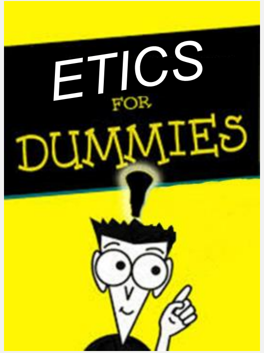


ETICS

... *the system we all (thought to) know ...*

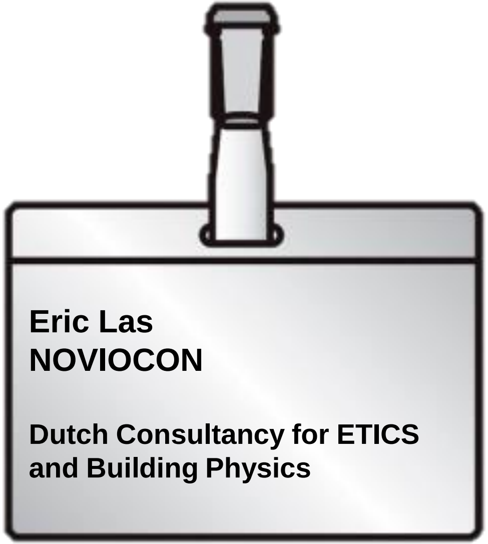
a personal view on the "experience and developments in ETICS"

Eric Las / Noviocon

Harmonised standard: *To ensure that* ***reliable technical information*** *is provided* ***about the performance*** *of construction products in a common technical language and tested using consistent assessment methods.*

17.05.2022

Eric Las – *a well experienced generalist in ETICS*



1977 - Bsc / PolyTechnic of Arnhem (Construction)

1982 - Msc / Technical University of Delft (Architecture, Construction and Building Physics)

1983 - EnergieAdvies / Consultancy Technical Engineering for Energy Conservation

1983 - Product development, Economics, Marketing, Building Physics

1985 - Isoned (now Sto Isoned) / Technical Manager ETICS, Regulatory Affairs

1998 - Unidek (now Kingspan) / Marketing, Quality Management, Product Development, Business Development, Regulatory Affairs

2015 - Stybenex (NA for Dutch EPS converters in Packaging and Construction) / MD, secretary general

2020 - Noviocon / consultancy for ETICS

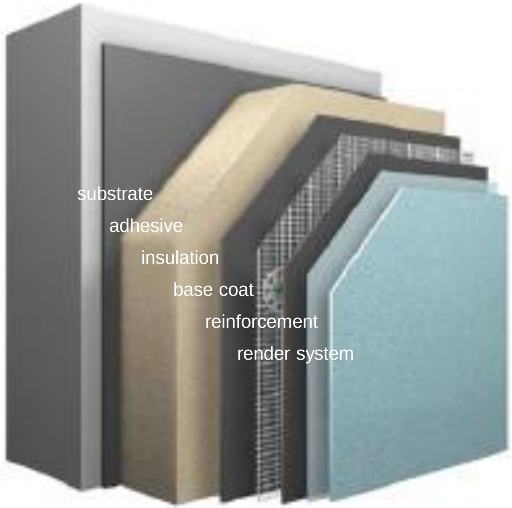
Ir. H.E. (Eric) Las
eric.las@noviocon.nl
+31 (6) 22971566

ETICS in the third decade of the 21st century

Nowadays, External Thermal Insulation Composite System (ETICS) with renderings is the most used technical solution aimed at increasing the energy efficiency of buildings in the EU. Over sixty years of using ETICS has clearly shown that it is a good solution in various climatic conditions, *and the factors that may affect the deterioration of the thermal insulation properties of the insulation are well known*. Manufacturers are constantly developing ETICS to meet customers' growing expectations and changing technical and legal requirements. Interestingly, despite over sixty years of widespread use of ETICS in EU countries, no European standard has been created so far that could be the basis for assessing and verifying constancy of performance (AVCP).

notes to the 8th International ETICS conference Łochów

- ETICS in the third decade of the 21st century
- The “Fingerprint”
- Some basics for ETICS
- FIW research project on ETICS
- Technical survey on mechanical performance of ETICS
- Food for thought / possible conclusions / discussion



1954 – The first ETICS project – Germany

Info is mainly aimed at the improvement of the thermal performance of the building.

