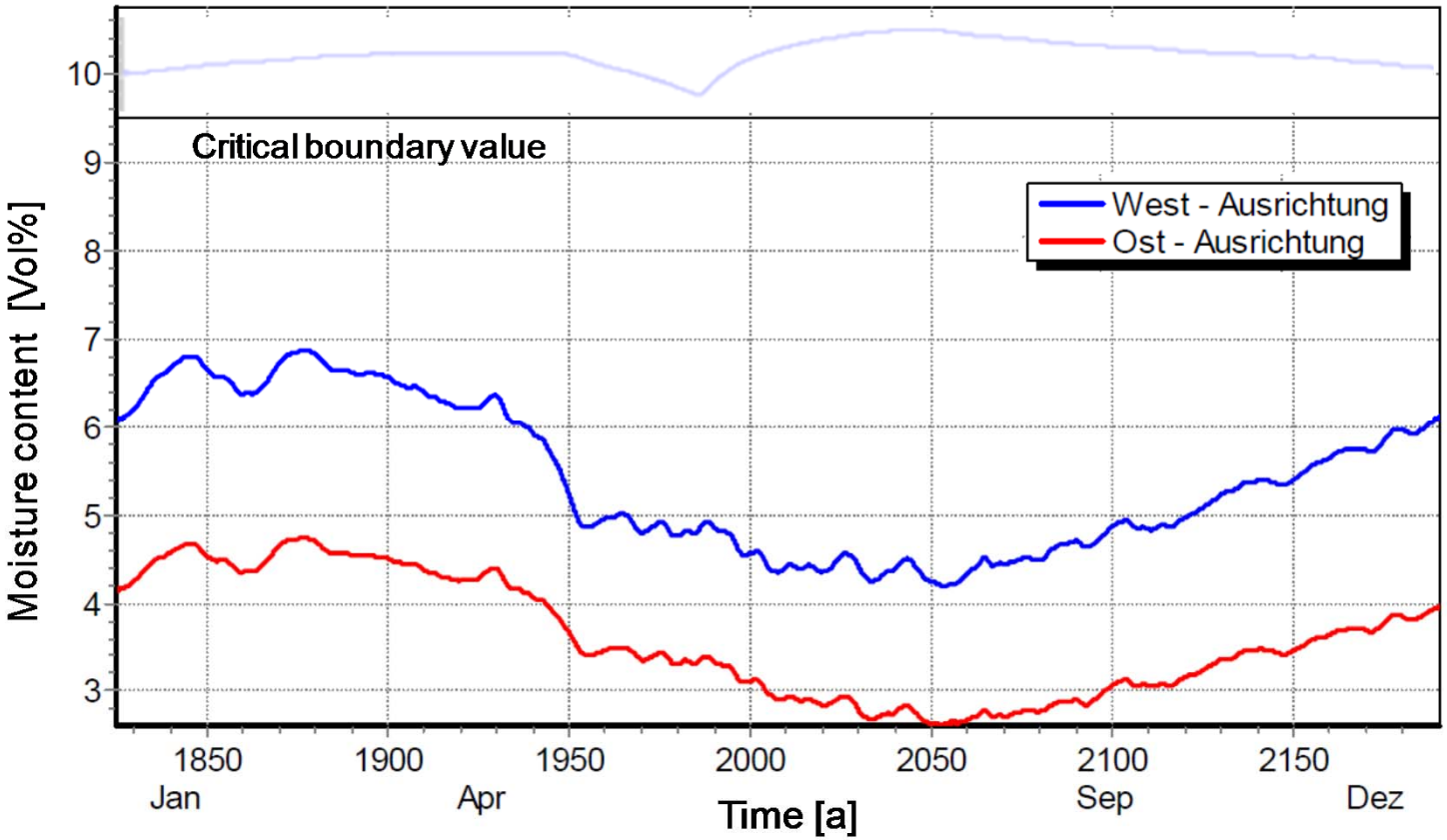
Moisture content of the wooden beam after hydrophobic impregnation [Vol%]



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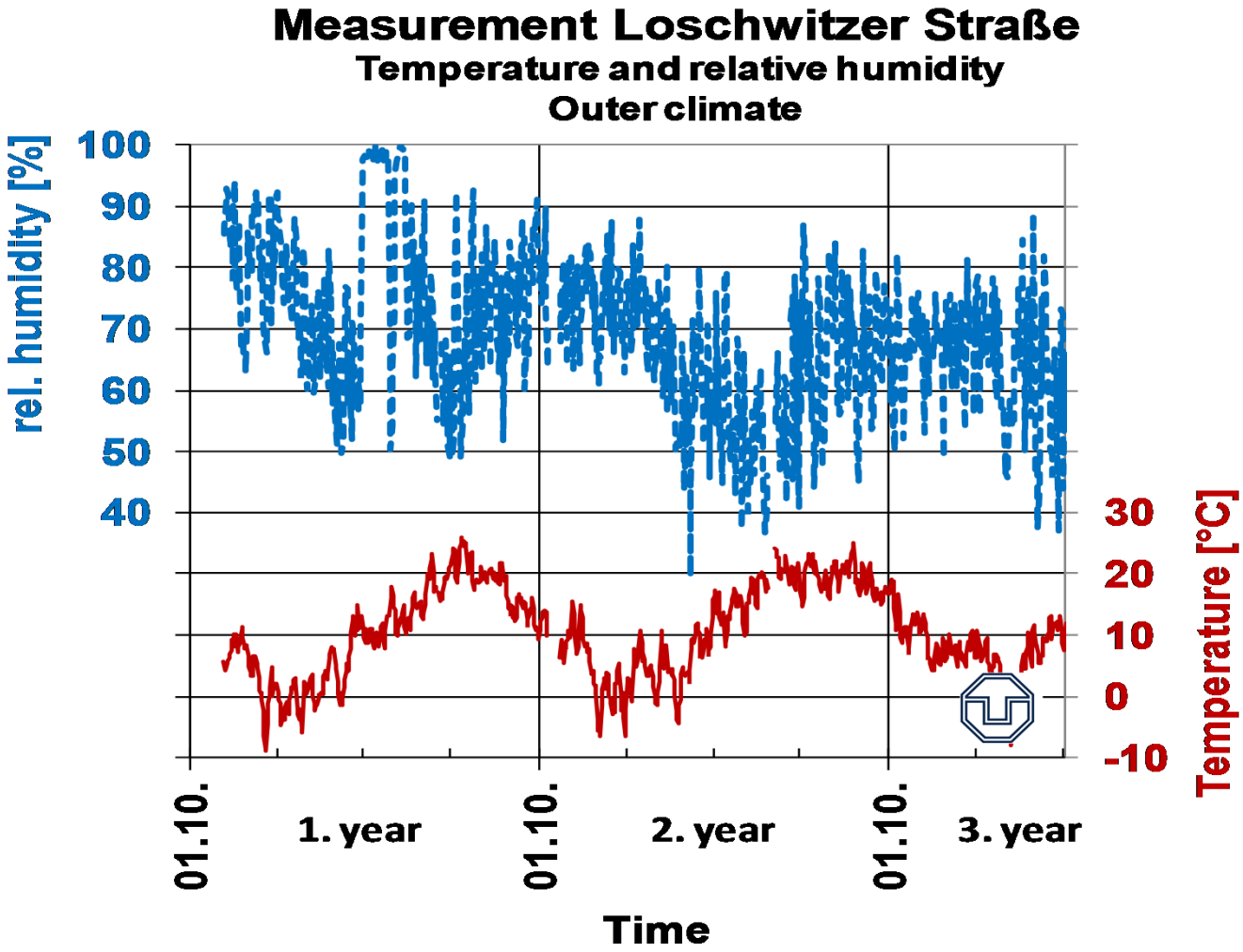
CS6 - Wilhelminian building in Dresden

