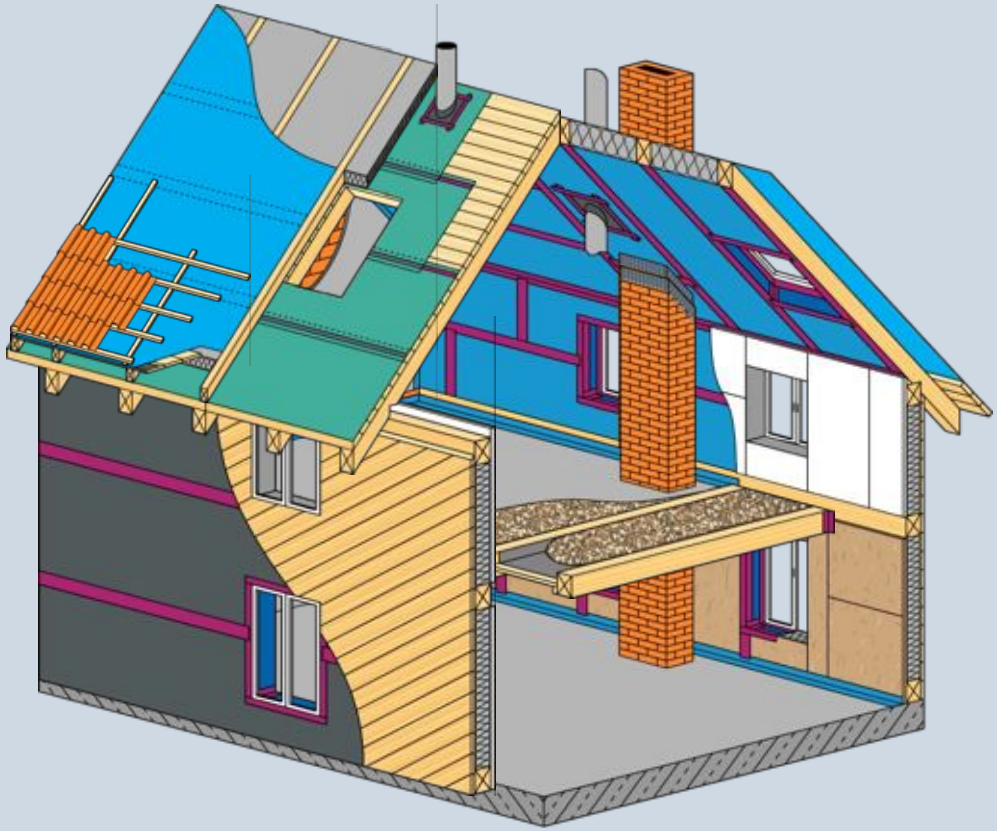
Building envelope and sealing systems interior and exterior



Moll bauöekologische Produkte GmbH

CEO: Lothar Moll

Engeneer wood technic and construction

Inside sealing membranes

Membranes Interior with
humidity-variable moisture management

- **Winter:** **diffusion inhibiting**
- **Summer:** **diffusion open**

providing highest safety potential for the construction - from the inside

Outside sealing membranes

Membranes Exterior with
active evaporation management

- **Highest resistance against rain**
- **Highest evaporation capacity**
- **Highest mechanical strenght**

providing highest safety potential for the construction - from the outside

Sealing products

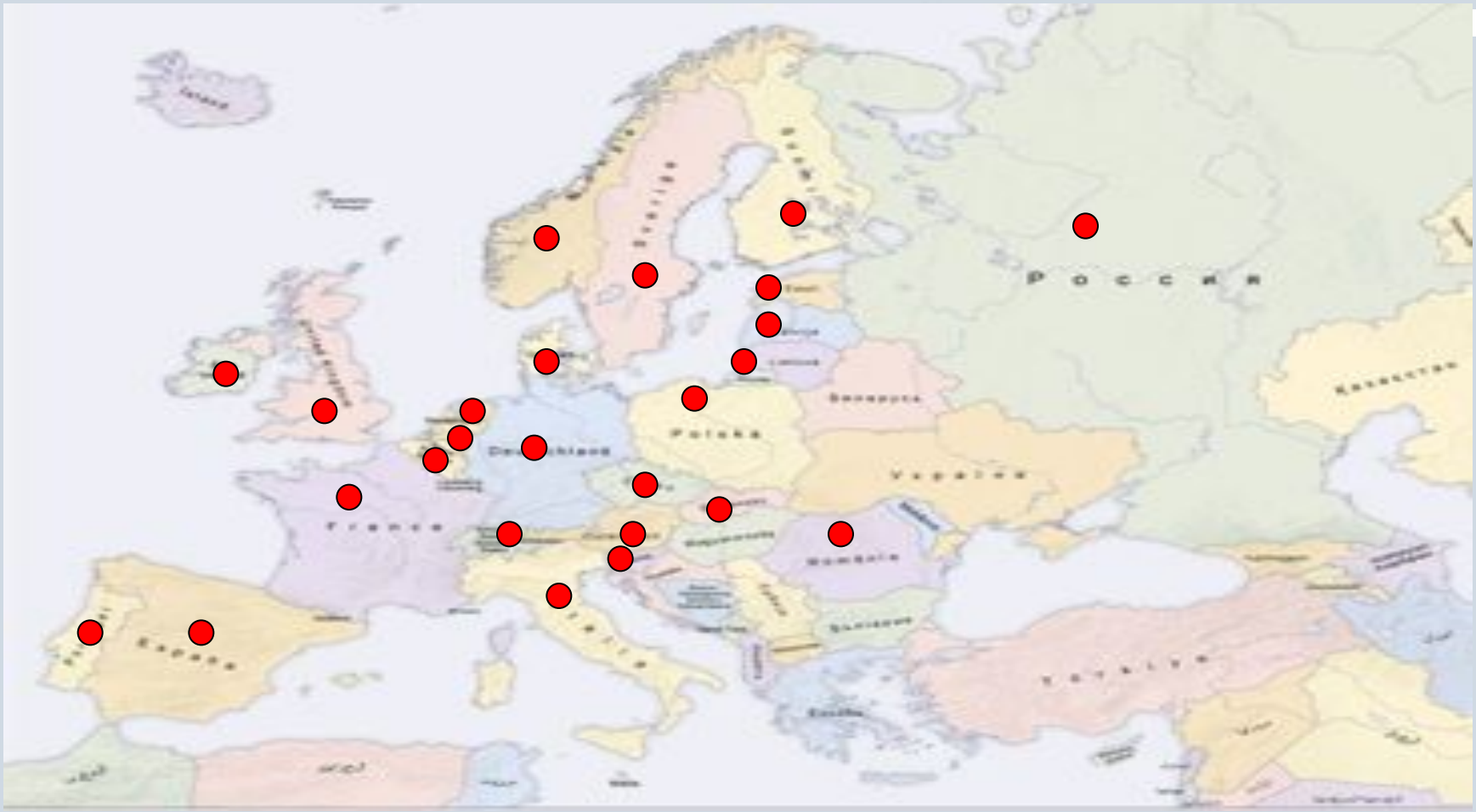
Sealing Tapes with SOLID Glue –
- **Absolute moisture and water resistant**

Airtight sealing glues for connections to component units
- **Highest sealing effect to rough surfaces**

providing highest safety potential for the construction - for the connections

pro clima worldwide – Europe Asia America Oceania

pro clima worldwide - Europe

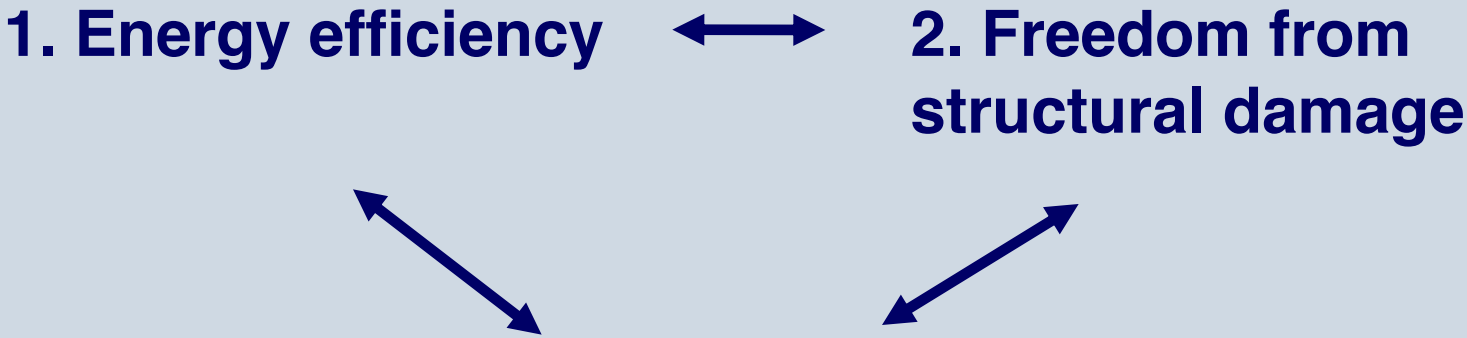


pro clima worldwide – United Kingdom and Ireland

MOLL bauökologische Produkte GmbH (Ecological building products)

pro clima is represented in:
Great Britain
Ireland

World wide Mega trends



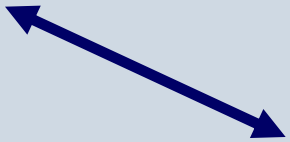
pro clima .....

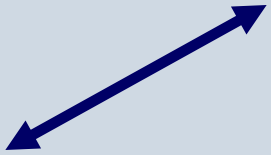
... and the insulation is perfect

World wide Mega trends achieved by pro clima

1. Air tightness
Low energy houses
Passiv houses

2. Intelligent Membranes
Mould free constructions



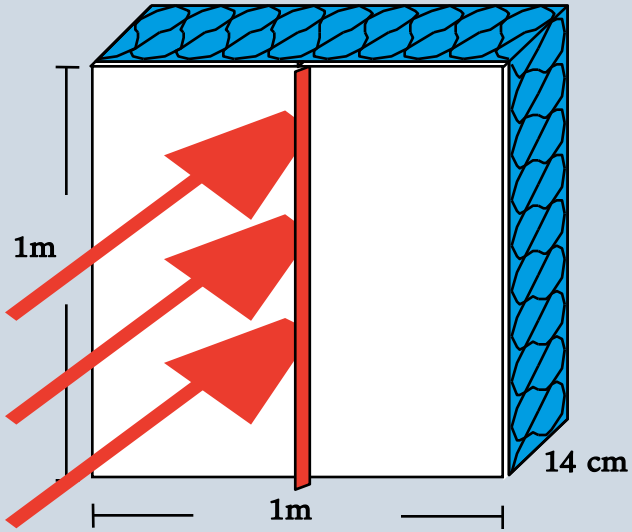


3. Sentinel-Haus
Proofed products and systems

pro clima .....

... and the insulation is perfect

1. Energy efficiency – Air tightness



Air tightness

Low energy houses

Passive house

Without gap: **U value = 0,30 W/m²K**

With gap of 1 mm **U value U = 1,44 W/m²K**

Performance down by factor 4,8

1. Application in Low Energy and Passive Houses

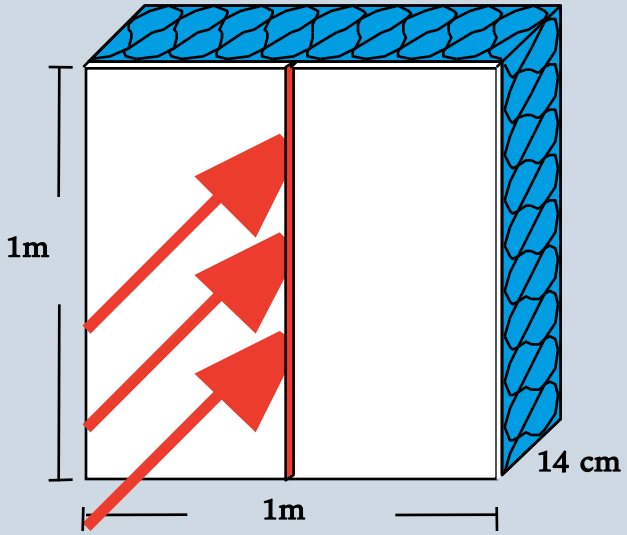
Air tightness

Low energy houses

Passive house

Sealing the overlappings

2. Freedom from structural damage – Air tightness

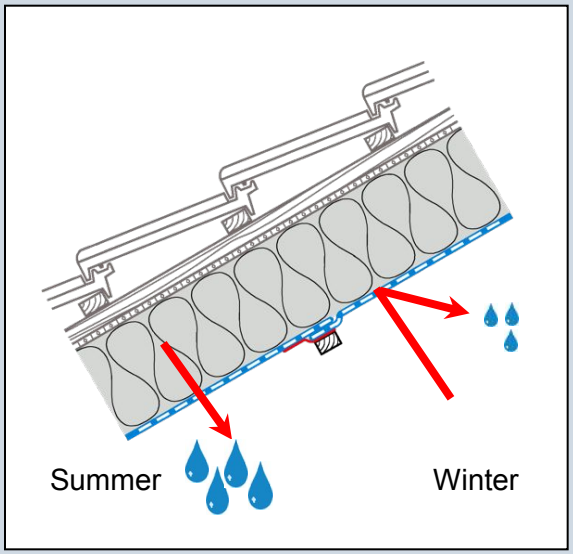


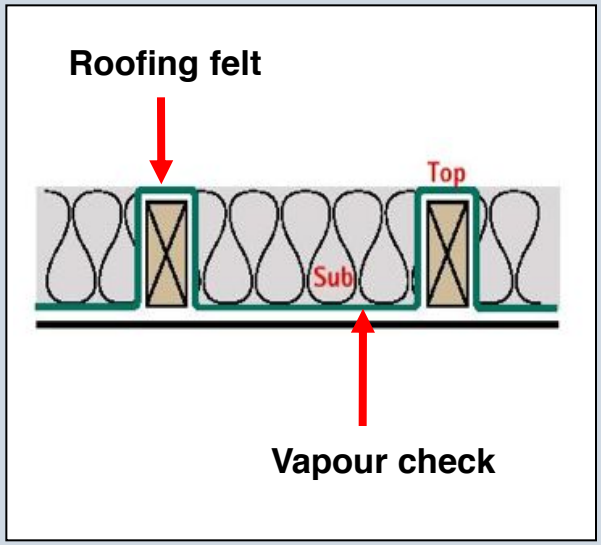
Without gaps: **0,5 g water/m² x 24h (diffusion)**

With gaps of 1 mm : **800 g water/m x 24h (convection)**

Performance down by factor **1600**

2. Freedom from structural damage – Membranes with intelligent moisture management





New building

Winter:
Protection against moisture

Summer:
high drying potential

Refurbishment

Outside:
roofing felt

Inside:
vapour check

3. Healthy living in Buildings – proofed quality

pro clima – benefits and use

Today's specific: Mechanism of moisture transport

……..through

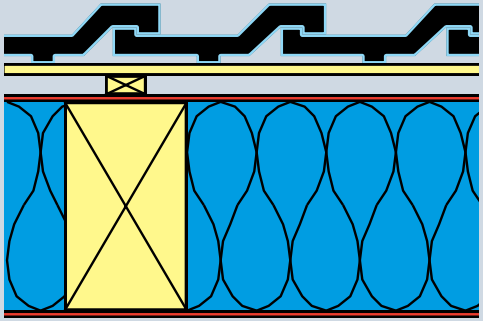
roof and wall underlays and

building components

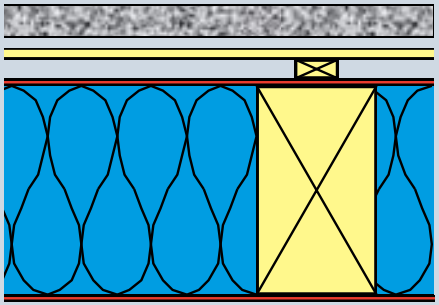
porous versus nonporous structures

The Building Envelopes – Interior and Exterior

Roof



Wall



The insulating material is covered and protected on both sides
without any air movement in the insulation