ETICS are seen as safe systems
… and why not?
In practice so far, there are no structural failures to be seen (or reported),

ETICS / WDVS
Wärmedämmverbundsystem

Since the early 1960's in most countries insulation thickness has gone from 50 mm to 350 or even 400 mm.
The average thickness in most countries is now at 180 mm.

Since the 1970's 'next to EPS also MW was available for ETICS

Since 2000 also other insulation materials and types came to the market.

We trust on the experience of 40 years of application and test methods from the past.

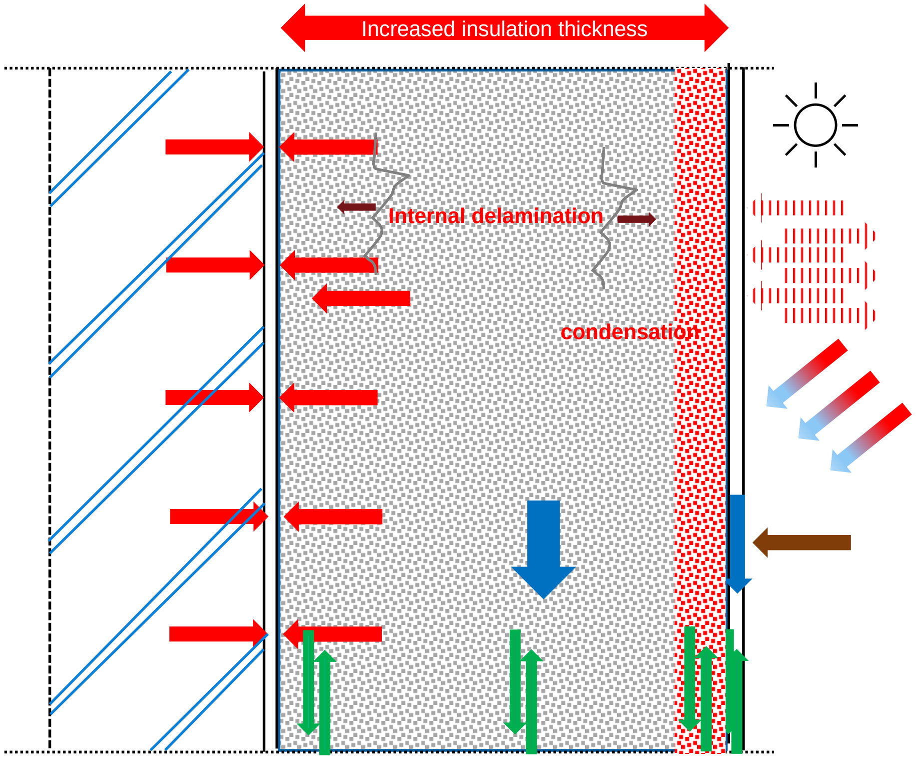
Transfer of loads – resistance to deformation

the mechanical performance and distribution of loads in/by the insulation ?

There is no typical insulation.

Multi-layer, of single layer with zones of different density /tensile strength, coverings or facings.

Differences linked to the thickness and densities.



direct sun

Surface temperature summer (+ 70°C)

wind

Repetitive dynamic load (pressure and suction)

ambient temperature

Summer (+15°C <> +40°C
Winter (-20°C <> +25°C

rain

Wind-driven rain
hail

mechanical impact

Need for reinforcement

dead load

Weight of the system

shrinkage / swelling

differences per layer

Loads occur not as isolated loads but always in combination

Wind load is not a static load, but a dynamic and repetitive load

Deformation from shrinkage / swelling is often ignored.

Real load transfer model - in how to assess the combination of loads - is not available or even considered