Building before and after renovation

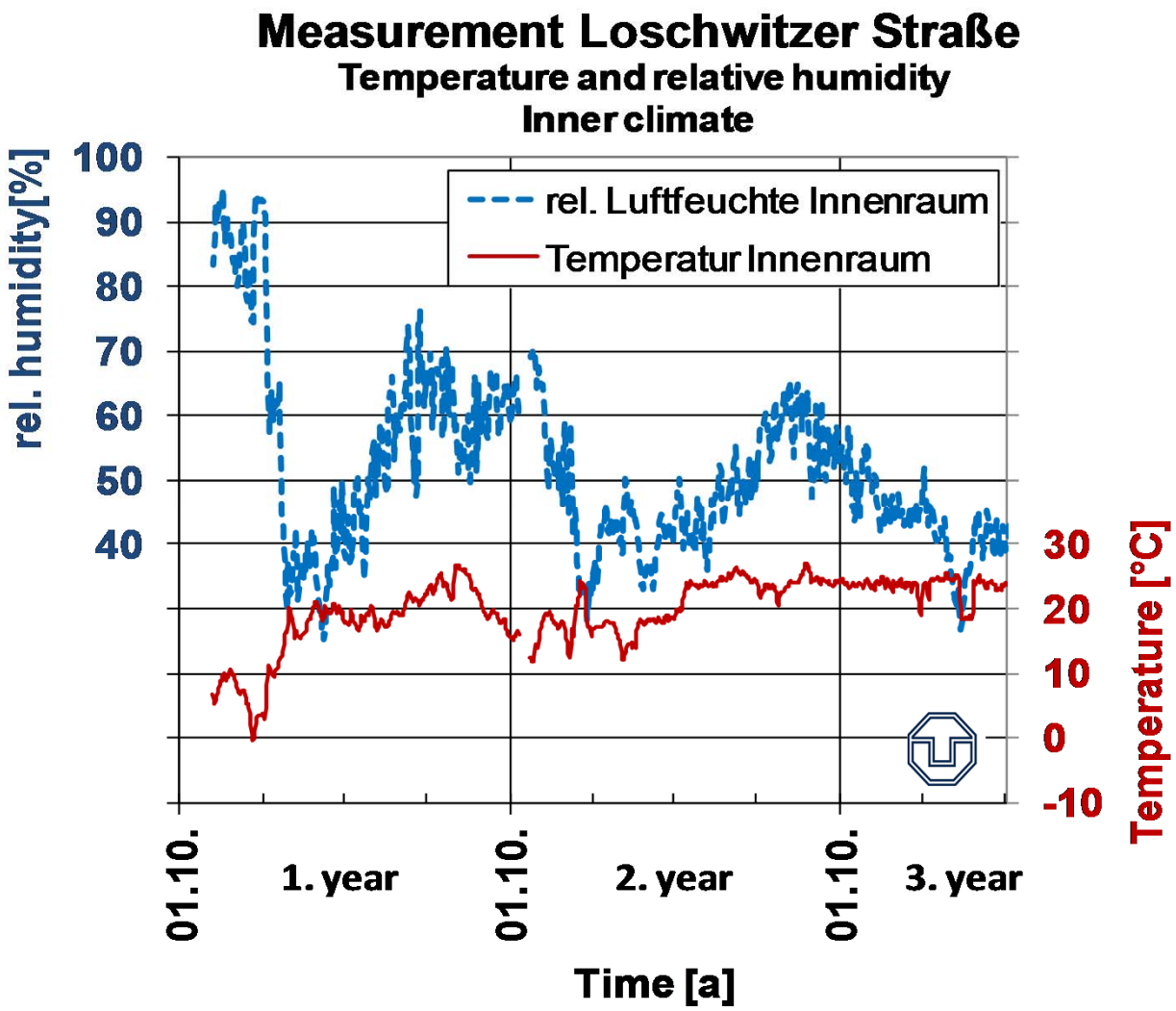
Focus

- construction details
- handling of wooden beam head
- suspended ceilings, F30 fire protection requirement
- evaluation of wall heating system

CS6 - Dresden – measurements



CS6 - Dresden – measurements



CS6 - Dresden – measurements

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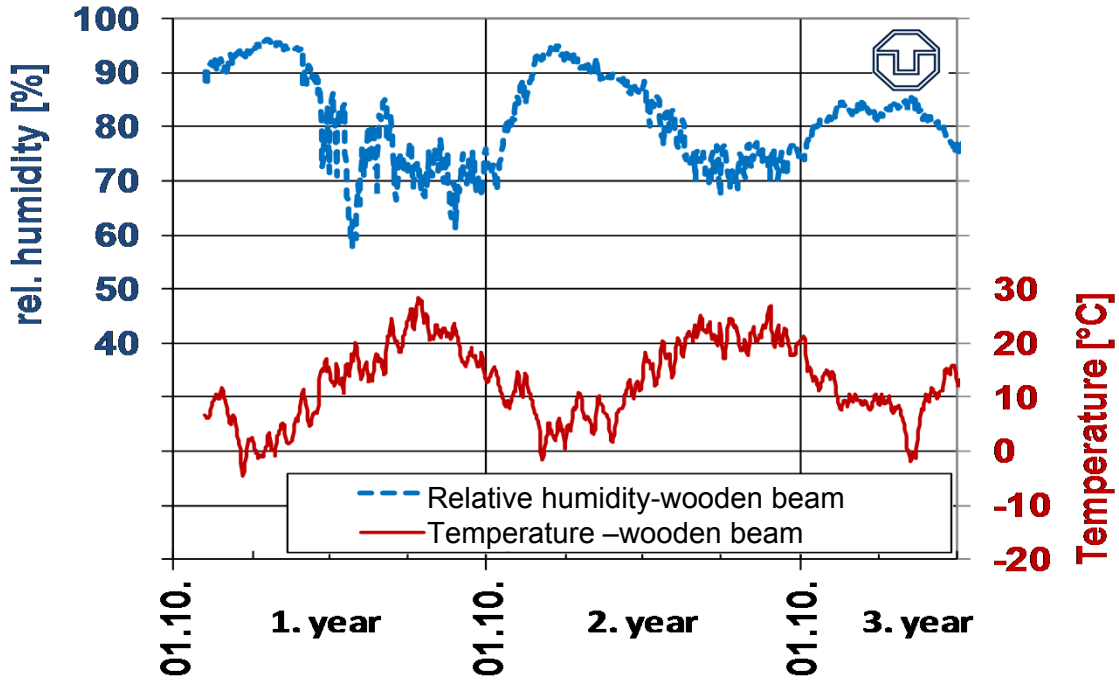

Temperature and relative humidity- wooden beam end

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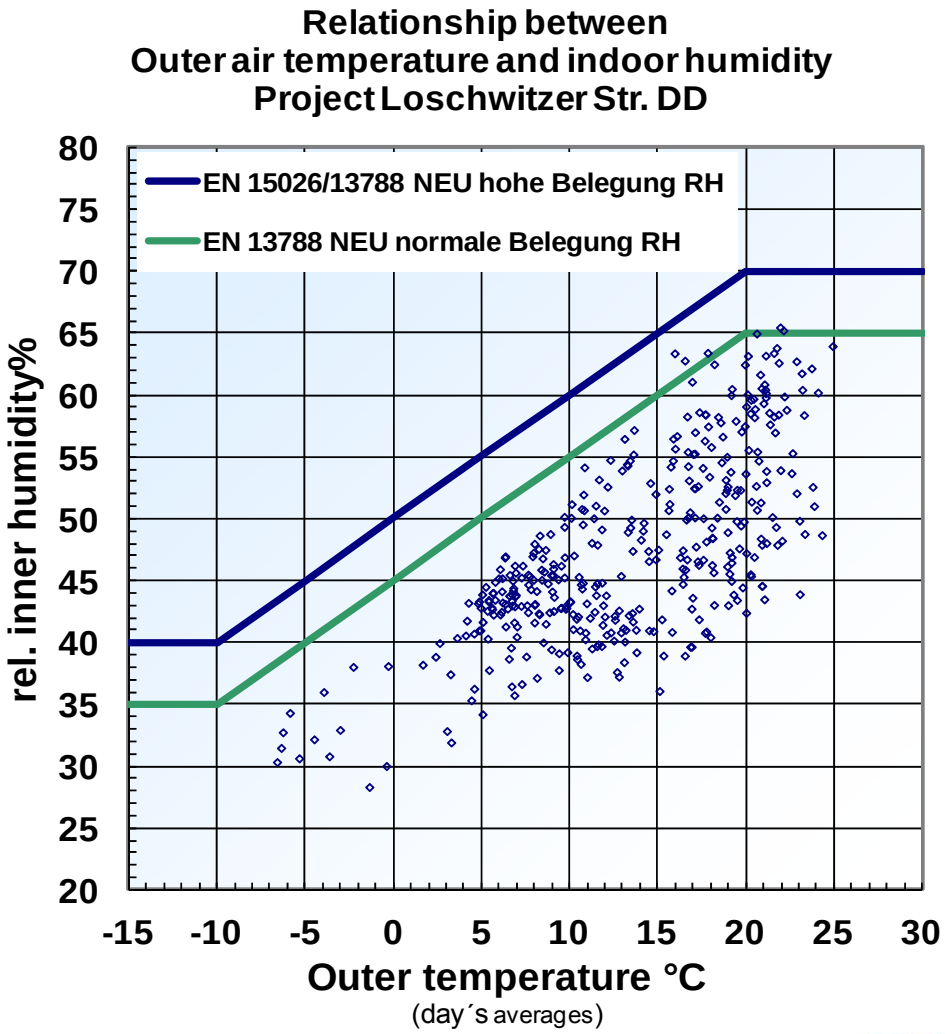
CS6 - Dresden – discussion of the results



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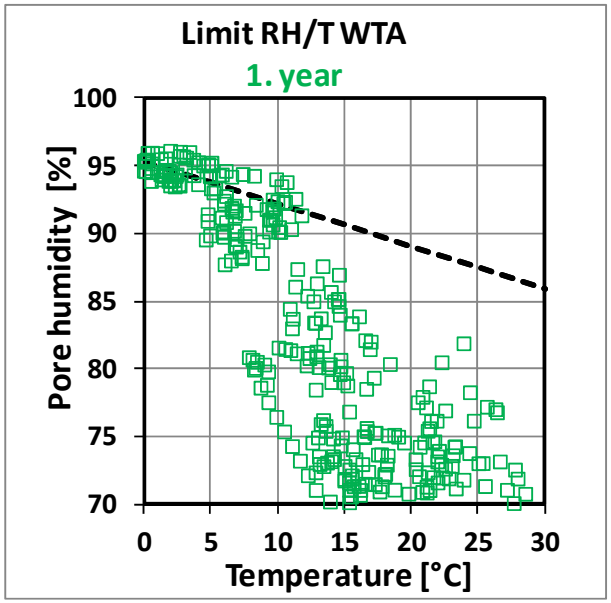
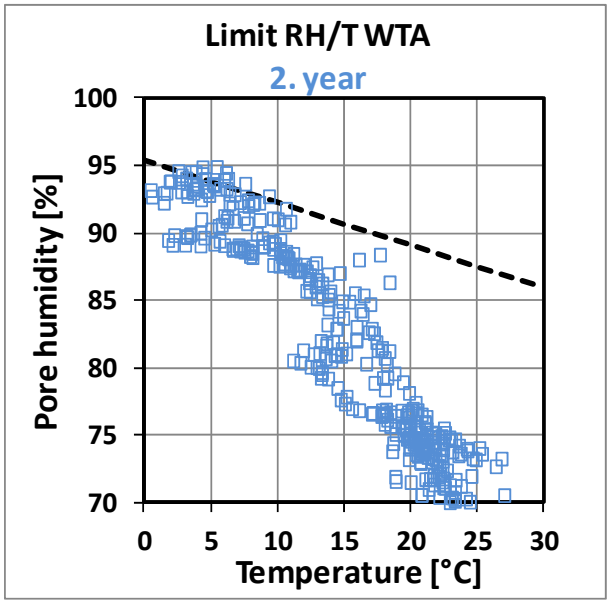
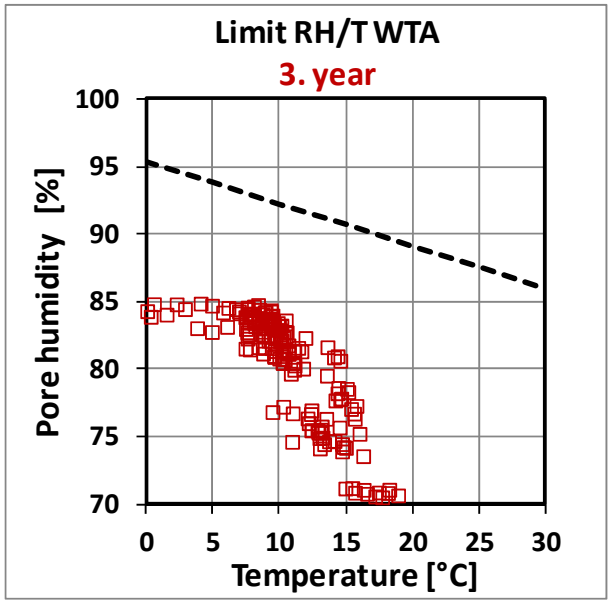
Evaluation of the temperature and relative humidity (boundary element)

daily averages for the evaluation is used

	1. year	2. year	3. year	...	7.year	
Number of d, over the limit	39	12	0		0	d
Maximum RH at > 0°C	96,1	94,9	84,8		0,0	%







