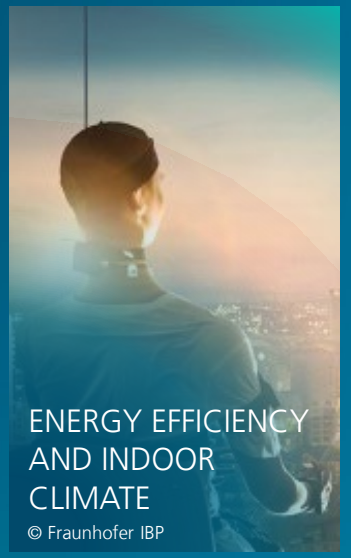
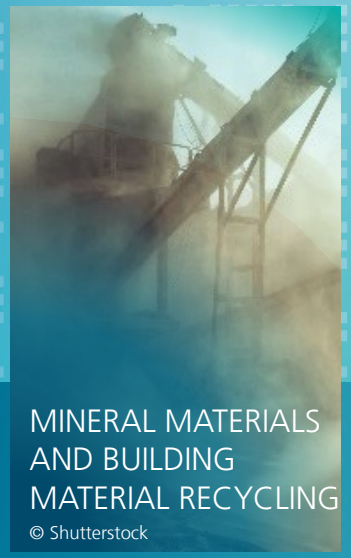
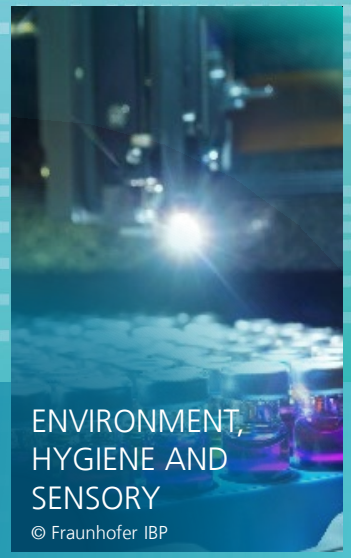
Fraunhofer
IBP







Fraunhofer-Institut für Bauphysik IBP
Stuttgart, September 2024
Andreas Zegowitz

Hygrothermics

THERMAL PROPERTIES AND HYGROTHERMIC SIMULATION

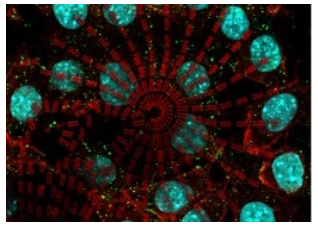
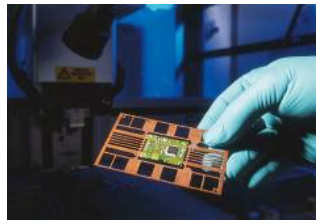
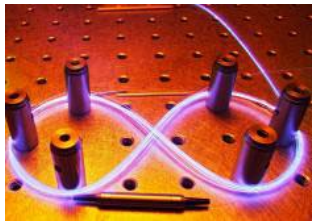
Build on knowledge

AGENDA

WELCOME TO FRAUNHOFER INSTITUTE FOR BUILDING PHYSICS

- 9:00 - Short introduction to Fraunhofer IBP and division Hygrothermics
- 9:30 – Laboratory tour Hygrothermics and more
- 10:00 – Acoustic tour
- 11:00 - Further cooperations – discussion
- 12:00 - Italian Restaurant

The Profile of the Fraunhofer-Gesellschaft


- 66 institutes and independent research units
- more than 22,000 staff

7 Groups:

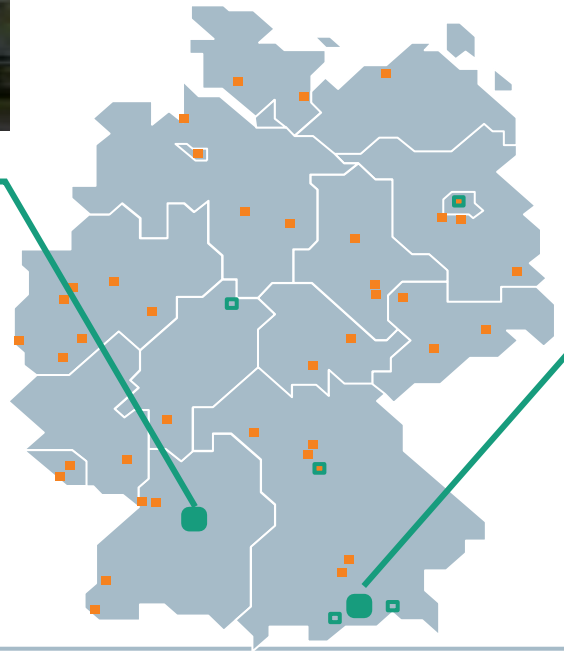
- Information and Communication Technology
- Life Sciences
- Microelectronics
- Light & Surfaces
- Production
- Materials and Components – MATERIALS
- Defense and Security