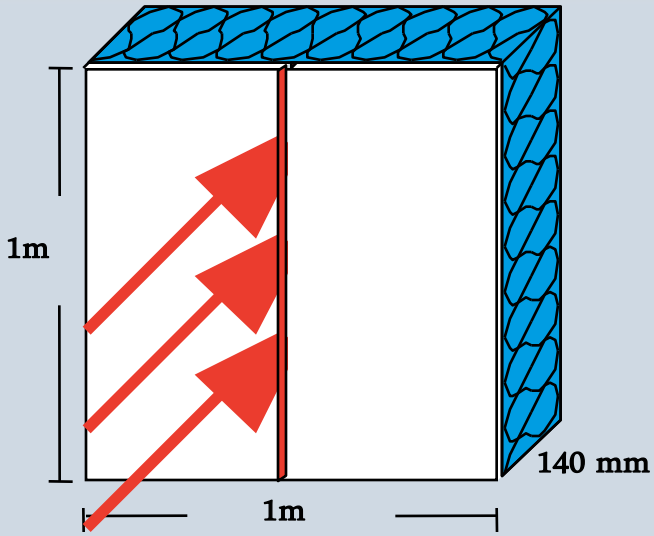
The ideal construction

Wall underlay / RAB
Roof underlay

Insulation

Airtightness layer
Vapour control layer

Moisture load: Diffusion and Convection



Without a gap: Diffusion MVTR of 50 MNs/g:
e.g. INTELLO: 1.5 g water/m²x24h

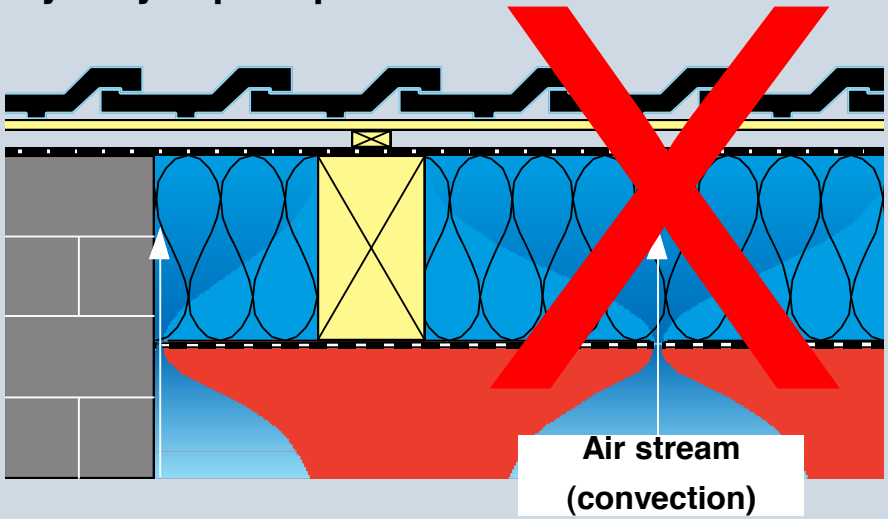
Without a gap: Diffusion MVTR of 0.50 MNs/g
e.g. plasterboard: 150 g water/m²x24h

With a 1 mm gap: No vapour diffusion
Only vapour convection: 800 g water/m²x24h

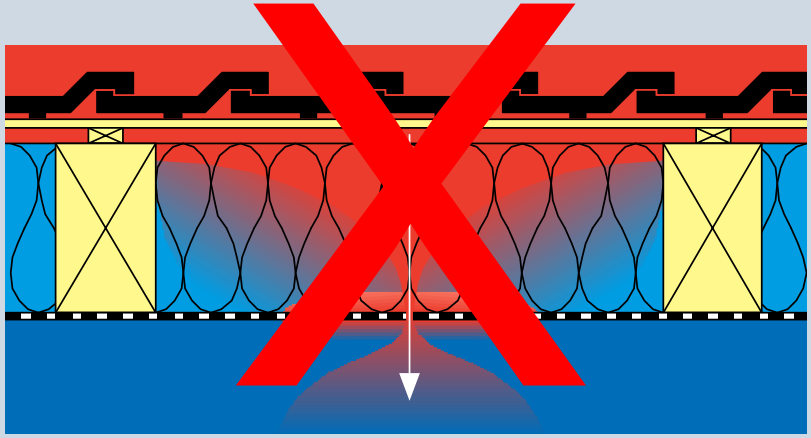
Data of the 1 mm gap:
Set-up experiment of the Fraunhofer Institute of Building Physics, Stuttgart:
Frame conditions:
Inside temperature +20° C
Outside temperature 0° C
Pressure difference 20 Pa
= wind force 2-3
Source: DBZ 12/89, page 1639ff

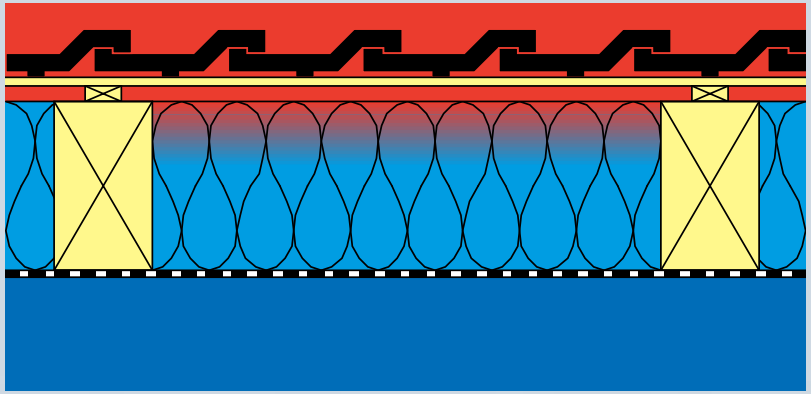
Eliminating convection paths through the construction

In winter: Moisture load towards the exterior layer by vapour pressure

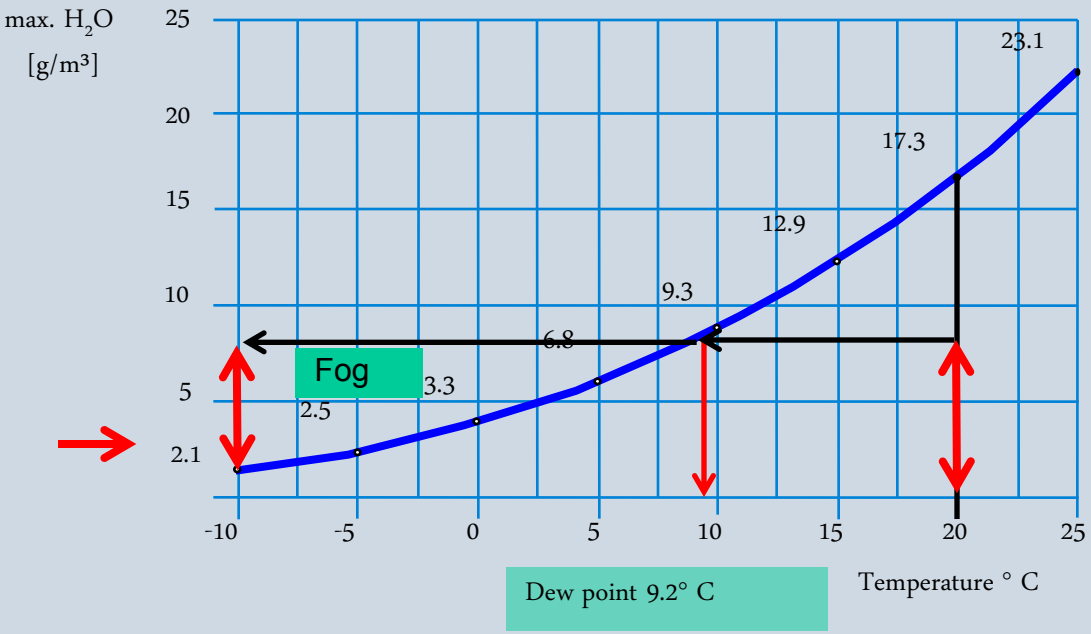


In summer: Moisture load towards the interior layer by vapour pressure and by wind





Principals of humidity and moisture of the air



Reasons of structural damage

Warm air will condensate, if cooling down below dew point - cold air can hold less water than warm air.

= condensation

Absolute humidity

at 50 %

rel. humidity:

⇒ **8.65 g/m³**

Standard: outside winter climate

according to DIN 4108-3

Temperature: -10° C

max. humidity: 2.1 g/m³

Condensation:

⇒ **6.55 g/m³**

“Fog“ condensates if meeting diffusion inhibiting layers

Vapour diffusion resistance coefficients of the most common building materials according to EN ISO 13788

Material	μ	Material	μ
Wool insulation	1	Plasterboard	8
Cellulose insulating material	1/2	Lime Plaster	15/35
Wood fibre insulating board	2/5	Wood	40
Cork	5/10	Concrete	100
Brickwork	5/10	Polyethylene sheet	100,000

Calculation of the equivalent air layer thickness: $s_d = \mu$ x s [m]
s_d x 5.1 = MVTR in MNs/g

Material		=	s_d-value [m]	=	MVTR [MNs/g]
Plasterboard 10 mm	8 x 0.01	=	0.08 m	=	0.40
Brickwork 30 cm	7.5 x 0.30	=	2.25 m	=	11.25
OSB	200 x 0.012	=	2.40 m	=	12.00
Wood 60 mm	40 x 0.06	=	2.40 m	=	12.00
Concrete 20 cm	100 x 0.2	=	20.00 m	=	100
Polyethylene sheet 0.2 mm	100,000 x 0.0002	=	20.00 m	=	100
Bitumen roofing felt	80,000 x 0.003	=	240.00 m	=	1200

“Fog“ condensates – if meeting higher *μ* values

Product	*μ* value [ ]	thickness [m]	MVTR [MNs/g]
Wool insulation / air	1	0.05	0.25
Wood fiber boards	3	0.028	0.42
Panel Vent	30	0.010	1.50
OSB	200	0.015	15.00
SOLITEX Plus ACTIVE vapour diffusion	50	0.0006	0.15
Porous Membranes PASSIVE vapour diffusion	100 – 1000	0.0005	0.25 – 2.50

Structural damage due to moisture

Quelle: Palmgreen Pegasus Hamburg

Mould

Mould is absolut harmful to health:

Spores: responsible for various allergies, harm the Immun system and organs

MVOC: responsible for toxification of body – and psyche

Structural damage due to moisture

Condensation and Mould

Mould .....

..... although the wood fiber boards are

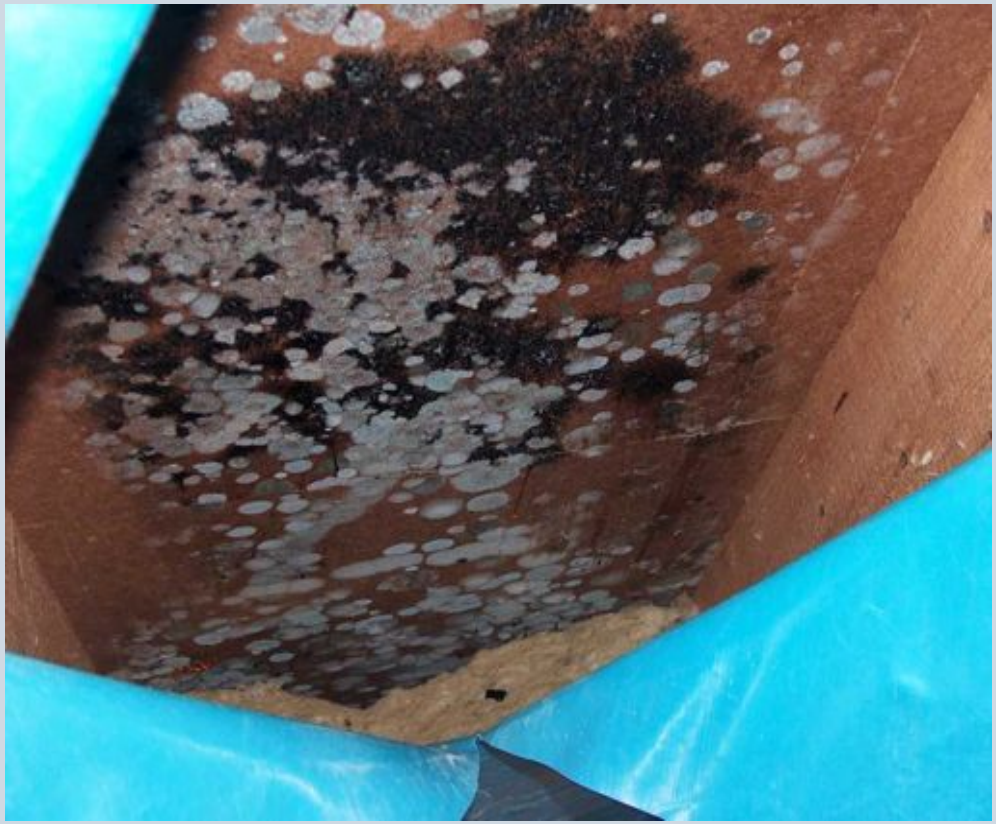
very permeable to vapour flux:

μ value: 3

s_d value of 28 mm = 0.084 m

mvtr of 28 mm = 0.42 MNs/g

Structural damage due to moisture



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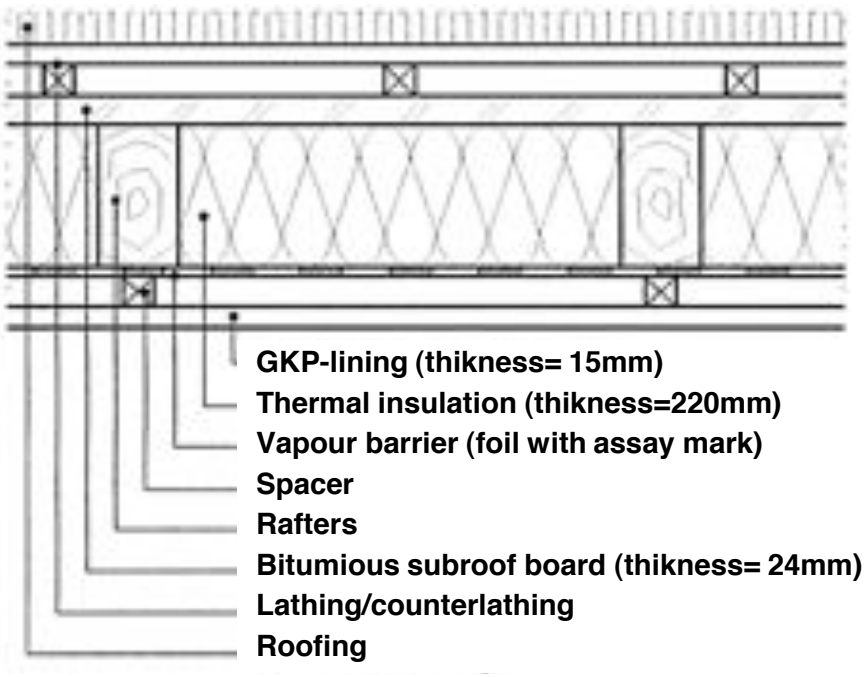


Fig.: Set-up of the roof construction

Residential park in Berlin: 25 terrace houses

Damage symptoms: 2 houses

- moisture at the connection between pitched roof/jamb wall
- Bulging of tiles

Set-up:

- Externally open to diffusion
- Construction free from condensate according to EN ISO 13788

Structural damage due to moisture

Fig.: Moisture damage and mould growth at the subroof (timber fiber board)

Residential park in Berlin: 25 terraced houses

Damage description:

Only at 2 houses:

- Bulging of tiles
- Plaster massively moistened at the jamb wall
- Softboard wet and mouldy

Structural damage due to moisture

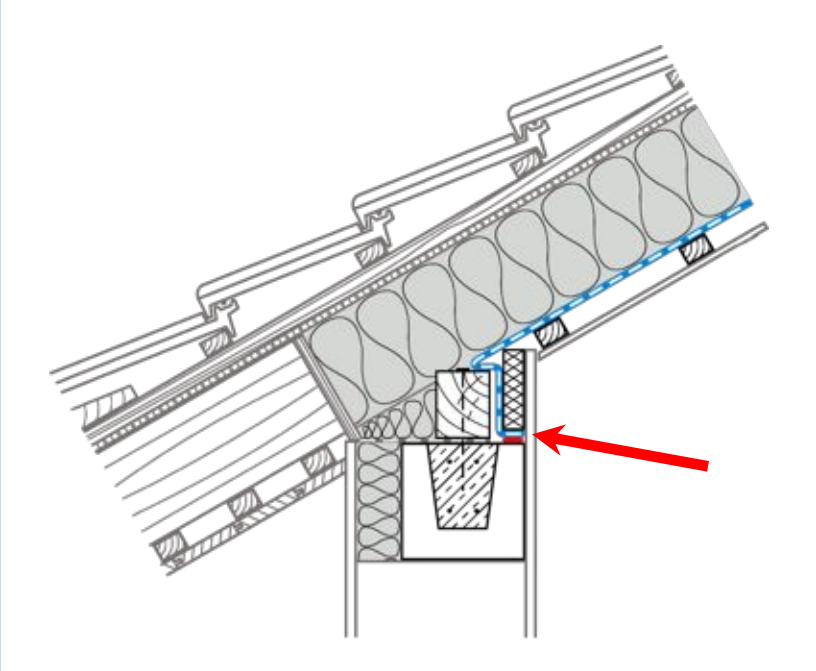


Fig.: Airtight connection at eaves purlin (example)

Possible causes :

First assumption:

Faulty connection of the vapour barrier in the jamb wall region.

