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Airtightness and Active Moisture Management Using Intelligent membranes

Niall Crosson, Senior Engineer, BTech,MEngSc,MIEI; CEPHC

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Presentation Overview

- Introduction
- What is Airtightness?
- What are the benefits of airtightness?
- How can I achieve airtightness?
- Potential moisture penetration into structural elements
- Moisture management, Intelligent membranes
- Pro clima Intelligent on-site solutions.
- Ensuring Quality control and measuring airtightness (International and national standards).
- Presentation summary
- Q & A

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- Extensive technical support on Airtightness & Insulation
- Building Regulation advice
- U-Values & Hygrothermal Modelling
- Site support – Toolbox Talks
- Centre of Knowledge training centre
- Airtightness installation DVD
- Airtightness specification clauses

Ecological Building Products:

Insulation:

THERMO HANF

therma fleece COSYWOOL

GUTEX® NATURALLY MADE FROM WOOD

WARMCEL® Insulation Fibre

DÄMMSTATTs CI 040 · Zellulosedämmstoff

CALSITHERM CLIMATE BOARD

CELENIT NATURAL INSULATORS

Airtight/Windtightness:

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wellhöfer ATTIC HATCHES

Optime Europe

Engineered Solutions:

SMART SIX

UNILIN

esb elka strong board

Natural Paint:

AURO my world ... naturally

Introduction to Ecological Building Systems Demonstration and Training Centre: Athboy, Co Meath

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Why Airtightness – Infiltration and Ventilation

Air Infiltration/Draughts and exfiltration – The uncontrolled entry or exit of outdoor or indoor air from the habitable space

Ventilation – The controlled/designed replacement of stale indoor air with fresh outdoor air

Airtightness – The elimination of uncontrolled air infiltration

BUILD TIGHT AND VENTILATE RIGHT!

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Airtightness testing and measurement – Blower Door Test & clarification on Air Permeability

Air Permeability :
Q50 = cubic metres of leakage, per square metre of building envelope per hour, at a differential pressure of 50 Pascals, i.e. m3/(m2.hr) @ 50Pa.

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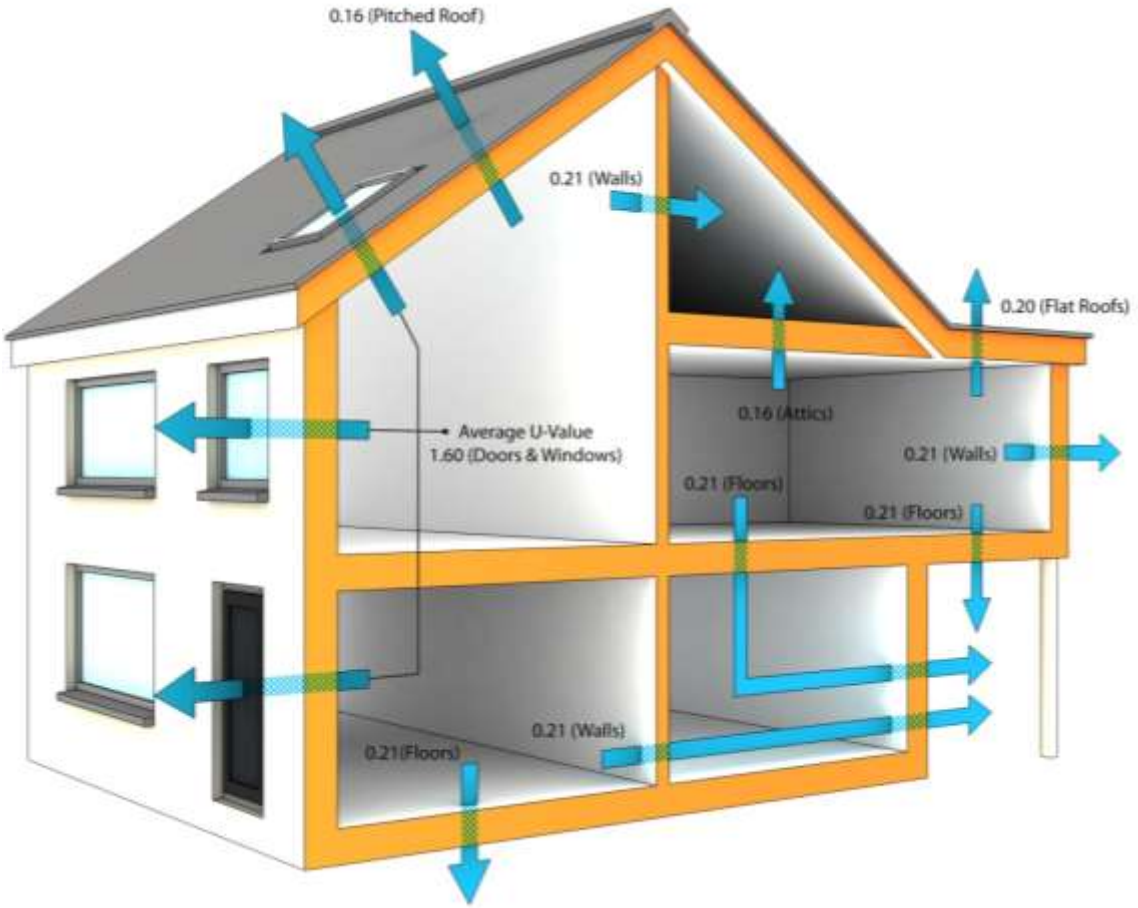
Building Regulation Requirements:
New Builds:
Backstop U value requirements to comply with Part L of Building regulations 2011



Summary

- **Air permeability: 7m3/hr/m2**
- **Limiting thermal bridging: Y-value of at least 0.08W/mK to the Acceptable construction details ***
- **Boiler efficiency: > 90%**
- **Renewables: 10kWh/m2/yr for thermal or 4kWh/m2/yr elec.**

***ACD's (see: http://www.environ.ie/en/TGD/**

Actual required improvement between 17-40%

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Mater Hospital, Dublin 2004 <1.5 ACH @50 Pa

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First Certified Non Domestic PassivHaus – Wales
0.37 ACH @ 50Pa

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Denby Dale Passivhaus 2009
0.33 ACH @ 50Pa

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green
building
store

Certified Non Domestic PassivHaus
Borris, Co Offaly
0.38 ACH @ 50 Pa

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Ventilation Systems

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Natural Ventilation
- Trickle vents
- Passive Stack
- Supply air windows
- Opening windows

Mechanical ventilation
- Extract fans
- Whole house extract
- Room ventilator with heat recovery
- Whole house mechanical ventilation with heat recovery
- Demand Controlled Ventilation

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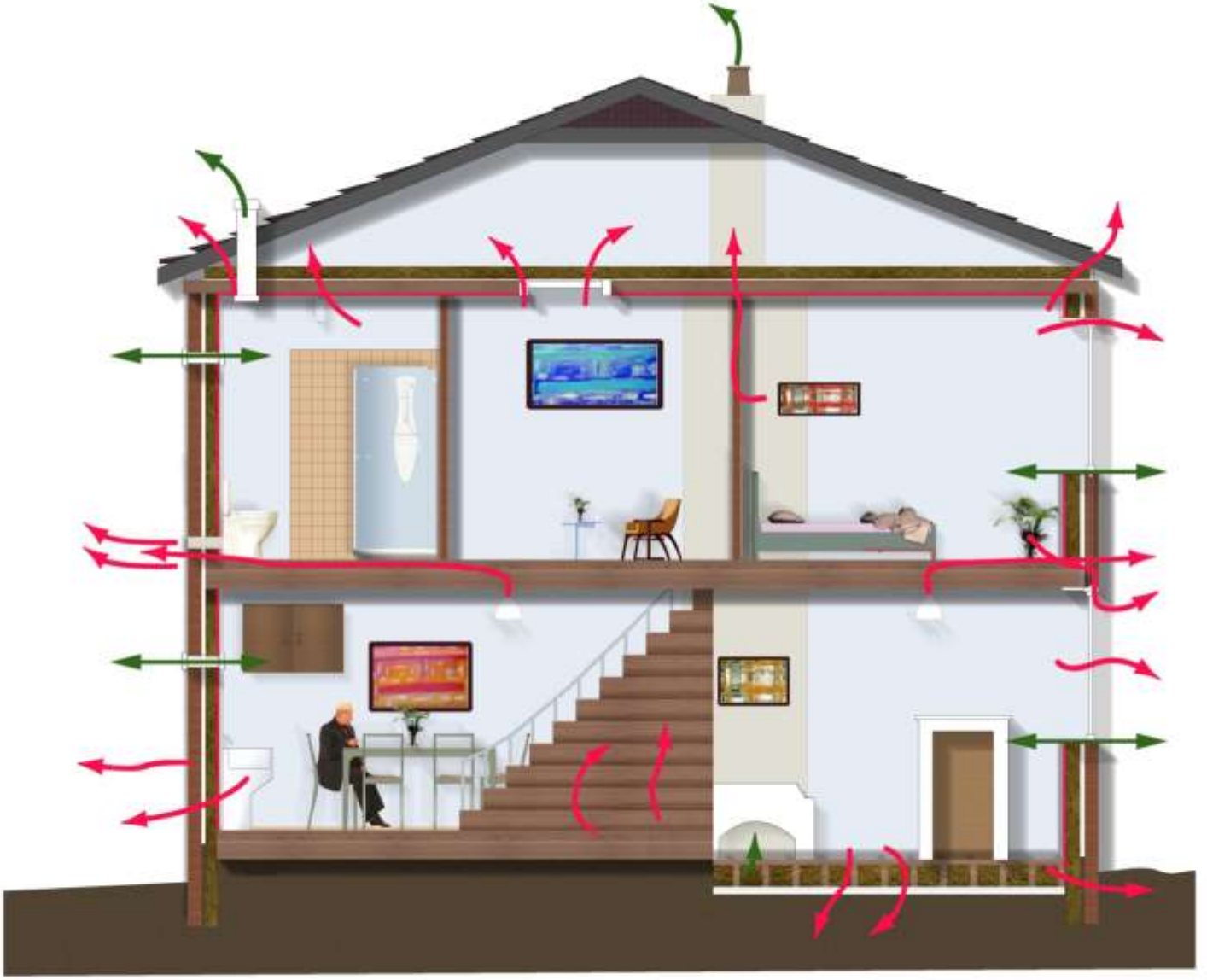

A draughty, “leaky” building

Why Airtightness?