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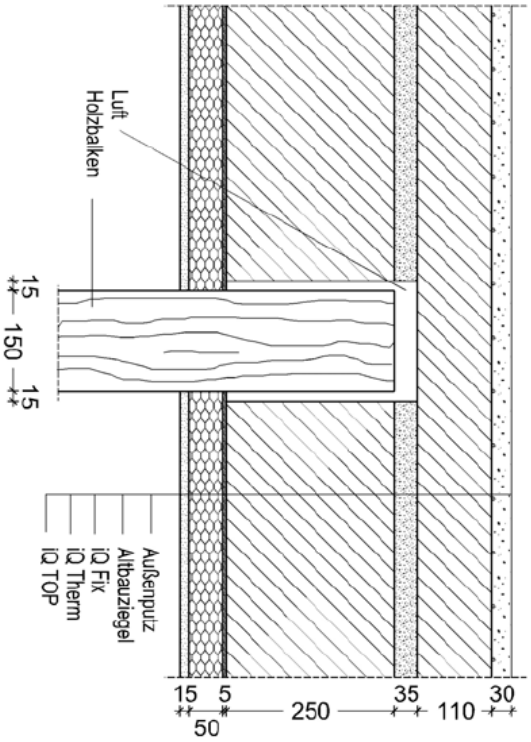
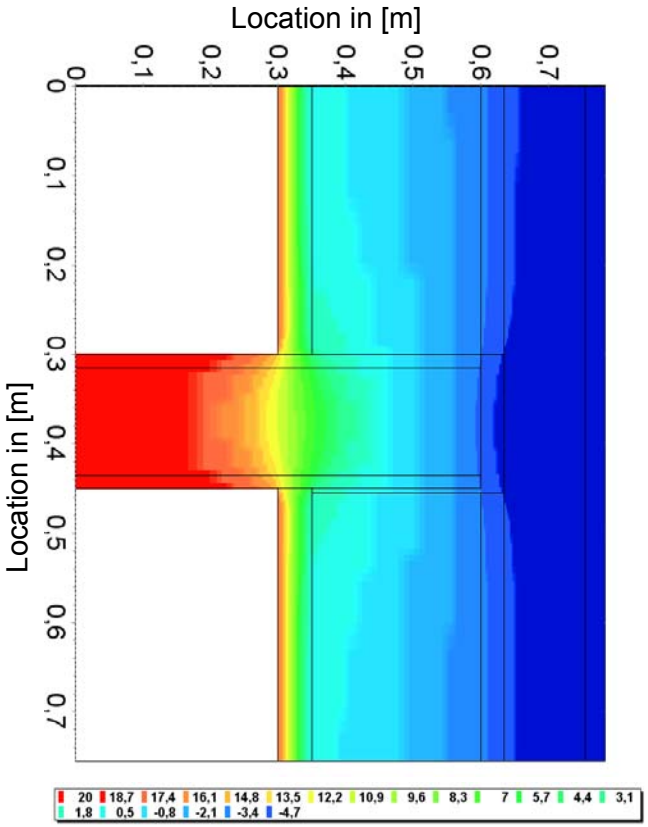
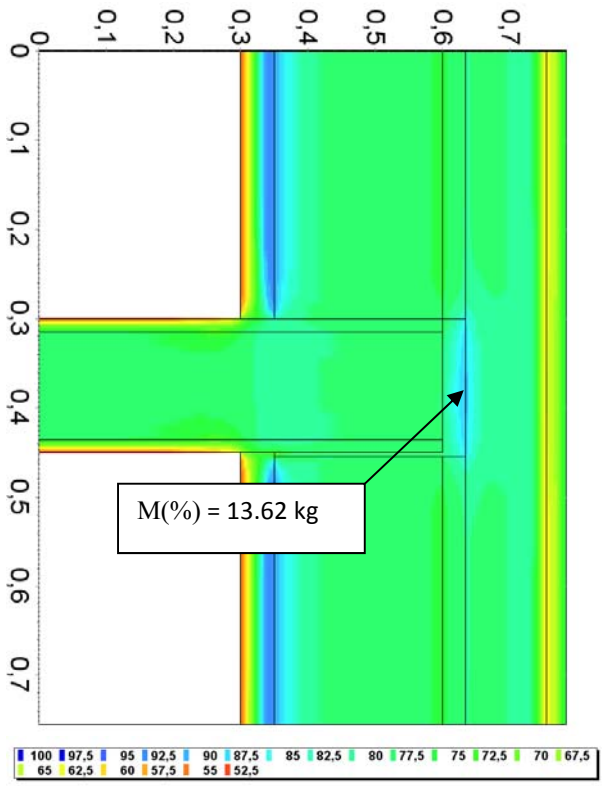
Simulation results of the wooden beam end under real climate condition





Temperature at the most critical day



Relative humidity at the most critical day

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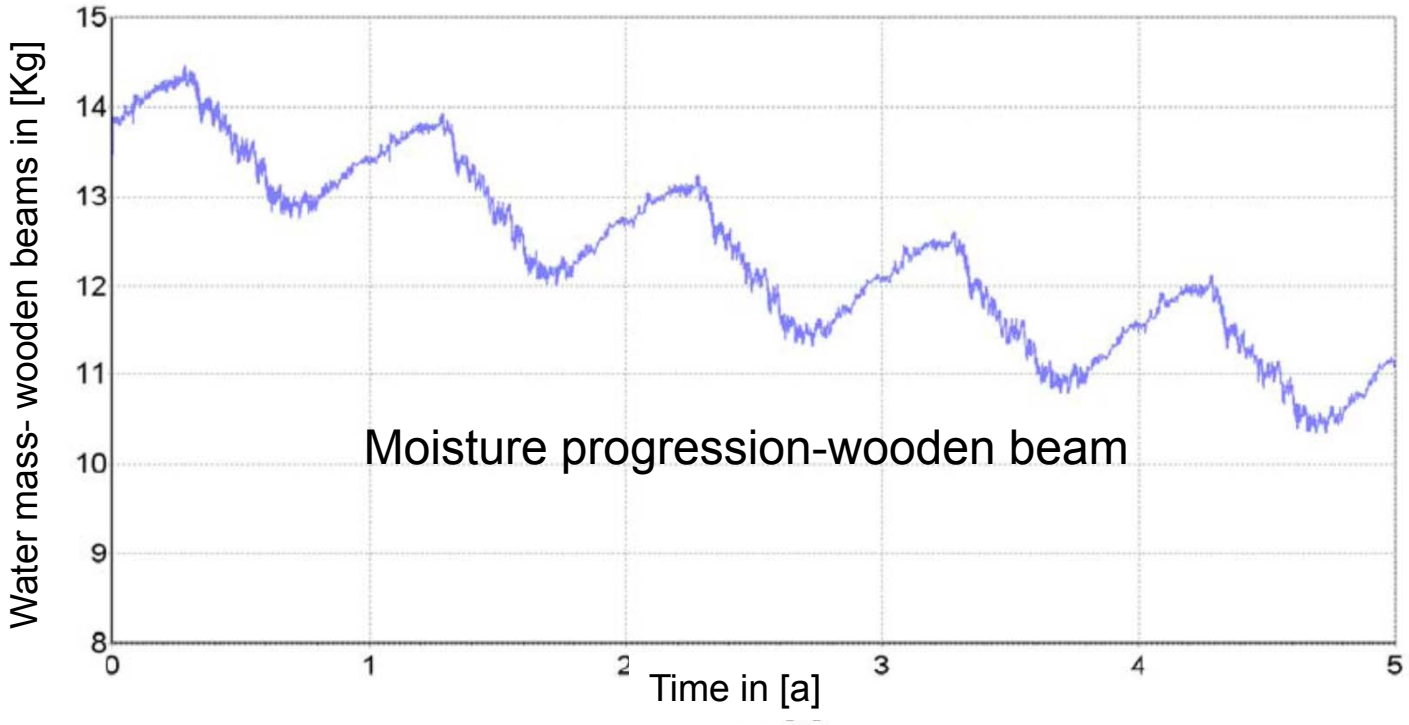
CS6 - Dresden – discussion of the results

Simulation results of the wooden beam head under real climate condition



M_{Wood} = 13.62 kg > $M_{Wood,\ allowed}$ = 20 kg (measurement after 1 year of settling)

CS1 - Case study Waaghaus, Bolzano

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Planning progress – use of building:

- Ideas competition to define the **future utilization concept** of the Weighhouse as a **“House of Photography"** -> published in May 2012, selection of 10 planners and start of competition phase: beginning of July, delivery of projects; November publication of decision -> besides utilization concept it was asked explicitly to exploit the energy potential of the building

- The winner will project and realize the **refurbishment**

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CS1 - State of diagnosis pre-intervention