Fraunhofer-Institut for Building Physics IBP

Stuttgart branch

Founded in 1929

Since 1959 part of the Fraunhofer Society which now holds 60 institutes specializing in different fields of applied science



Holzkirchen branch

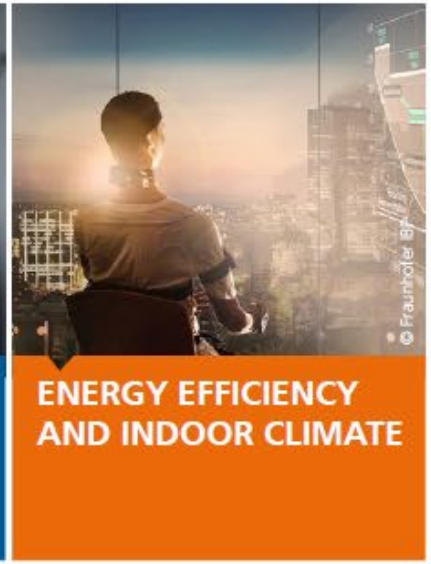
R&D budget: € 30 Mio.

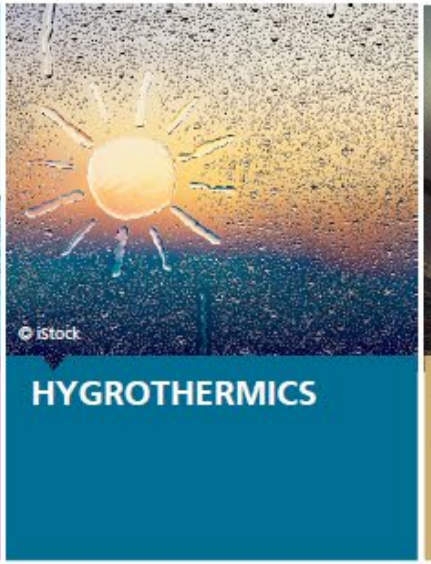
Approx. 40% from private contracts

ca. 400 staff

Fraunhofer IBP

Fraunhofer-IBP, Departments





Department Hygrothermics

Analysis, Prognosis and Evaluation of Heat and Mass Transfer Effects in Buildings, Building Assemblies and Materials by Laboratory and Field Tests as well as Numerical Simulation

Competences

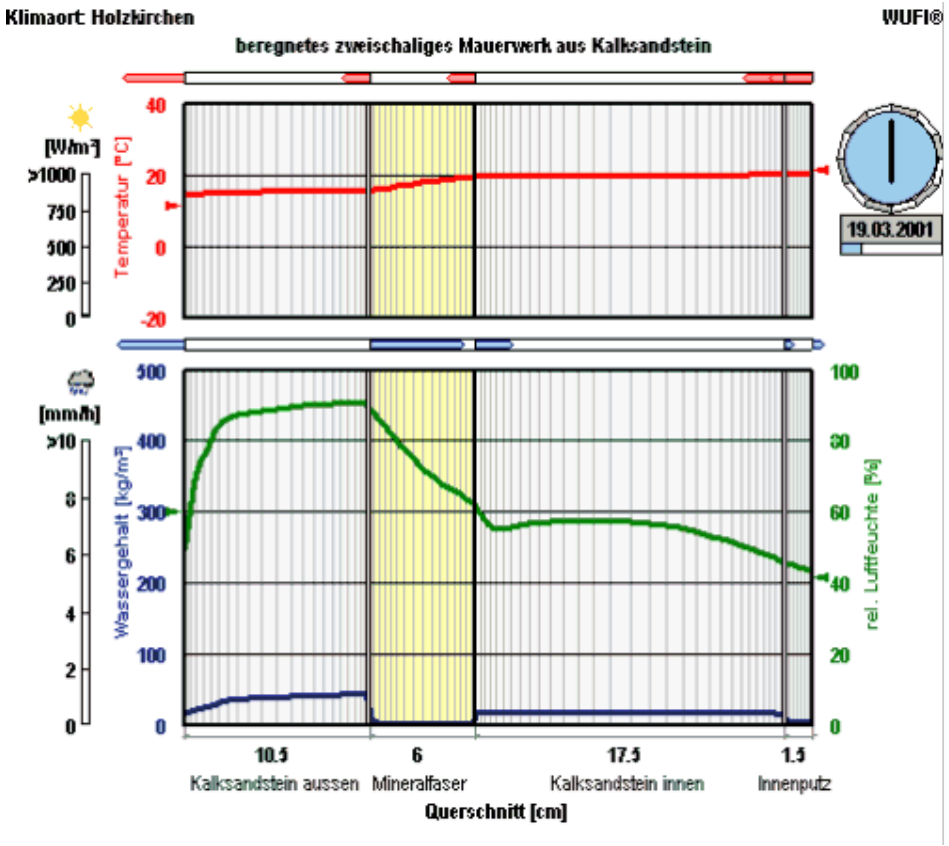
- Heat and moisture protection, climate adapted building design
- **Climate and exposure simulation**
- Model- und software development
- **Testing, independent quality monitoring, material property determination**
- Building assembly and HVAC design and optimization
- Heritage preservation and rehabilitation of building stock, technical drying