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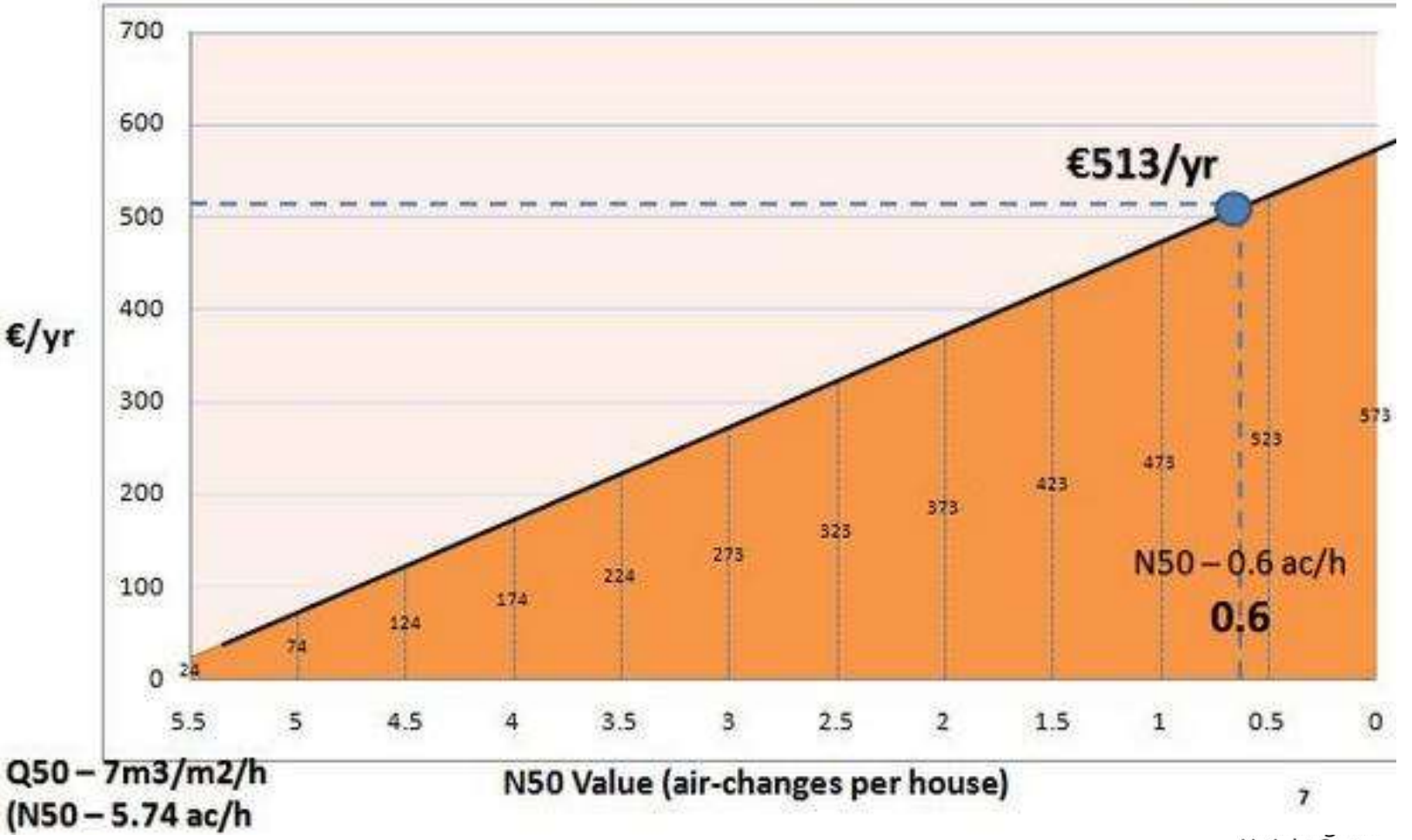
Savings from making building airtight

Based on a 200m2 two storey Dwelling , based on €0.12/kwh using oil of gas.
Compared to Naturally Ventilated Building that meets Part Q50 of 7m3/m2/h



Q50 – 7m3/m2/h
(N50 – 5.74 ac/h

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REF: TARGET ZERO GROUP

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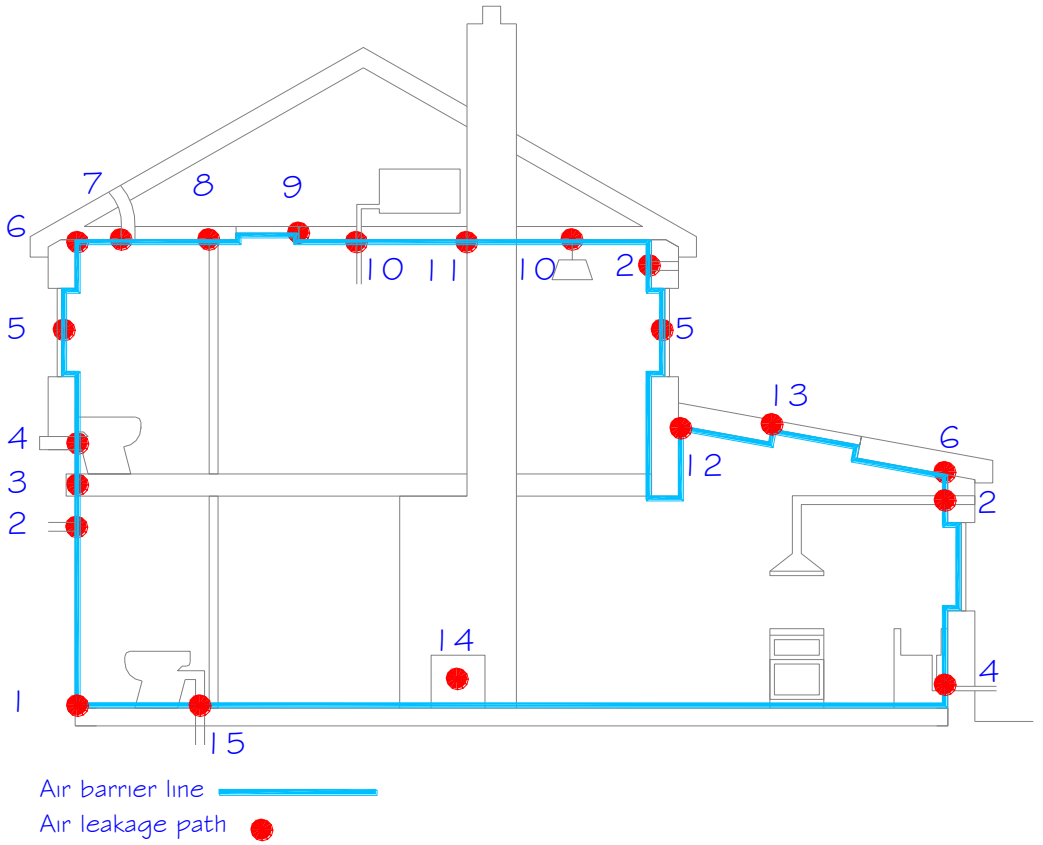
Clearly define air barrier layer and detail airtightness solutions



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The principle of insulation

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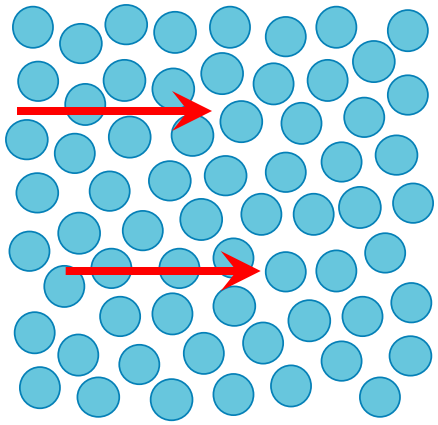
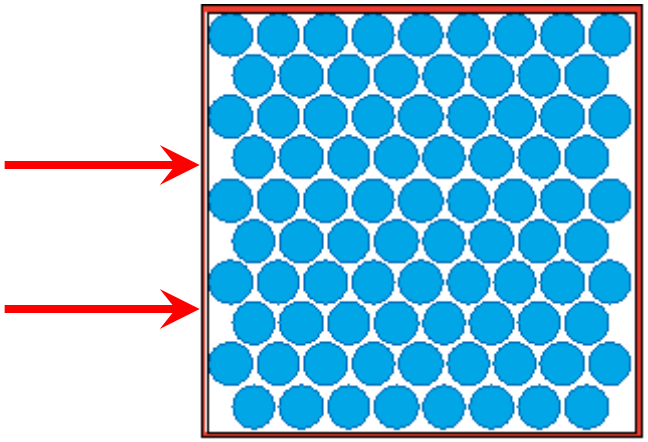


air movement

= **heat transport**



only inclusions of air that are protected against air movement insulate!

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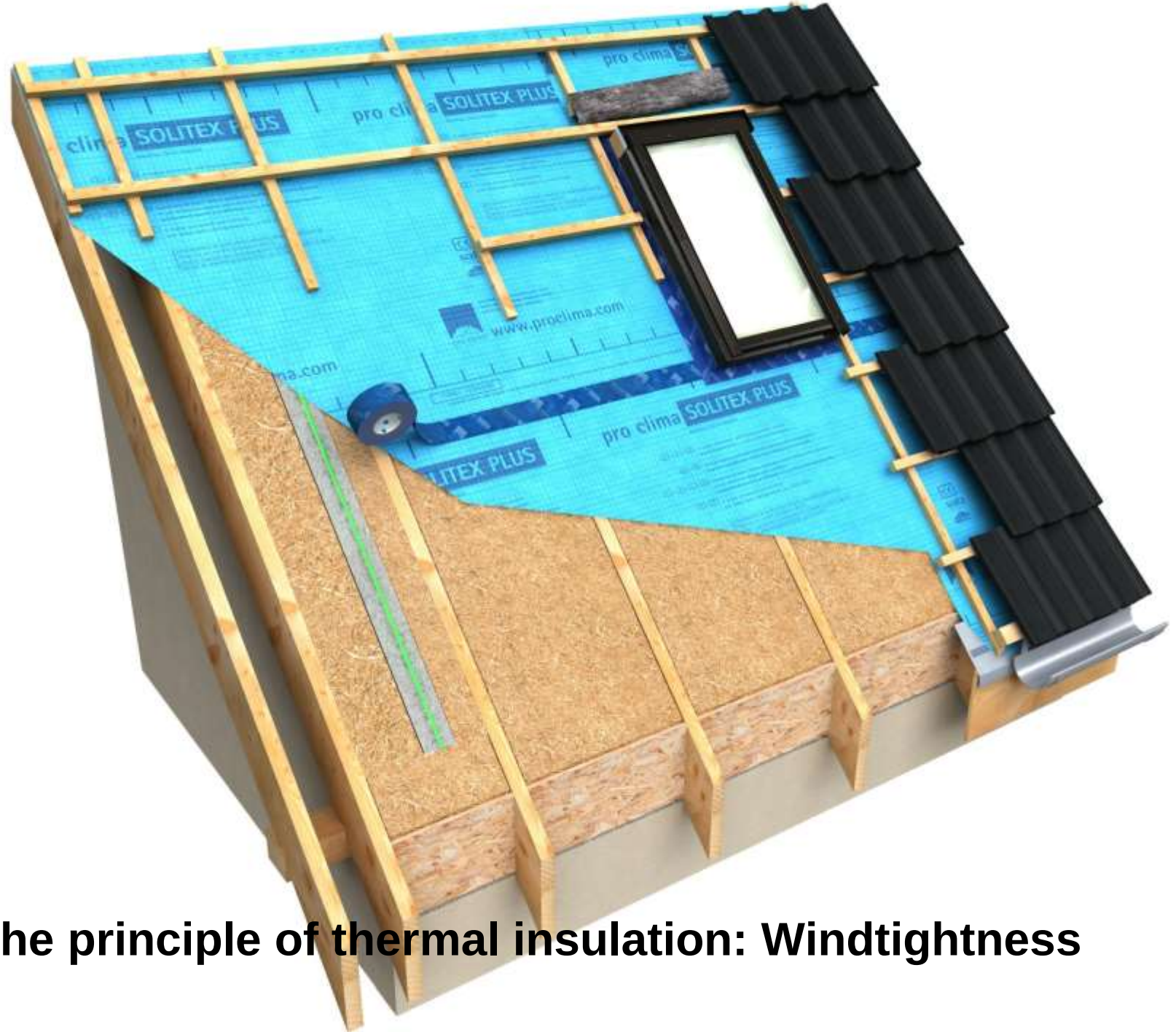
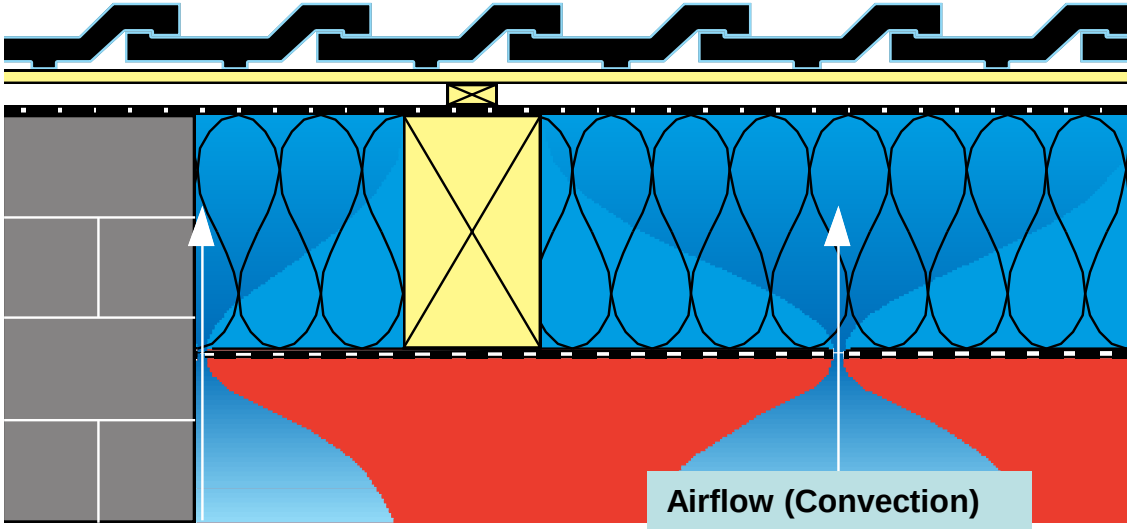


