FASBA's straw building activities

ESBG 2015

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DIRK SCHARMER

- **straw architect** since 1999
- office near **Hamburg** (North Germany)
- member of Board of **FASBA**
- designed some single- and multifamily straw houses
- and the **5-story building in Verden** with others
- coordinated of 3 straw building **R&D projects**
- developed the current German **general approval Z-23.11-1595** (straw insulation)
- wrote the **german straw building guidelines** SBR-2014 with others
- certified **straw as a building material**
- **Calculates ecological** building assessments (LCA)

OUR PRESENTATIONS

- Mother natures **circle of birth and destruction**: how straw withstands microbial decomposition
- **Legalize** it!
- German **guidelines** for good straw building (SBR-2014)
- The **good reason to build** with: Life cycle assessment (LCA)

BUT FIRST SOME OTHER INFORMATION'S

FASBA'S CHRONOLOGY I

- 1998-2002: first Straw building activities (single family, huts, experimental, owner built)
- 2002: FASBA is born
- 2003: ‚professional' building with straw (3-storey, companies, first tests and approvals)
- 2005: successful conducted straw R&D project
- 2006: ‚General Building Approval' (AbZ) for straw as an insulation material
- 2009: successful conducted 2nd straw R&D project
- 2010: start of 3rd R&D project: 5-storeys

CHRONOLOGY II

- 2011: start project: Developing an acknowledged straw building apprenticeship
- 2012: Start of project: „Straw building 2012-13“ (SBR-2014 new AbZ)
- 2013: ~300 straw buildings
- 2013: 5 storeys with straw, directly plastered
- 2014 new, extended general approval Z-23.11-1595
- 2014 Straw building guidelines published (SBR-2104)
- 2015 new fire resistance certificate up to REI90
- 2015 EPD for building bales

2014

Straw as a building material is our new star!

Christian Schmidt, German Minister for agriculture

Architekt Scharmer
Häuser aus Stroh

IT LASTS A HUNDRED YEARS AND MORE

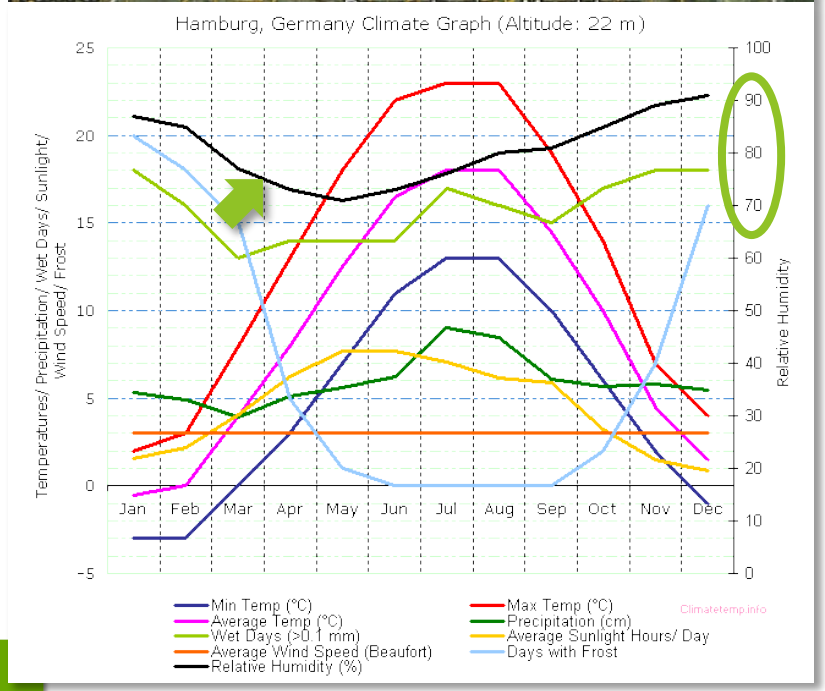
FASBA

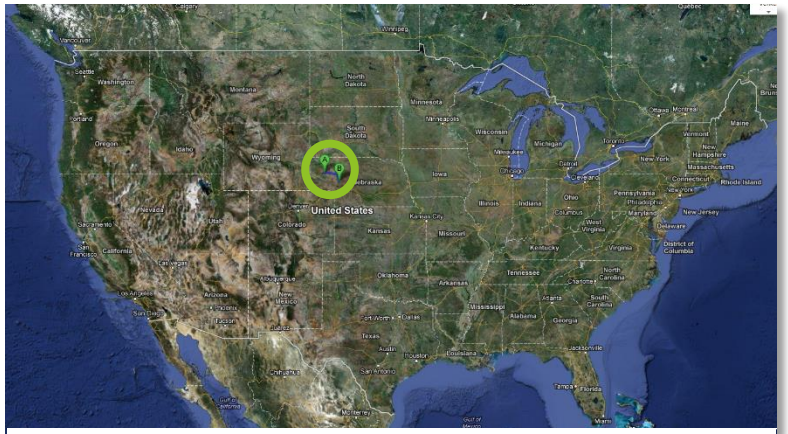
Nebraska, built in 1913

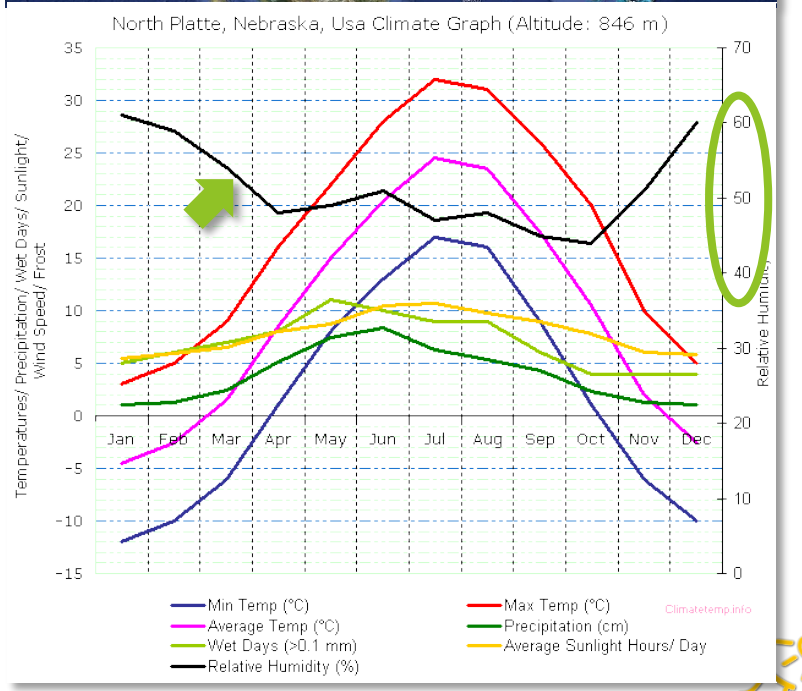

... with lime plaster
FASBA

BIOHYGROTHERMAL PERFORMANCE OF STRAW BUILDING ELEMENTS

HAMBURG VERS. NEBRASKA







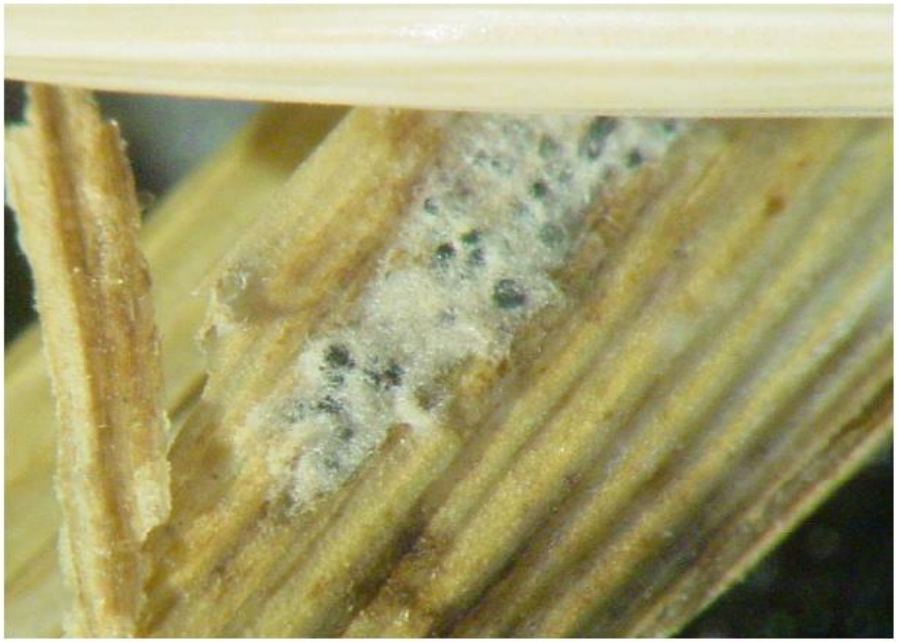
WITHSTAND AGAINST THAT EVIL MOULD!