This assumption could not be confirmed

Structural damage due to moisture

Fig.: Moisture damage and mould growth at the subroof (timber fiber board)

Causes of Condensation and Mould

Mould .....

..... although the wood fiber boards are

very permeable to vapour flux:

μ value: 3

s_d value of 28 mm = 0.084 m

mvtr of 28 mm = 0.42 MNs/g

Structural damage due to moisture

Fig.: Moisture damage and mould growth on the subroof

Causes:

Diminished drying of the construction:

- Water film creates a vapour hampering layer at the diffusion open timber board
- Due to the installation of the interior vapour barrier
- Due to climatic data in autumn/winter

Structural damage due to moisture

Fig.: Screed installation

Causes of damage:

Moisture entry due to faulty construction sequence:

1. Installation of the insulation
2. Installation of screed (gypsum)
3. Installation of vapour barrier.

Season: early September

⇒ **Heavy occurence of condensate at the timber fiber board.**

Structural damage due to moisture

Fig.: A new construction of a roof

Restoration:

- Complete removal of the roof to the rafters
- Treatment of the rafters with fungus repelling admixtures
- A new conversion of the roof

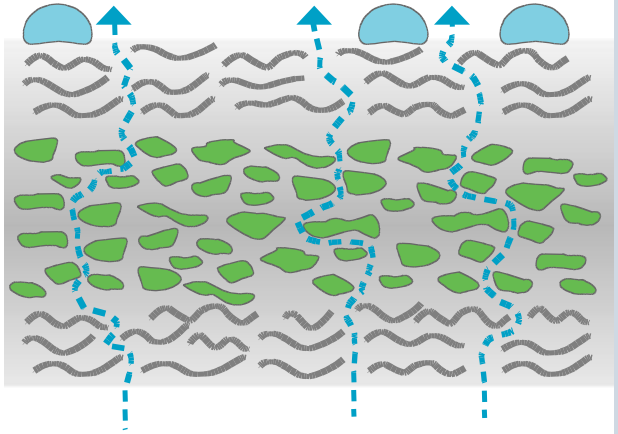
Moisture transportation performance

Hitherto technology: PE / PP

Fleece

Microporous membrane

Fleece

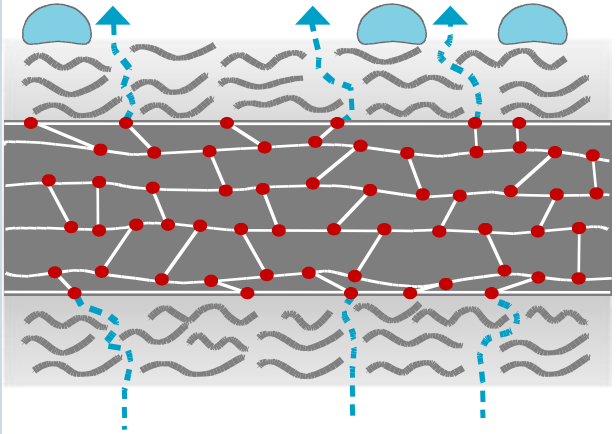


Vapour Convection

Moisture Transport physically by air exchange not by diffusion

= passive transport

High performance TEEE technology:



Fleece

Non porous membrane

Fleece

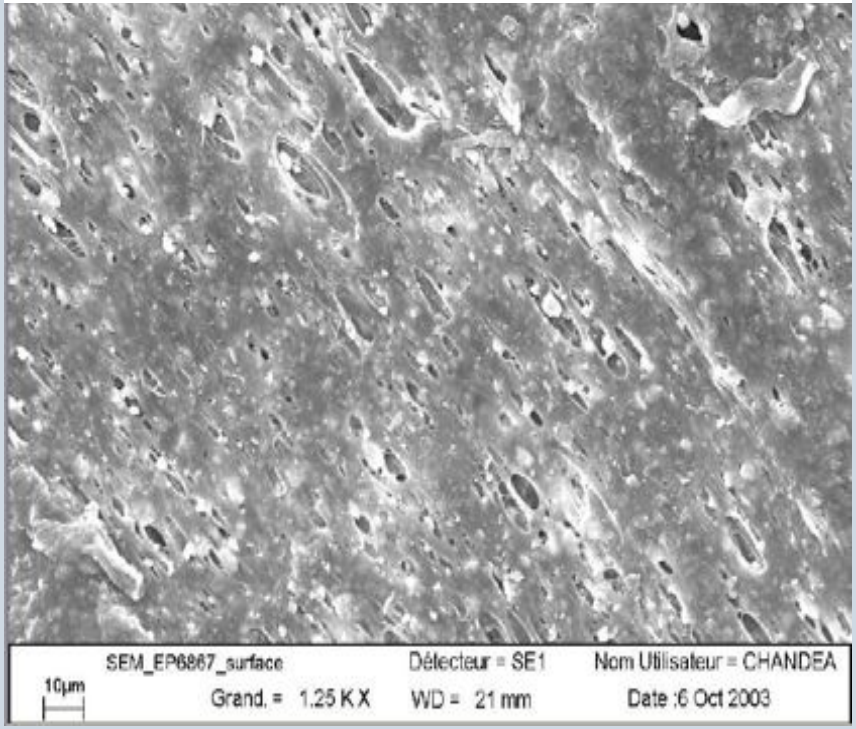
Vapour Diffusion

Moisture transport along the molecular chains as chemical reaction

= active transport

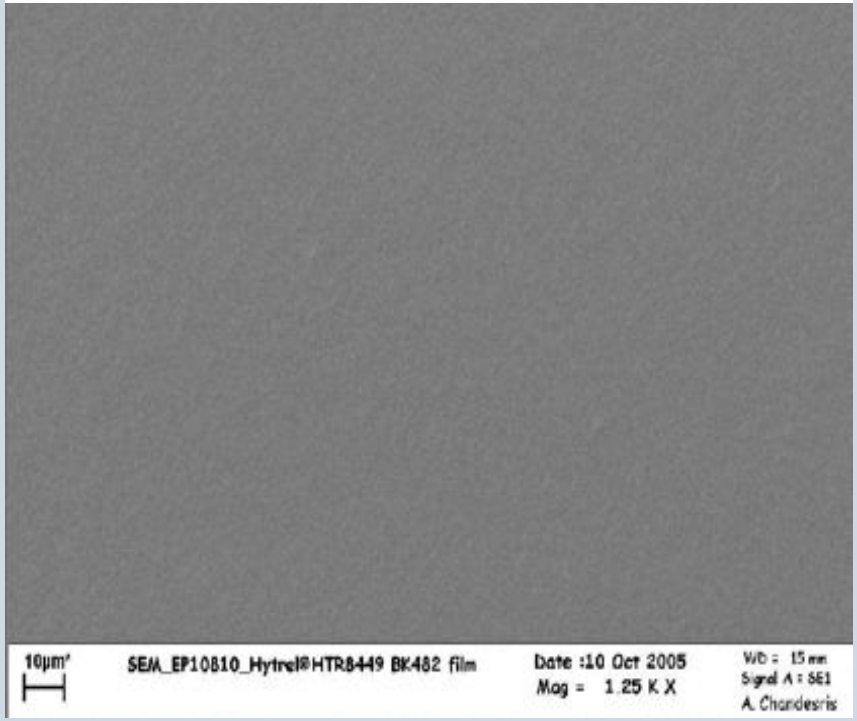
Structure of membranes

Hitherto technology: PE / PP microporous membrane



= passive transport

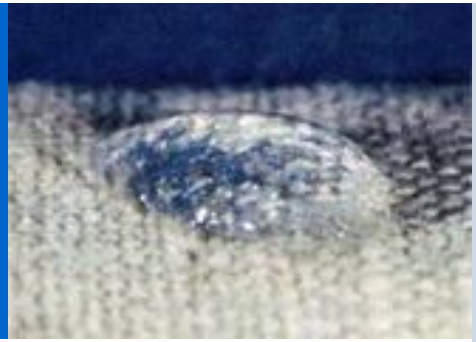
High performance technology: TEEE monolithic nonporous membrane



= active transport

Water penetration due to reduced surface tension

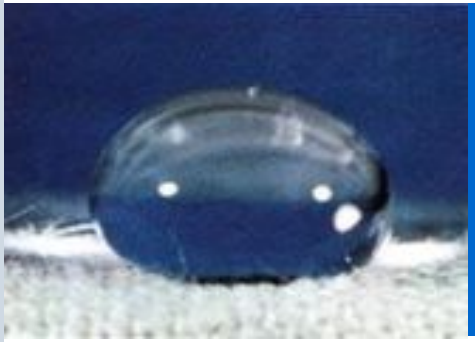
Hitherto technology: PE /PP membrane: porous



Water can penetrate the structure due to the reduced water tension caused by:

- Wood preservatives (salts and detergents)
- Chainsaw oil
- Materials contained in the wood (resins, oils or terpentines)

New technology : TEEE membrane: nonporous and monolithic

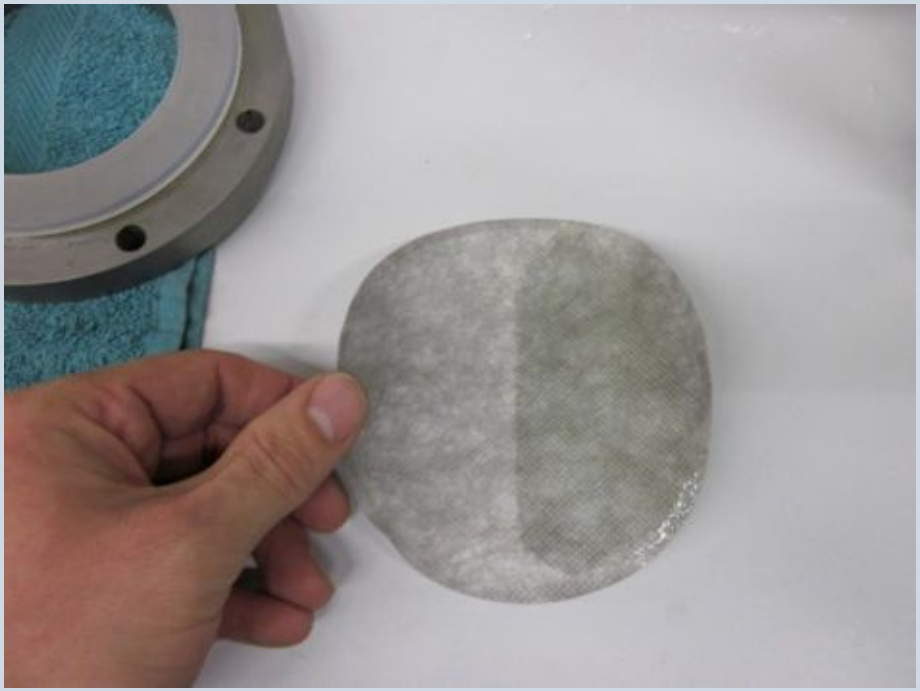


Nonporous structures are always watertight and are not effected by:

- Wood preservatives (salts and detergents)
- Chainsaw oil
- Materials contained in the wood (resins, oils or terpentines)

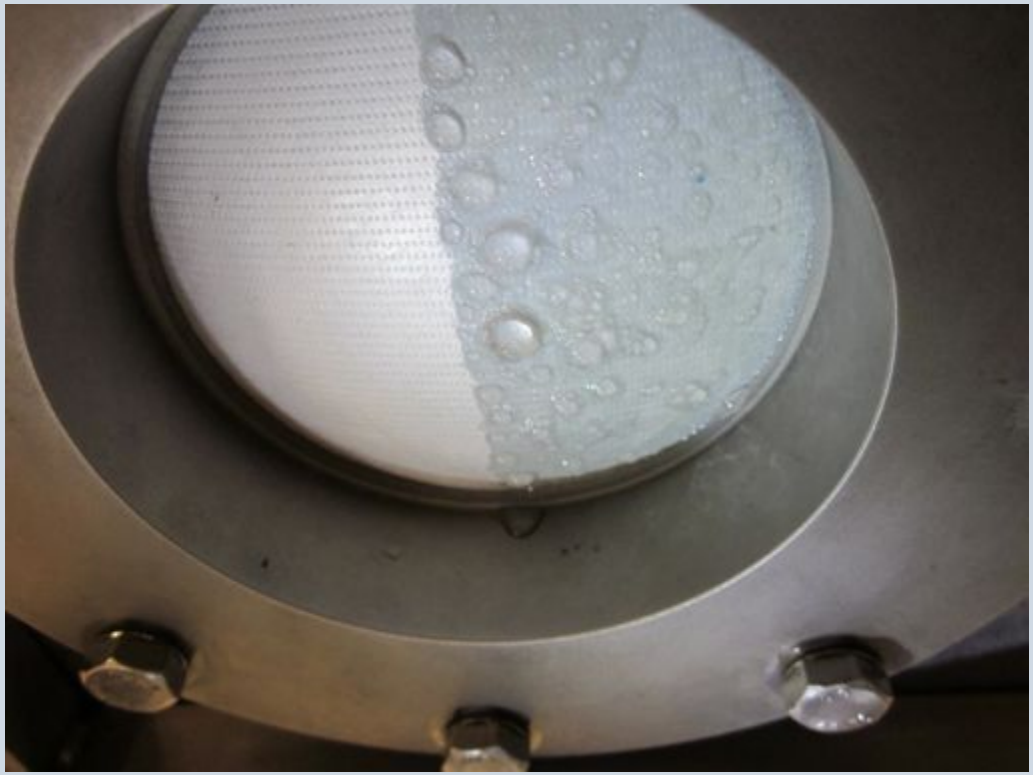
Watertightness testing of underlays

Watertightness testing of underlays



Half of the microporous sample is treated with oil

Watertightness testing of underlays



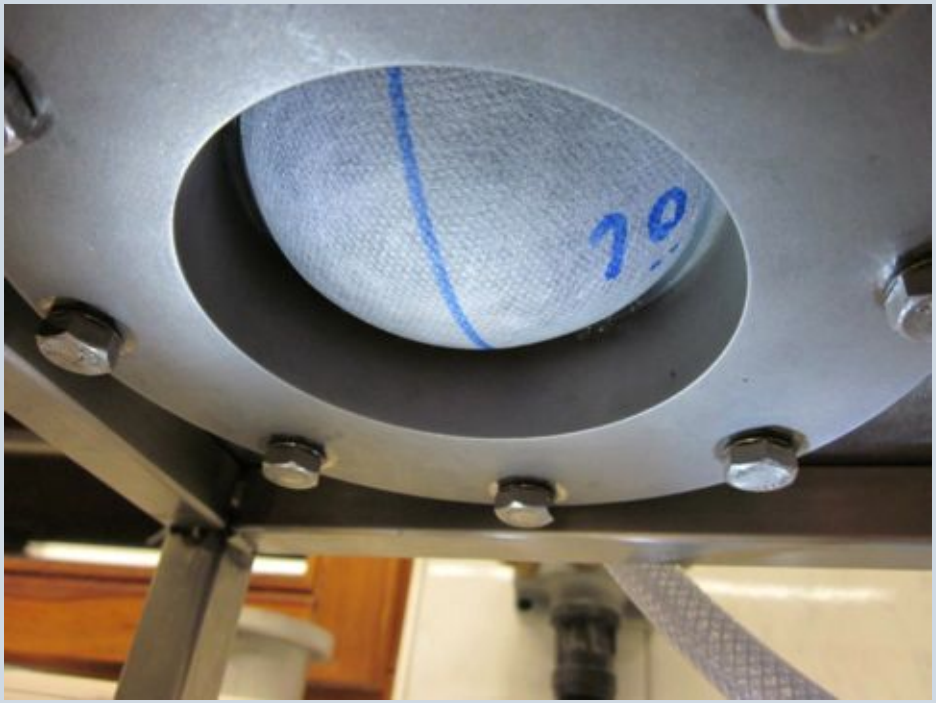
Water penetration at the microporous membrane on the side with treated oil