The principle of thermal insulation: Windtightness

The principle of thermal insulation: Airtightness

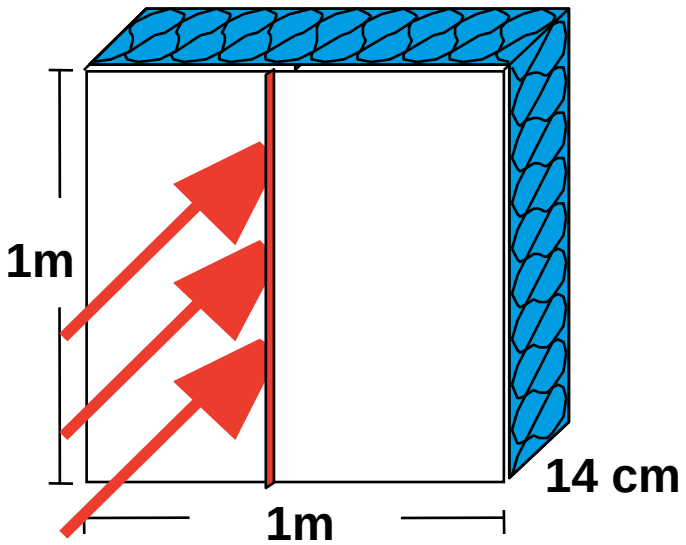
Typical construction situation



Consequences of defective air-tightness

1. Heat loss
2. Building damage due to moisture
3. Deficient heat protection in summer
4. Deficient sound proofing

Heat losses due to Convection



Without gap: U-Value = 0,3 W/m²K

With 1 mm gap : U-Value =1,44 W/m²K

Performance reduced by factor 4,8

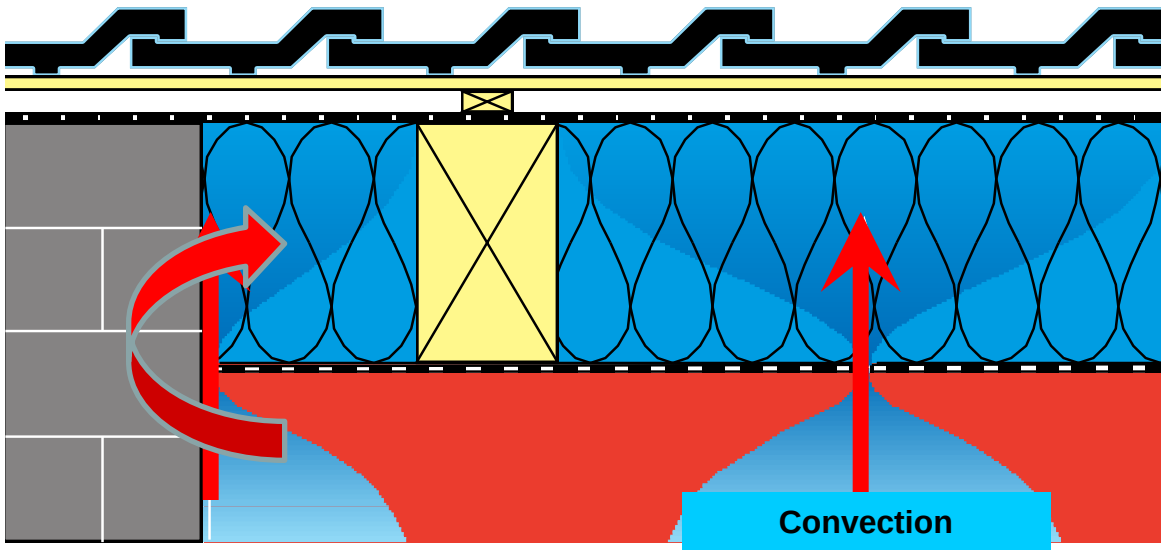
Experiment set-up
Construction of insulating material

Gap in the vapour Check (air-tightening).

Frame conditions:
Inside temperature +20°C
Outside temperature -10°C
Pressure difference 20 Pa
= wind force 2-3

Measurement:
Institute of building physics, Stuttgart
Source: DBZ 12/89, page 1639ff

Structural Damage due to Moisture



Structural damage due to moisture

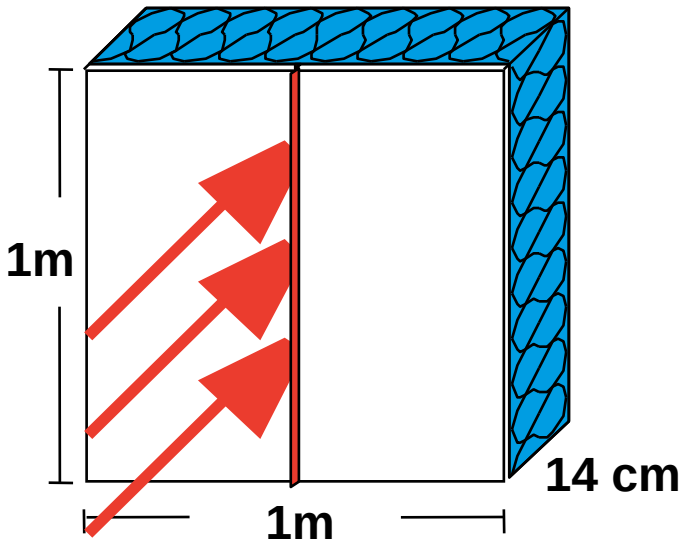
a. Diffusion

b. Convection

c. Moist installed construction materials

d. Flank Diffusion

Comparison diffusion/convection



Without gap: 0,5 g water/m²x24h

With 1 mm gap: 800 g water/m²x24h

Performance reduced by factor 1600

Experiment set-up constr. of insulating material

Inside vapour seal
s_d = 30 m (mvtr = 150 MNs/g])
Gap in the vapour Check
(air-tightening)

Frame conditions:
Inside temperature +20° C
Outside temperature -10° C
Pressure difference 20 Pa
= wind force 2-3

Measurement:
Institute of building physics, Stuttgart
Source: DBZ 12/89, page 1639ff

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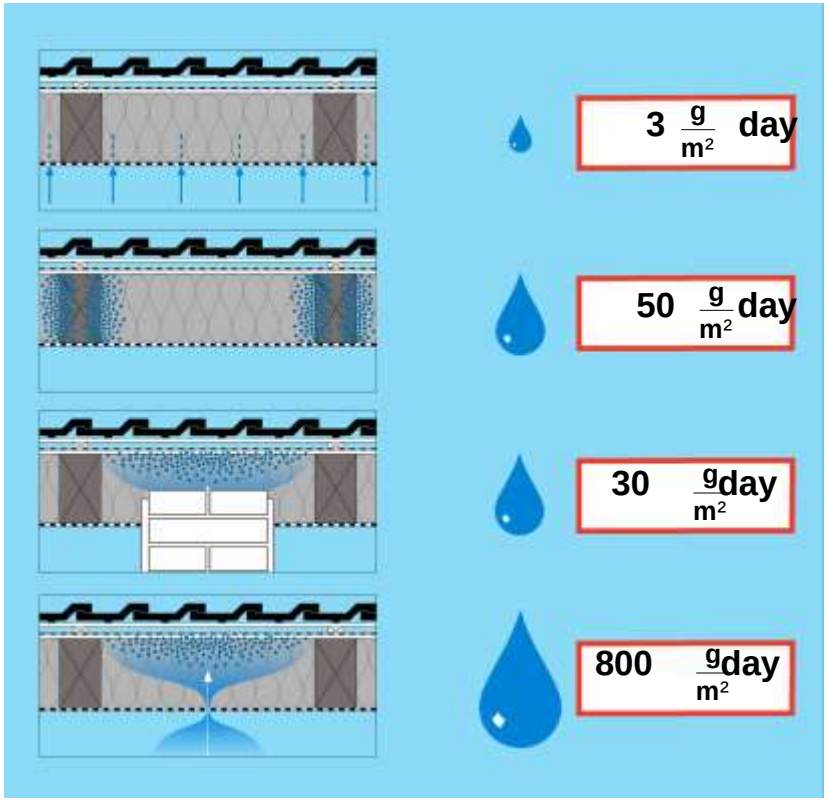
Consequences of faulty airtightness