...microbial decomposition is one wonderful and necessary part of mother nature circle of birth and destruction...

THERE IS NO MOULD IN STRAW

Ha, ha

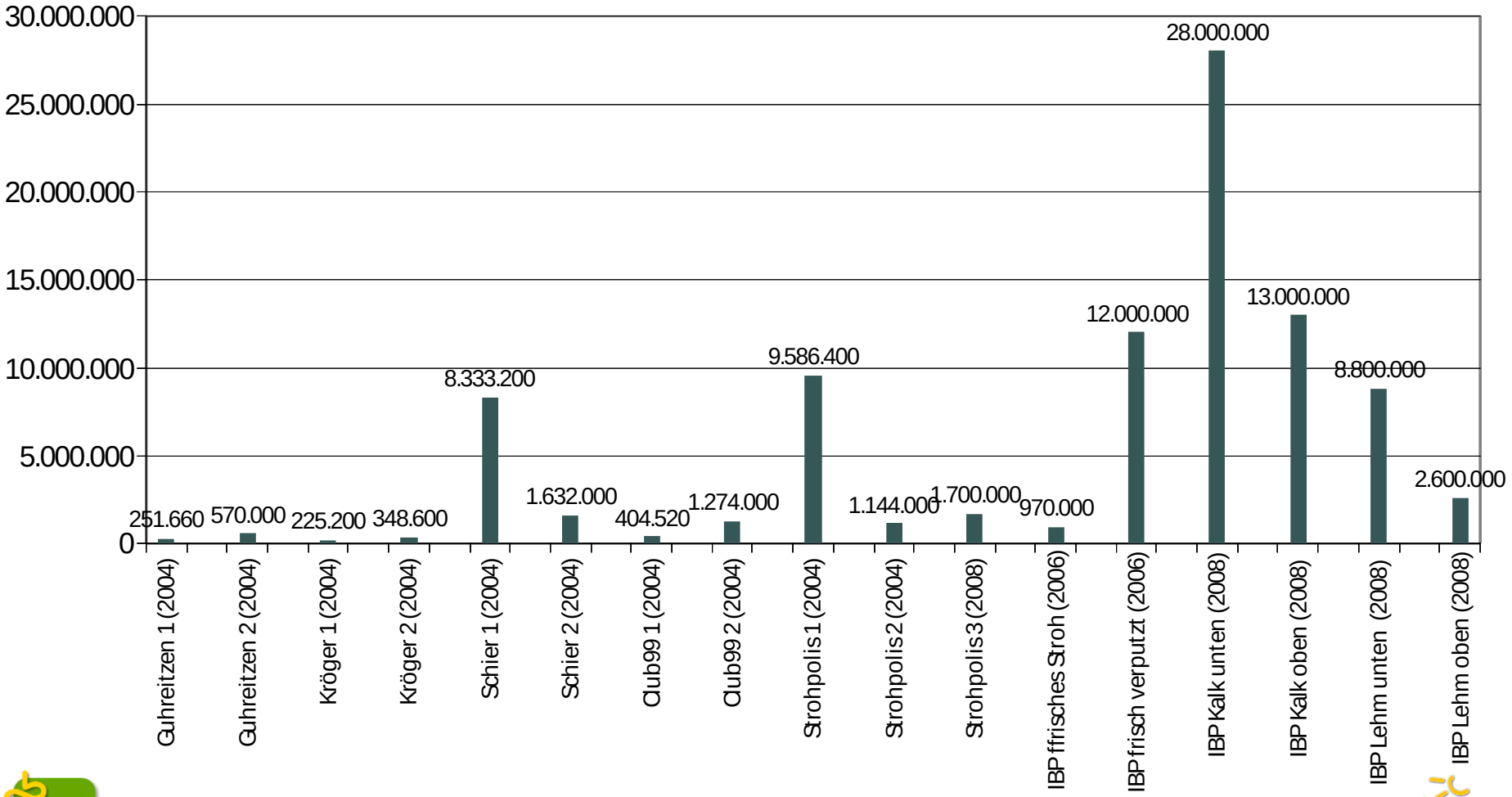
(BIO-) HYGROTHERMAL BEHAVIOUR OF STRAW



After keeping in wet & warm climate: microscopical view

MICROBIOLOGICAL ANALYSIS

of extracted straw samples CFU/ g dry material, for comparison: up to 900.000 CFU/g can be normal for house dust, without active mold sources



OK, OK THERE COULD BE MOULD IN STRAW

No problem, no problem, this is healthy, you just have to drain the wall and everything will be fine.

Ha, ha

THE PACT WITH THE DEVIL

To build everlasting, healthy buildings out of straw we've to make a pact with those little fellows: you'll get the straw in ... let's say ... ***hundred years or so****, ok?*

BUT SERIOUSLY

Avoiding mould *and microbial decomposition in order to ensure a* ***long life*** *of the structure and* ***healthiness*** *for the habitants*

AND THAT MEANS

We've to minimize moisture from outside and handle moisture from inside considering temperature

STRAW IS STRAW IS STRAW IS STRAW

Straw is constant:

coverings can be varied

WHAT CAN WE DO?

Exterior covering rainproof and diffusion-open

Interior covering: strictly air tight

In some cases additional insulation might help

WHAT ELSE?

In some cases additional exterior insulation might help

HOW DO WE KNOW?

In some cases additional exterior insulation might help

GOT IT DONE

We examined reality.

We monitored buildings.

We calculated the risk.

Now we know.

GOT IT DONE

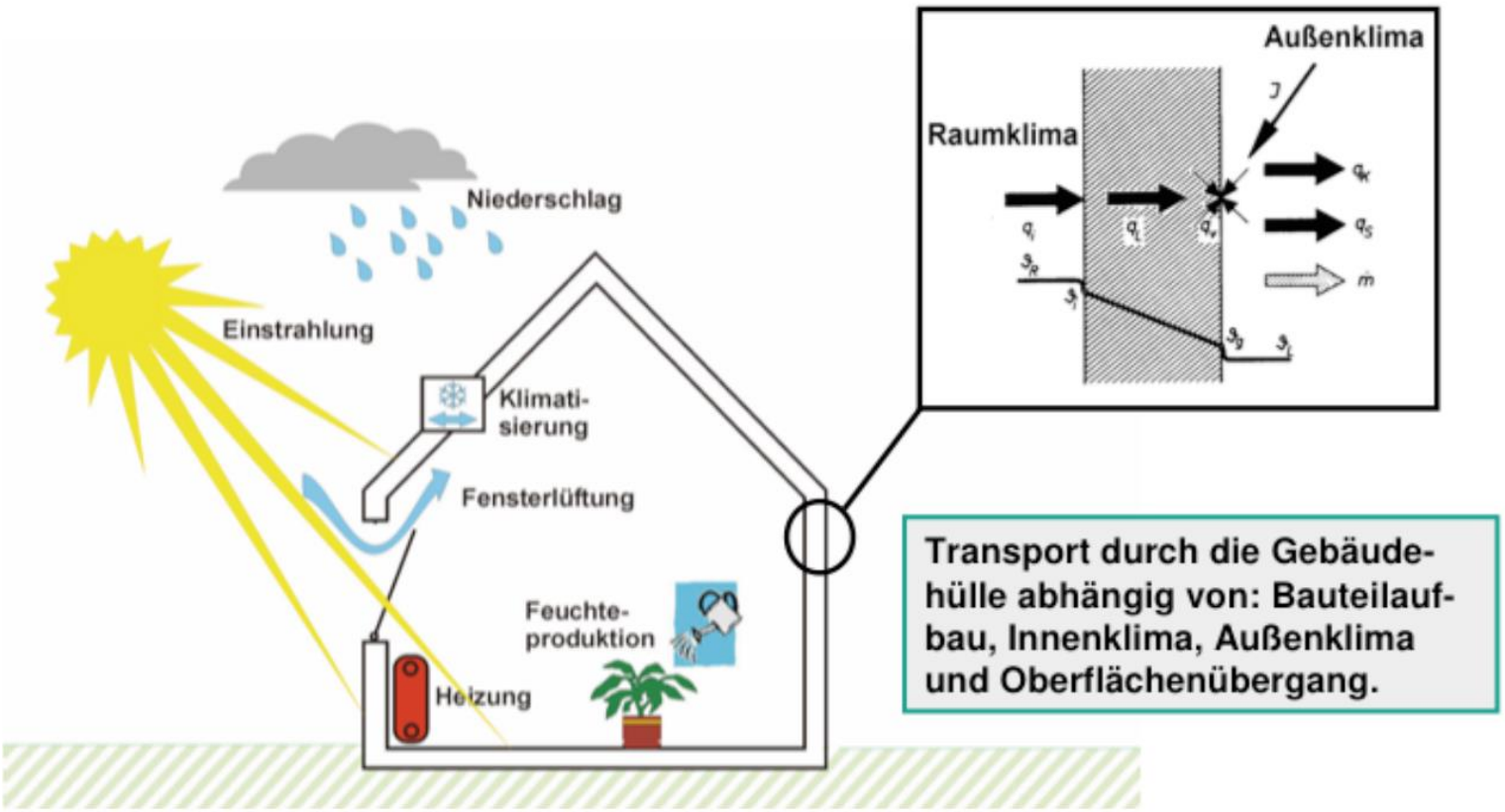
We examined reality.