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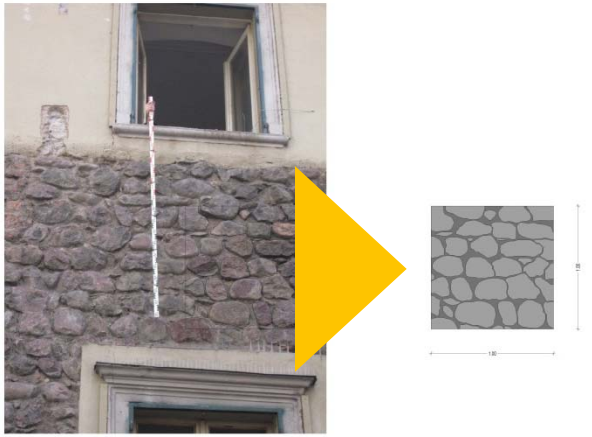
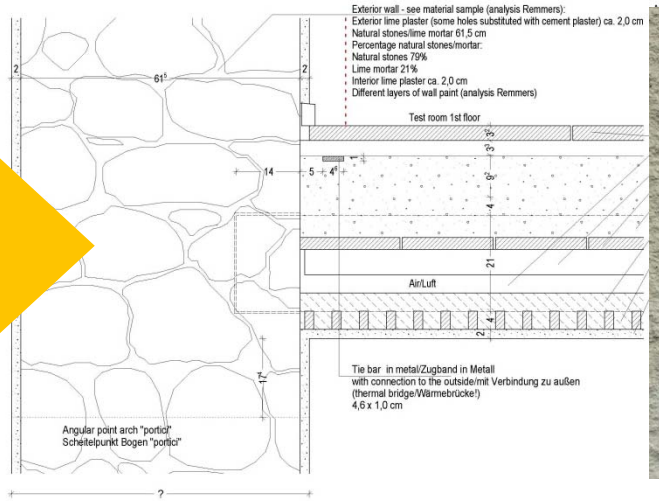
Analysis of architectural elements

- Precise **measurement of stratigraphy** of construction elements -> drawing of detail sections with correct dimensions
- **Analysis of material parameters** (from material samples) through TUD for the Delphin database
- Documentation of the building in the DIS database





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CS1 - State of diagnosis pre-intervention

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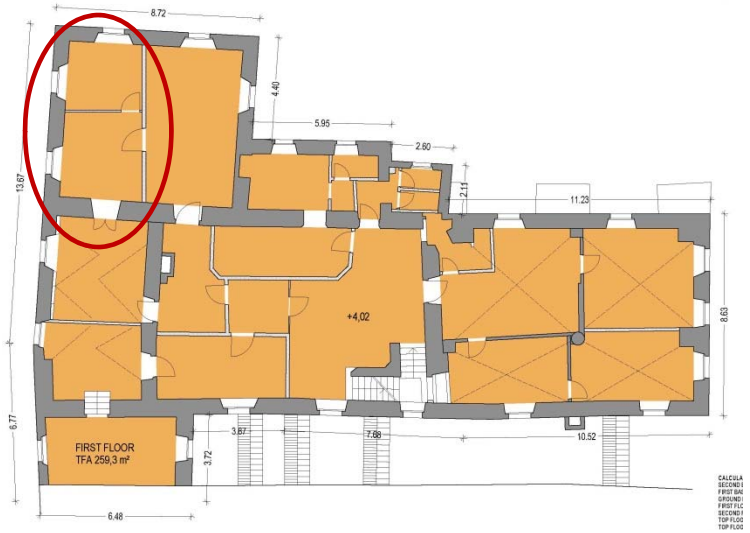
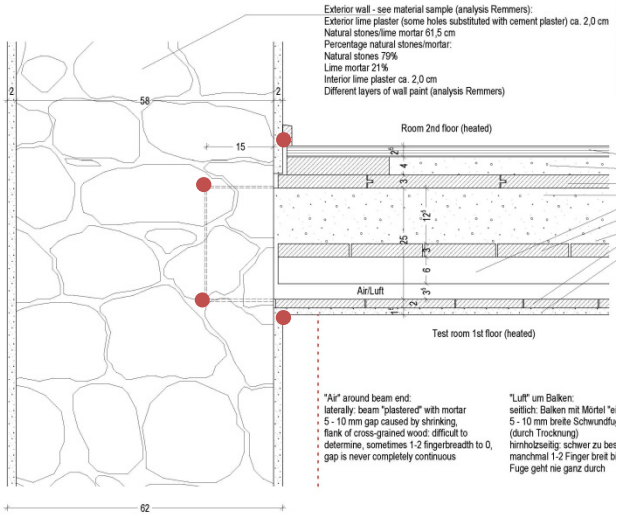
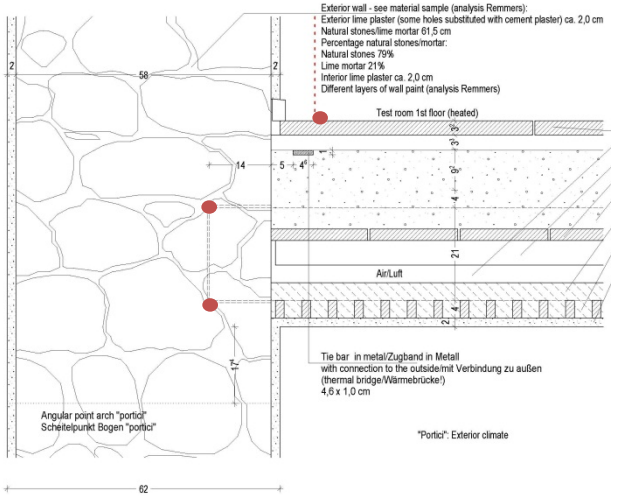
Installation of internal insulation in one test room – actual state

Simulations in DELPHIN of **two significant points**:

- Floor (beam ends)
- Ceiling (beam ends)
- Comparison of 2 thicknesses: 5 and 8 cm with as-is-state







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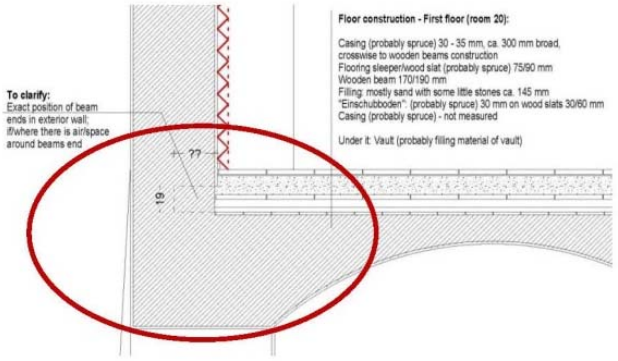
CS1 - Internal insulation

- **Installation of internal insulation in one test room – actual state**

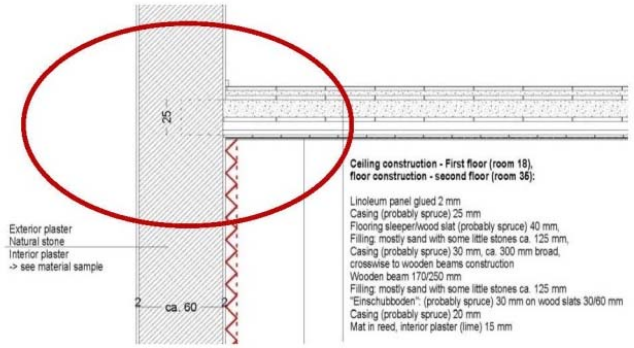
- Simulations of three points in Delphin by TUD:

- Window prototype/window reveal
- Floor (beam ends)
- Ceiling (beam ends)

Comparison of 2 thicknesses: 5 and 8 cm



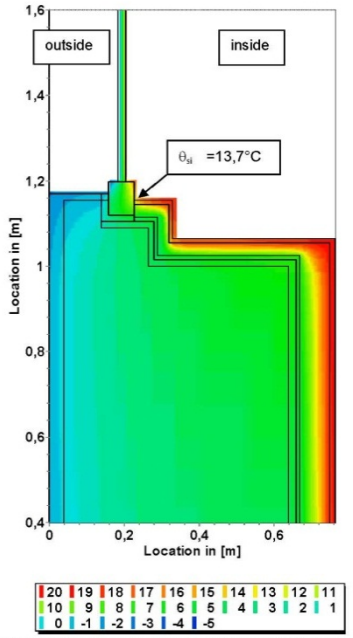
floor construction – first floor (room 20)



: ceiling construction- first floor (room18)

1.5 Calculation under unsteady state conditions (real climate of Bolzano)

Outer wall thickness = 60 cm, insulated with 8 cm IQ -therm, window reveal insulated with 3 cm IQ Therm,
Distance between window rfigureet to the outer edge: ≥ 12.5 cm



Temperature field, surface temperature [° C], OW 60 cm insulated with 8 cm IQ Therm, window reveal insulated with 3 cm IQ Therm
Boundary conditions: Bolzano outdoor climate,on January10th