Diffusion

Drying of wood

Flank diffusion

Convection 1 mm gap



In winter constructions are exposed to moisture

Conclusion:

There is no absolute protection against moisture

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Consequences of faulty airtightness

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There is no absolute protection against moisture

Solution:
high drying potential

Ideal:
Intelligent membranes with Humidity – variable diffusion resistance

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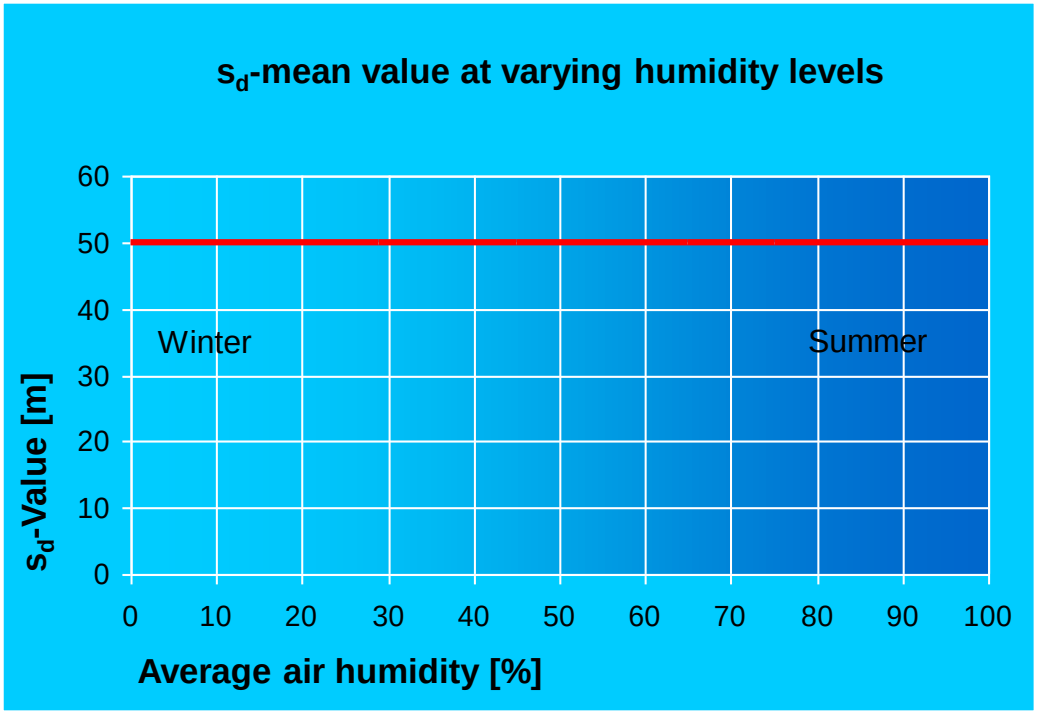
Constant High diffusion resistance: Vapour Barrier



Vapour barrier

e.g. PE-Foil s_d = 50 m (mvtr = 250 [MNs/g])

No possibility for constructions to dry out when unexpected moisture occurs

Continuous High Vapour Resistance

Back Diffusion in summertime

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Humidity – variable diffusion resistance: Intelligent Technology

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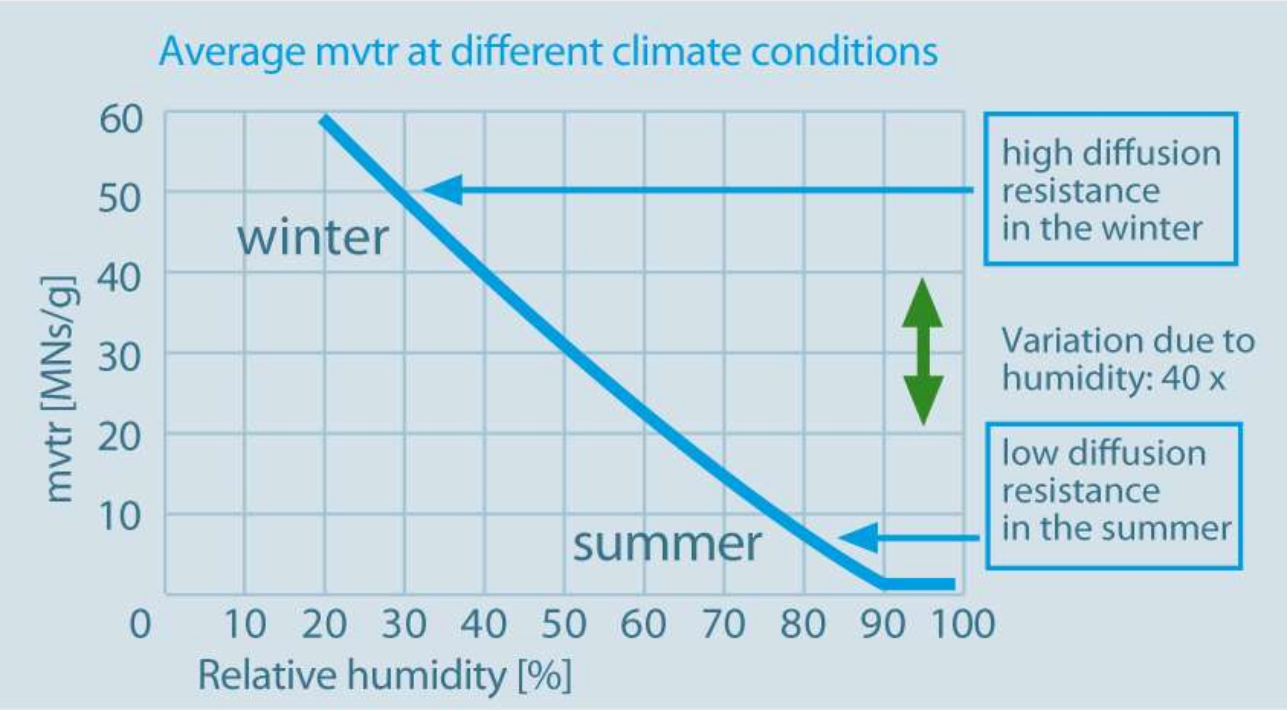

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Vapour Checks with humidity – variable diffusion resistance

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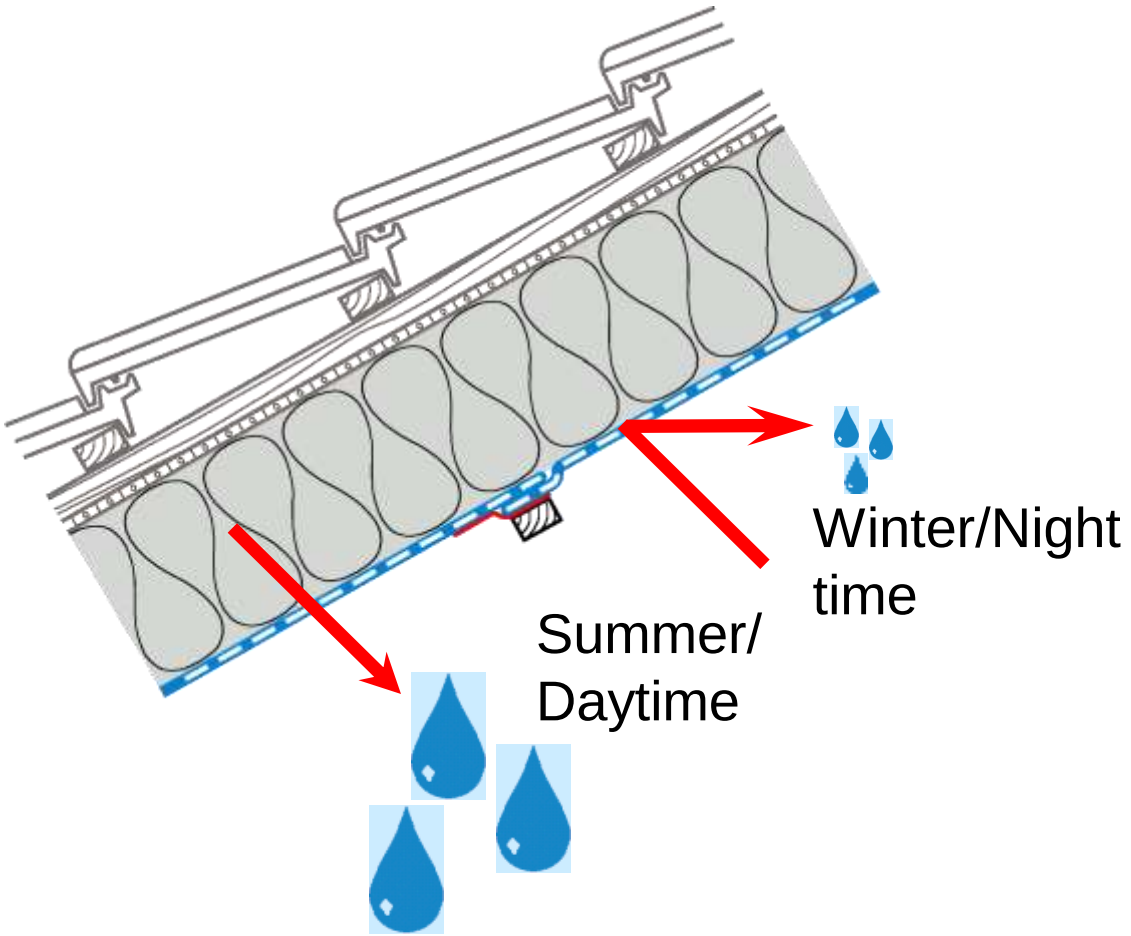

Freedom from structural damage due to vapour checks with humidity – variable diffusion resistance

In winter: protection against moisture entry

In summer: high drying potential

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Calculating Potential Freedom from Structural Damage