We monitored buildings.

We calculated the risk.

Now we know.

HYGROTHERMAL LOADS

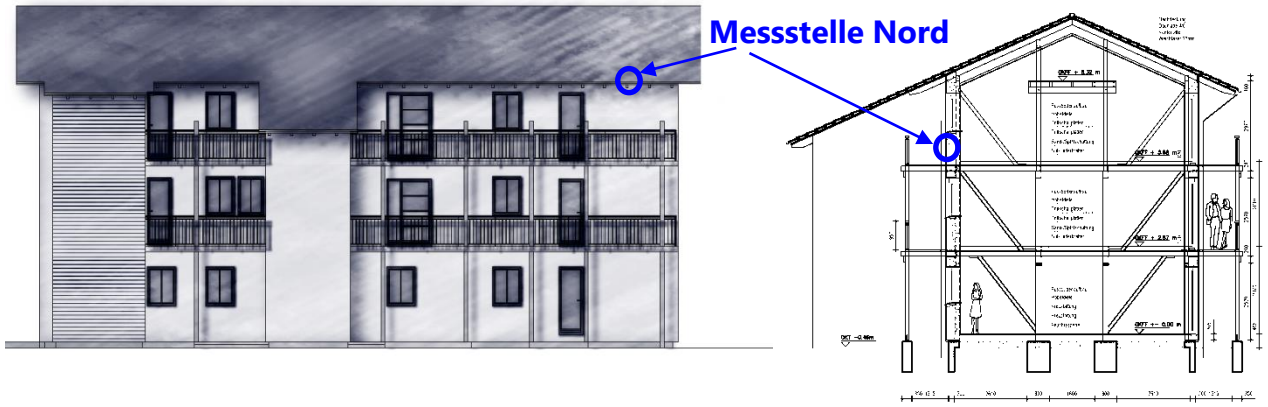


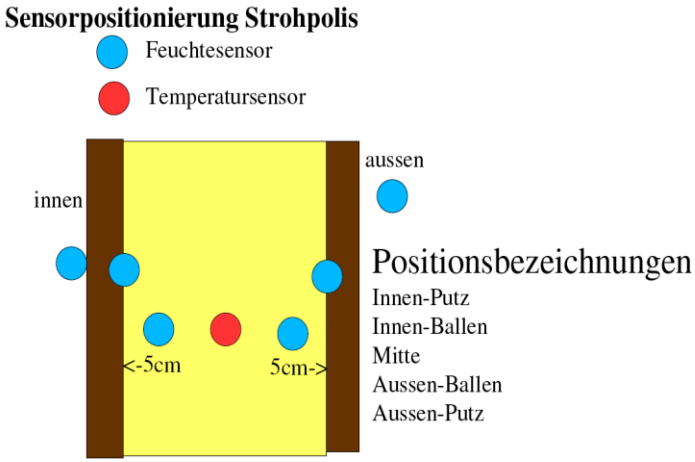
Quelle: IBP Holzkirchen

NACHWEIS SCHIMMELFREIHEIT

- Grundlage der Zulassung
- Temperatur und Feuchte gemessen oder simuliert
- Schimmelempfindlichkeit von Stroh festgestellt
- Berechnung des Schimmelrisikos
- Zusätzlich: Mikrobiologische Analyse der ausgebauten Strohproben