CS1 - State of diagnosis pre-intervention

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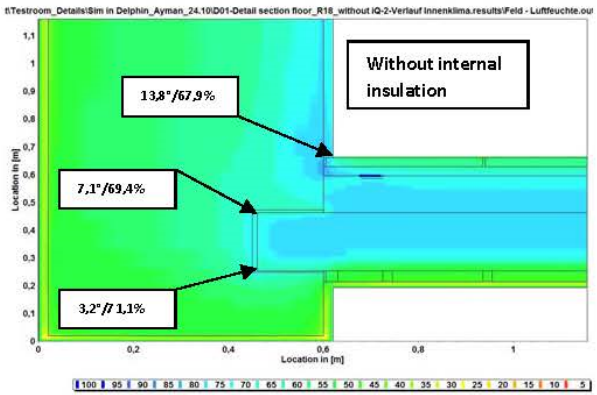
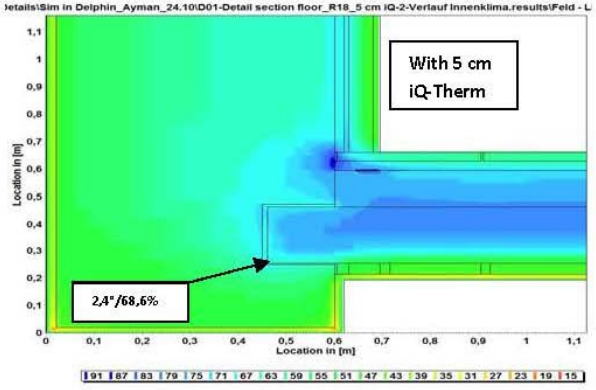
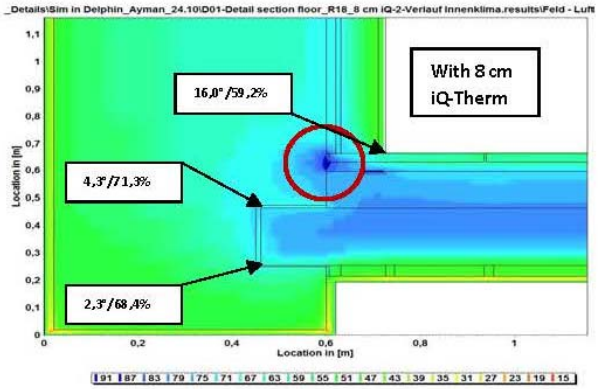
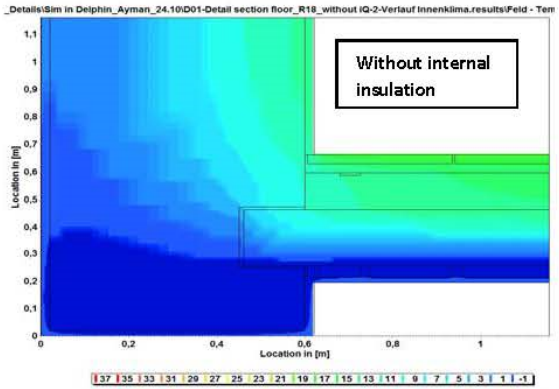
Simulation of beam ends floor (ceiling “portici”)

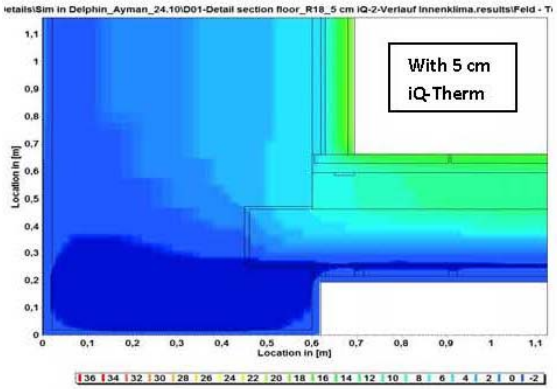
Comparison: relative **humidity and temperature** within the structure on a cold winter day (Winter 2nd/3rd year: 12th January)

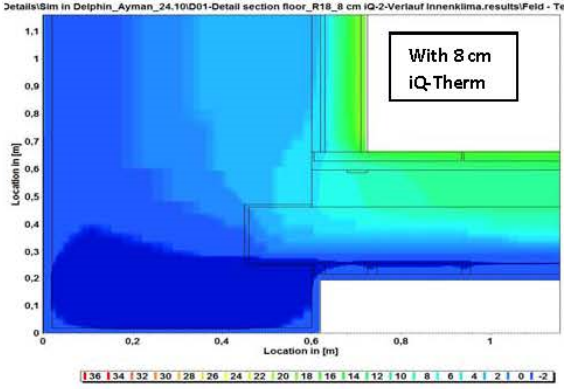












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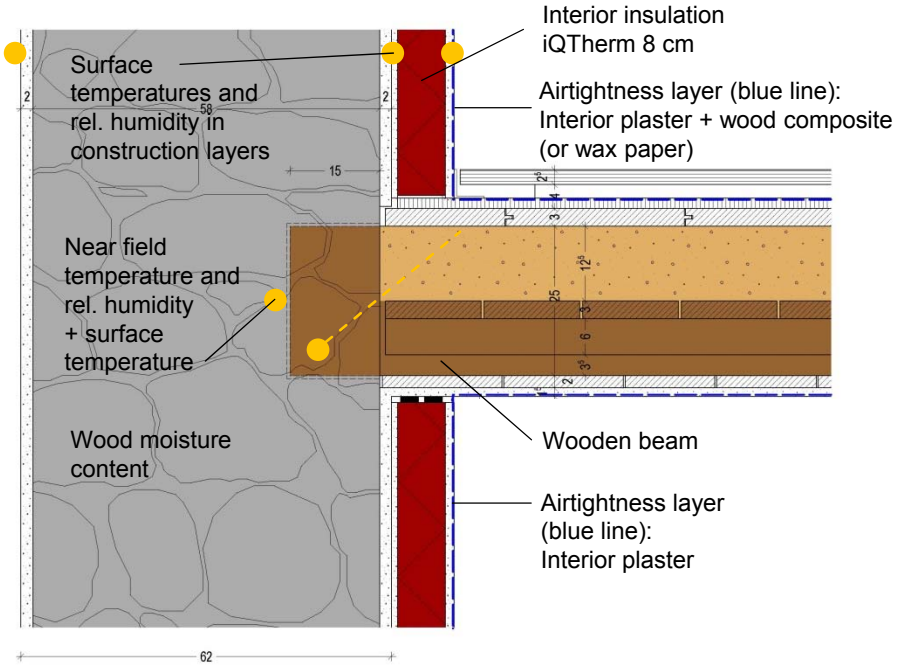
CS1 - Internal insulation

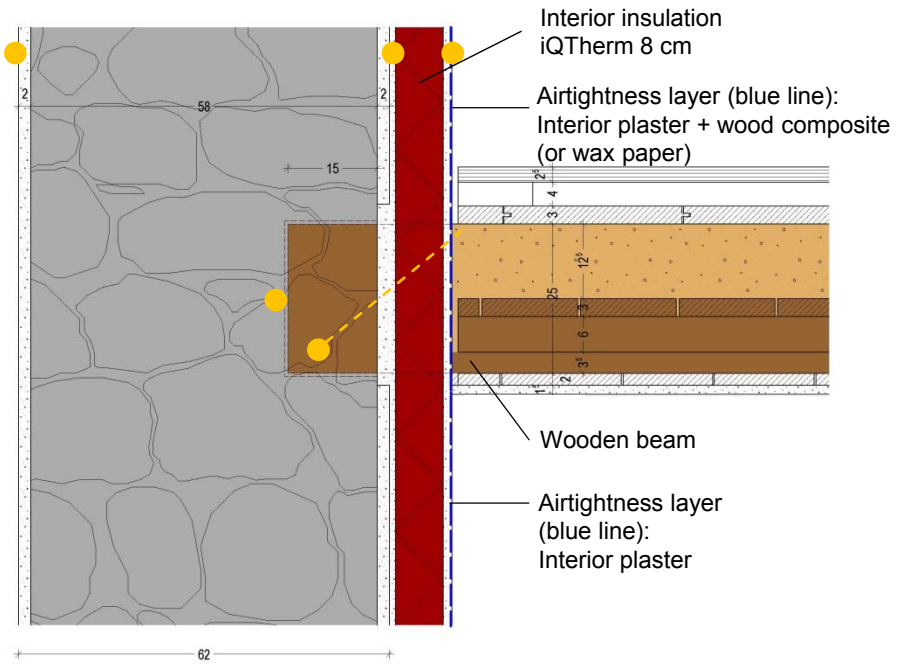
Installation of diffusion open interior insulation with capillary redistribution

- **Wooden beams in ceiling:** implementation of two different connections
- **Monitoring and comparison of both solutions:** wood moisture content, temperature and rel. humidity

Version I: „interrupted" insulation



Version II: „continued" insulation



Summary of the research results

Ayman Bishara

Criteria for comparison of different internal insulation systems

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	Potsdam	Dresden	Freiberg	Görlitz
Name	loam cork	IQ-Therm	Tec-Tem	Calciumsilicate
Appearance				
insulation effect	λ= 0.08 W/mK	λ = 0.031 W/mK	λ = 0.045 W/mK	λ = 0.065 W/mK
material and form	frame, plaster	board, plaster	board, plaster	board, plaster
capillary active	++	+	+	++
moisture regulation	++	+	+	++
natural material	++	- -	+ / -	+ / -
fire protection	-	-	++	++
soundproofing	++	-	+	+
sustainable	++	-	+	+
workmanship	-	++	+	+
costs	100 €/m²	45 €/m²	45 €/m²	75 €/m²

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Compatibility of energy saving potentials

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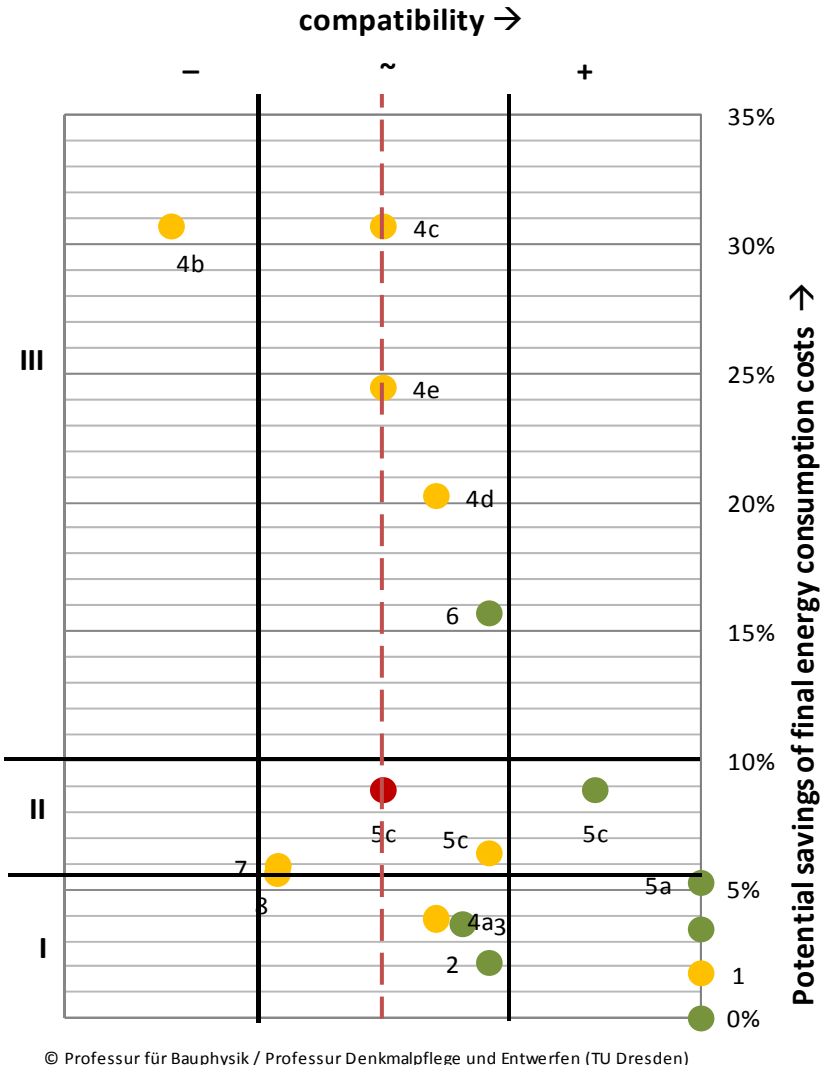