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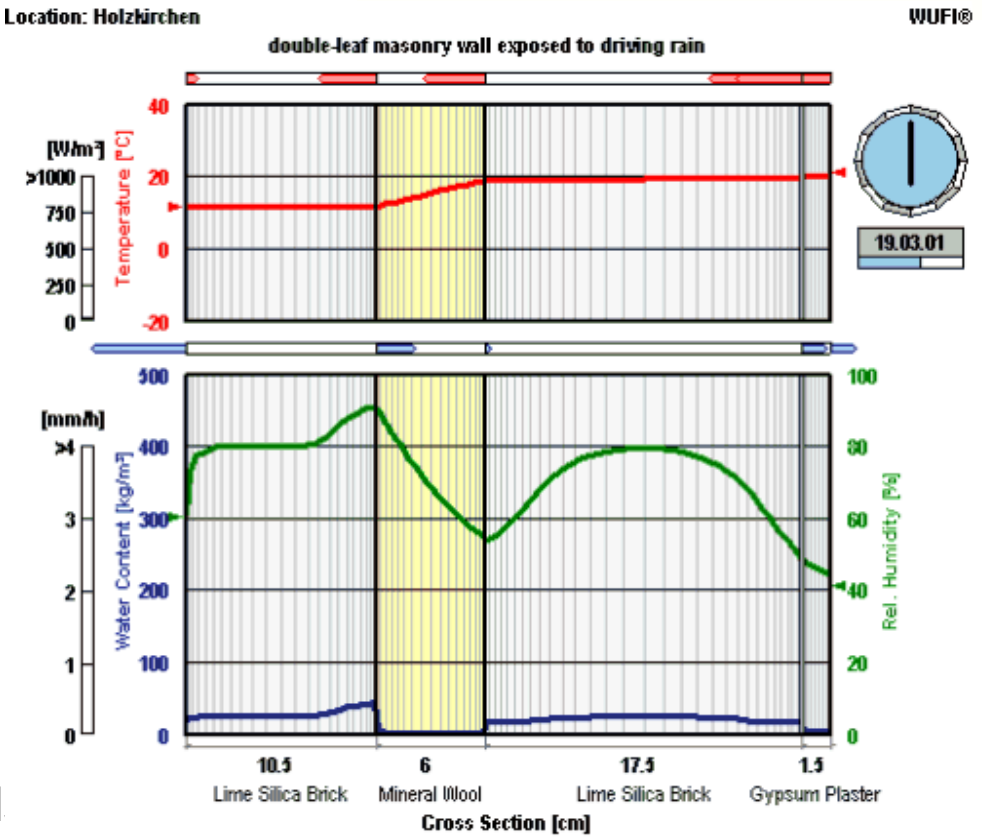
Calculation program

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

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

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



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Current BS EN 15026: 2007 provides higher accuracy compared with EN 13788:2002 in BS 5250.

www.wufi.de

Humidity-variable vapour checks

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Membranes with
Humidity-variable diffusion resistance:

Not suitable for buildings with
permanent high air humidity:

- Swimming pools
- Gardening Centres
- Commercial kitchens

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Humidity-variable vapour checks

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Preconditions for the functionality of humidity-variable vapour checks

- No diffusion-hampering building materials on the interior side, e.g. OSB, Plywood
- Profiled timber sheathing, plasterboards and Celenit boards with plaster are suitable

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Humidity-variable vapour checks

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Preconditions for the functionality of humidity-variable vapour checks

- Consider shade externally
  - **Colour of the external layer, dark colours promote greater back diffusion**
- Diffusion resistant foam insulation material
- **Green roofs significantly reduce back diffusion and not compatible with non vented cold deck**

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Air leakage on site:

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Common Gable Wall-Roof junction

Faulty but “common“ airtight connection of vapour barriers

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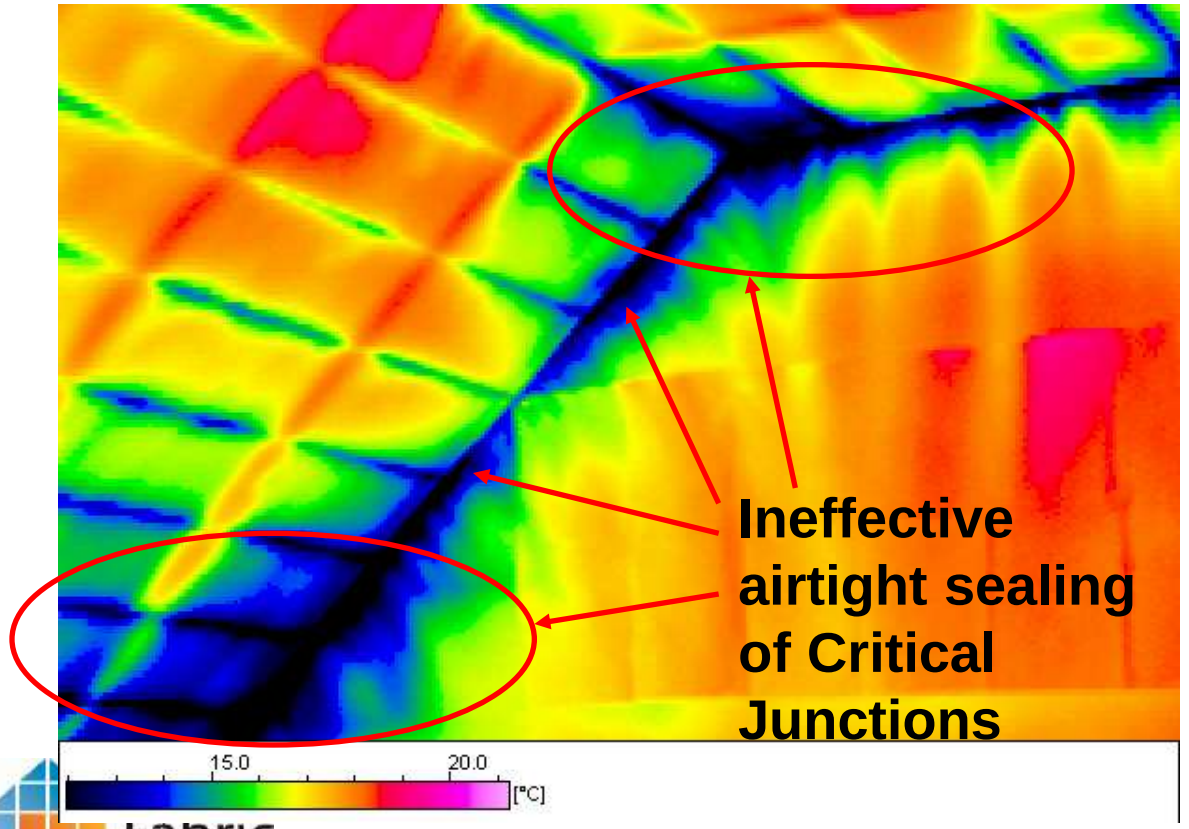
Thermo graphic images of faulty constructions



Infrared picture:

Gable wall-roof connection

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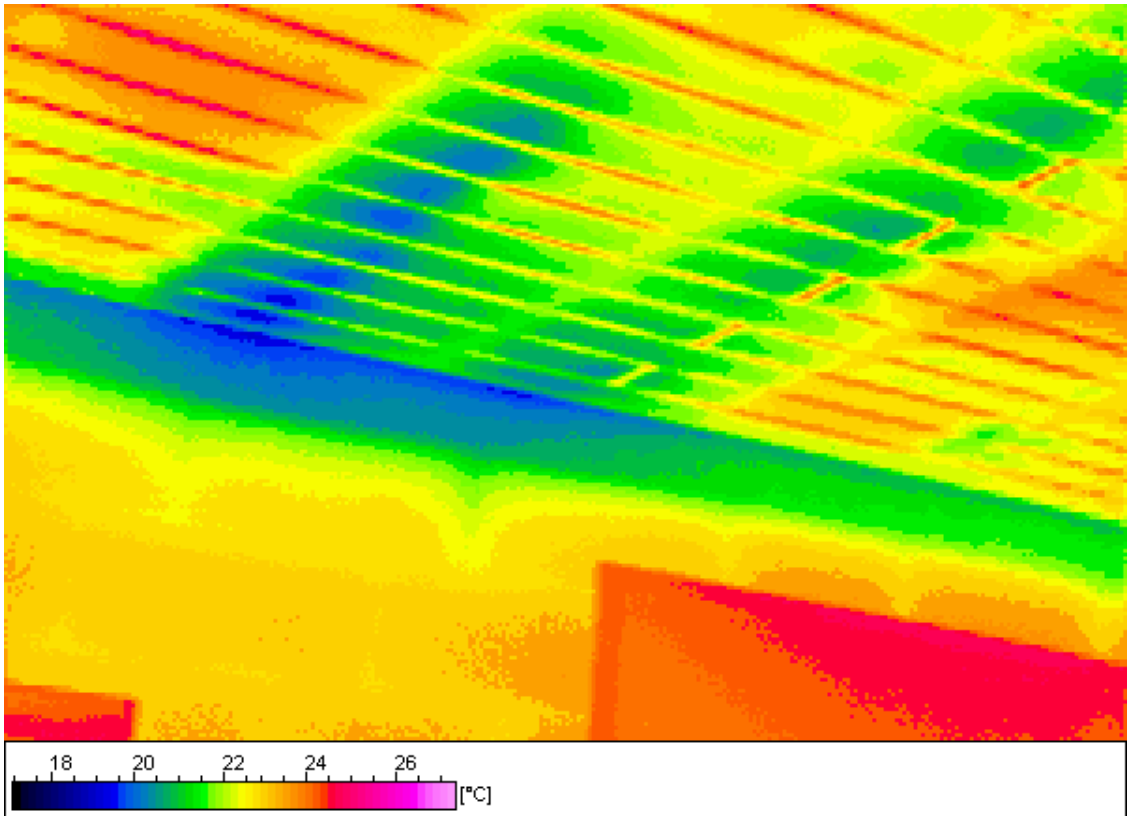
Thermo graphic images of faulty constructions



Infrared picture:

Wall-ceiling connection

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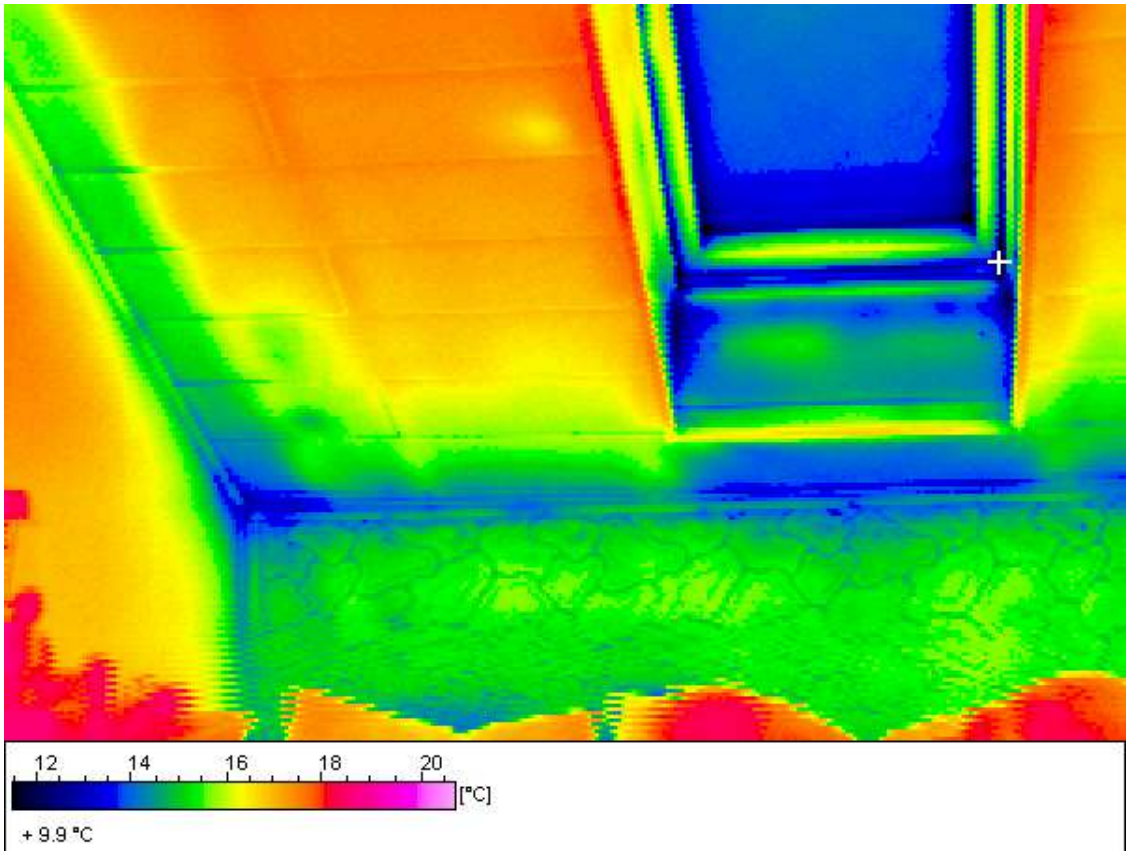
Thermo graphic images of faulty constructions