DATA LOGGER IN WALLS



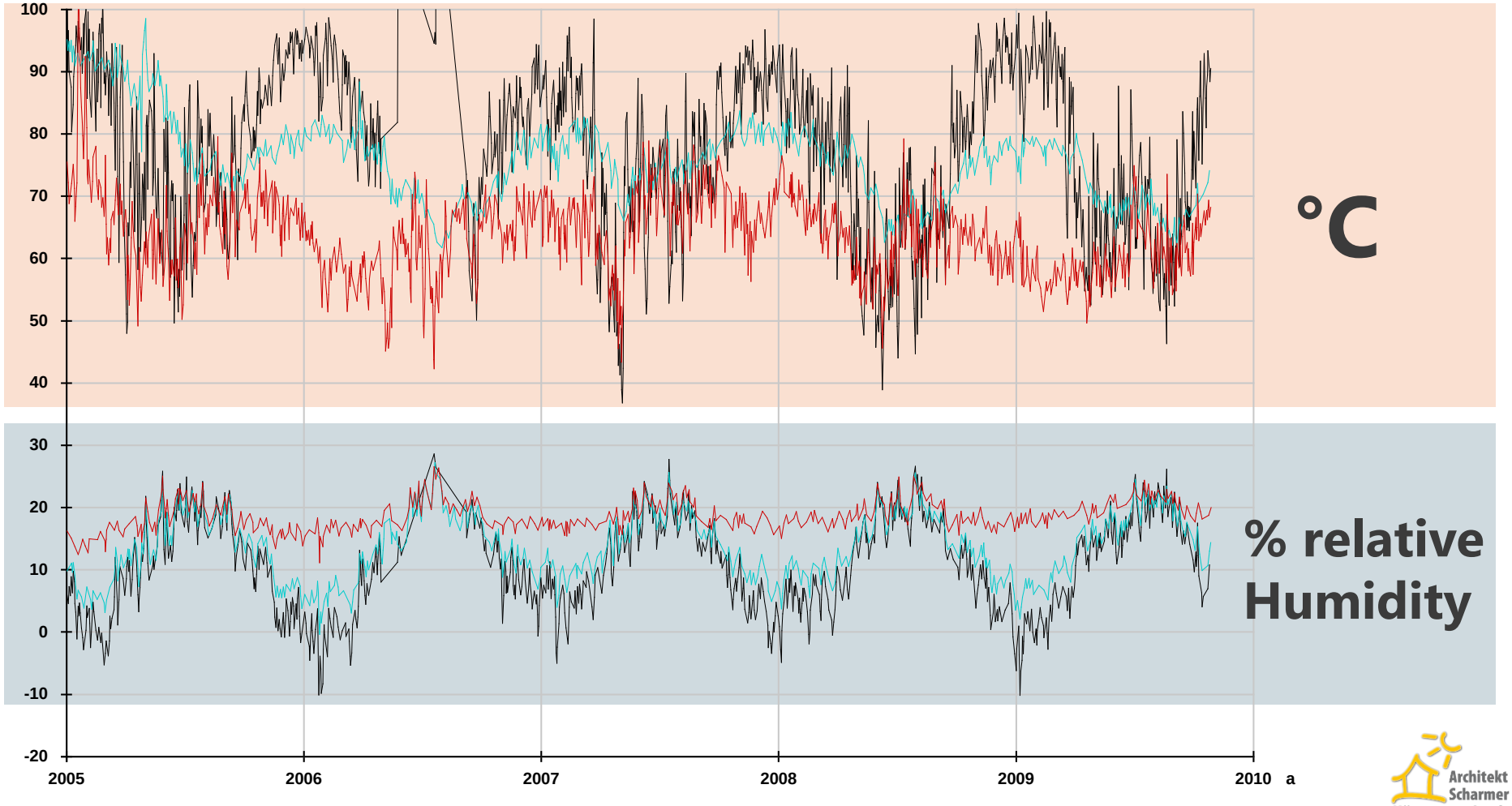


NORTH WALL 2005-10

exterior climate

5cm deep in straw

inside



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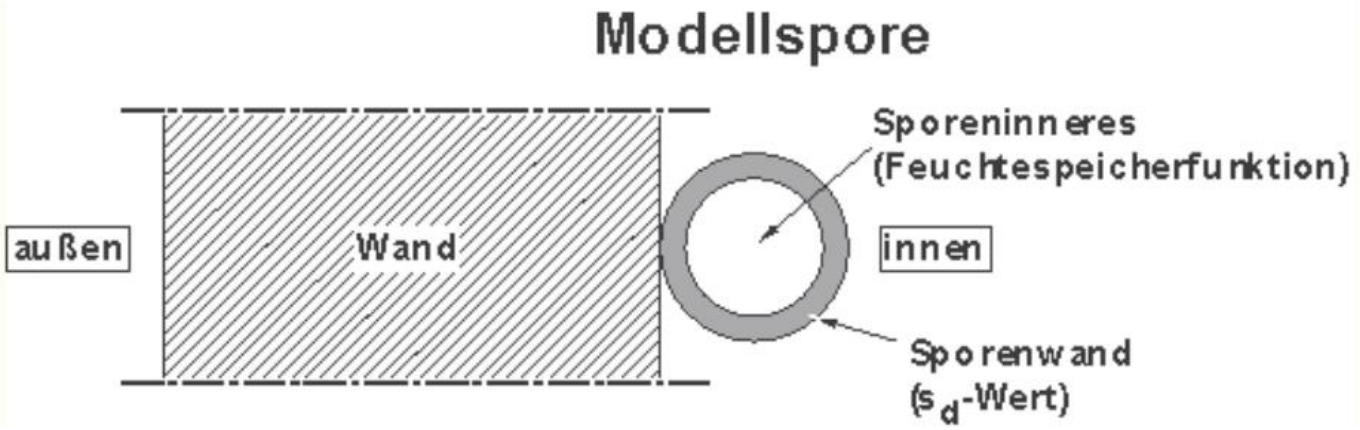
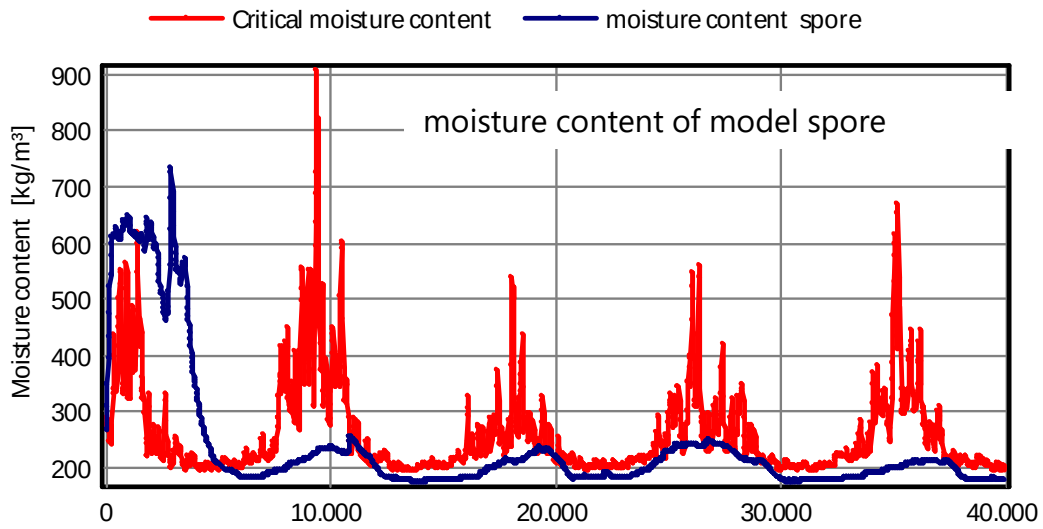
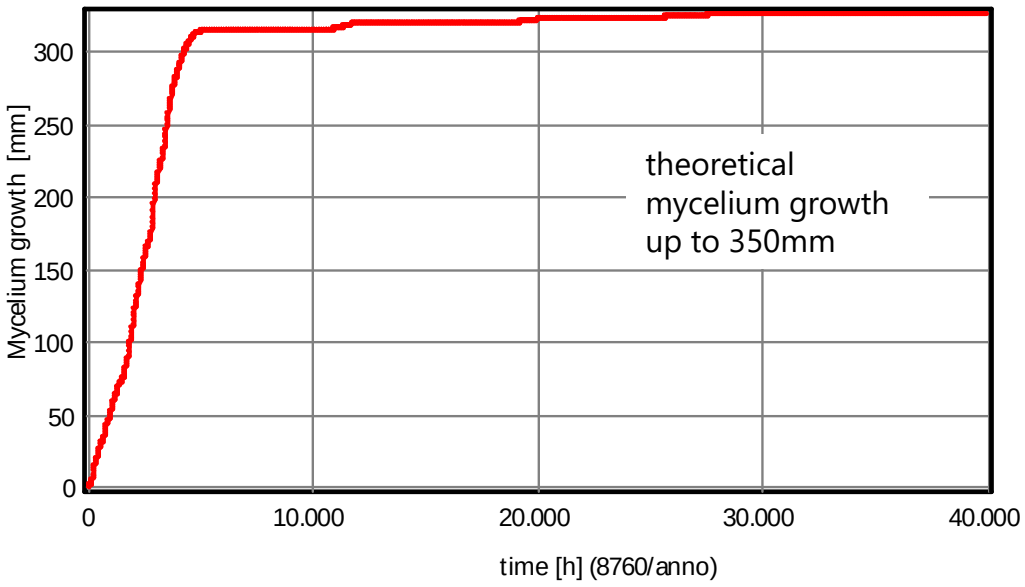
WUFI-BIO


Modellspore
außen
Wand
innen
Sporeninneres
(Feuchtespeicherfunktion)
Sporenwand
(s_d-Wert)