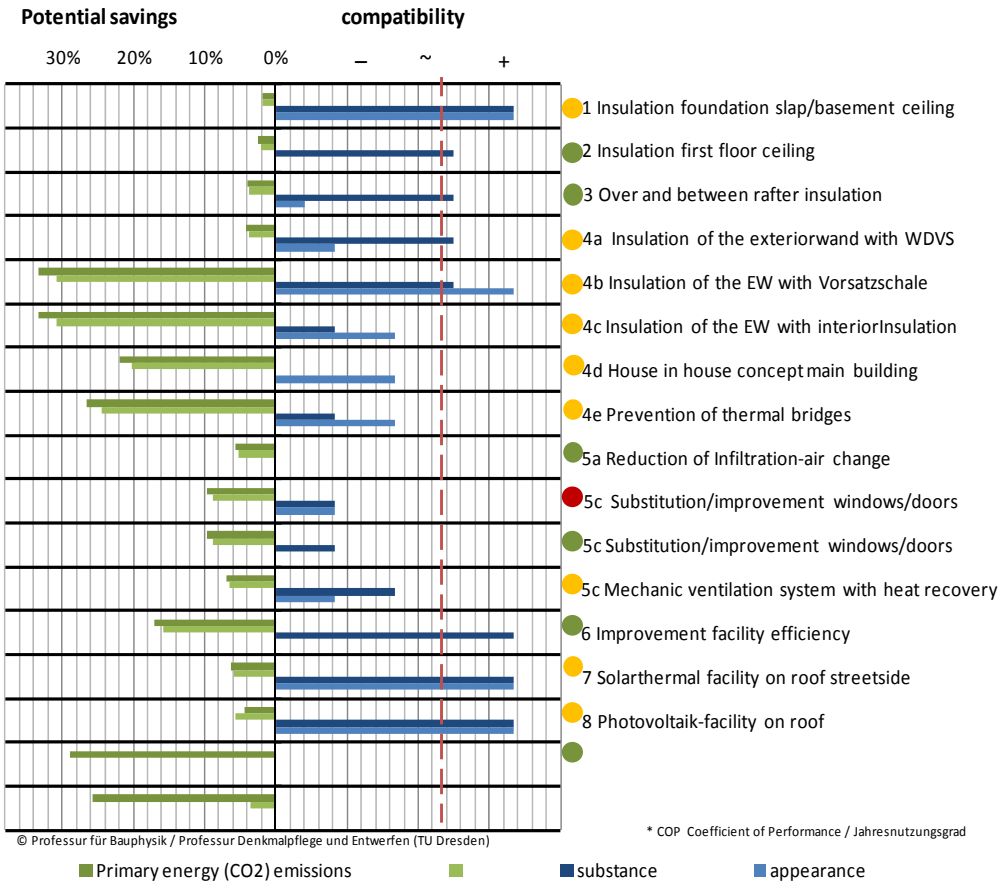

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Summary

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Positive effects of interior insulation

- Energy saving and CO_2 –reduction
  → contribution to the environmental protection
- Protection against condensate and mould growth
  → prevention of damaged e.g. after window exchange
- Improvement of thermal comfort
  → increasing value of rehabilitated buildings
- Keeping brick masonry constructions as they are
- Fast heating for temporary used rooms

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Summary

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Advantages of capillary active interior insulation

(multi functional properties vary between different building materials)

- Moisture regulation of construction
- Keeping healthy room climate
- Diffusion open construction
- Keeping drying potential
- Reduction of freezing damage probability

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Guidance for future projects

Ayman Bishara

Planning guide for the application of interior insulation

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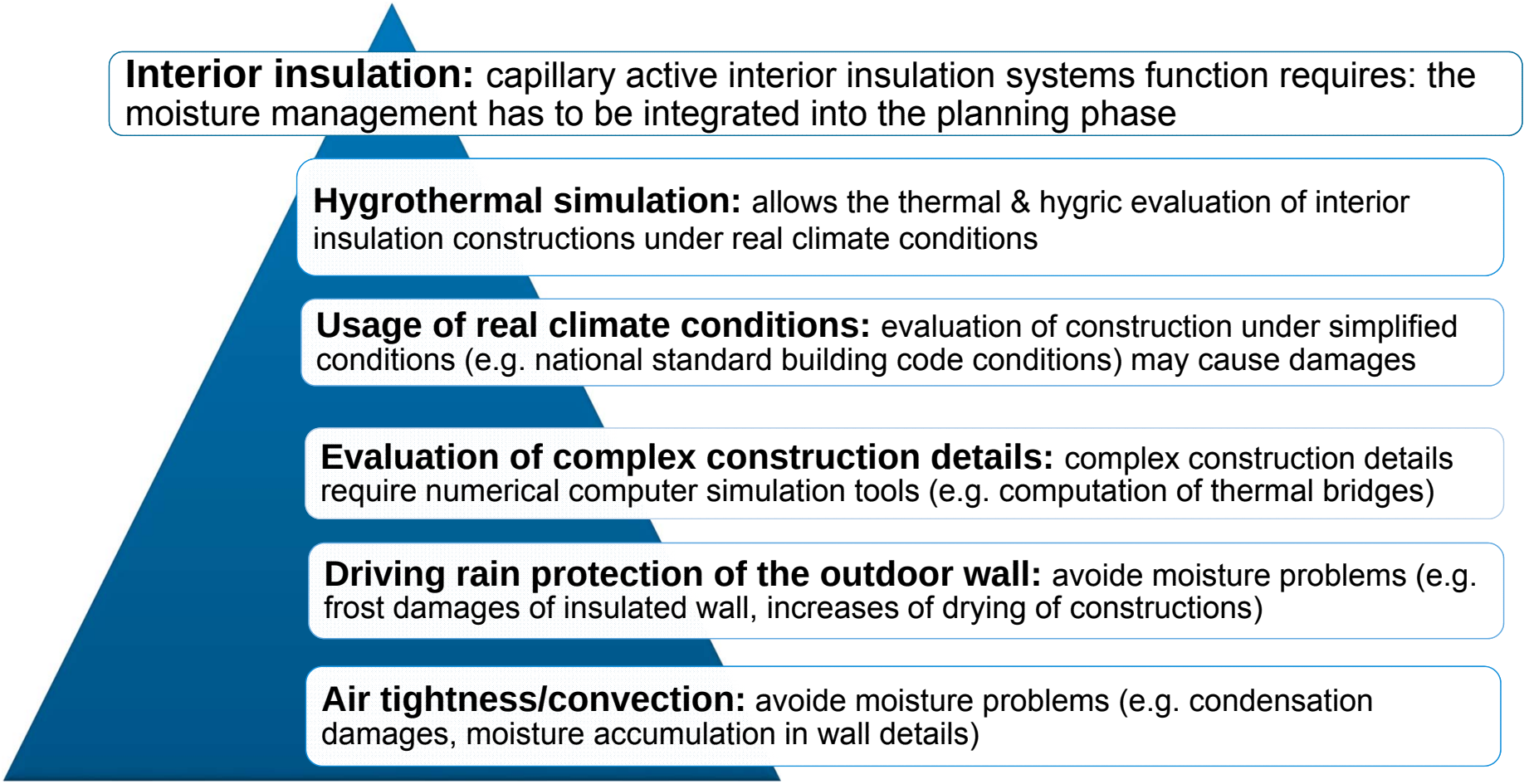

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Develop of new material

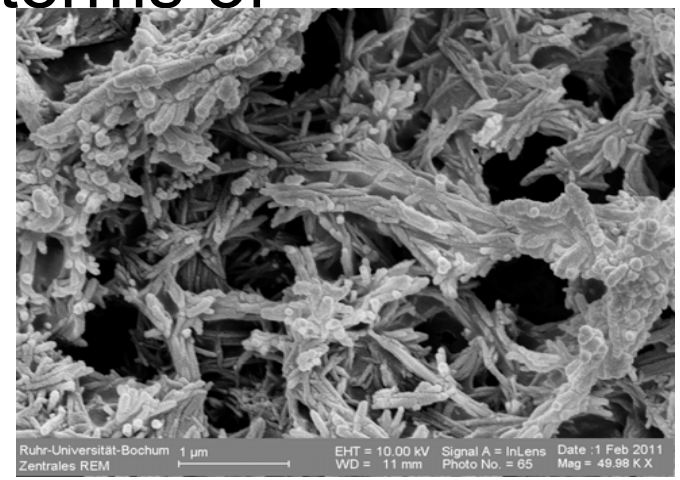
Jens Engel

Aim

- Optimisation of the filling gel
- Development of a new capillary active render
- Further developement of a clay based, reversible adhesive
- Developement of insulation boards based on different insulation materials related to
  - improved fire resistance
  - improved thermal conductivity
- Demonstration of the interior insulation system at several historic buildings / Practice tests