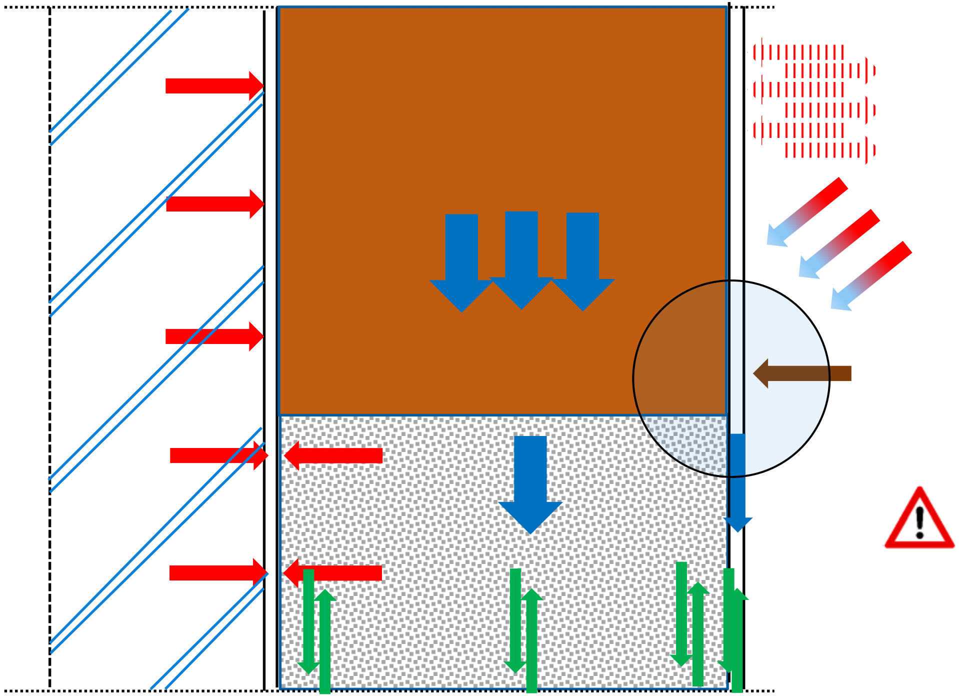
ETICS – transfer of loads – resistance to deformation

Impact of the use of the combination of insulation ?

There is no model for assessing the impact.

Difference in fixing systems (bonded or by mechanical fixings only.

Differences linked to the thickness and densities.



Increase of thickness / difference in density

wind

rain

mechanical impact / deformation?

Extra / difference in dead load (insulation: 40 kg/m² vs 4,5 kg/m²)

Shrinkage / swelling

EN 17237 - Specification and assessment of the ETIC kit

The EN 17237 is on the ASSESSMENT ONLY

The EN 17237 does only cover the described (and assessed) systems (by fixing method and the limitations to the components).

The EN 17237 is NOT about

- the (influence or the quality of the) substrate
- the application
- the fit to any National regulation or guideline
- the DoP by the manufacturer
- the real performance of the system?

EN 17237 - systems covered by the standard

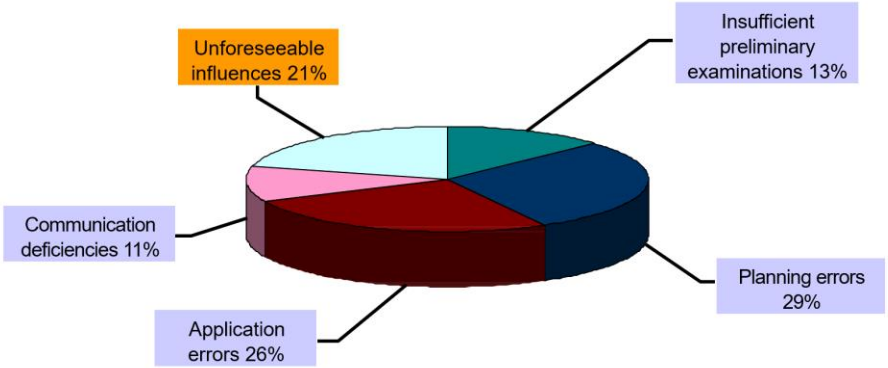
Table of the covered ETIC kits by the fixing system

Fixing method	I	II	III	III	IV	V	VI	VII	VIII	ALL
	< BONDED >		< MECHANICALLY FIXED >							
Description	bonded with adhesive and supplementary mounting aid plate anchors	bonded with adhesive	mechanically fixed on adhesive bed with plate anchors	mechanically fixed on adhesive bed with plate anchors	mechanically fixed on adhesive bed with spiral anchors countersunk	mechanically fixed with plate anchors	mechanically fixed on adhesive bed with profiles and rails and optional plate anchors	mechanically fixed with profiles and rails and optional plate anchors	mechanically fixed by an anchored metal mesh	
bonded area [%]	≥ 40%	≥ 40%	≥ 40%	≥ 20%	≥ 40%	-	≥ 40%	-	-	
Foam adhesive Use	-	-	-	-	-	-	-	-	-	EPS, XPS, PU only
Anchors [p/m2]	-	-	≥ 4	≥ 4	≥ 4	≥ 4	-	-	-	
thickness insulation [mm]	≤ 400	≤ 400	≤ 400	≤ 200	≤ 400	≤ 200	≤ 200	≤ 400	≤ 200	
weight rendering [kg/m2]	≤ 30	≤ 30	≤ 40	≤ 20	≤ 40	≤ 20	≤ 30	-	≤ 30	
weight system [kg/m2]	≤ 60	≤ 60	≤ 65	≤ 45	≤ 65	≤ 45	≤ 60	-	≤ 60	