MEASURED CLIMATE IN NORTH WALL

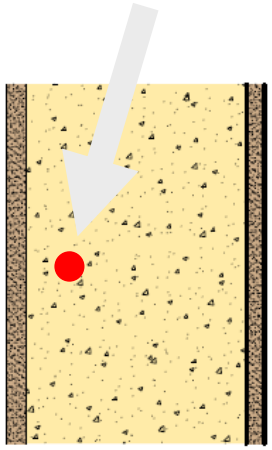
WITH CLAY PLASTER WUFI-BIO



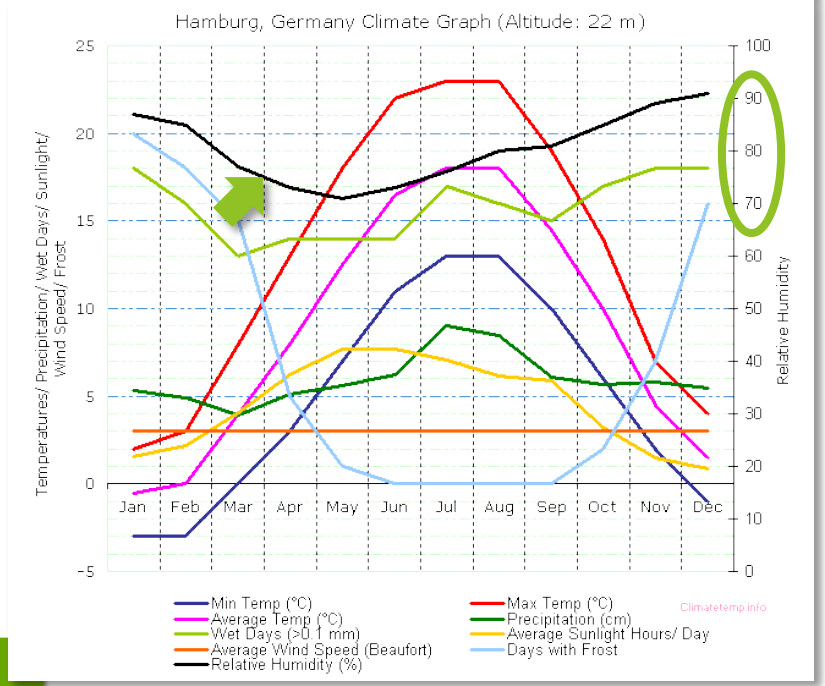


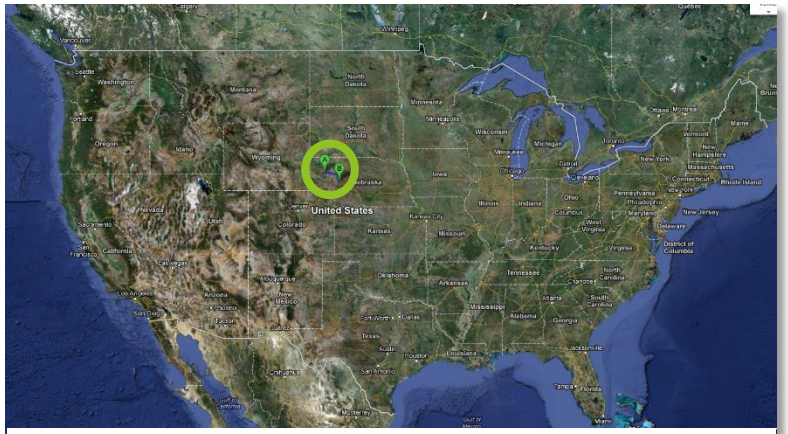
(Substrat category I)

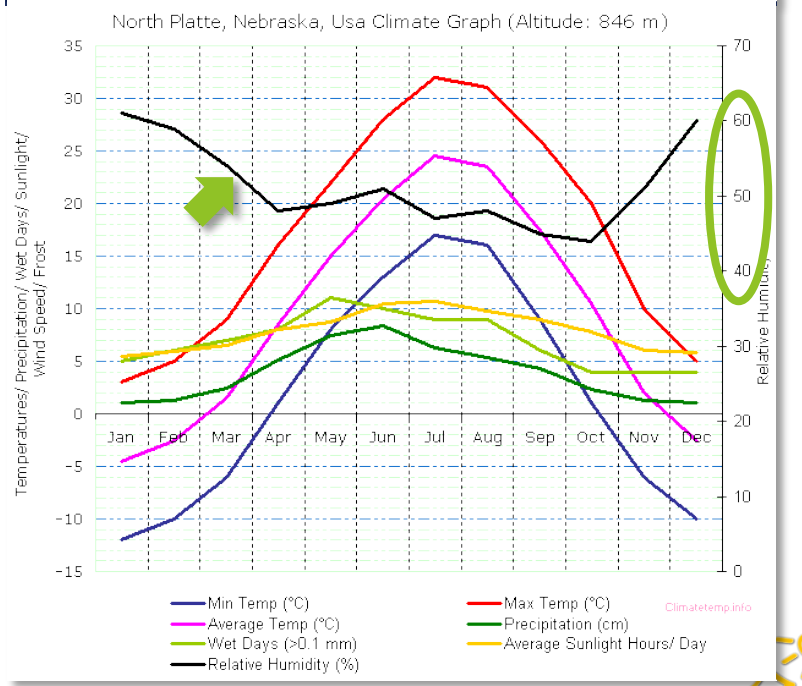
Source: Monitored data of STROHPOLIS north wall in the straw bale (5cm deep from outside)



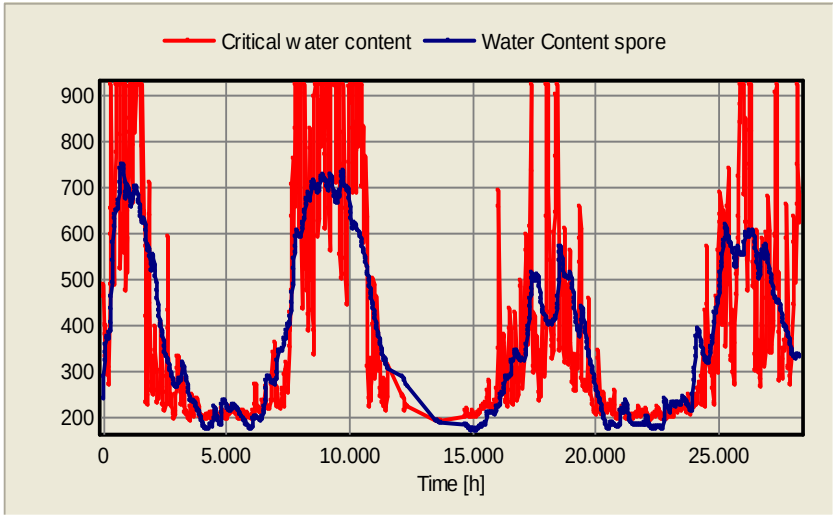
HAMBURG VERS. NEBRASKA



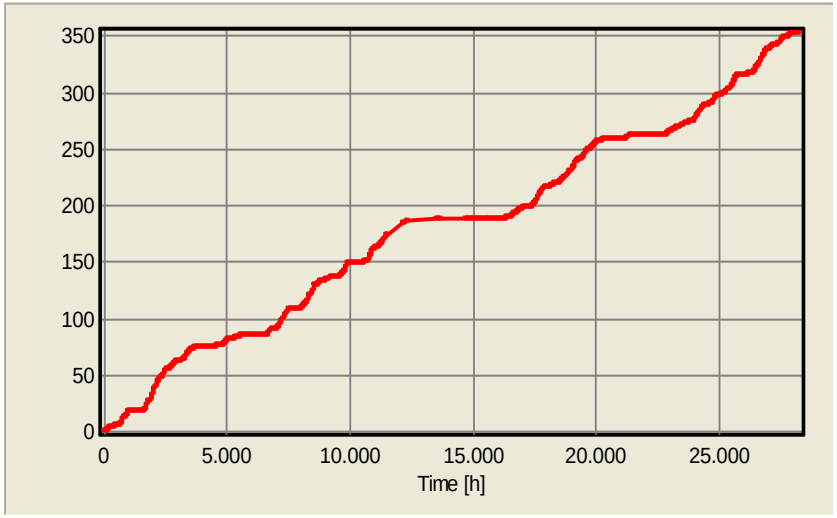




FOR COMPARISON: WUFI-BIO OUTDOOR CLIMATE



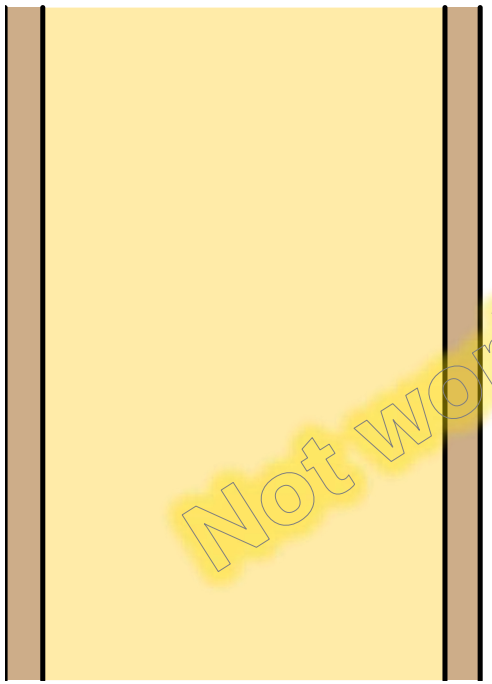
Calculated water moisture content of a modell spore