Infrared picture:

Roof window connection

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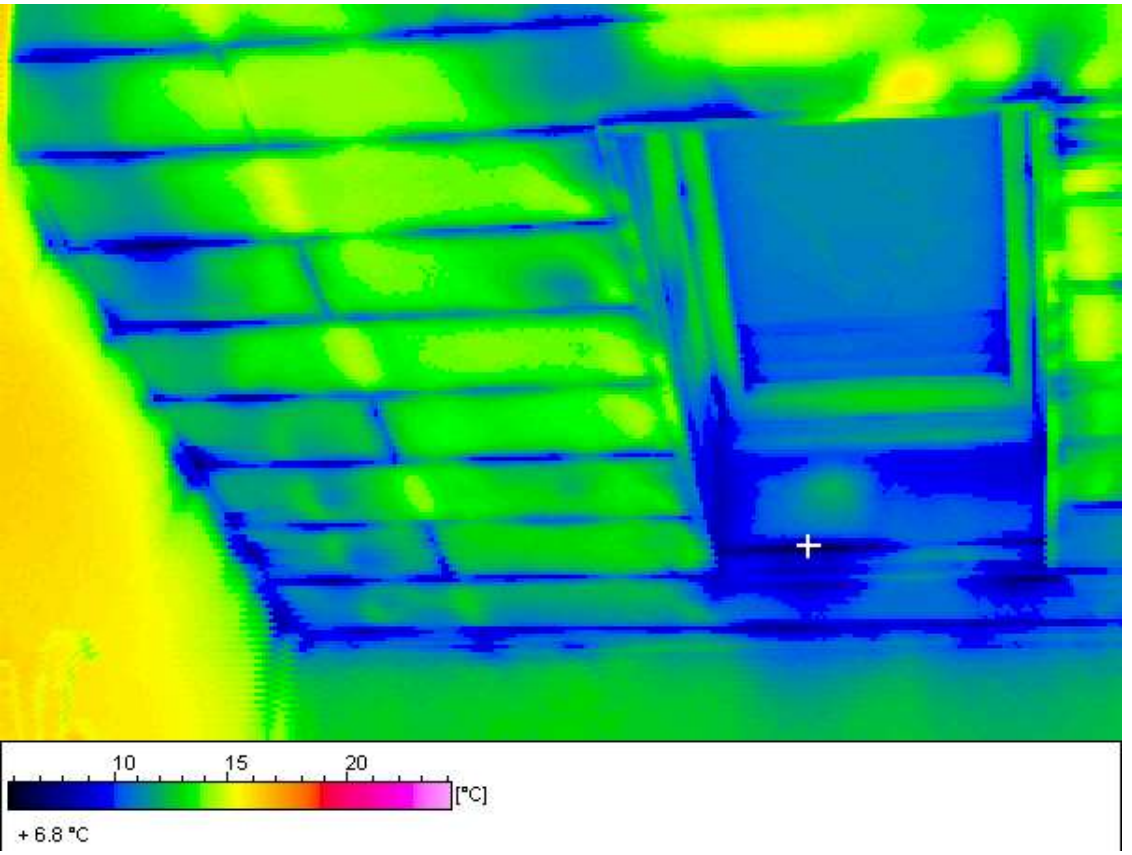
Thermo graphic images of faulty constructions



Infrared picture:

Roof window joint at negative pressure
The cross shows 6,8 °C, which is lower than the dew point

=> Condensation

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Durable specialist airtightness accessories fit for purpose

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Airtightness barriers, tapes and accessories must be:

- Made from air impermeable material
- Continuous
- Of sufficient strength
- Long lasting and will not dry out or crack – (3rd party certification beneficial)
- Able to accommodate movement of structural elements
- Easily applied in areas the in difficult to access
- Durable and accessible for maintenance or replacement
- Simple for the installer to use

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Attention to detail?

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Airtight ???

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Airtight??????


Airtight?????

Make sure blocks are continuously plastered!

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Ref: Paul Jennings

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Air leakage though OSB3

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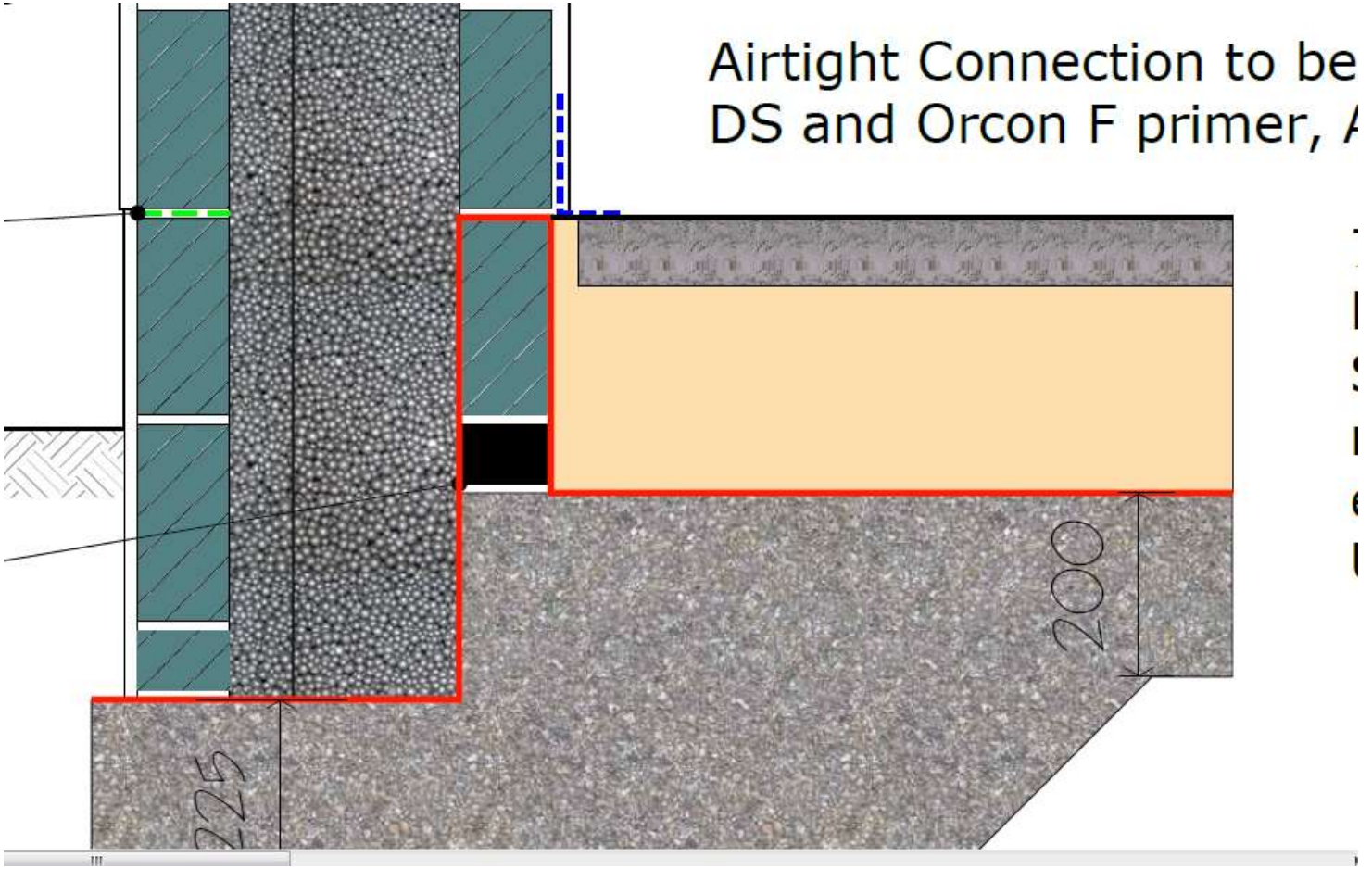

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- large board dimensions available on request up to 2620x6350mm
- assists in the design of a healthy living environment and durable construction

Sometimes Windows Can leak…even the best ones…

Leakage identified associated with windows – despite them being PHI certified

Temporary sealed over openings with polythene

Depressurised with blower door – plastic bulges inwards

Comparing before & after readings gives effective leakage area of windows

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IT DOESN'T HAPPEN BY ACCIDENT!

"It's time we face reality, my friends. ... We're not exactly rocket scientists."

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Airtightness…How?

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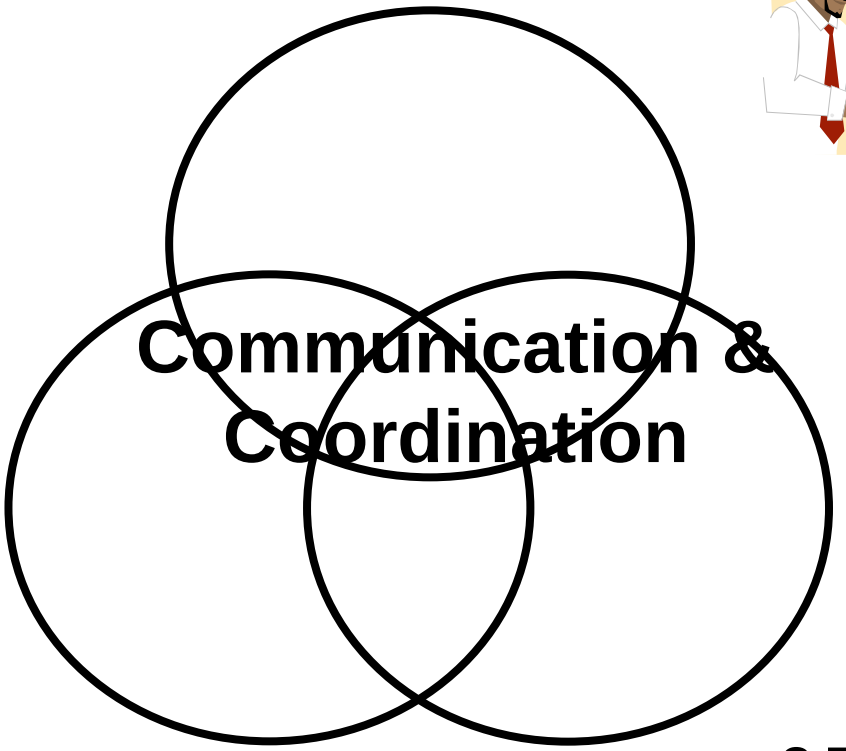
1.To design for airtightness



2.Build to achieve airtightness

3.Test for airtightness

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Ensure everyone on site understands airtightness!