Thermal properties and hygrothermic simulation

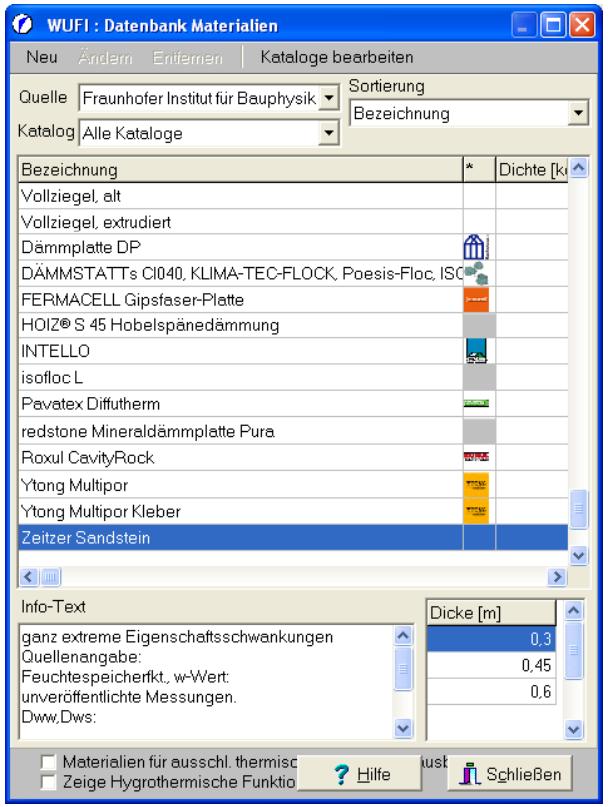
- Hygrothermal Laboratory – Testing and hygrothermic simulation
- Hygrothermal Free – Field – Testing
- Hygrothermal simulation