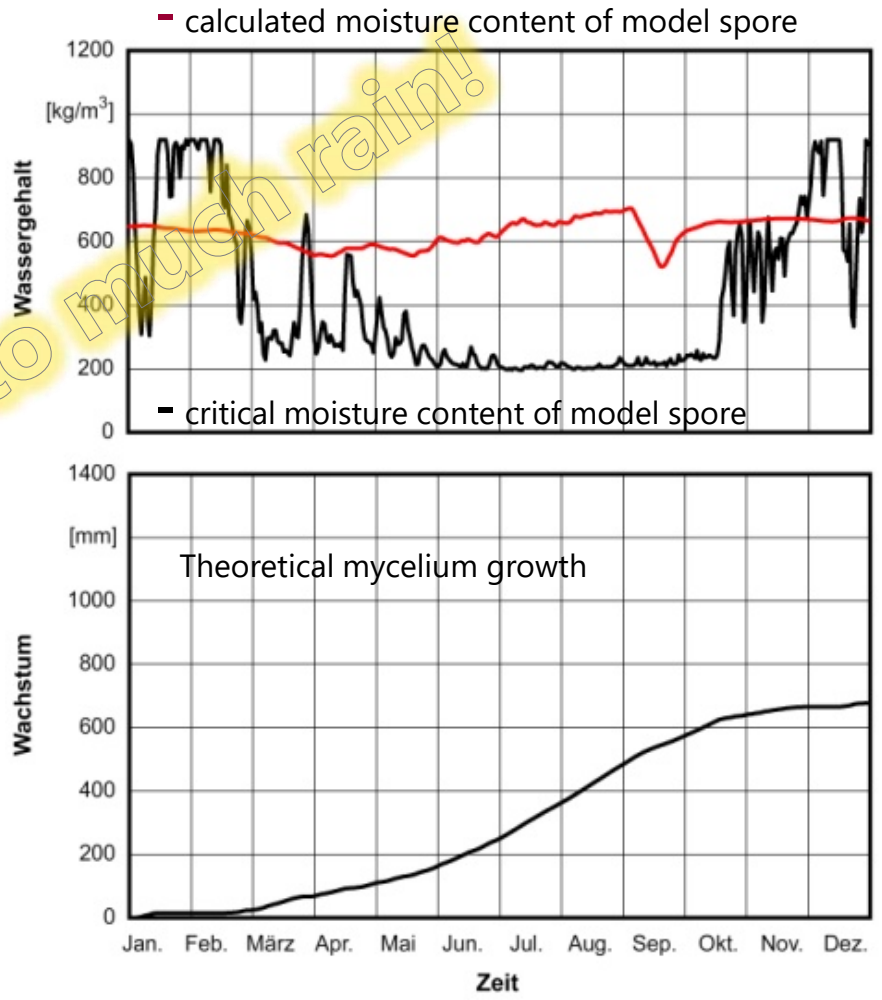


Calculated mycelium growth

North Germany. Substrate class I

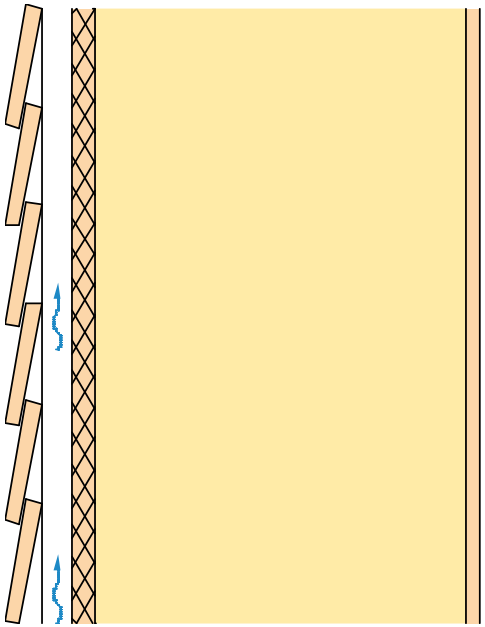
INITIAL IDEA: EARTH-STRAW-EARTH- NOTHING ELSE

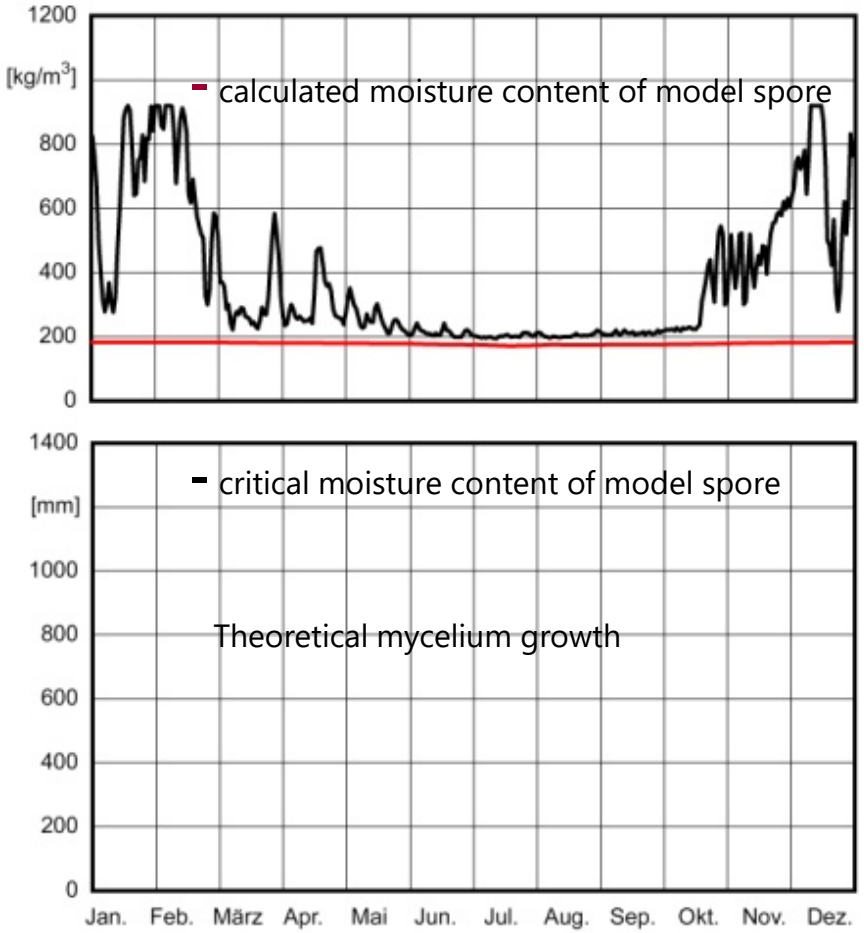




Layers: 30mm earth, 360mm straw, 30mm earth

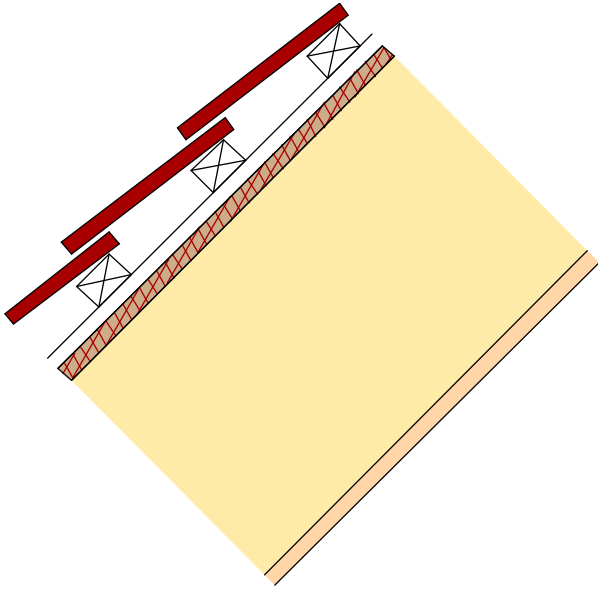
WALL: FORMER Z-23.11-1595 (2006-2014)