Optimisation of the Filling Gel

- Different types of the filling gel have been developed and investigated in terms of
  - pourability,
  - pot life,
  - capillary absorption,
  - capillary condensation,
  - diffusion coefficient,
  - microstructure



- For the production of the boards one suitable filling-gel has been defined (improvement compared to the initial formulation)

Development of a New Capillary Active Render

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- New render (thickness 5 mm) for use instead of the plaster (thickness 10 to 15 mm)
  - easier to process (especially for painters)
  - higher capillary moisture transport
  - lower water vapour sorption,
- Developement is completed, filler has been put on the market (iQ-Top SP)

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Further Developement of a Clay Based, Reversible Adhesive

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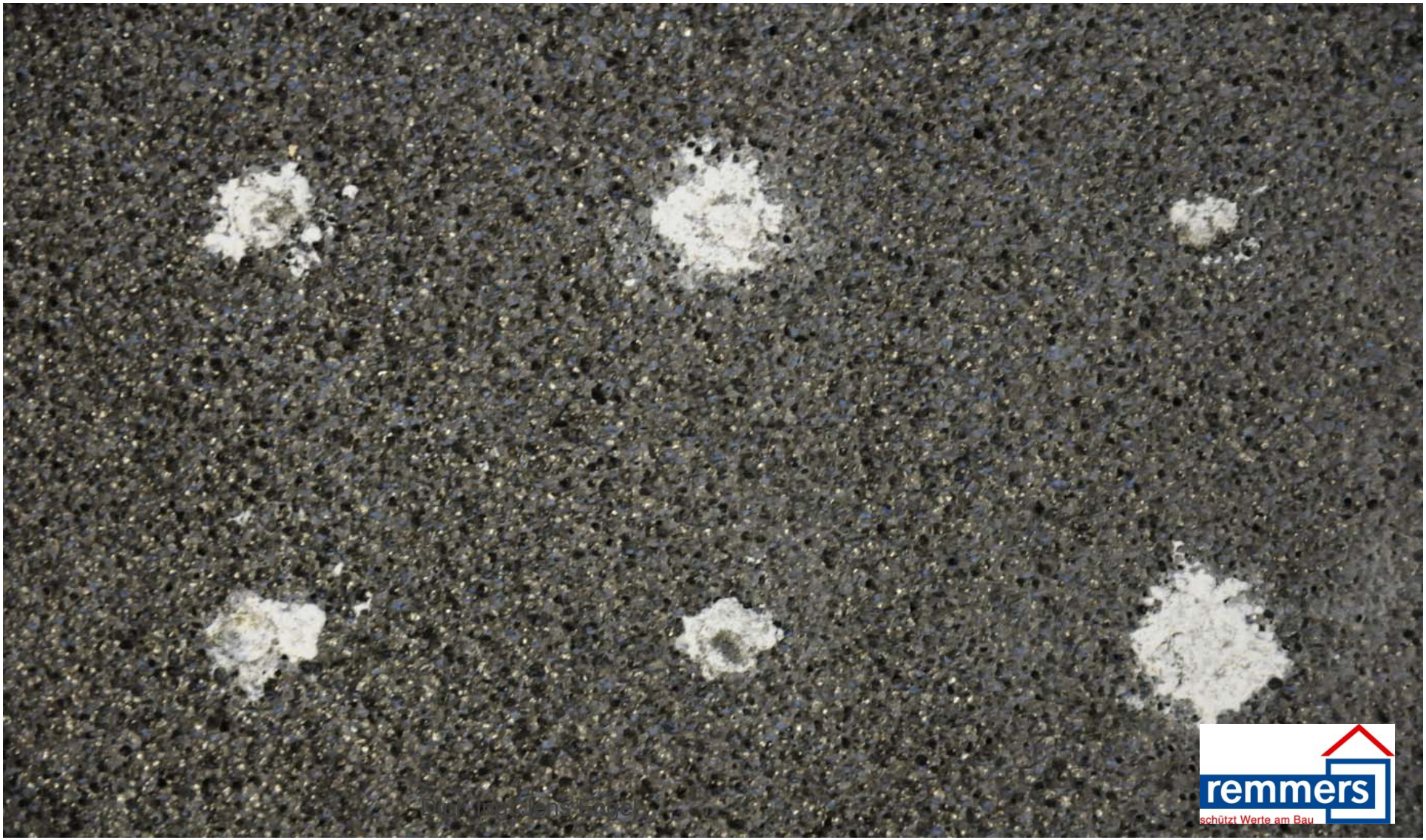
Development of Insulation Boards Based on Different Insulation Materials Than PU-foam

- related to
  - improved fire resistance
  - improved thermal conductivity
- Two different Materials have been tested
  - Foamglass-boards
  - Aerogel (ciliceous aerogel produced in a glassfibre fleece with a thickness of 10 mm)

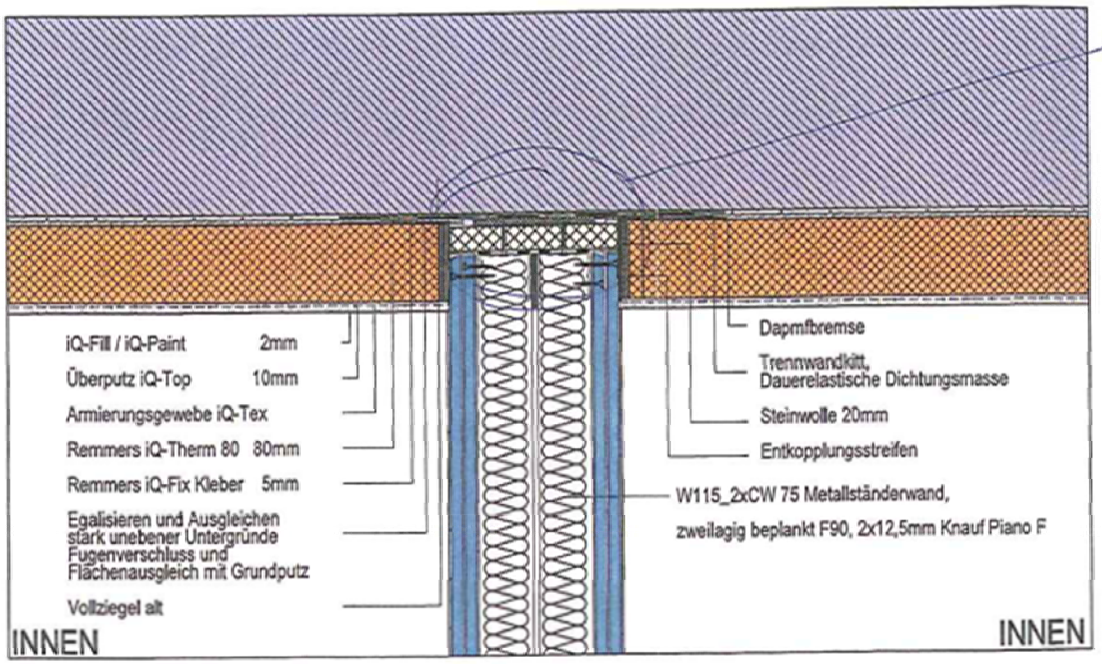
Foam glass-boards



Foam glass-boards

- Advantages: not flammable and very stiff (noise protection)
- Problem:
  - the foam glass could not be produced with the already existing production line because the process produced granular glass which has negative effects on the automation and conveyor technology
- Nevertheless foam glass was used in one of the demonstration projects for reduction of the longitudinal sound transfer of the insulated wall at the connection point to a flat partition wall

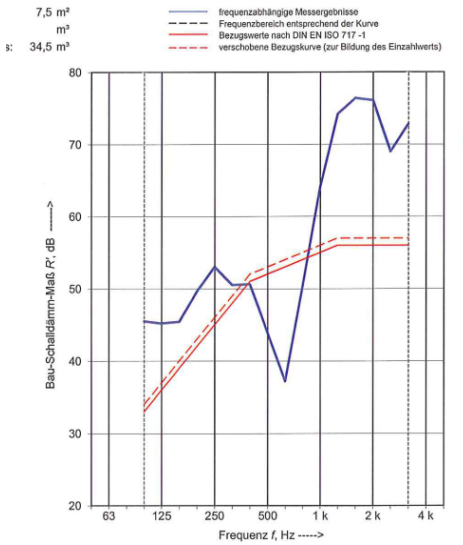
Foam glass-boards



ANSCHLUSS F90 WAND AN AUSSENWAND, GRUNDRISS

AR_DT_0_XX_002

Anschlussdetail entspricht nicht den Vorgaben des Herstellers. Eine Verschlechterung der Luftschall-dämmung kann nicht ausgeschlossen werden. Wir empfehlen die Luftschalldämmung vor Einbau der Mieter zu prüfen.