Thermal properties and hygrothermic simulation

Hygrothermal component simulation



WUFI® Pro 1D animated parameter distribution

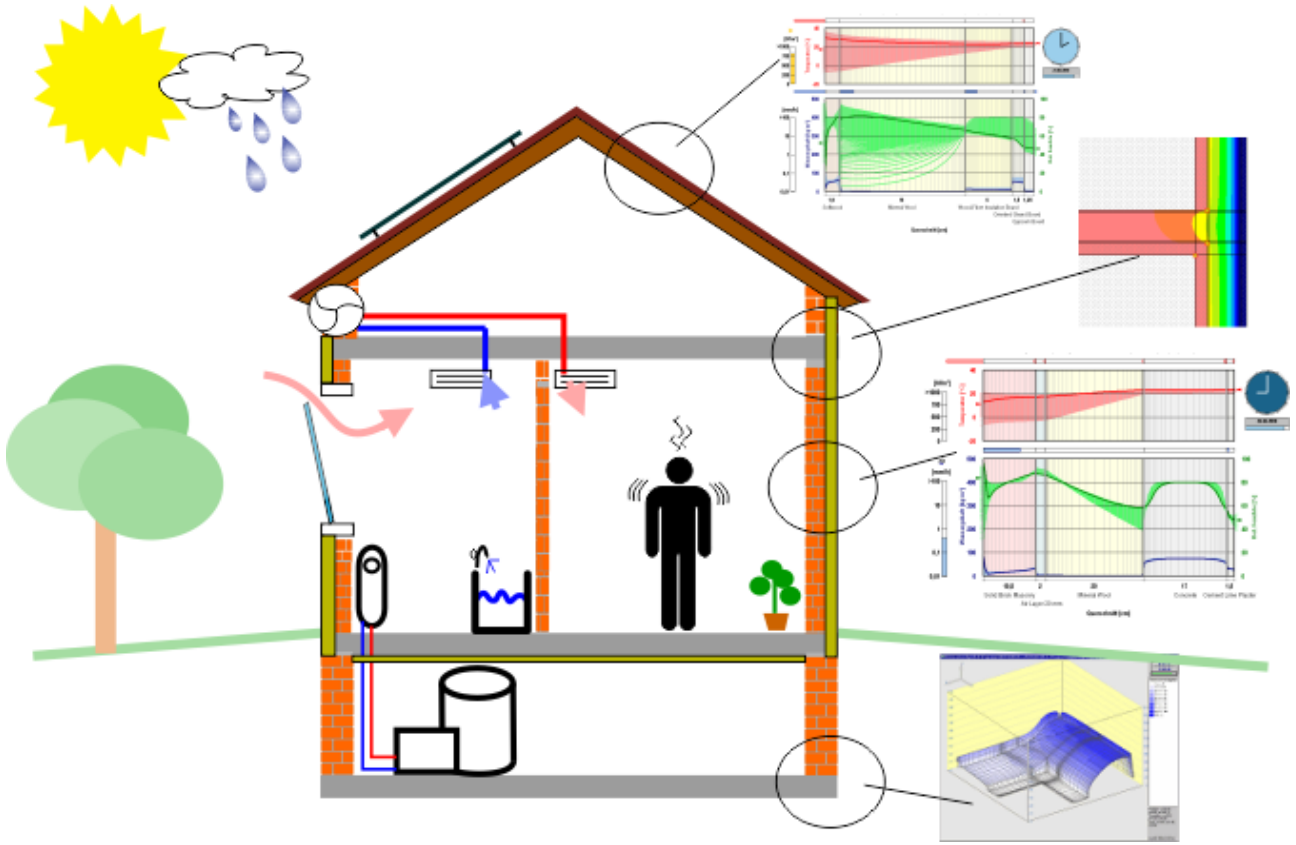


WUFI® material data base

Hygrothermics

Hygrothermal Analysis of Buildings, Components and HVAC Systems

- Hygrothermal whole building simulation



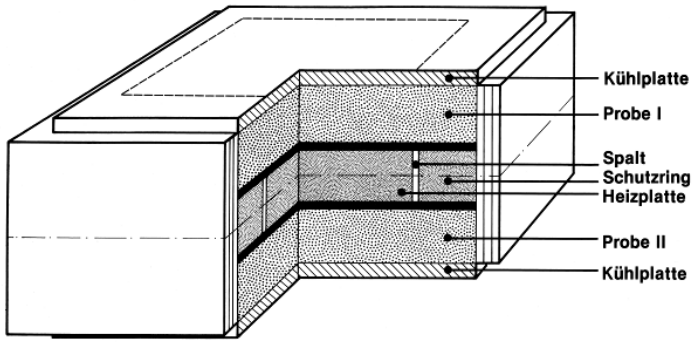
Benefits compared to standard simulation tools:

- Real life moisture effects reproducible
- Moisture control analysis of individual components
- Occupant's behaviour and interzonal air flow models included
- Integral evaluation of energy demand, comfort and damage prevention

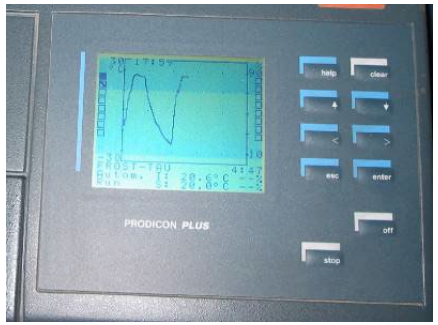
Hygrothermics
Material Properties, Thermal Tests

Standard test methods for insulation materials and other building materials

- Thermal conduction
- Freeze-thaw
- Water absorption
- Air permeability
- Corrosion tests
- Dynamic flexibility
- Compressive & tensile strength
- etc.



λ [W/(mK)]



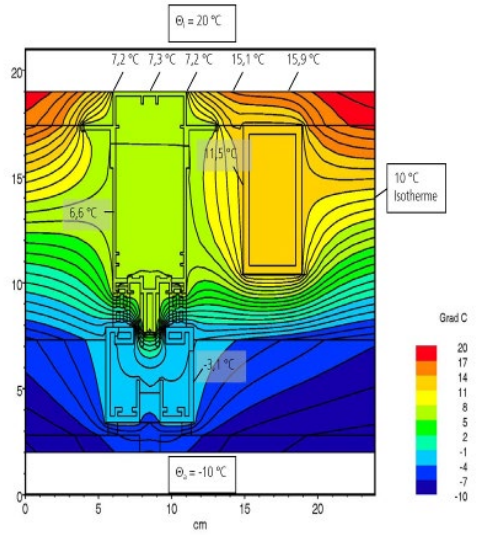
-70°C to +180°C, Freeze-thaw (-20°C ←→ +20°C)

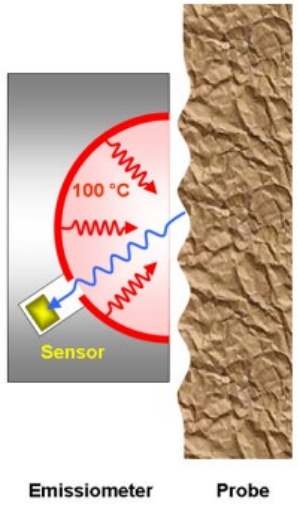
Hygrothermics
Thermal and Radiation Parameters