Watertightness testing of underlays

Half of the nonporous TEEE monolithic membrane

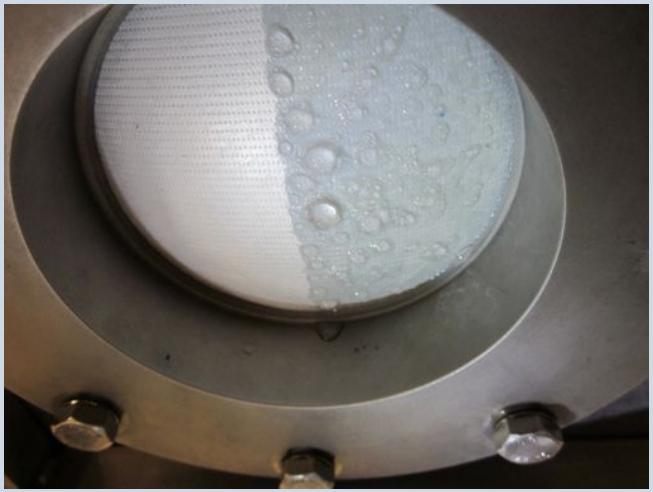
SOLITEX PLUS
sample is treated with oil

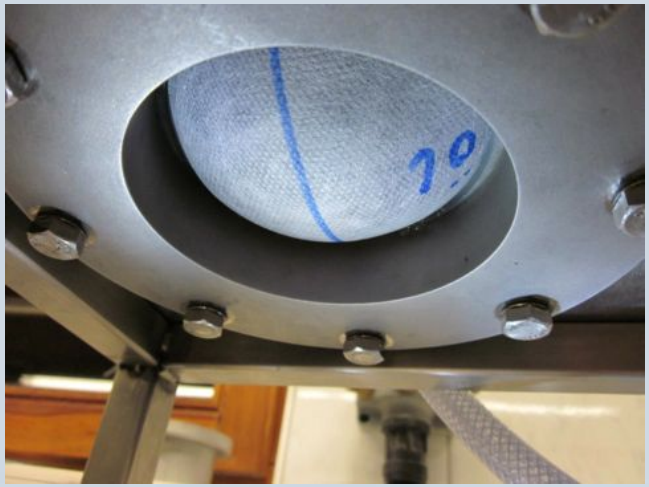
Watertightness testing of underlays



Both sides of the TEEE membrane – with oil and without oil – are watertight

Watertightness testing of underlays





Direct comparison of treated and not treated surfaces of

- microporous PP / PE

- nonporous TEEE membrane

Construction project in Ireland

With different roof underlays

Partial

SOLITEX Plus

Partial

Porous roof underlay

Insufficient airtightness

Structure is not airtight

Protection from Leaky Building from the outside

Condensation on PE / PP porous membrane

Dry surface on TEEE nonporous monolithic SOLITEX Plus membrane

Construction project in Ireland

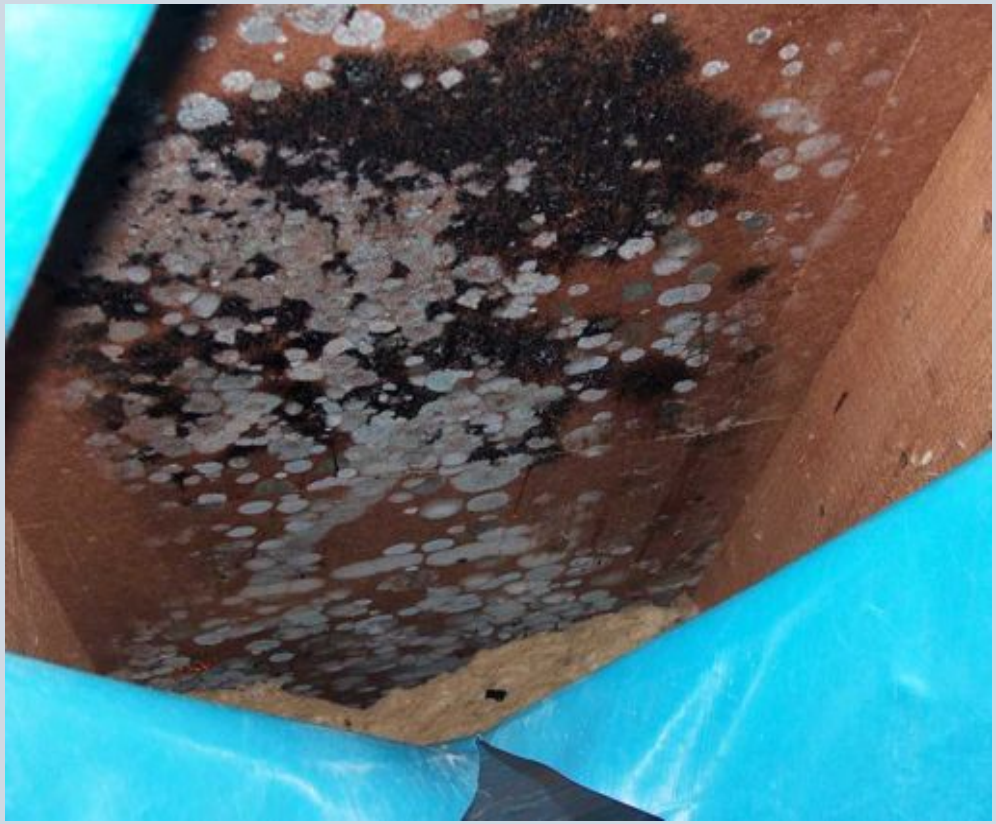
With different roof underlays

- **Partial**
- **SOLITEX Plus**
- **Partial**
- **porous roof underlay**

Protection from Leaky Building from outside

Damages and mould because of only passive transport performance

Structural damage due to moisture



Condensation and Mould

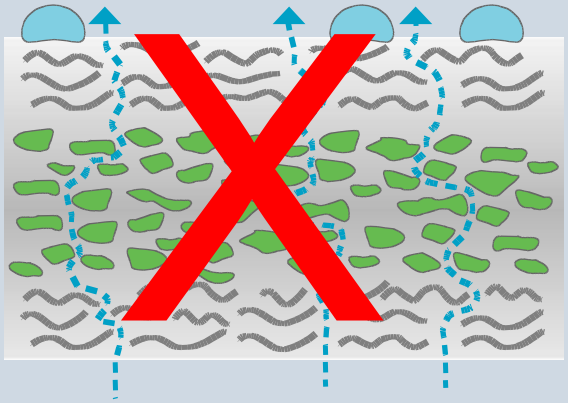
Altough the wood fiber boards are very permeable to vapour flux:

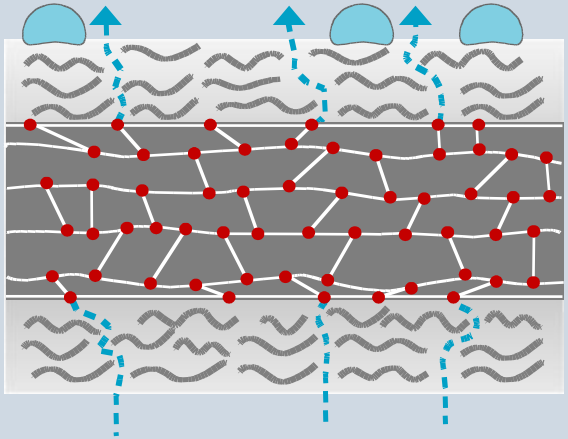
μ value: 3

s_d value of 28 mm = 0.084 m

mvtr of 28 mm = 0.42 MNs/g

2nd line of defense: watertight nonporous monolithic TEEE membrane highly diffusion open, active moisture transport



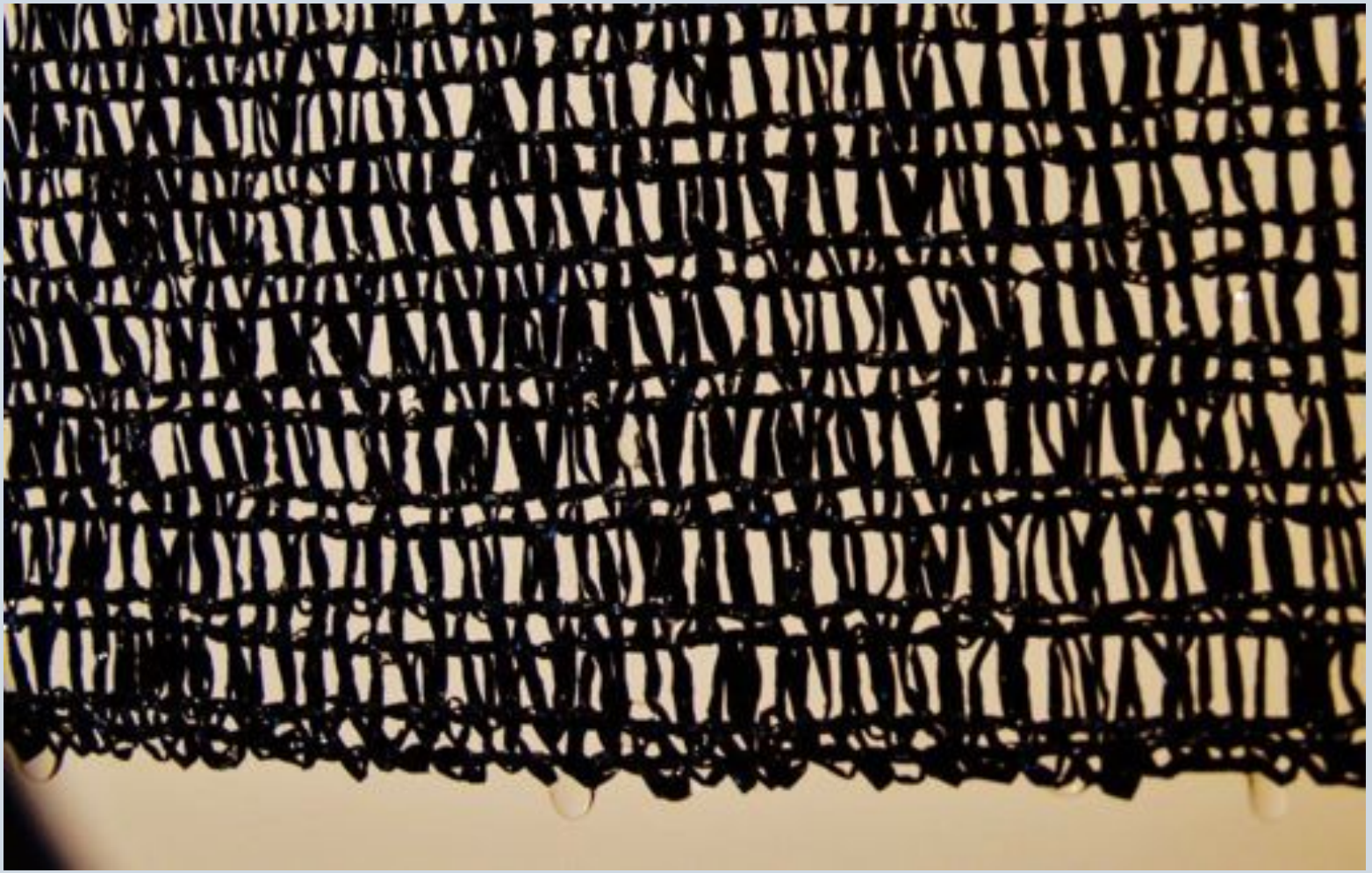


Direct comparison of

- microporous PP / PE

- nonporous TEEE membrane

pro clima – supports the condensation of fog



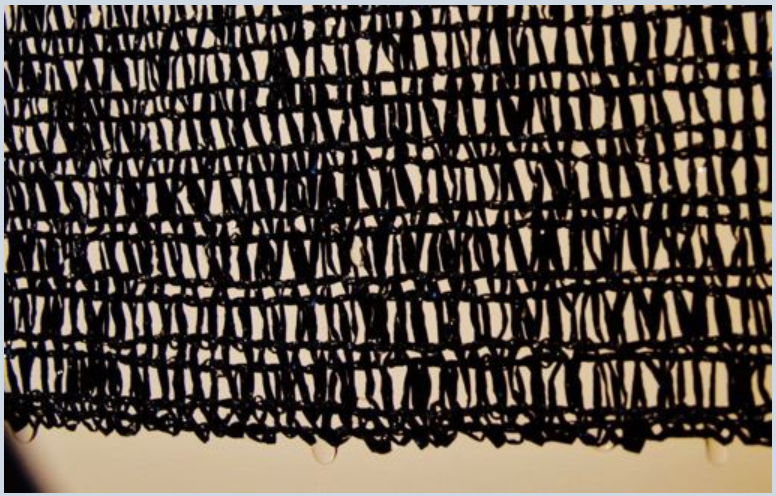
pro clima – supports the condensation of fog

Fog Net Collectors

in Tanzania

pro clima – supports the condensation of fog

pro clima – supports the condensation of fog



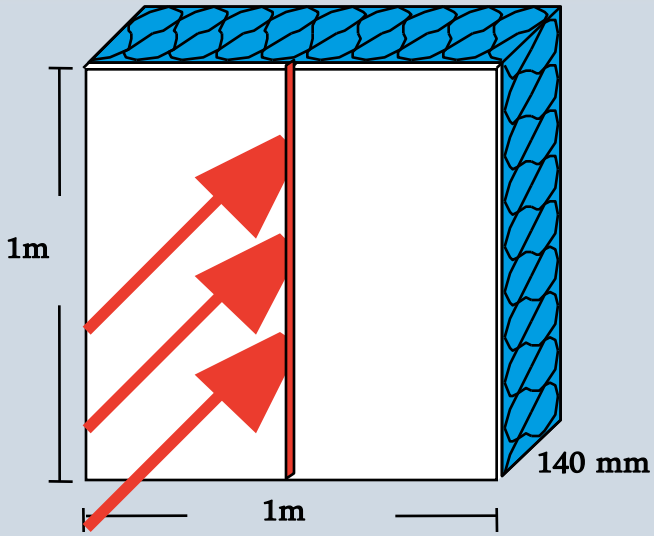
Condensation of fog
in net structure is
good in Africa

Requirements for membranes

Requirements for underlay membranes

Watertightness:	**Absolute watertight** **water column > 2.50 m** **nonporous membrane structure**
Moisture vapour diffusion:	**Very low vapour resistance** **MVTR < 0.25 MNs/g**
Moisture transport:	**Active transport along the molecular chains**
UV stability:	**more than 6 months in UK climate**
Air barrier:	**windtight - airbarrier** **nonporous membrane structure**

1st line of defense: Reduction of moisture load by airtightness and intelligent moisture management



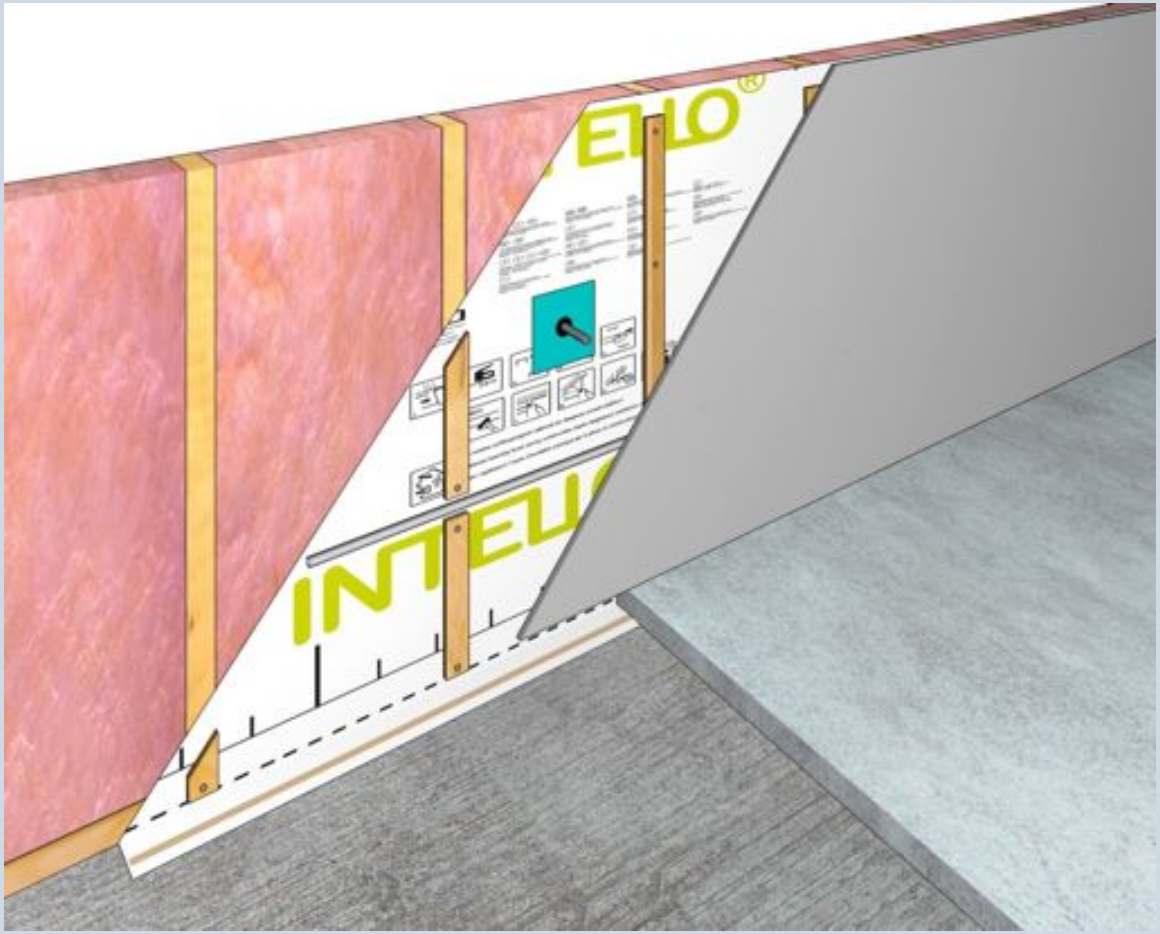
Without gap and diffusion (e.g. INTELLO)
mvtr of 50 MNs/g: 1.5 g water/m²x24h