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Ensure everyone on site understands airtightness!

Airtightness must be planned….

Purlins

Ridge beams

Internal to external walls

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Sealing of overlaps – TESCON VANA

- Fix vapour check to timber studs securely
- Overlap joints by 50-60mm
- Seal all overlaps using suitable airtightness tapes

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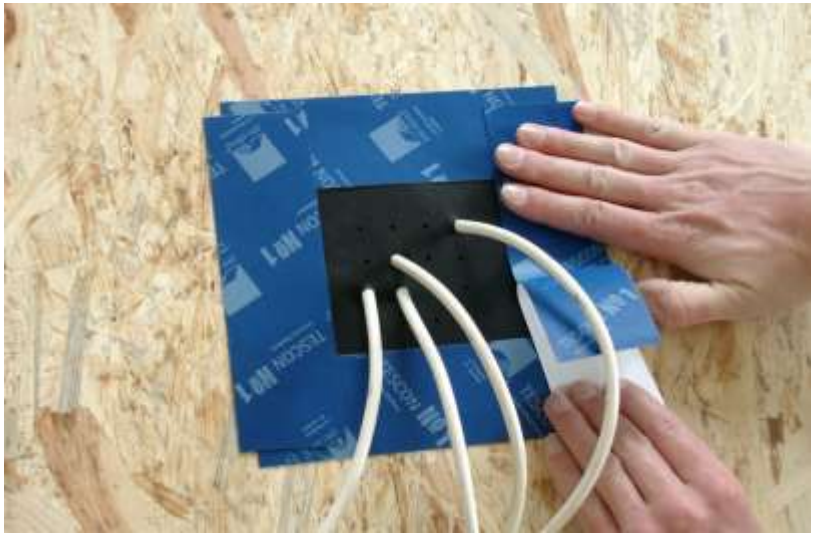
Positioning of service penetrations critical

Sealing Pipes & Cables



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INTE
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CZ
DK
H

Window Sealing: CONTEGA SOLIDO SL/EXO

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Ensuring appropriate airtightness materials are used

Pro clima adhesives and glues on tapes are:

BBA APPROVAL INSPECTION TESTING CERTIFICATION

CERTIFICATE 14/5155

NSAI Agrément

pro clima Intelligent Airtight System

CERT No. 07/0297

The problem with airtightness is…
Tapes don't last!

UNIKASSEL VERSITÄT

Untersuchung der Dauerhaftigkeit von Klebeverbindung für den Bereich der Luftdichtheitsschicht der Gebäudehülle (nach dem internen Manuskript der DIN 4108-11 Stand August 2012) sowie weiterführende Messungen bis zu zwei Jahren beschleunigter Alterung.

50 years passed...

aging now tested to 100 years

pro clima

CONFIRMED BY TESTS

100 years

Permanent airtightness with pro clima!
Tested for the entire usage period

- ✔ Reliable functioning tested for 100 years
- ✔ Independently confirmed
- ✔ Minimum requirements significantly exceeded

Thermal insulation and airtightness should perform for more than 50 years

Adhesive tapes which are applied to attain airtightness in accordance with DIN 4108-7, SIA 180 or OENORM B 8110-2 should have a durability of 50 to 100 years – after all, this is the expected service life of thermal insulation layers, to ensure that they protect against damage due to convection and moisture vapour ingress.
This period corresponds with reality as airtightness is currently being optimised and thermal insulation is being replaced or adapted for today's legal requirements on structures dating from the 1950s, 1960s and 1970s.

As little as 17 years can be regarded as permanent

A process for accelerated aging of adhesive tape joints has been developed at the University of Kassel as part of a research project on "Quality assurance for adhesive-based joint technology in airtightness layers". With this process, adhesive tapes have to demonstrate certain specified minimum tensile strengths after being stored at increased air temperature and humidity (65 °C and 80% relative humidity) for a period of 120 days (this corresponds to around 17 years in reality). On successful completion of this test an adhesive tape can be regarded as permanent.

pro clima adhesive tapes have been successfully tested for 100 years

As part of tests to ascertain the durability of airtight joints, pro clima's TESCON VANA, UNI TAPE and TESCON No.1 adhesive tapes have also been subjected to accelerated aging at the University of Kassel under the conditions described above. At the request of pro clima, the test period was increased from 120 days to 700 days. Accelerated aging for 700 days corresponds to 100 years in reality. The test results for the three adhesive tapes from pro clima were also positive for this increased period of accelerated aging.

You are on the safe side with pro clima!

These demanding tests with increased test periods have confirmed the suitability of TESCON VANA, UNI TAPE and TESCON No.1 adhesive tapes for the creation of permanent airtightness which surpass the requirements of DIN 4108-7, SIA 180 and OENORM B 8110-2. This confirms that vapour check and airtightness membranes and airtight wood-based panels can be reliably bonded using pro clima products!

High quality tapes - resistance against humidity

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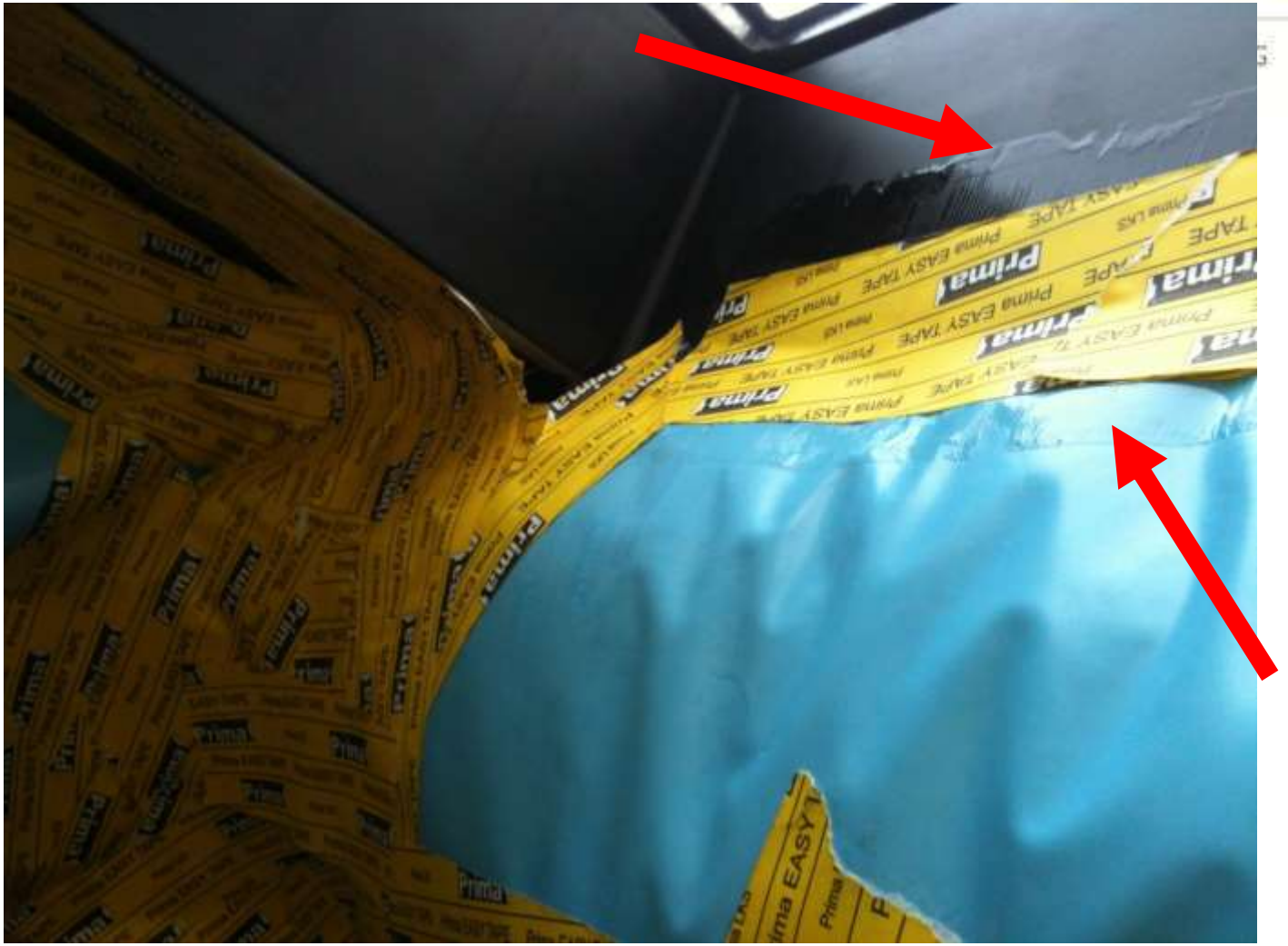
High quality tapes – inner strength of the glue