- Thermal transmittance testing & calculation of complex building components

U-Value [W/(m²K)]

- Radiation characteristics
  - Long-wave emissivity
  - Short-wave absorptivity





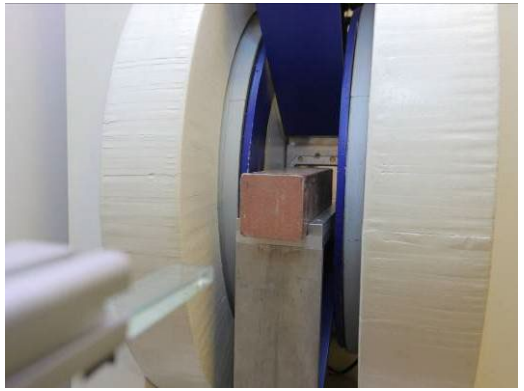
Hygrothermics
Thermal and Radiation Parameters

- Hygric properties for code compliance and hygrothermal simulation

Vapour diffusion: μ, s_d

Water retention: $w = f(p_C)$

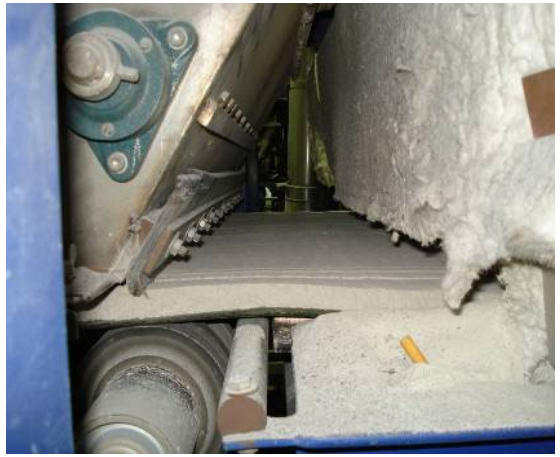
Water absorption: A-value



Water diffusivity: $D_w = f(w)$

NMR scanner for monitoring transient moisture distributions in material samples

Hygrothermics
Thermal properties and Durability

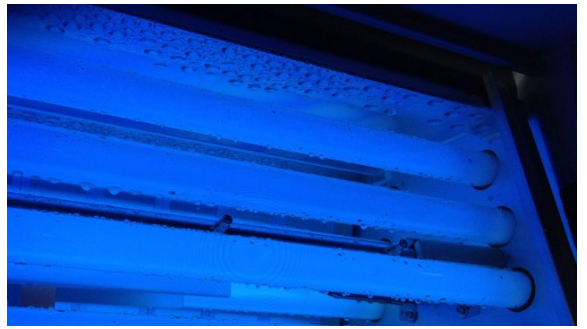

Example Foam Glass Gravel
Load bearing insulation under ground slaps

Hygrothermics
Technical drying

- Solar radiation loads
- Air permeance
- Driving rain protection
- Wind resistance
- Mechanical loads
- Alternating temperature loads
- Condensation tests