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Aerogel-Boards

- Aerogel (siliceous aerogel produced in a glass fibre fleece with a thickness of 10 mm)
- Prototypes have been produced by lamination of several glass fibre fleeces on each other
- Application tests have been carried out in the remmers testing facility
- Advantage:
  - Thermal conductivity $\lambda \leq 0{,}16$ W/mK
- Problems:
  - punching the necessary holes
  - price (~ 2000,- €/m³)

iQ-Therm – Installation Decoupling

iQ-Therm – Installation
Level Out The Surface

iQ-Therm - Installation
Prepareing The Machining Area

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iQ-Therm – Installation Bonding

iQ-Therm - Installation
Combinated Bonding Technique

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iQ-Therm - Installation Avoidance of Crossing Gaps

iQ-Therm – Installation Cutting

iQ-Therm - Installation Cutting

iQ-Therm - Installation
Fixing of the Boards

iQ-Therm - Installation Wedges Insulation

iQ-Therm - Installation Sockets

iQ-Therm – Installation Sockets

iQ-Therm – Installation sockets

iQ-Therm - Installation Fixture Tubes

iQ-Therm - Installation Fixture Tubes

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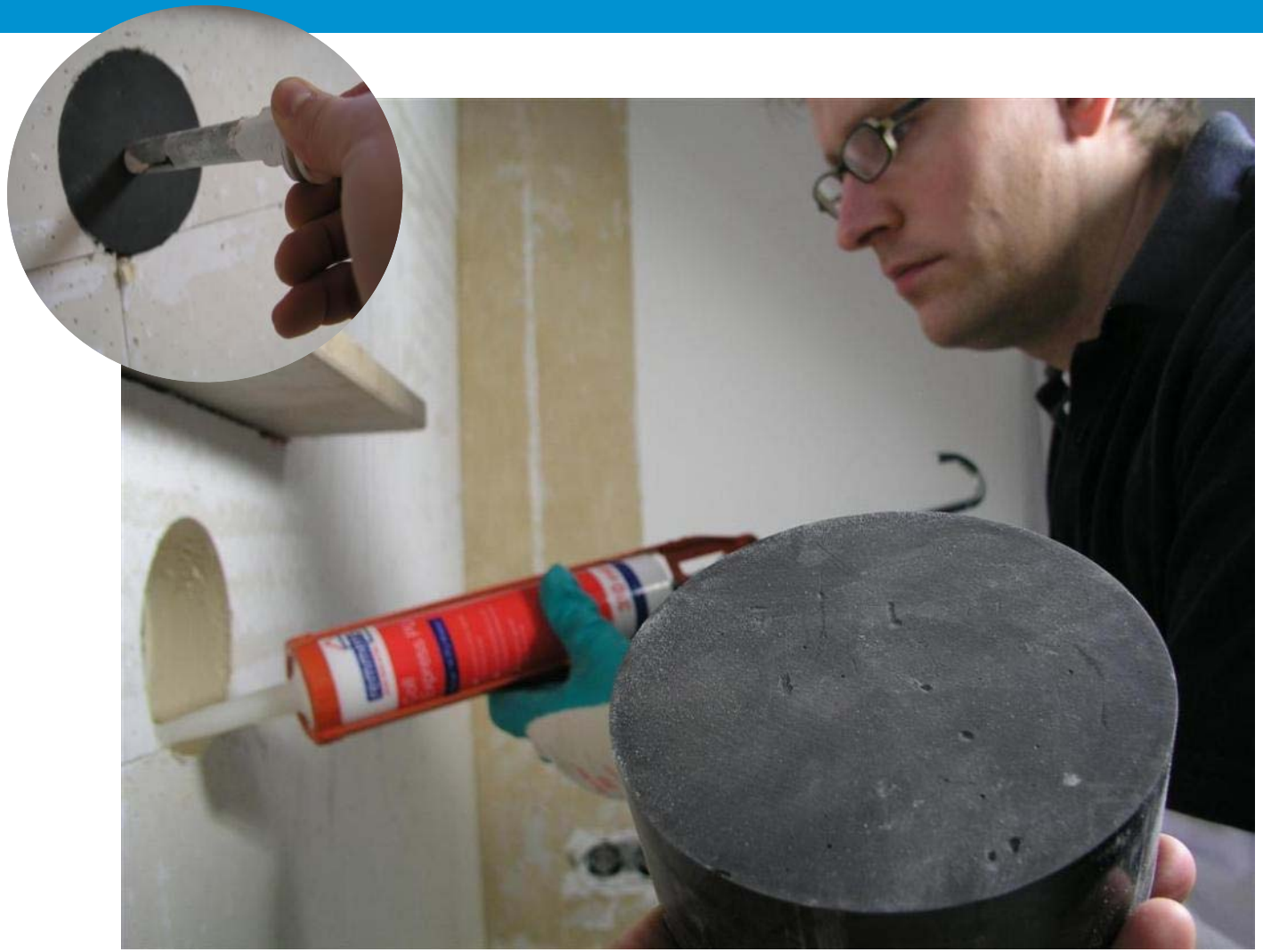

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iQ-Therm - Installation
Elimination of Faults

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iQ-Therm - Installation
Fixing of Protection Rails With iQ-Fix

iQ-Therm - Installation
Fixing of Protection Rails With iQ-Fix

iQ-Therm - Installation
Plastering iQ-Top, First Layer

iQ-Therm - Installation
iQ-Tex (Glass Fibres Fabric)

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iQ-Therm – Installation Additional Reinforcement at Window Corners

iQ-Therm - Installation
Plastering, Final Layer

iQ-Therm - Installation
iQ-Top/iQ-Top SP, Final Layer

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iQ-Therm - Installation
Coating With Mineral Paint

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System Products

- iQ-Fix / Lehmkleber
- iQ-Therm L15/30/50/80
- iQ-Top / iQ-Top LM / iQ-Top SP
- iQ-Tex
- iQ-Fill / iQ-Fill Q4
- iQ-Paint / iQ-Paint ST / iQ-Paint IR

Complementary products

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	**Compressed Band 15 / 5-10** Pre-compressed, soft PU foam waterproofing band wrapped in PP foil for subsequent de-compression	**Art.-Nr.** 4272	**Packaging** 10 m in a carton	**Properties** The band is activated by pulling off the foil, air tight, (corresponds to the requirements of DIN 4107-7)	**Application rate** approx. 1.0 m/m
	**Partition Wall Strips** Closed-cell, PU foam on which the system is placed at floor level	**Art.-Nr.** 4258	**Packaging** 12 rolls in a carton	**Properties** 3 mm thick, 75 mm wide, roll 30 m long	**Application rate** approx. 1.0 m/m
	**All-Purpose Dowels 50** Insulating screw dowels made of polyamide for wood screws, D = 8 – 10 mm	**Art. No.** 4284	**Packaging** 50 dowels in a carton	**Properties** Load bearing capacity: 15 kg For fast cost effective fixing with normal tools	**Application rate** as required
	**Mounting Cylinder** CFC-free, rigid PU foam cylinder that can be cut to size for attaching heavier loads in the **iQ Therm** System	**Art.-Nr.** 4257	**Packaging** 1 cylinder	**Properties** Lambda = 0.04 W/(m*K), highly compression resistant, fast, precise execution, subsequent fixings without problems , D = 125 mm, L = 540 mm	**Application rate** as required
	**Shaping Tool** Tool for easily and quickly cutting and shaping an exact fit of the **Mounting Cylinder**	**Art.-Nr.** 4255	**Packaging** 1 tool set	**Properties** Contents: Cutting table D = 125 mm, cutting guide bell with handle, adjusting ring with pinion spanner, carrier for cutting depths up to 200 mm	**Application rate** N/A

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iQ-Therm – Demonstration Projects

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more? www.remmers.com

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D5.1 - Demonstration

- Guideline for installation
- User Manual
  - How to place the Wardrobe
  - How to fix pictures, cupboards, etc.
  - What paint-systems should be used
  - What about wallpapers
- FAQs
- Reference database
- Certifications and approvals

Certifications And Approvals

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Prüfzeugnisse / Berichte / Zusatzinformationen

- Umwelt-Produktdeklaration
- Prüfbericht FIW, München
- Klassifizierung Brandverhaltens nach DIN EN 13501-1-MPA Braunschweig
- Prüfung Brandverhalten DIN EN ISO 11925-2
- DIBt Allgemeine bauaufsichtliche Zulassung
- Prüfzeugnis_Brandverhalten DIN 41021_MPA Braunschweig
- Untersuchungsbericht_Baustoffklasse DIN 41021_MPA Braunschweig
- Untersuchungsbericht_DIN EN ISO 11925-2_MPA Braunschweig
- Allgemeines bauaufsichtliches Prüfzeugnis - MPA Braunschweig
- Klassifizierung Brandverhalten EN 13501-1 - FIW München
- Brandverhalten incl. Oberputz iQ-Top SP - MPA Braunschweig
- Brandverhalten incl. Oberputz iQ-Top SLS - MPA Braunschweig

NONYLPHENOLFREI · EMISSIONSARM VOC gemäß AgBB-Bewertungsschema remmers GEPRÜFT

Institut Bauen und Umwelt e.V.

Qualitätssiegel IDSysteme INNENDÄMMUNG für Innendämmung

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Conclusion

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Conclusion

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Energetic upgrade of historic building construction requires detailed knowledge in various fields

- building materials
- construction details
- real climate conditions
- hygrothermal simulation tools

→ A special education is required for an adequate refurbishment

→ New fields of education for architects, engineers, handcraft:

_ university level (TUD, TU..)

_ graduation level (WTA, 3ecult.)

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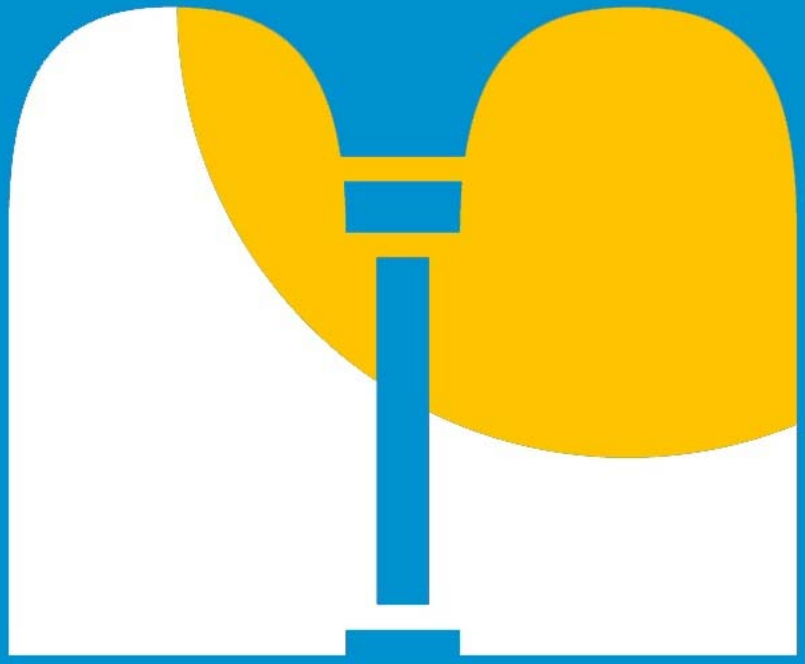

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