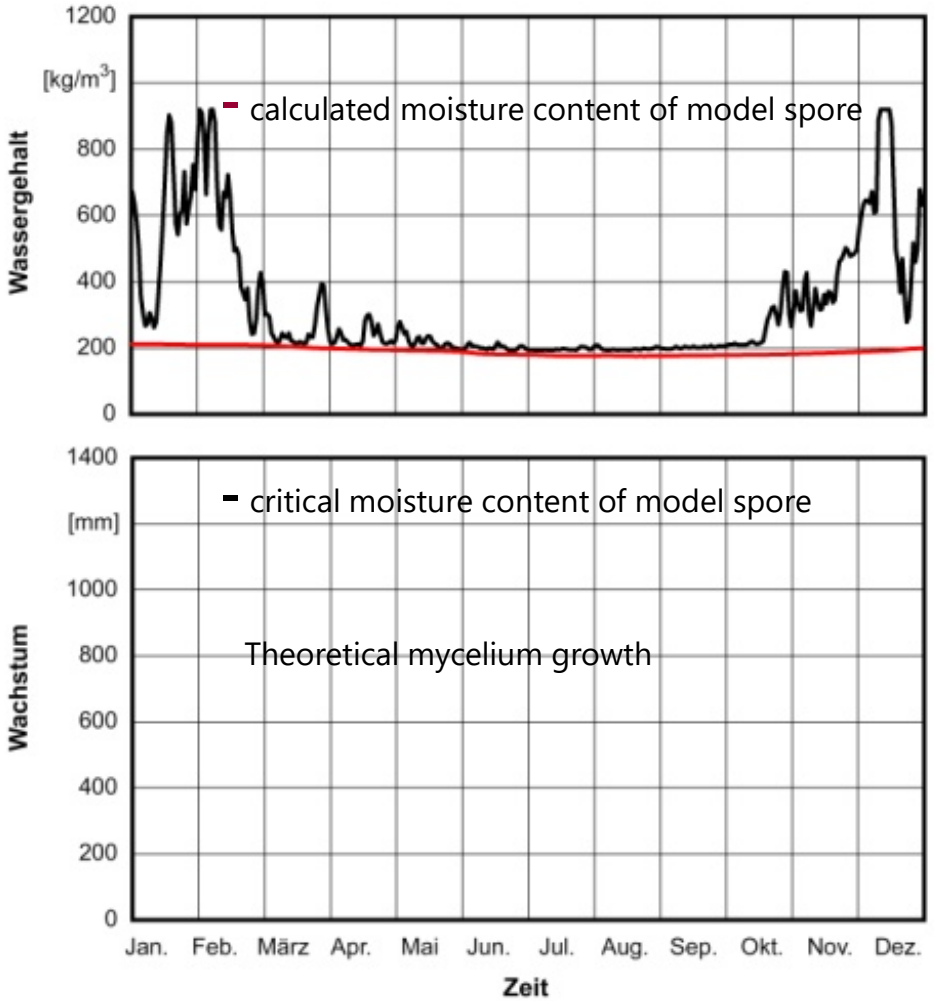




Ventilated rain screen, additional exterior insulation für wooden soft fibre 20mm (R>0,4m²·K/W, sd≤0,1m) 360mm straw 15mm OSB (sd>2,1m)

ROOF, FORMER Z-23.11-1595 (2006-2014)





Layers: roof tiles ventilated, 20mm wooden soft fibre board, 360mm straw, 15mm OSB

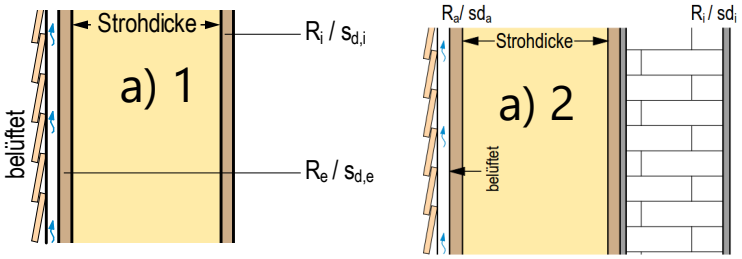
- **Approved building components in acc. with Z-23.11-1595 (since 2014)**

PROPERTIES OF LAYERS ACC. ANLAGE 1 Z-23.11-1595

Feuchtetechnisch zulässige Schichteigenschaften von Konstruktionen mit Baustroh als Wärmedämmung

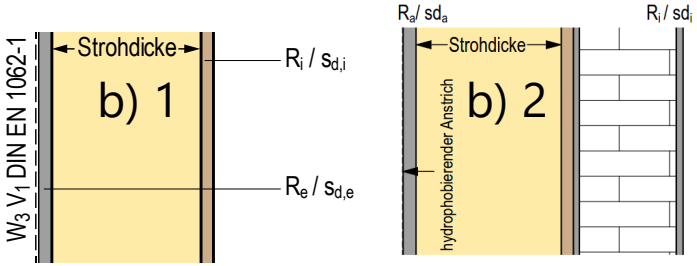
a) Außenwandkonstruktionen mit vorgesetztem, hinterlüftetem Wetterschutz

Zeile	Strohdicke [m]	$s_{d,i}$ [m]	R_i [m²·K/W]	$s_{d,e}$ [m]	R_e [m²·K/W]
1	≤ 1,00	**≥ 0,10**	**≤ 0,35**	**≤ 0,50**	**-**
2	≤ 0,48	**≥ 0,76**	*≤ 3,14*	≤ 0,50	-
3	≤ 0,48	≥ 0,10	≤ 0,35	*≤ 1,00*	**≥ 1,00**
4	≤ 0,48	**≥ 2,00**	≤ 0,35	*≤ 1,50*	**≥ 0,70**
5	≤ 0,48	≥ 0,10	≤ 0,35	*≤ 1,50*	**≥ 1,43**
6	≤ 0,48	≥ 0,10	≤ 0,35	*≤ 2,00*	**≥ 1,90**



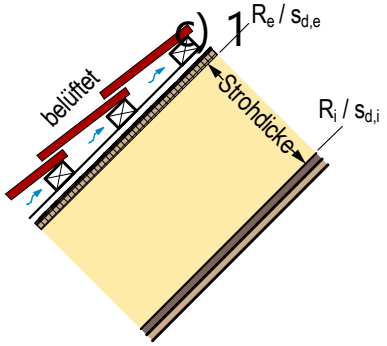
b) Frei bewitterte, verputzte Außenwandkonstruktionen
Putz gemäß DIN EN 998-1 mit wasserabweisender Beschichtung gemäß DIN EN 1062-1 in W_3 und V_1

Zeile	Strohdicke [m]	$s_{d,i}$ [m]	R_i [m²·K/W]	$s_{d,e}$ [m]	R_e [m²·K/W]
1	≤ 0,70	**≥ 0,10**	**≤ 0,35**	**≤ 0,50**	**-**
2	≤ 0,48	**≥ 0,76**	*≤ 3,14*	≤ 0,50	-
3	≤ 0,48	**≥ 3,00**	≤ 0,35	*≤ 1,50*	**≥ 0,30**



c) Dachkonstruktionen mit belüfteter Dachdeckung

Zeile	Strohdicke [m]	$s_{d,i}$ [m]	R_i [m²·K/W]	$s_{d,e}$ [m]	R_e [m²·K/W]
1	≤ 0,48	**≥ 2,00**	**≤ 0,35**	**≤ 0,50**	**≥ 0,14**
2	**≤ 0,36**	**≥ $s_{d,a}$**	≤ 0,35	*≤ 3,00*	≥ 0,14