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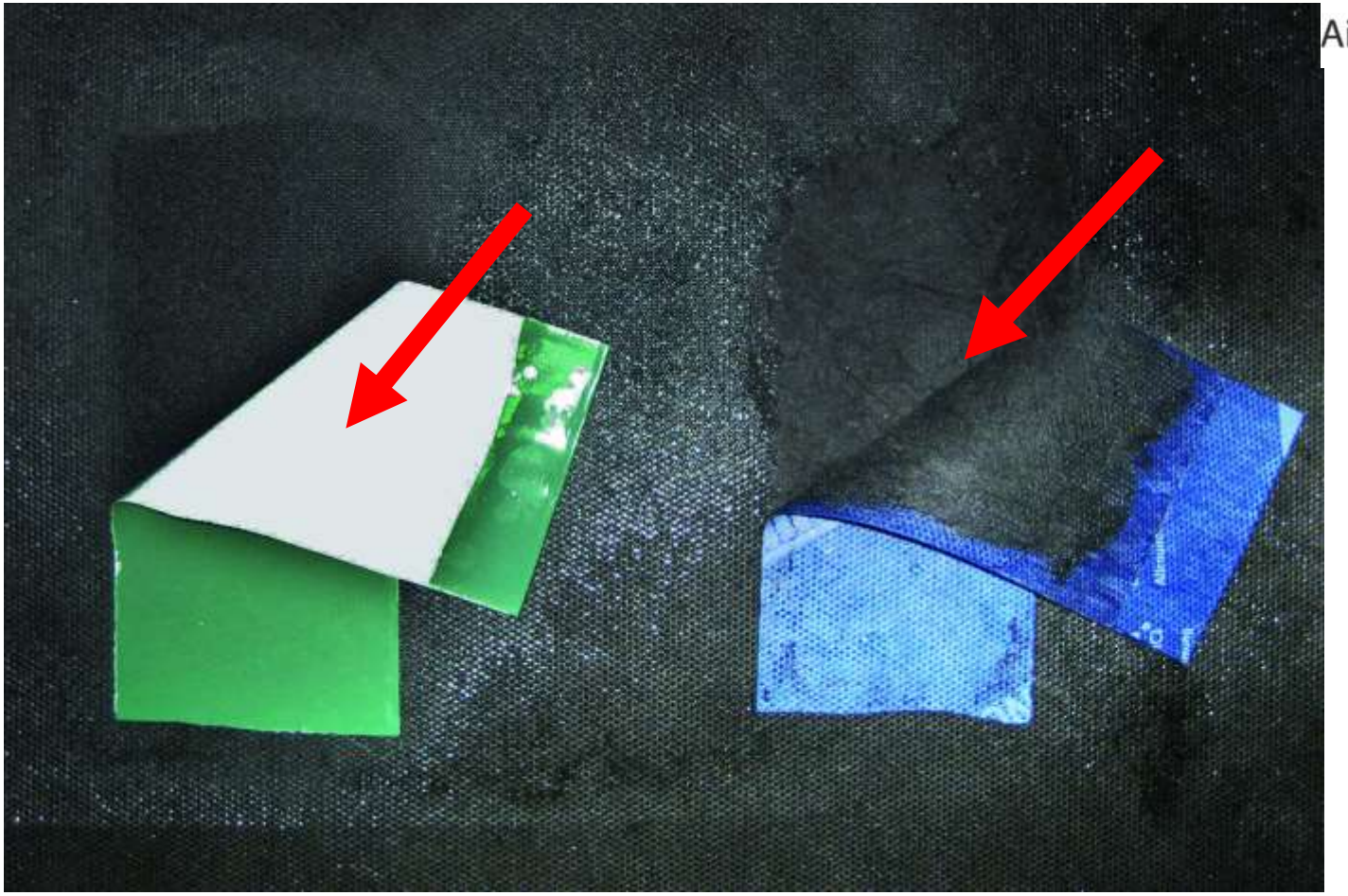
High quality tapes - resistance against humidity

Glue strength after 24h under water stress



Airtight Solution: Certified Airtight Attic Hatch

Airtightness Quality Control – Wincon

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WINCON
... Quality assurance for airtightness

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Testing of airtightness of Constructions: Standards

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German building code ("EnEV" Energy Saving Standard) –
• Without a mechanical ventilation system the n50-airchange-values have to be less than 3 h-1,
• With a mechanical ventilation systems 1.5 h-1.

Passive house - The requirement is n50 not greater than 0.6 h-1.

Canadian Super E Standard - The requirement is n50 not greater than 1.5 h-1

NI – Upper limit Air Permeability Q50 of < 10 m3/hr/m2

ROI – Upper limit Air Permeability Q50 of < 7 m3/hr/m2

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Testing of airtightness of Constructions: UK Standards

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ATTMA – Technical Standard 1 – Measuring Air Permeability of Building Envelopes

Type	**Air Permeability**	
	m3/(h*m2) @ 50Pa	
	Best Practice	**Normal**
Offices		
Naturally ventilated	3	7
Mixed Mode	2.5	5
Air conditioned/low energy	2	5
Factories/warehouses	2	6
Superstores	1	5
Schools	3	9
Hospitals	5	9
Museums and archival stores	1	1.5
Cold Stores	0.2	0.35
Dwellings		
Naturally ventilated	3	9
Mechanically ventilated	3	5

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Airtightness Summary:

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Moisture loading > Drying reserves

= Structural damage

Drying reserves > Moisture loading

= No structural damage

Build with adequate reserves and
you will never have structural damage!

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Airtightness Summary

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Airtightness:

1. Determines the effectiveness of the insulation Layer
2. Reduces CO_2 emissions – critical for efficient energy assessment
3. Enhances construction without structural faults
4. Creates a comfortable healthy room climate
5. Absolutely essential for low energy and passive house design

To achieve this the membranes must be meticulously sealed to one another and to proximal structural components

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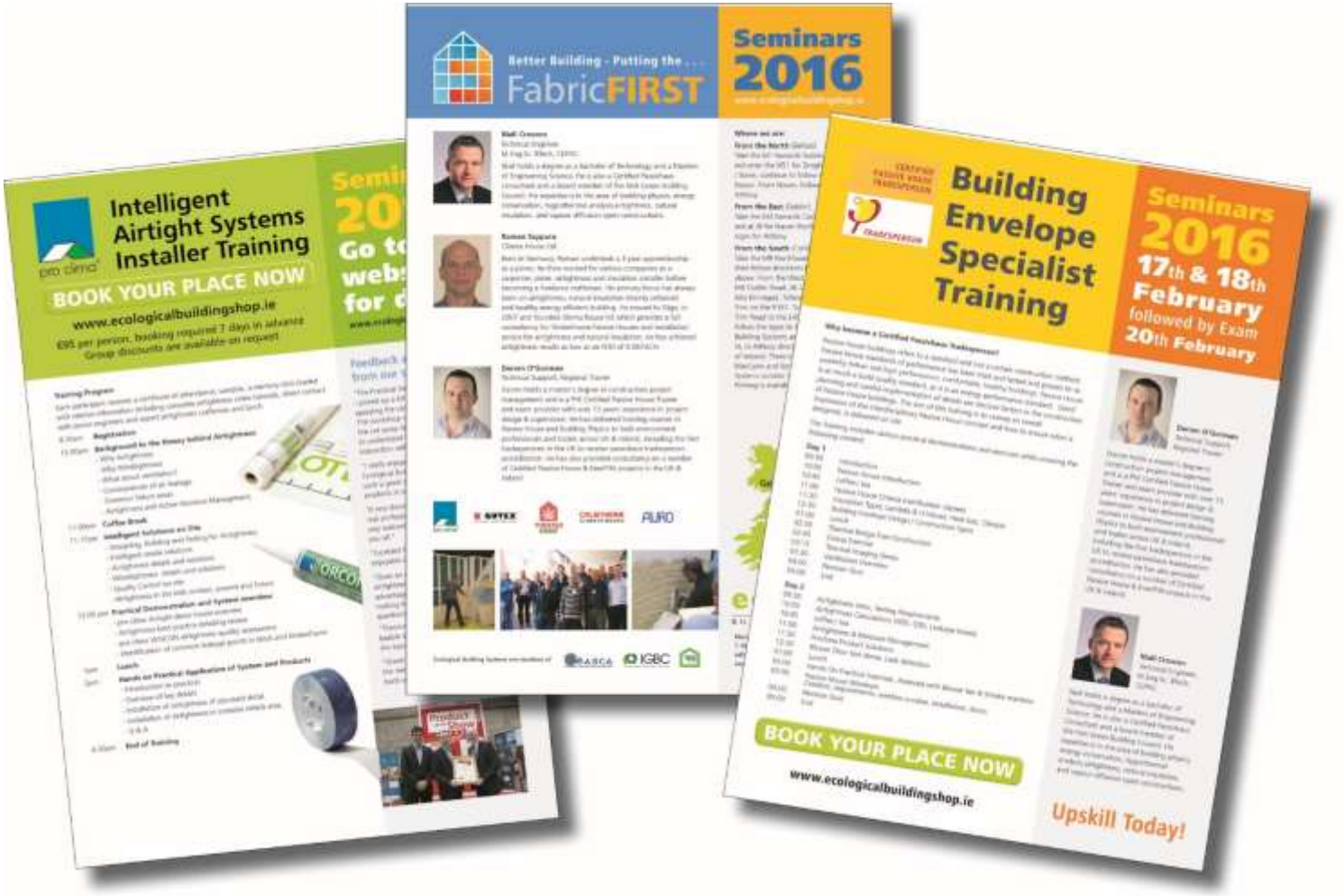
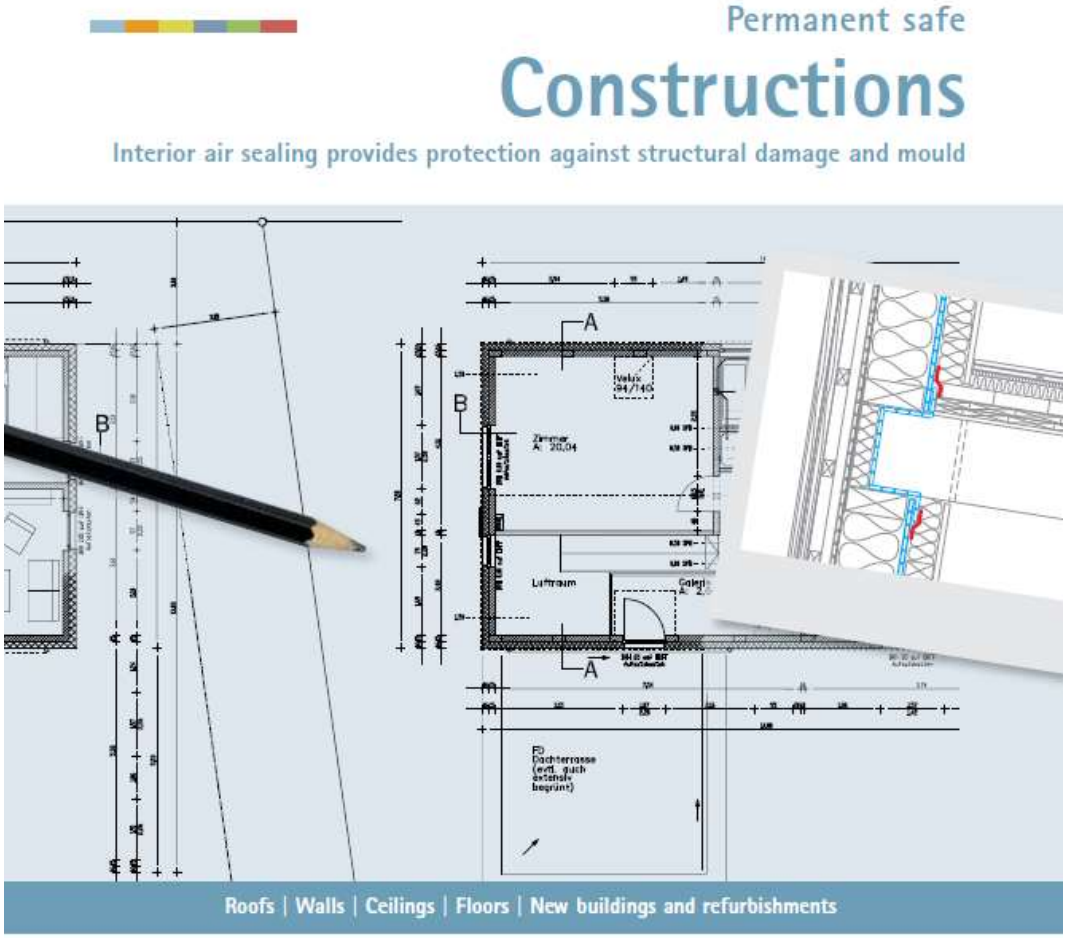
Further Training



Fabric FIRST


Experience is priceless

Further Details



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Questions?

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