Without gap and diffusion (e.g. gypsum board)
mvtr of 0.50 MNs/g: 150 g water/m²x24h

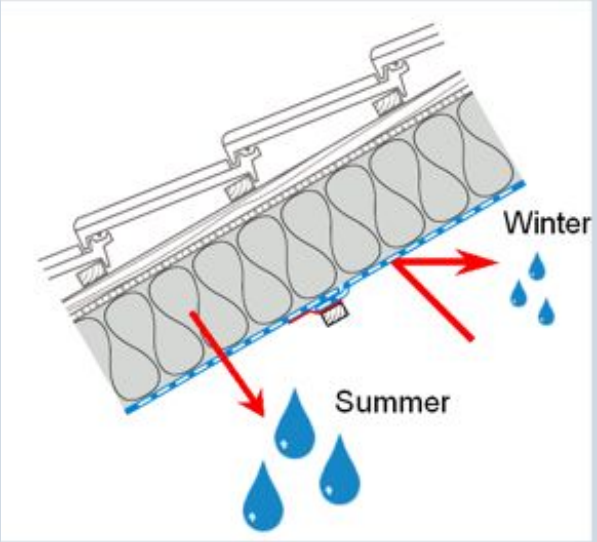
With 1 mm gap and
mvtr of > 150 MNs/g: 800 g water/m²x24h

Data of the 1 mm gap:
Set-up experiment of the Fraunhofer Institute of Building Physics, Stuttgart:
Frame conditions:
Inside temperature +20° C
Outside temperature 0° C
Pressure difference 20 Pa
= wind force 2-3
Source: DBZ 12/89, page 1639ff

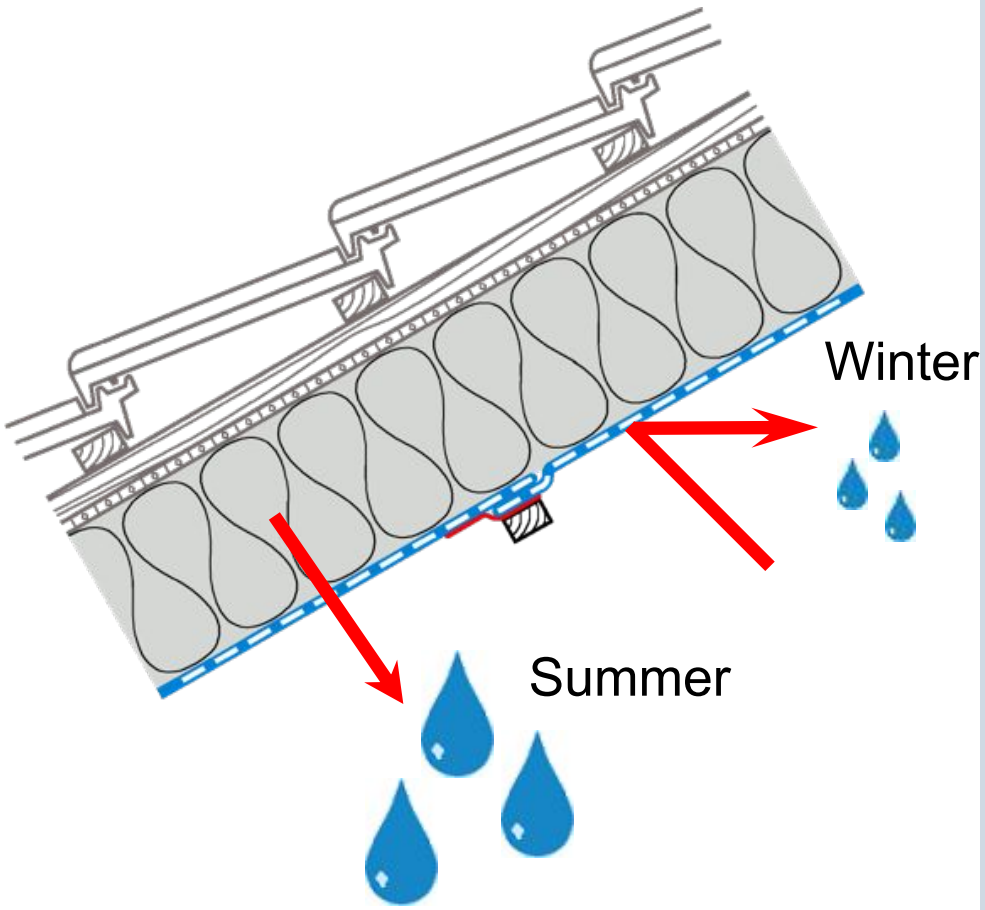
1st line of defense: Internal airtightness layer
Humidity-variable vapour control function



Construction with internal airtightness layer with humidity-variable vapour control function



Airtightness layer with (intelligent) humidity–variable moisture vapour transmission rate



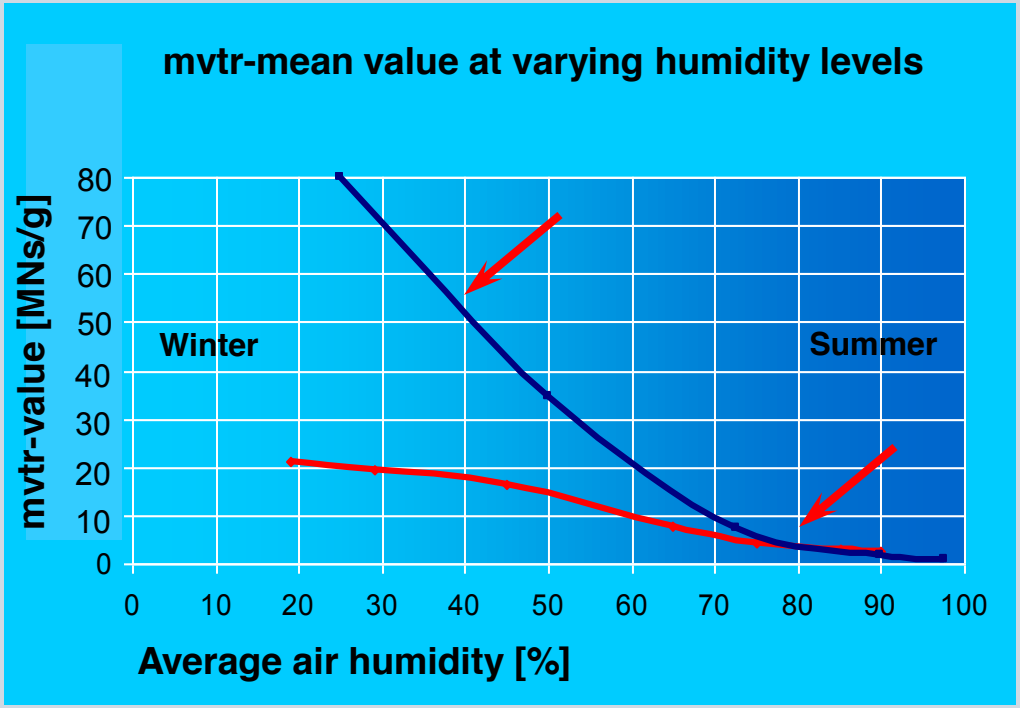
Freedom from structural damage due to vapour membranes with humidity-variable diffusion resistance

In winter: protection against moisture penetration

In summer: high drying potential

Consequence: Optimum protection against mould

Humidity – variable diffusion resistance



pro clima INTELLO® and DB+

In dry climate tighter against diffusion

INTELLO > 50 MNs/g

DB+ > 15 MNs/g

In humid climate more open to diffusion

INTELLO < 1,3 MNs/g

DB+ 4,0 MNs/g

Calculating Potential Freedom from Structural Damage in Timber and Steel Frame Construction

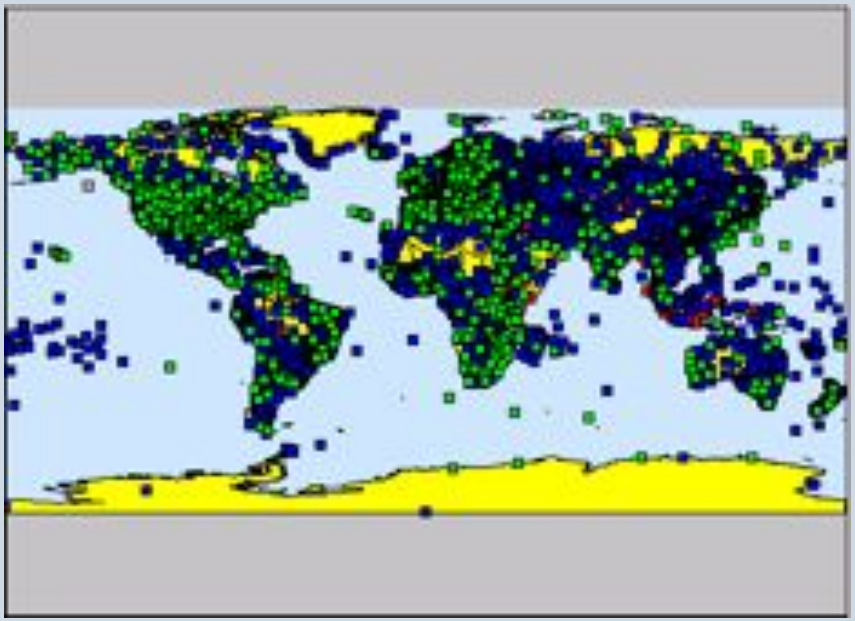
Thermal and moisture transports

Clima- data set of WUFI

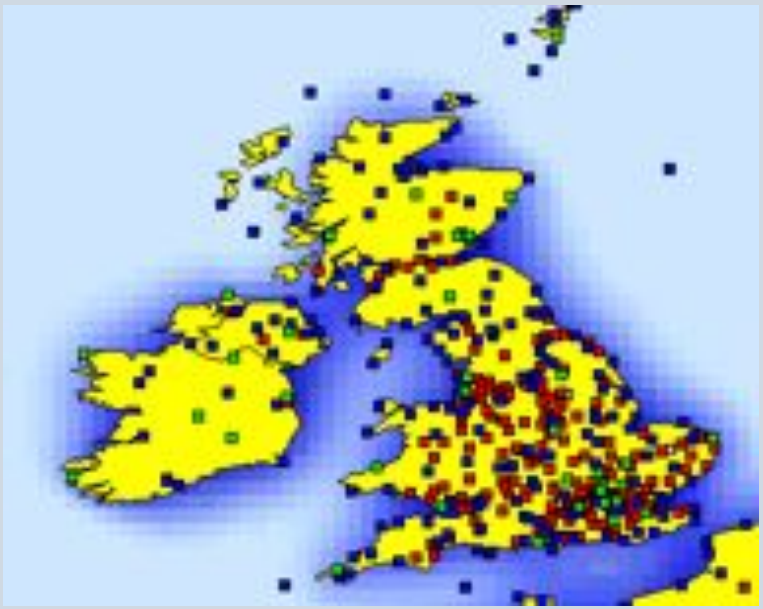
Calculation of thermal and moisture transports

Clima- dataset of Meteonorm Data

Wordwide 7.000

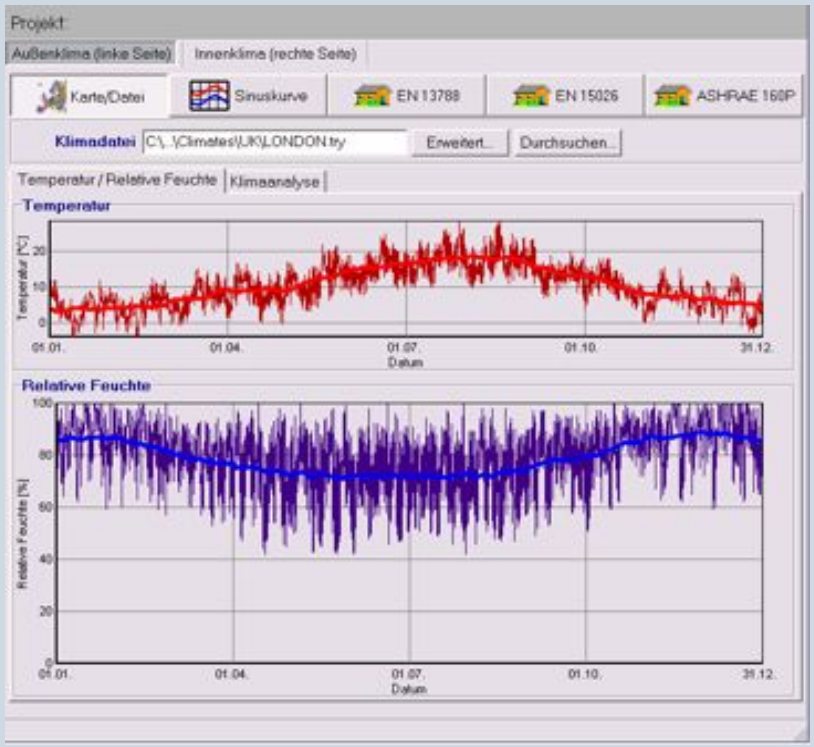


Ireland/UK 400

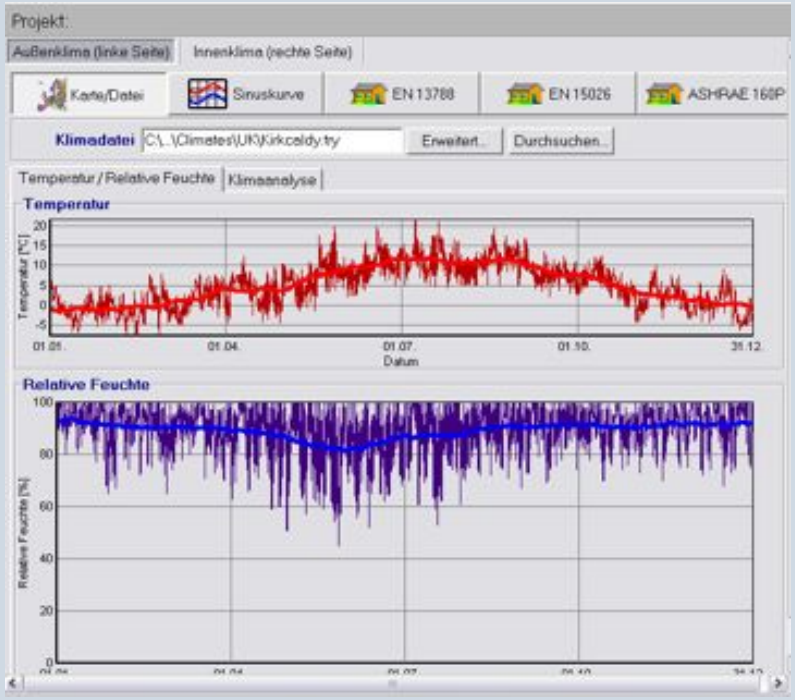


Calculation of thermal and moisture transports

London



Kirkaldy



Calculating Potential Freedom from Structural Damage

Calculation methods

EN ISO 13788 (static)
Method according to Glaser

Winter 60 days

Inside +20° C/50 % rel. humidity

Outside -10° C/80 % rel. humidity

Summer 90 days

Inside +12° C/70 % rel. humidity

Outside +12° C/70 % rel. humidity

Computer- assisted simulation program for heat and humidity transports (dynamic)