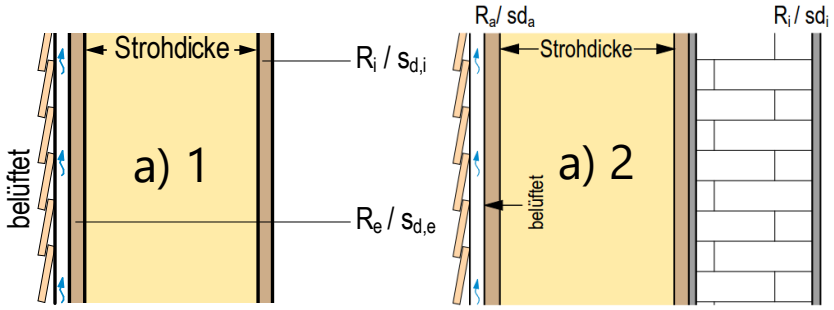


Symbole, Indizes:
$s_{d,e}$: Diffusionsäquivalente Luftschichtdicke für die äußeren Schichten/ Bekleidungen.
$s_{d,i}$: Diffusionsäquivalente Luftschichtdicke für die inneren Schichten/ Bekleidungen.
R_i: Wärmedurchlasswiderstandes für die inneren Schichten/ Bekleidungen.
R_e: Wärmedurchlasswiderstandes für die äußeren Schichten/ Bekleidungen.
W_3: Die Wasserdurchlässigkeit der nach DIN EN 1062-1 klassifizierten und nach DIN EN 1062-3 geprüften Beschichtung: $w_{24} \leq 0{,}1$ kg/(m²·√h); Index 24 = Prüfdauer 24 h.
V_1: Wasserdampf-Diffusionsstromdichte der nach DIN EN 1062-1 klassifizierten und nach DIN EN 1062-3 geprüften Beschichtung: V > 150 g/(m²·d) mit s_d < 0,14m

Hinweise:
Zeile 1 charakterisiert die jeweils zulässige Grundvariante.
Weitere Zeilen: mögliche Varianten mit geänderten Bauteil-eigenschaften (grau hinterlegt), die in der Folge dann zu ändernde Schichteigenschaften erfordern (fett gedruckte Werte).

Architekt Scharmer
Häuser aus Stroh

VENTILATED RAINSCREEN



Appendix 1 zu Z-23.11-1595

hygrothermal approved layer properties of walls with straw as insulation material
a) Exterior walls with ventilated rain screen

Row	strawthickness [m]	$s_{d,i}$ [m]	R_i [m²·K/W]	$s_{d,e}$ [m]	R_e [m²·K/W]
1	≤ 1,00	**≥ 0,10**	**≤ 0,35**	**≤ 0,50**	**-**
2	≤ 0,48	**≥ 0,76**	*≤ 3,14*	≤ 0,50	-
3	≤ 0,48	≥ 0,10	≤ 0,35	*≤ 1,00*	**≥ 1,00**
4	≤ 0,48	**≥ 2,00**	≤ 0,35	*≤ 1,50*	**≥ 0,70**
5	≤ 0,48	≥ 0,10	≤ 0,35	*≤ 1,50*	**≥ 1,43**
6	≤ 0,48	≥ 0,10	≤ 0,35	*≤ 2,00*	**≥ 1,90**

Explanation:
Row 1 shows the approved base variant.
Further rows: possible variants with changed properties (grey), forces other properties to change **fat**).

a) 3-6 if tighter on outside
> addit. Ext. insulation required

Symbols, Indices:
$s_{d,e}$: exterior sd value [m] Diffusion equivalent air layer thickness.
$s_{d,i}$: interior sd value [m] Diffusion equivalent air layer thickness.
R_i: Thermal resistance of interior layers.
R_e: Thermal resistance of exterior layers.
W_3: water permeability of the acc. to DIN EN 1062-1 classified and acc. to DIN EN 1062-3 examined coating: w_{24} ≤ 0,1 kg/(m²·√h); Index 24 = duration of examination 24 h.
V_1: water vapour diffusion stream density of the acc. to DIN EN 1062-1 classified and acc. to DIN EN 1062-3 examined coating: V > 150 g/(m²·d) mit s_d < 0,14m

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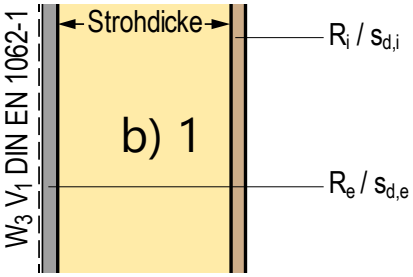
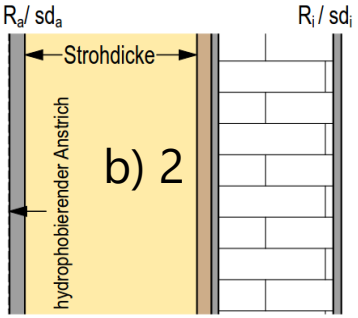
Häuser aus Stroh

VERPUTZT





Anlage 1 zu Z-23.11-1595

Hygrothermal approved layer properties of walls with straw as insulation material
b) Exterior walls with plaster

Plaster acc. to DIN EN 998-1 with hydrophobic paint acc. to DIN EN 1062-1 in W_3 und V_1

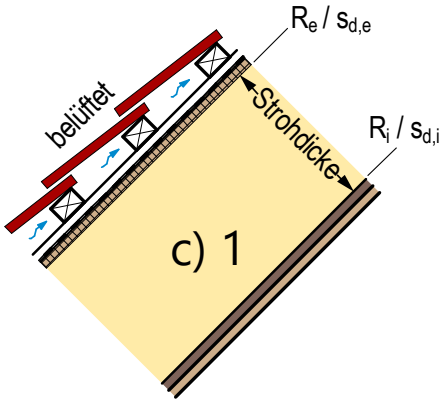
Row	Straw thickness[m]	$s_{d,i}$ [m]	R_i [m²·K/W]	$s_{d,e}$ [m]	R_e [m²·K/W]
1	≤ 0,70	**≥ 0,10**	**≤ 0,35**	**≤ 0,50**	**-**
2	≤ 0,48	**≥ 0,76**	*≤ 3,14*	≤ 0,50	-
3	≤ 0,48	**≥ 3,00**	≤ 0,35	*≤ 1,50*	**≥ 0,30**

Row b) 2 if tighter on outside
> addit. Ext. insulation required

Explanation:
Row 1 shows the approved base variant.
Further rows: possible variants with changed properties (grey), forces other properties to change **fat**).

Symbols, Indices:
$s_{d,e}$: exterior sd value [m] Diffusion equivalent air layer thickness.
$s_{d,i}$: interior sd value [m] Diffusion equivalent air layer thickness.
R_i: Thermal resistance of interior layers.
R_e: Thermal resistance of exterior layers.
W_3: water permeability of the acc. to DIN EN 1062-1 classified and acc. to DIN EN 1062-3 examined coating: $w_{24} \leq 0{,}1$ kg/(m²·√h); Index 24 = duration of examination 24 h.
V_1: water vapour diffusion stream density of the acc. to DIN EN 1062-1 classified and acc. to DIN EN 1062-3 examined coating: V > 150 g/(m²·d) mit s_d < 0,14m

ROOF



Appendix1 zu Z-23.11-1595

hygrothermal approved layer properties of roofs with straw as insulation material

c) Roof with ventilated cladding

Row	Strawthickness [m]	$s_{d,i}$ [m]	R_i [m²·K/W]	$s_{d,e}$ [m]	R_e [m²·K/W]
1	≤ 0,48	**≥ 2,00**	**≤ 0,35**	**≤ 0,50**	**≥ 0,14**
2	**≤ 0,36**	**≥ $s_{d,a}$**	≤ 0,35	*≤ 3,00*	≥ 0,14

Explanation:
Row 1 shows the approved base variant.
Further rows: possible variants with changed properties (grey), forces other properties to change **fat**).

Row c) 2 if tighter on outside
> reduce max. straw thickness

Symbols, Indices:
$s_{d,e}$: exterior sd value [m] Diffusion equivalent air layer thickness.
$s_{d,i}$: interior sd value [m] Diffusion equivalent air layer thickness.
R_i: Thermal resistance of interior layers.
R_e: Thermal resistance of exterior layers.
W_3: water permeability of the acc. to DIN EN 1062-1 classified and acc. to DIN EN 1062-3 examined coating: w_{24} ≤ 0,1 kg/(m²·√h); Index 24 = duration of examination 24 h.
V_1: water vapour diffusion stream density of the acc. to DIN EN 1062-1 classified and acc. to DIN EN 1062-3 examined coating: V > 150 g/(m²·d) mit s_d < 0,14m

Architekt Scharmer
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THANK YOU!

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