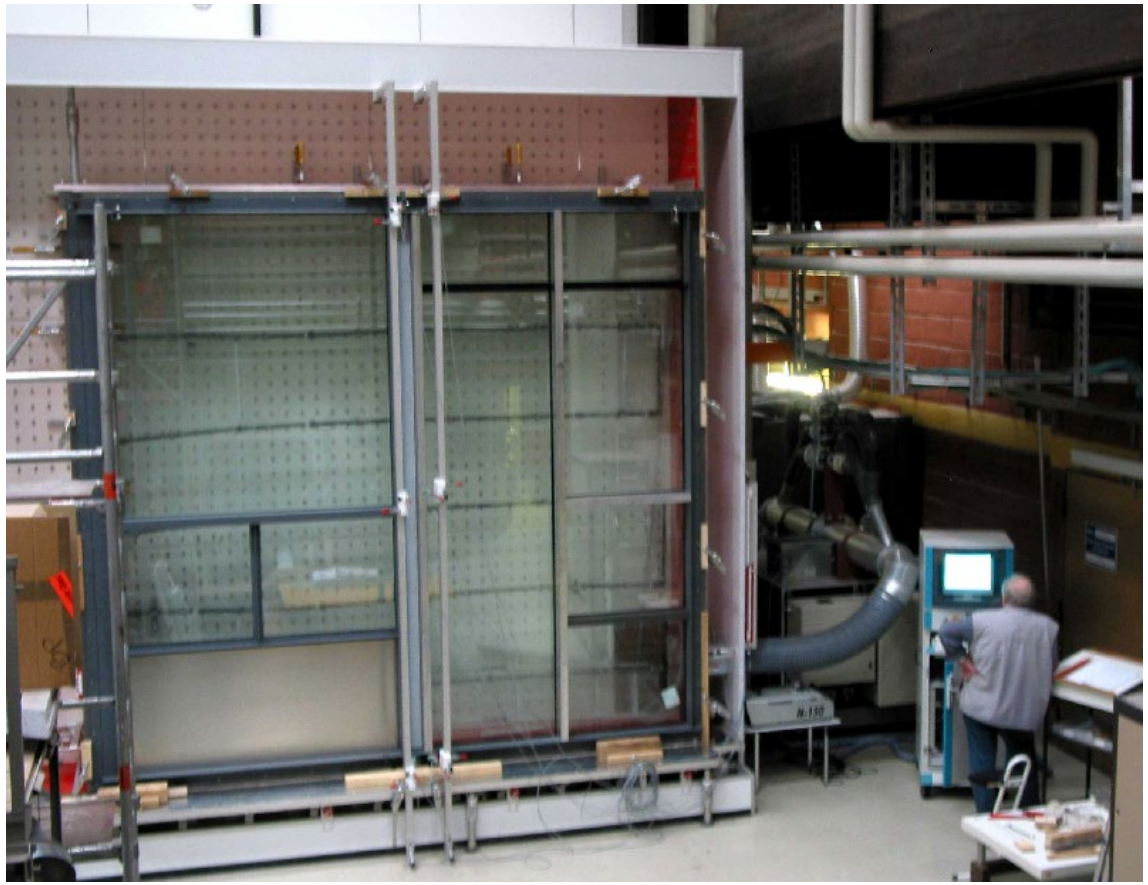
← *Large-scale sun simulator*

Accelerated ageing tests
↓ (UV, Temp., H_2O)



Hygrothermics

Air tightness, Water tightness, Resistance to wind load



at different temperatures

- Testing of windows and facades according EN-standards
- Sample up to 4 m x 4 m
- Automatic, programbable control system
- Pressure difference up to 8.000 Pa
- 2.500 m³/h
- Cooling and heating -20°C bis 70°C