- Real climatic data
- Inside and outside temperature
- Inside and outside humidity
- Light absorption
- Moisture storage capability
- Capillary

(Data of one reference year at intervals of 1 hour)

Calculating Potential Freedom from Structural Damage

1. Bitumen roofing felt 3 mm thick, diffusion-tight
2. Wood decking 24 mm
3. Mineral wool 200 mm

Initial moisture: 20 kg/m³ = 4 l/m²

4. Vapour checks/Vapour barriers
5. Air layer 20 mm
6. Gypsum plasterboard 10 mm

Constructions

Building component layers from the outside to the inside

Calculating Potential Freedom from Structural Damage

Roofing construction

Pitched roof, faced north side,

red or grey roof tiles, pitch 40°

Calculating Potential Freedom from Structural Damage

s_d-values

- 50 m (250 MNs/g) PE-sheet
- DB+ 2,3 m (11,75 MNs/g)
  humidity -variable 0,8 bis 3,5 m
  (2 – 18 MNs/g)
- INTELLO 7,5 m (38 [MNs/g])
  humidity -variable 0,25 to > 10 m
  (1,3 to > 50 MNs/g)

Diffusion resistance
Vapour checks and
Vapour barriers

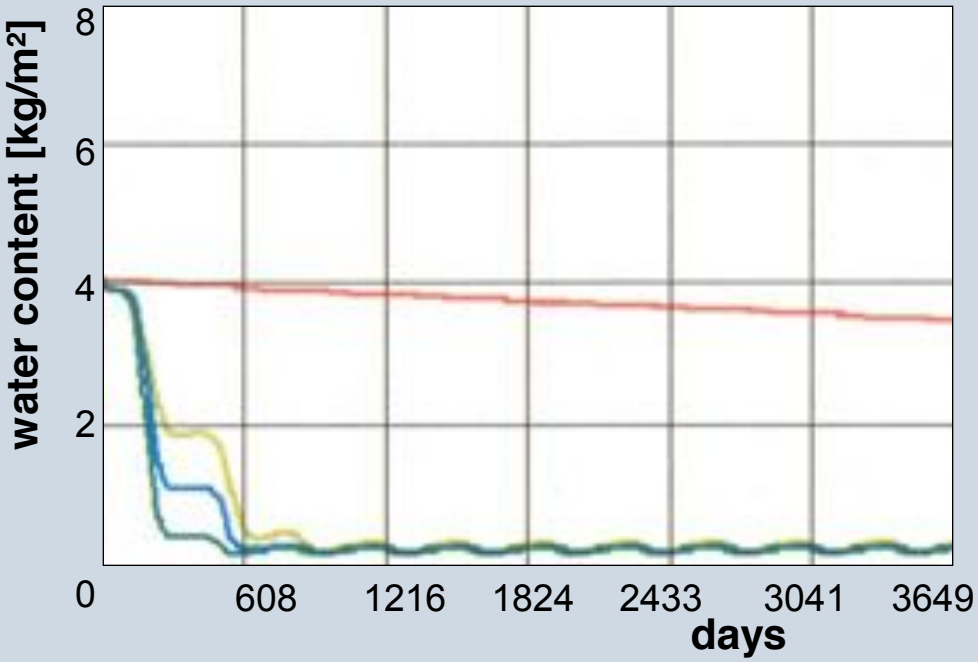
Calculating Potential Freedom from Structural Damage

The speed of drying out describes:

- the tolerance of the construction to unexpected moistue
- the degree of safety of the construction against structural damage
- the amount of water that can enter into the construction without damaging it

Diskussing the results

Calculating Potential Freedom from Structural Damage



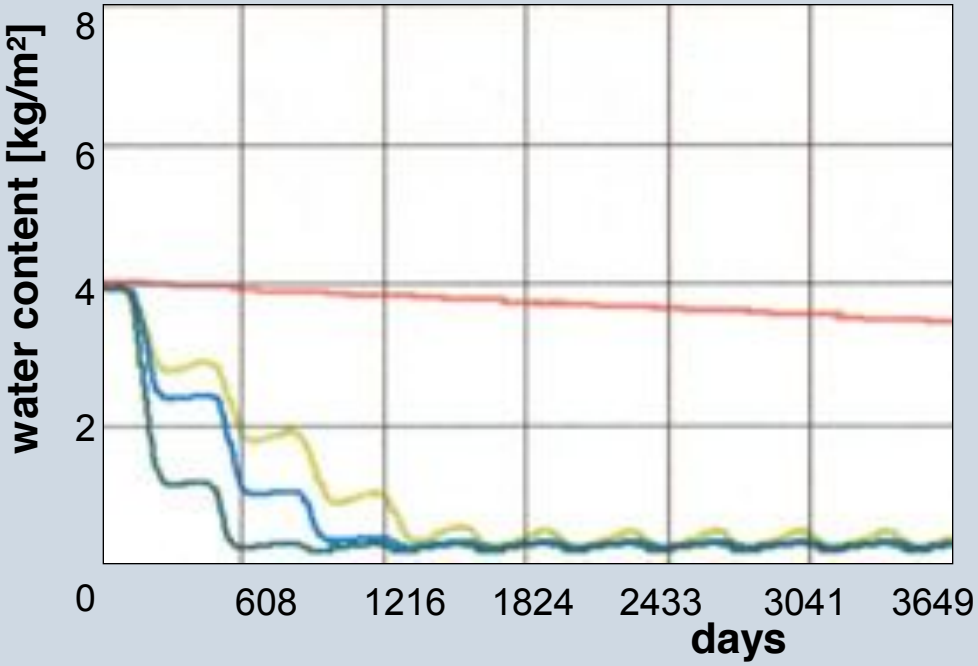
Potential freedom from structural damage:

pro clima INTELLO® black tiles	= 3800 g/m² per year
pro clima INTELLO® grey tiles	= 3000 g/m² per year
pro clima DB+	= 2000 g/m² per year
PE sheet	= 10 g/m² per year

Location

Great Britain
London
Pitched roof

Calculating Potential Freedom from Structural Damage



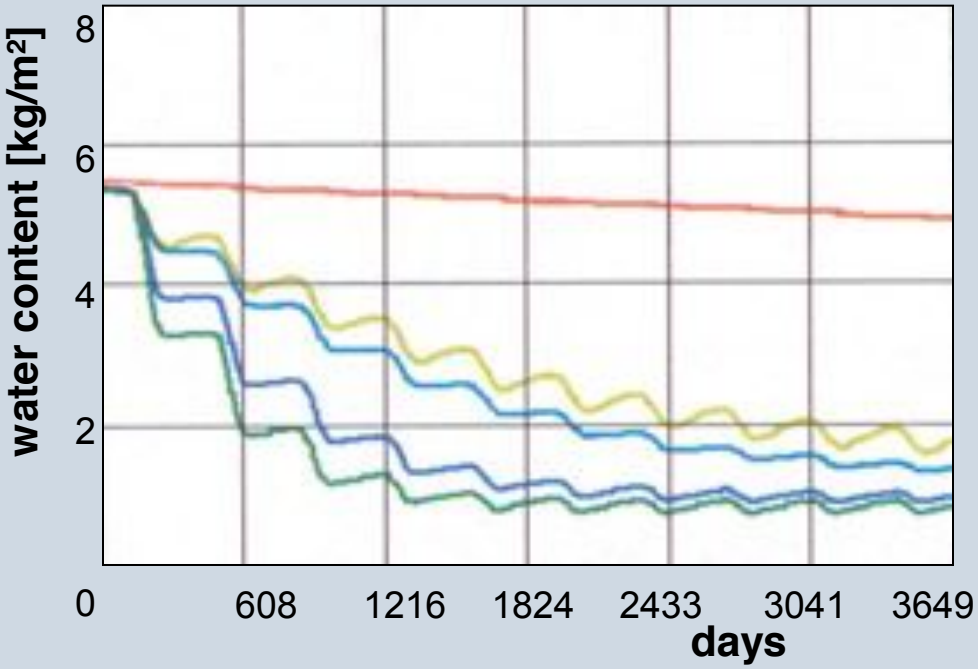
Potential freedom from structural damage:

pro clima INTELLO® black tiles	= 2500 g/m² per year
pro clima INTELLO® grey tiles	= 1700 g/m² per year
pro clima DB+	= 1300 g/m² per year
PE sheet	= 10 g/m² per year

Location

Great Britain
Rhymney Valley
453m above sealevel
Pitched roof

Calculating Potential Freedom from Structural Damage



Potential freedom from structural damage:

pro clima INTELLO® black tiles, 40° = 1800 g/m² per year
pro clima INTELLO® grey tiles, 25° = 1500 g/m² per year
pro clima INTELLO® grey tiles, 40° = 800 g/m² per year
pro clima DB+, 40° = 300 g/m² per year
PE sheet, 40° = 10 g/m² per year

Location

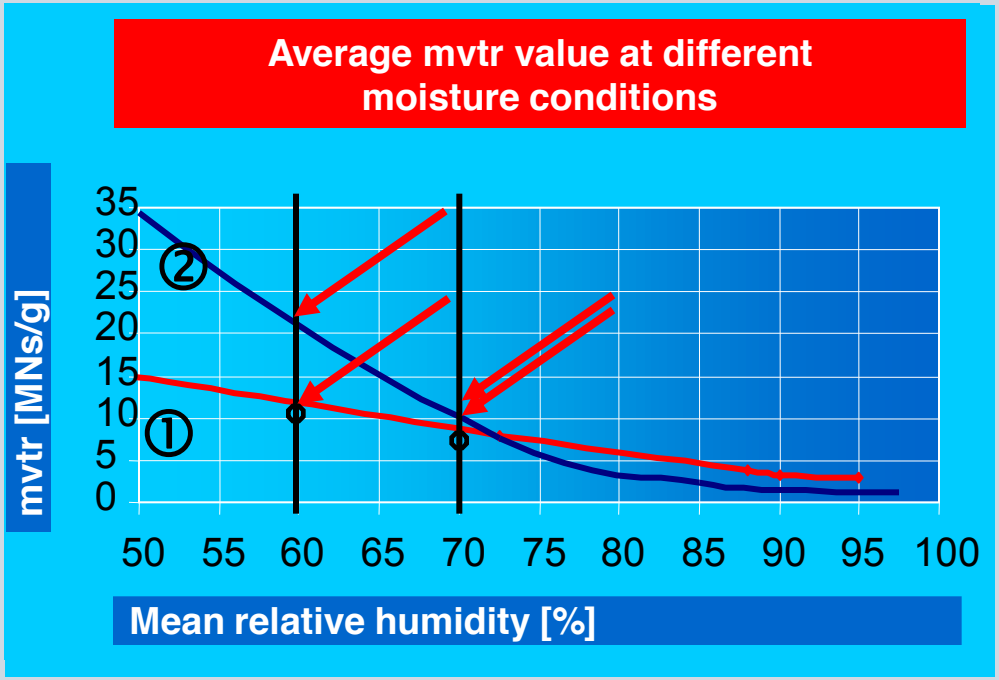
Scotland
Inverness
Pitched roof

Moisture during construction time
Caused by screed and plaster

Condensation on the pane and on the PE- sheet

Moisture even condensate at structural units, with a high surface-temperature.

Protection in all climate situations



① pro clima DB+

② pro clima INTELLO®

Even under new-building conditions: sustainable security with INTELLO® and DB+

High security against moisture entrance even at high air-humidity

The 60/10 and 70/7.5 rule

At 60 %: mvtr > 10 MNs/g

At 70 %: mvtr > 7,5 MNs/g

Moisture during construction time
Caused by screed and plaster

Condensation on the PE- sheet

Water drops all over the window knob

Moisture even condensate at structural units, like the window knob, which are not external units.

Moisture during construction time
Caused by screed and plaster

Condensation on the PE- sheet

Water drops all over the window knob

Moisture even condensate at structural units, like the window knob, which are not external units.

Moisture during construction time
Caused by screed and plaster

Condensation on the PE- sheet

Water drops all over the window knob

Moisture even condensate at structural units, like the window knob, which are not external units.

Moisture during construction time
Caused by screed and plaster

Condensation on the pane of the roof-window

condensation all over the pane …

Moisture during construction time
Caused by screed and plaster

Condensation on the pane of the roof-window

… and runs down below.

Moisture during construction time
Caused by screed and plaster

Condensation on the PE- sheet

Drops run down below.

Water condensate on the PE- sheet and run down below.

Moisture during construction time
Caused by screed and plaster

Adhesive tape peels due to water influence off:

Adhesive tapes for airtightness-layers should be moisture solid, but they need not to be water save.

Adhesive tapes for external use must be water save.

The pro clima tape sticks save in spite of moistness.

Moisture during construction time
Caused by screed and plaster

Condensation water on the PE- sheet

Water drops at the window knob

Moisture even condensate at parts, like the window knob, which are not external parts.

Moisture during construction time
Caused by screed and plaster

pro clima Tapes:

Watersafe SOLID glue, offers safety during moist situation during building time:

- not dispersion...
- …but SOLID based
- free from emulsifying agents
- no reemulsification
- high waterresistance

Moisture during construction time
Caused by screed and plaster

pro clima Tapes:

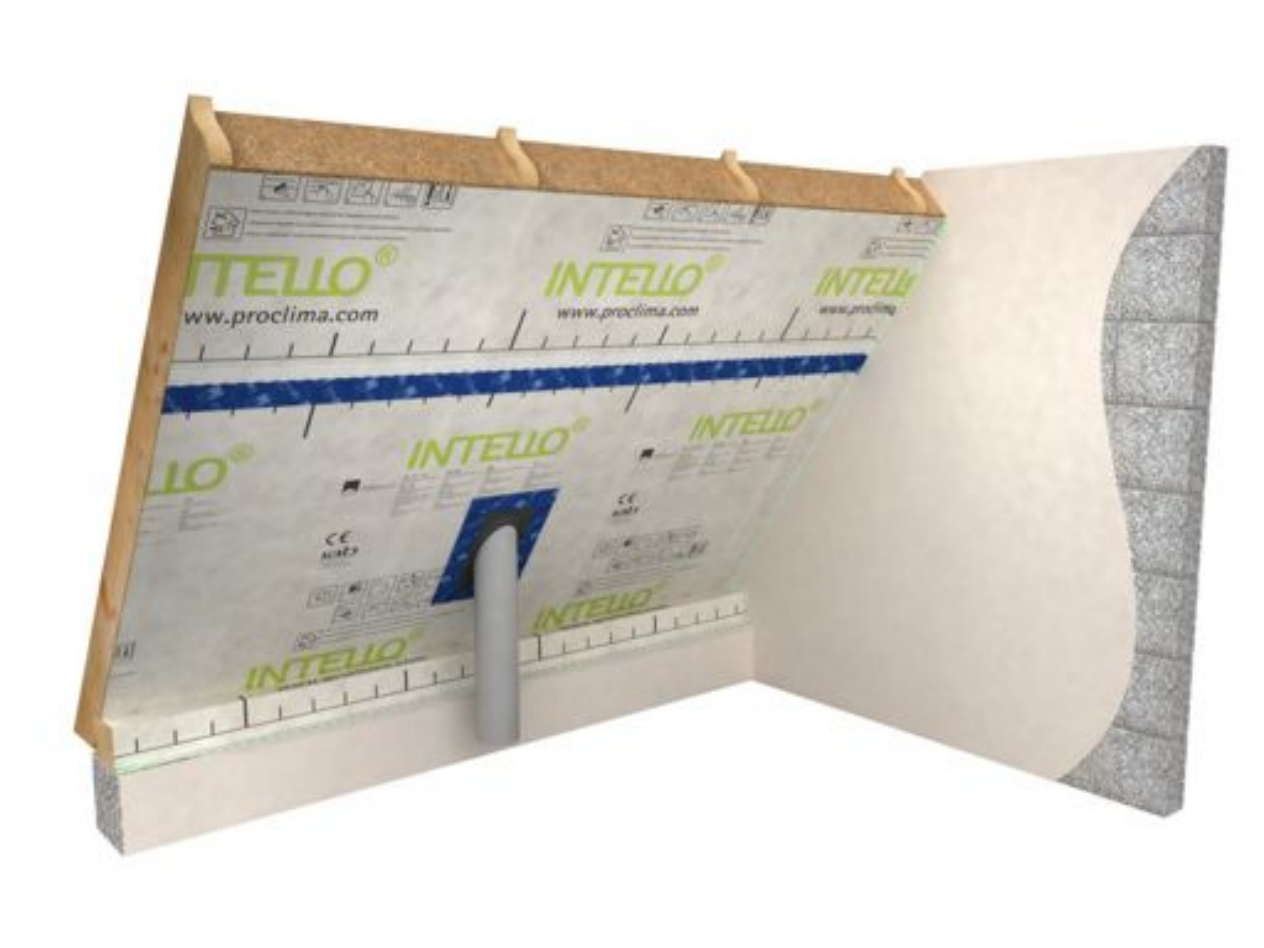
Watersafe SOLID glue, offers safety during moist situation during building time:

- not dispersion...
- …but SOLID based
- free from emulsifying agents
- no reemulsification
- high waterresistance

Application

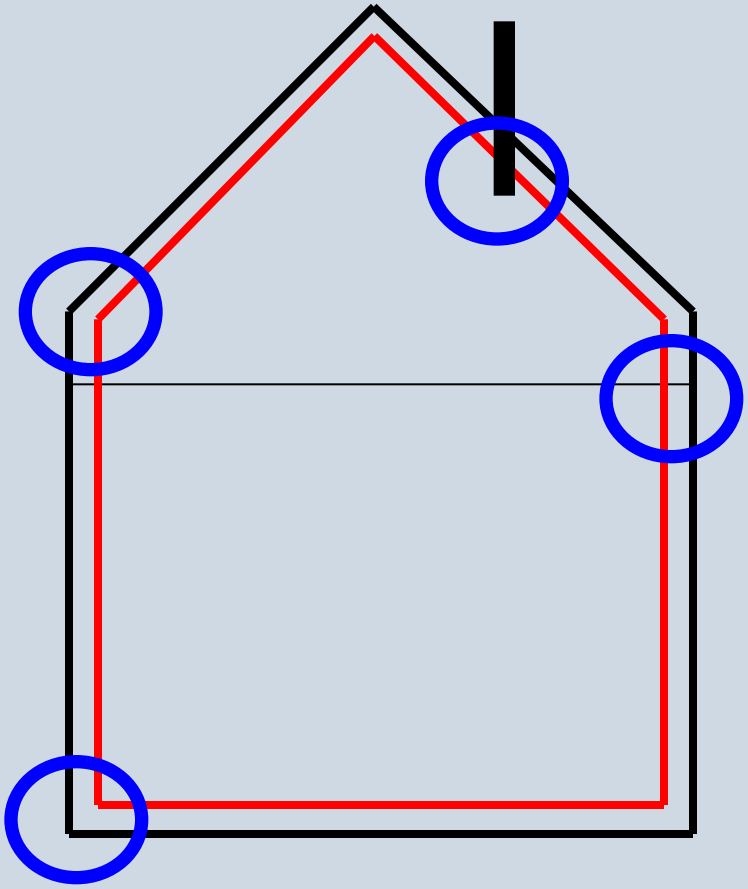
Intelligent airtight system

Application



Application

Planning of airtightness – the principal



Application

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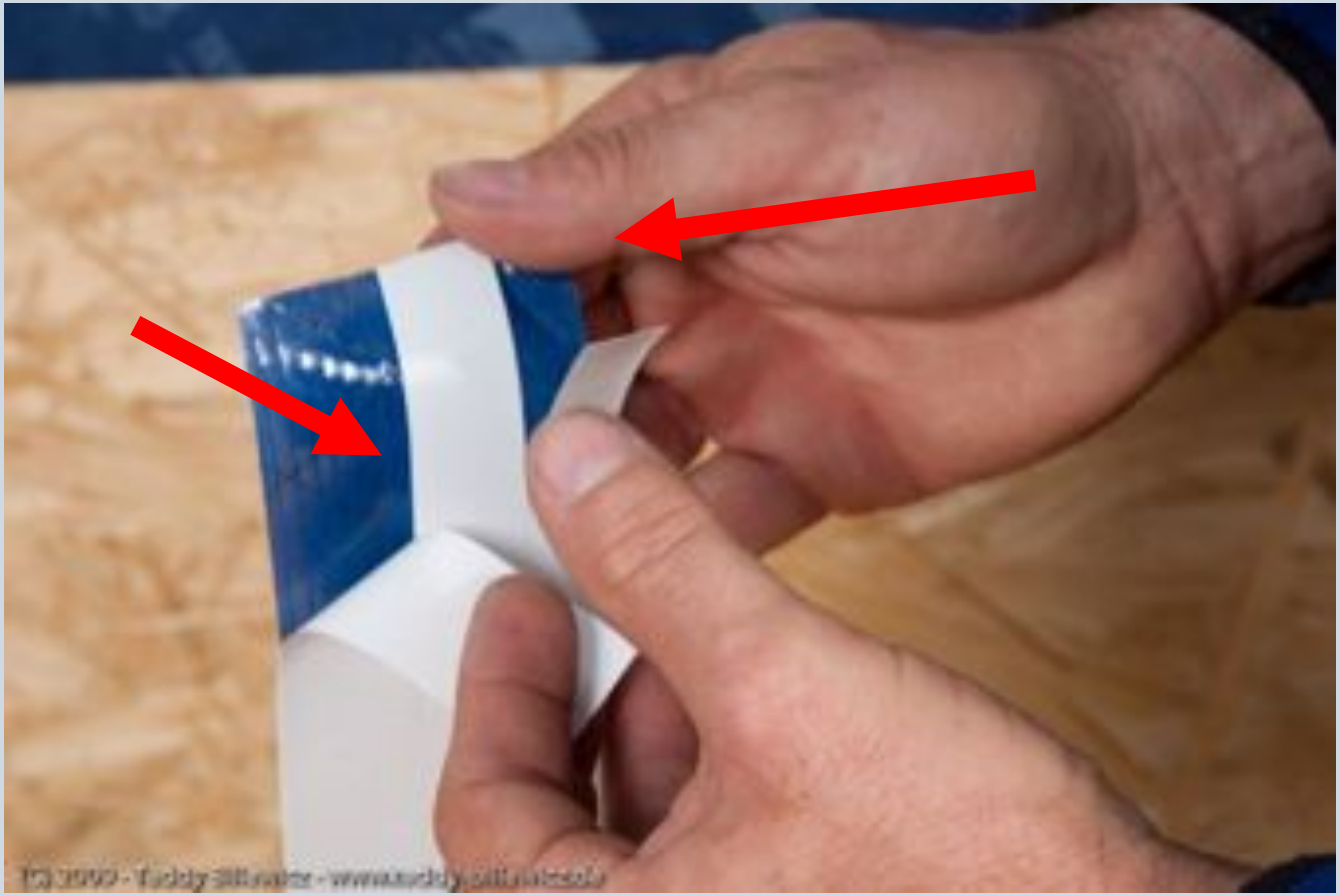

Application

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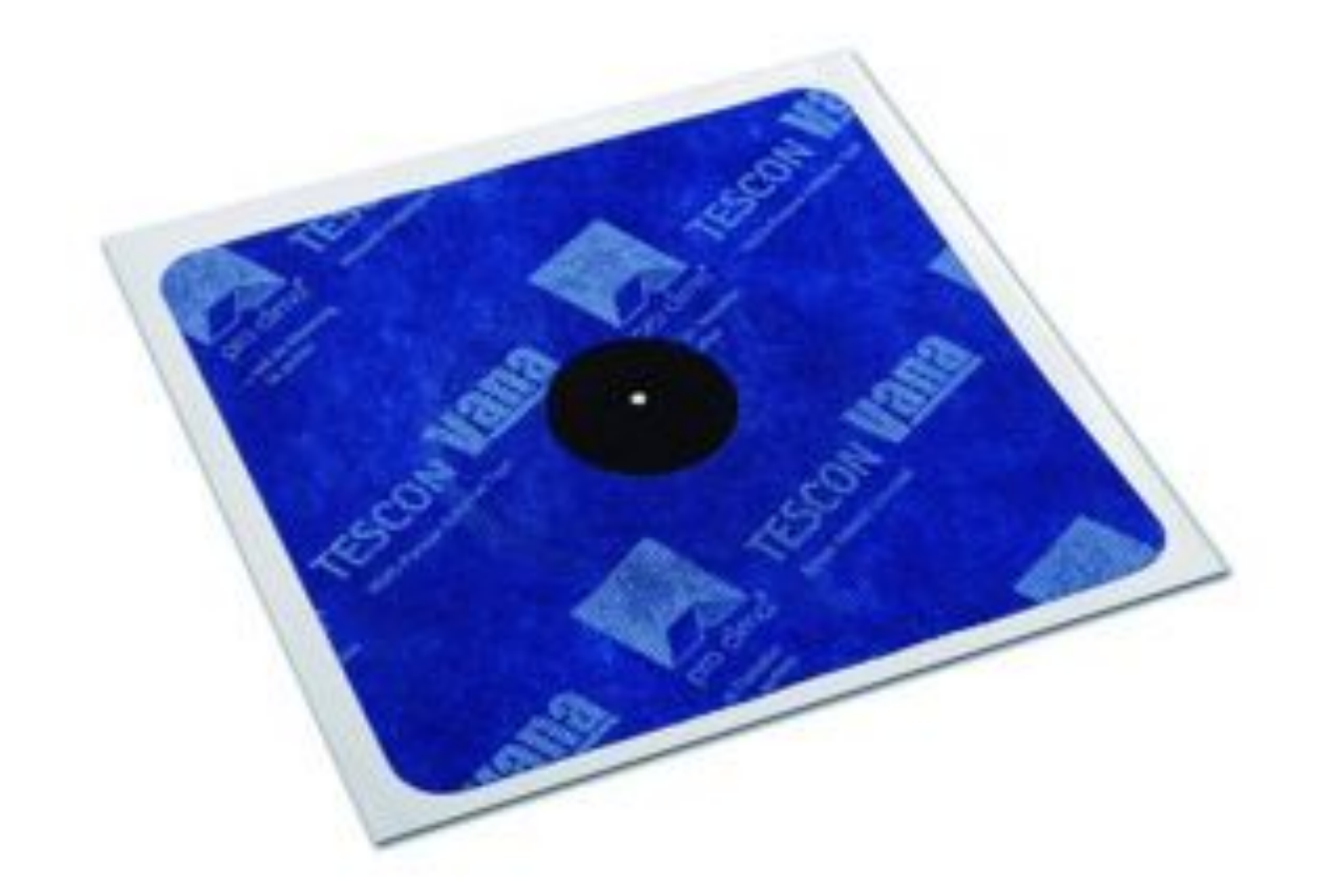

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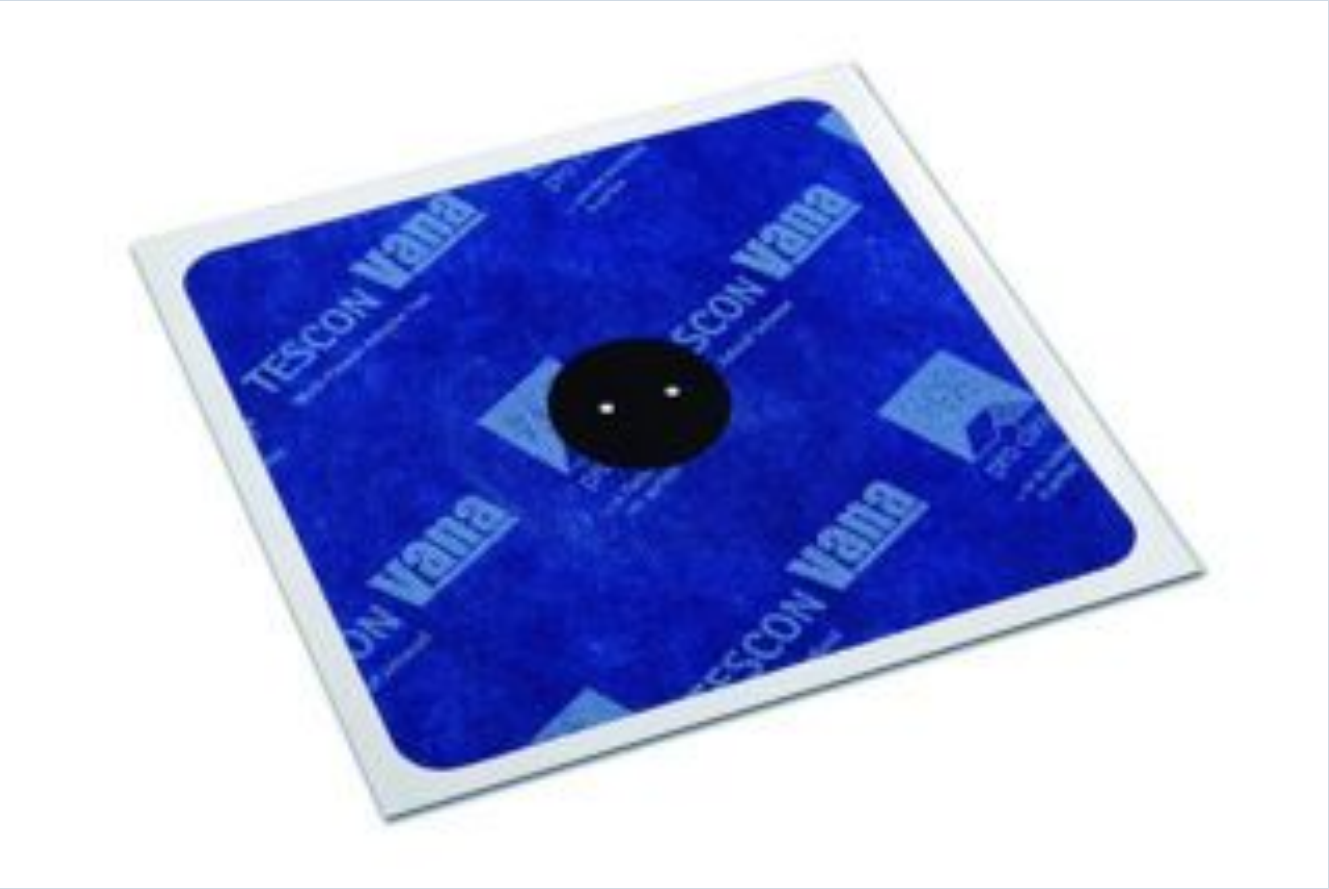

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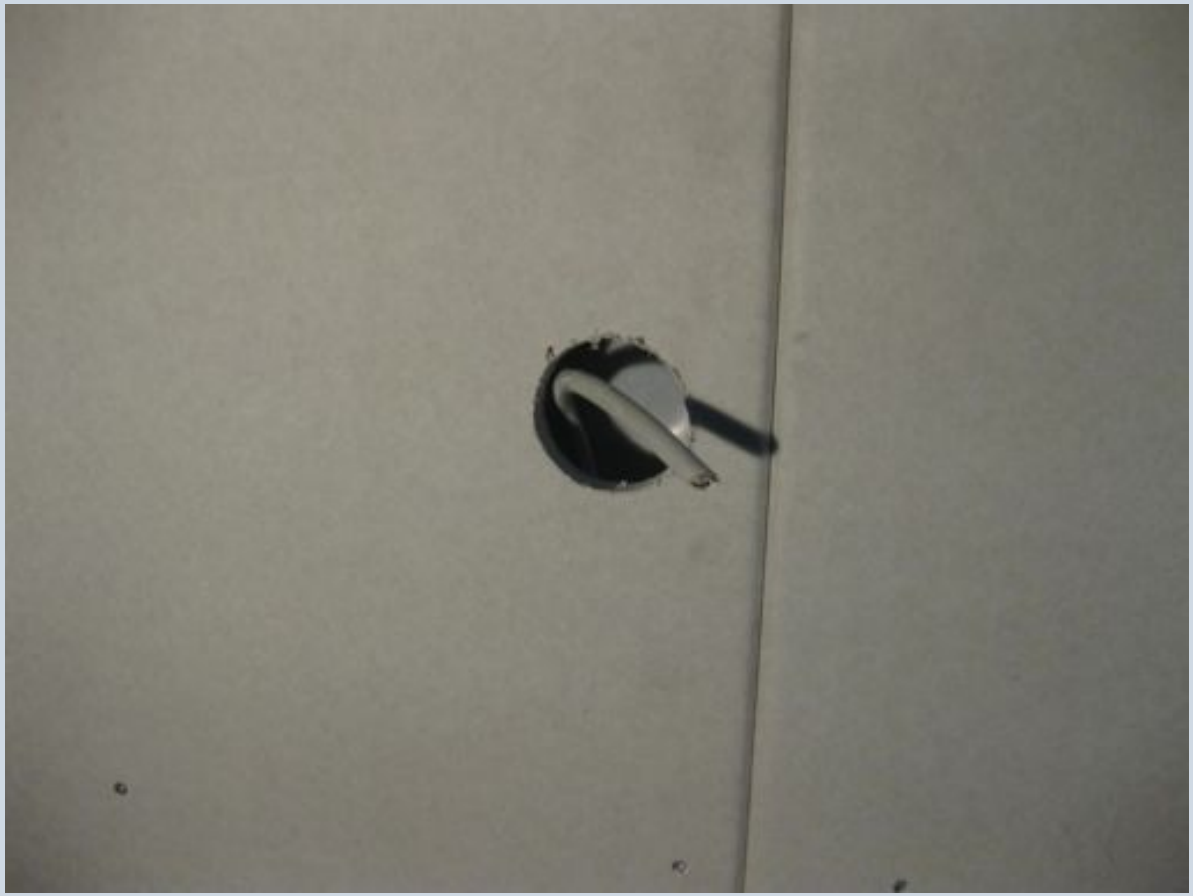