Hygrothermics

Durability, functional and hygrothermal behaviour

- Heat flow
- Condensation
- Sun simulation
- Pressure difference

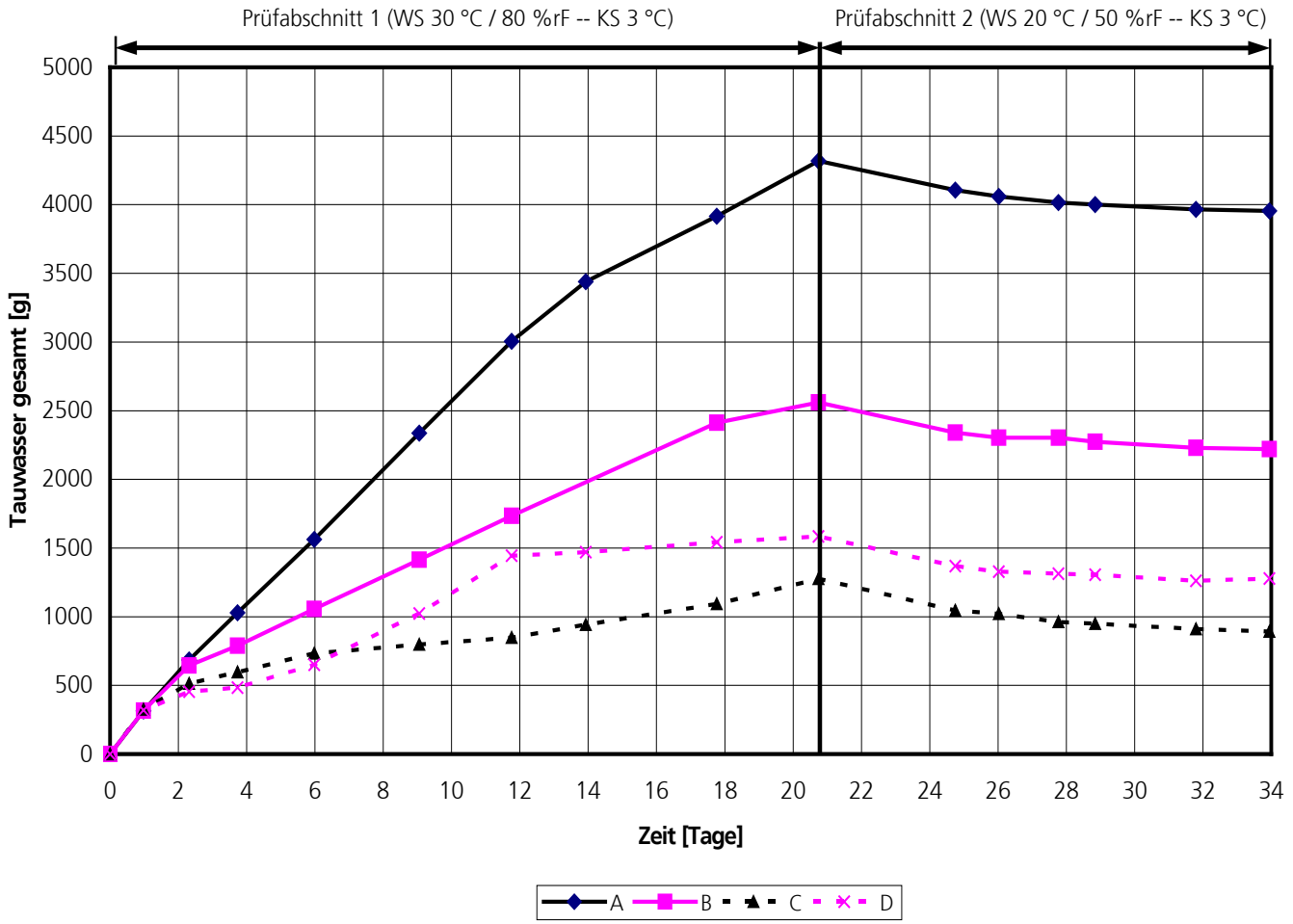
Hygrothermics
Technical drying

- Reasons for damages
- Efficiency of drying methods
- Developments of drying techniques

Example

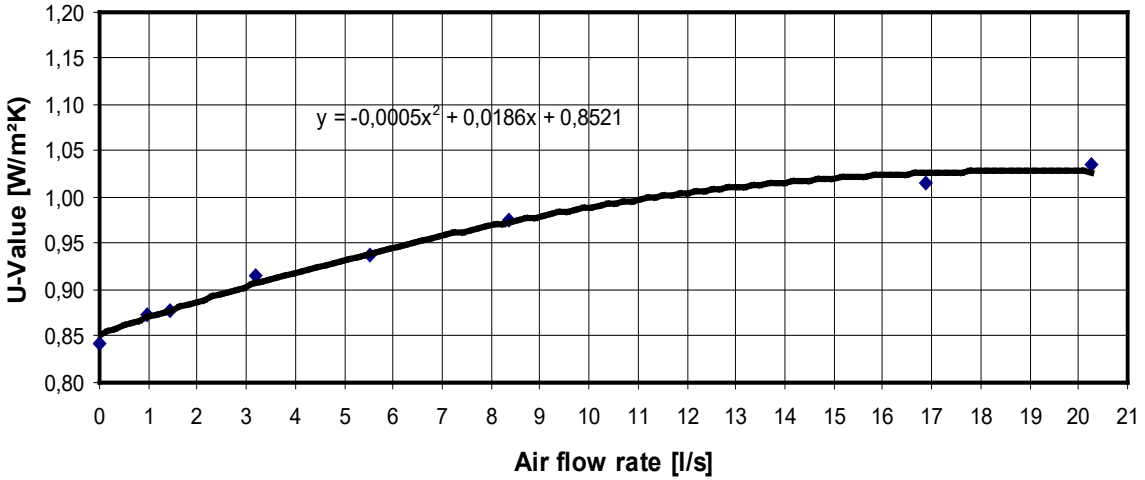
Hygrothermics

Hygrothermal behaviour of sandwich facade panels



Hygrothermics

Function, U-value and hygrothermal behaviour



U-value in dependence of the air flow rate in a gap between two glazing layers.

Hygrothermics
Durability of interjacent systems

Blinds in the gap of double glazing are tested with hight temperature differences