Application

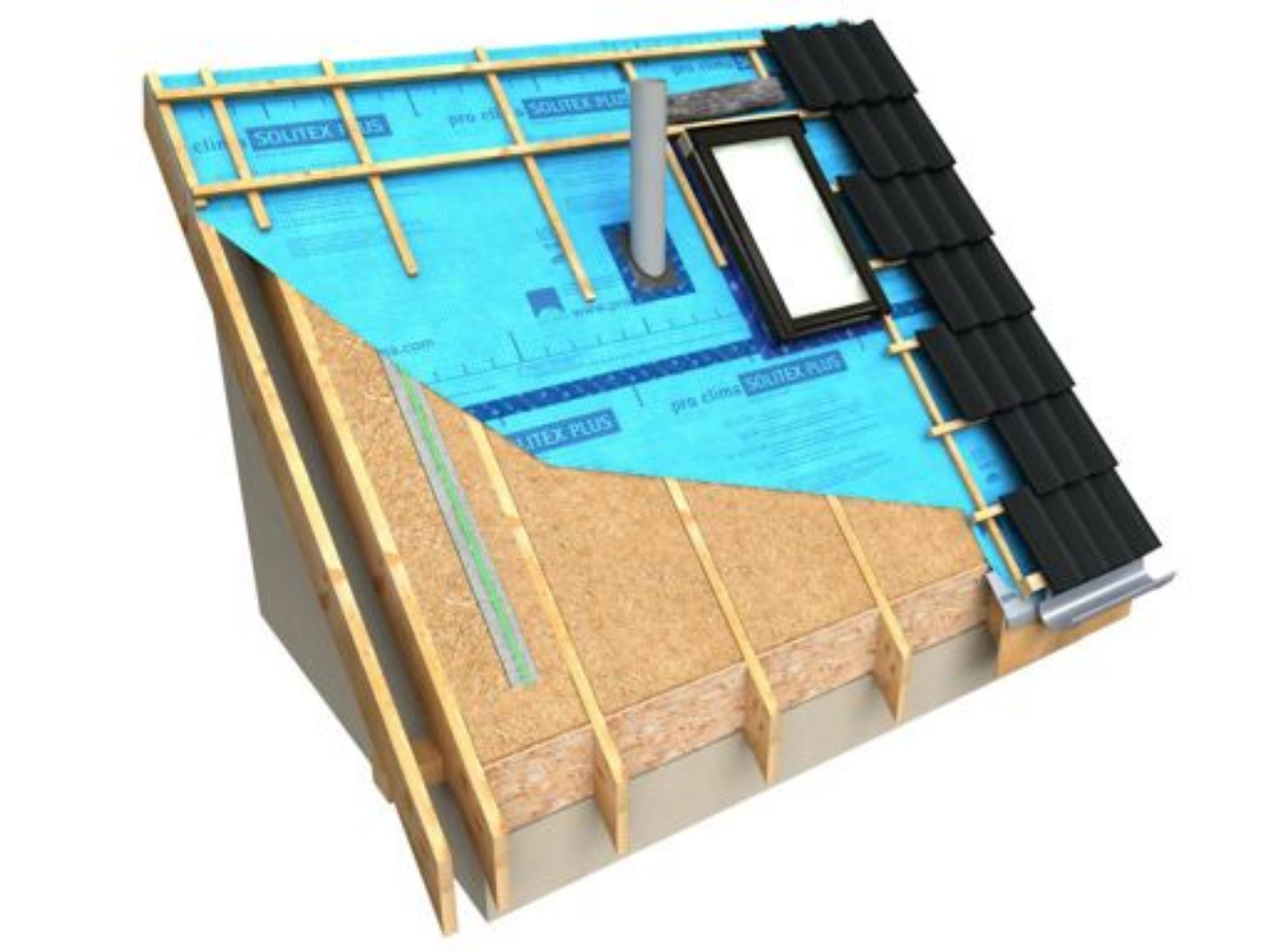
Application

Application

Application

Airtightness testing

Application



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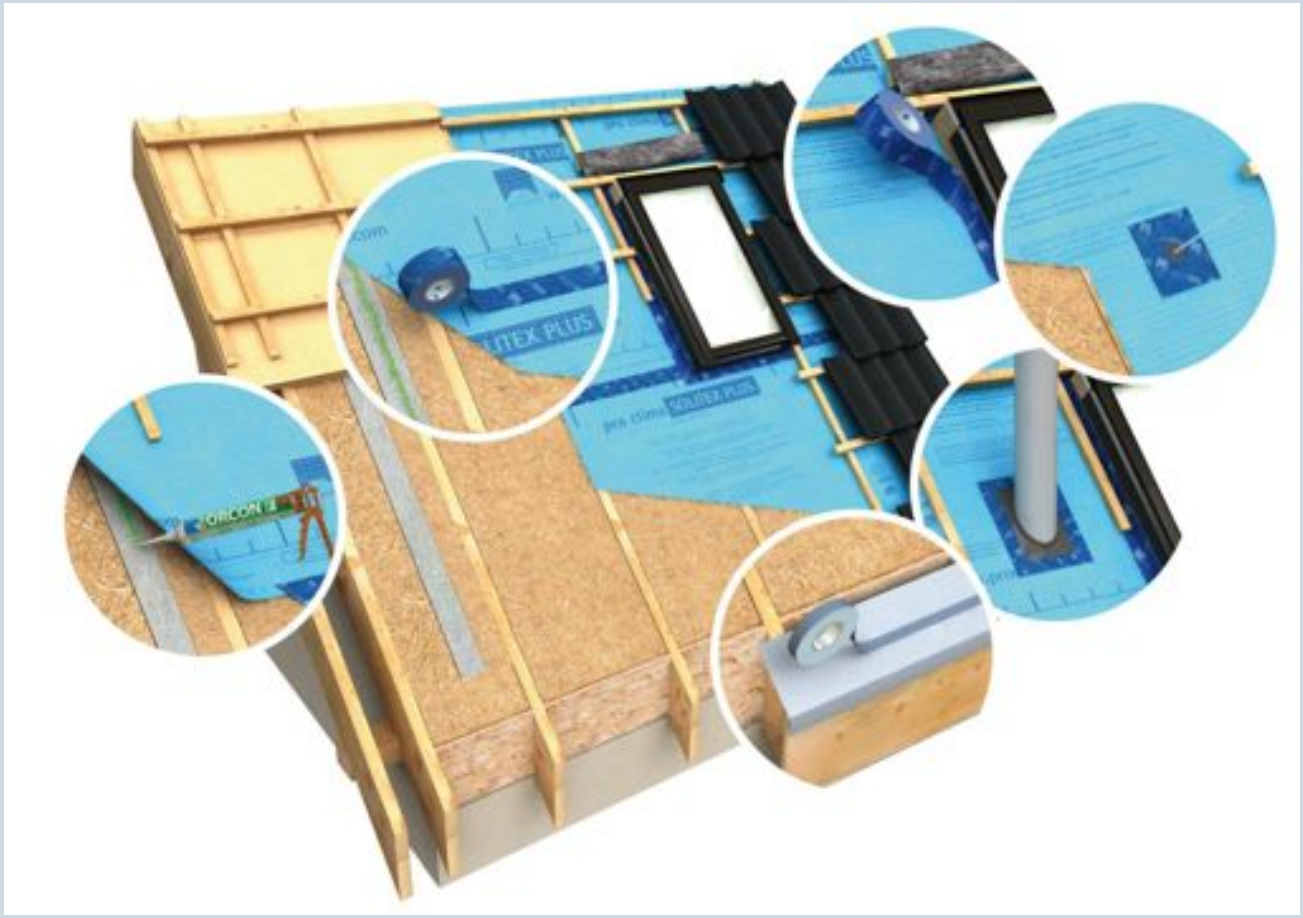
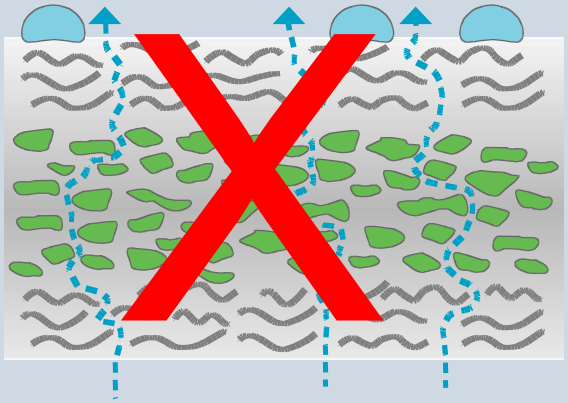
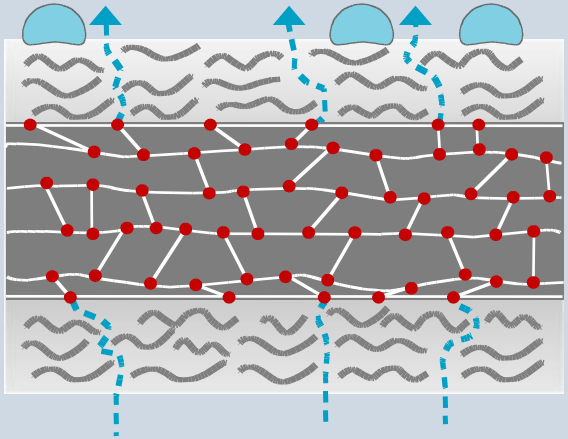


2nd line of defense: watertight nonporous monolithic TEEE membrane highly diffusion open, active moisture transport





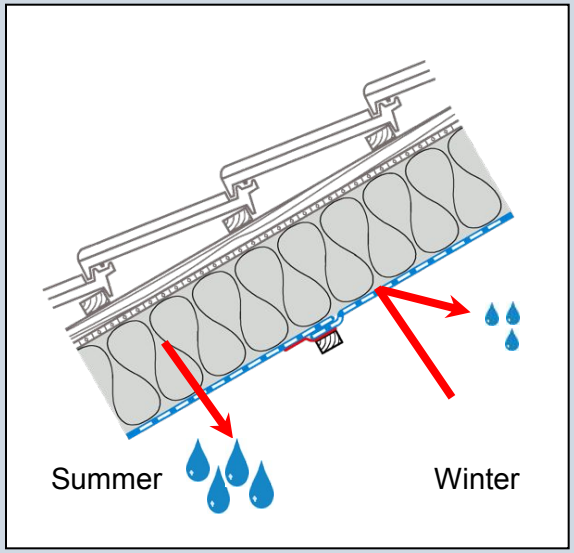
Direct comparison of

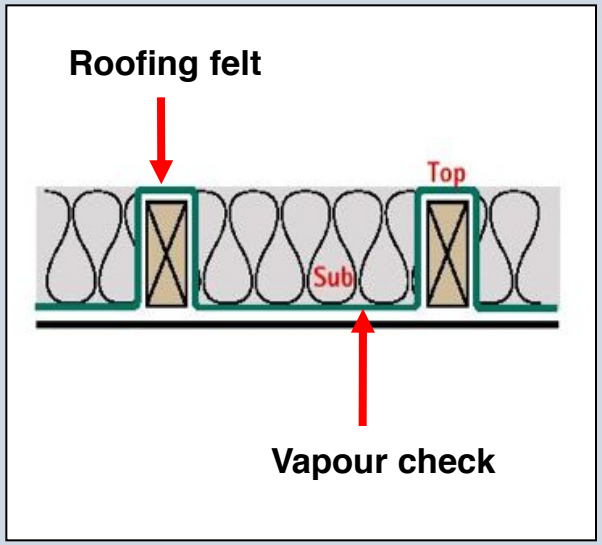
- microporous PP / PE

- nonporous TEEE membrane

Application

1st line of defense: Reduction of moisture load by airtightness and intelligent moisture management





New building

Winter:
Protection against moisture

Summer:
high drying potential

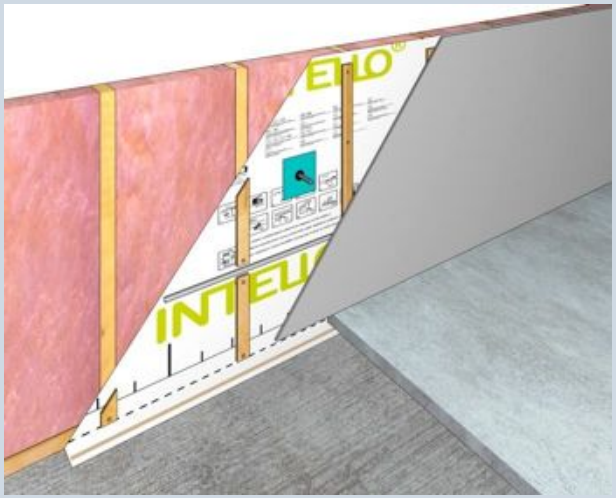
Refurbishment

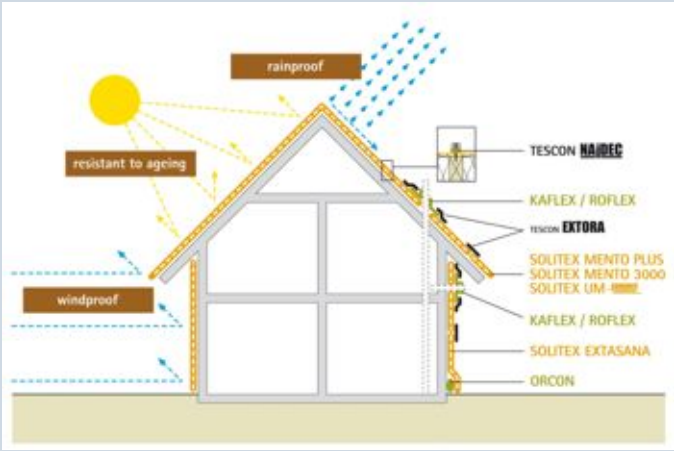
Outside:
roofing felt

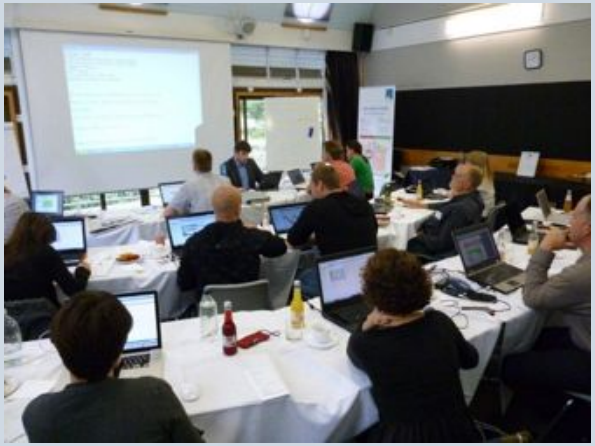
Inside:
vapour check

Application

pro clima sealing systems



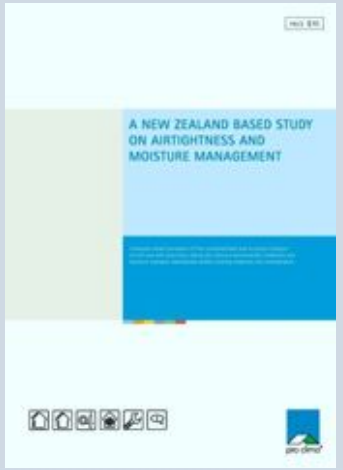




Education in UK

Solutions for UK

Realisation in UK



pro clima – benefits and use

pro clima worldwide – United Kingdom and Ireland

MOLL bauökologische Produkte GmbH (Ecological building products)

pro clima is represented in:
Great Britain
Ireland