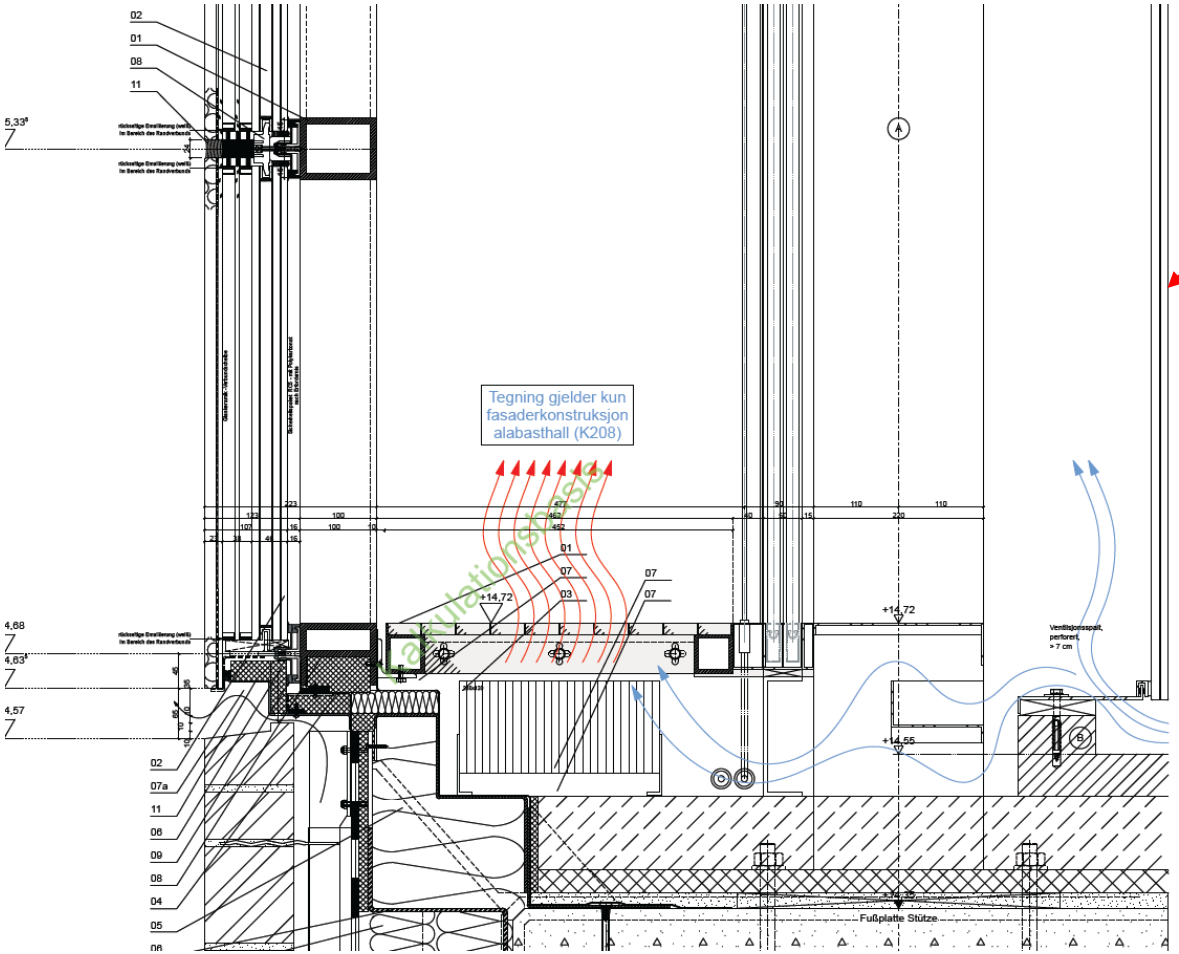
Durability of a light deflecting system

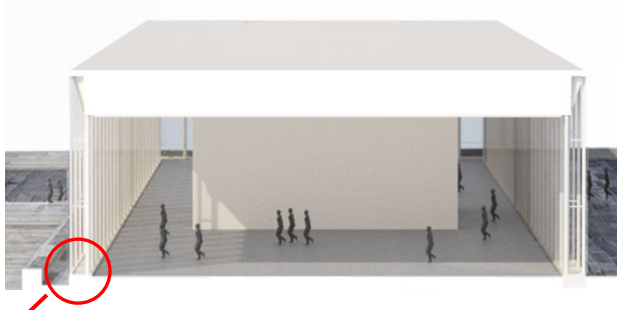
Large scale sun simulator

- Simulation of a high quality sun with a radiation spectrum near to sun light
- Total energy transmission
- Temperatures within transparent façade constructions
- Sample size 6 m² to 8 m²
- Orientation and ancle of the test elements turnable up to 360°, ancle 0-90°.
- Optical portal (solar and photometric properties, luminence distribution)
- Durability testing
- Test of functionality

Testing Example

Nationalmuseum Oslo – Alabasterhalle

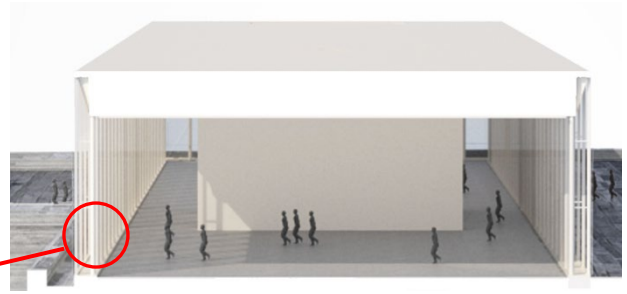




- 12 glazing layers + sun protection
- Thickness ca. 1,2 m
- 2 ventilated gabs
- Tests on a Mock-up 2 x 2m

Total energy transmission g

Testing Example
Nationalmuseum Oslo – Alabasterhalle



- 12 glazing layers + sun protection
- Thickness ca. 1,2 m
- 2 ventilated gabs
- Tests on a Mock-up 2 x 2m

Total energy transmission g

Test Field Site Holzkirchen

Hygrothermics

Many Thanks!!

Andreas Zegowitz

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Hygrothermics

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