ETICS are systems with a promise for performance

The design configuration must offer the real performance over the promised lifespan

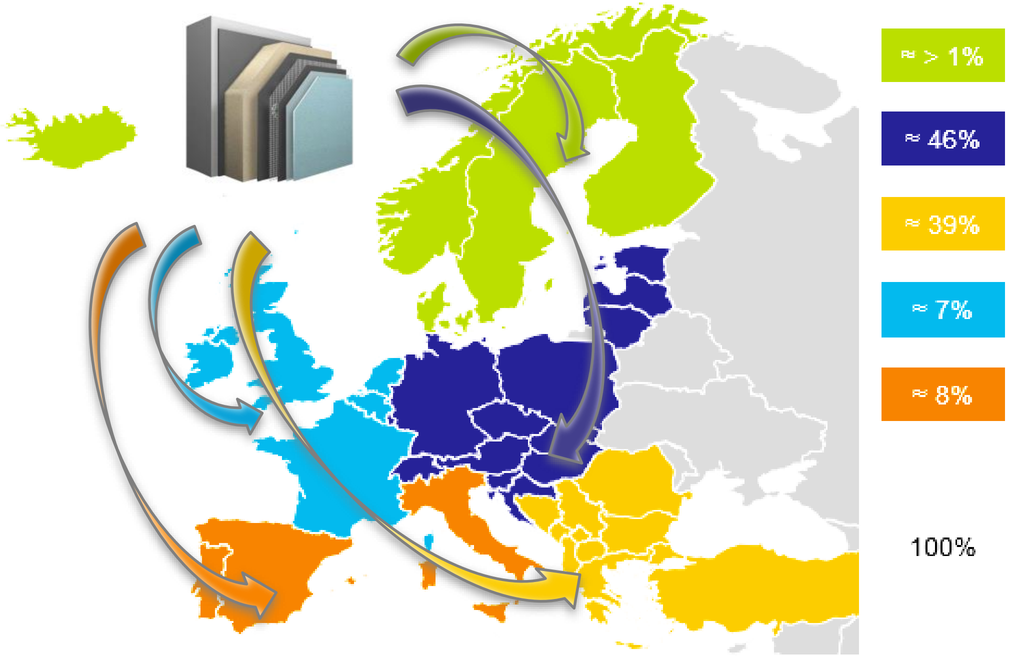
The real performance (as in thermal and mechanical) requires no failures or degradation - in the system (components / layers) or by the system – no water penetration or accumulation in the system or to the substrate, no mould, and keeping the good aesthetics.



The performance of an ETICS depends for ca. 30% product on the development and FPC and for ca. 70% on application.

So you have to build in margins and now where they are needed.

The "starting questions"



What is influencing the quality of ETICS?

What are the most relevant parameters?

In which range of values does the system work properly?

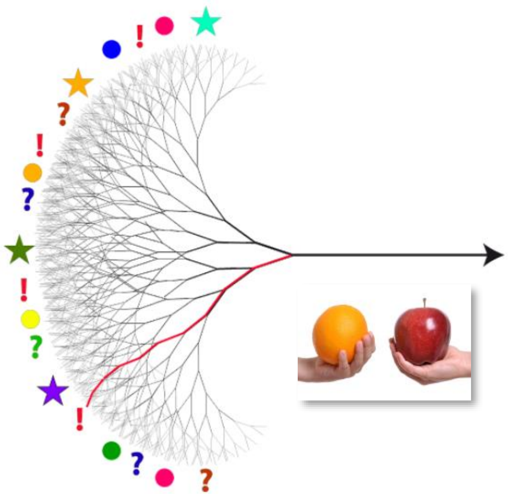
Does this range of values comply with regulations?

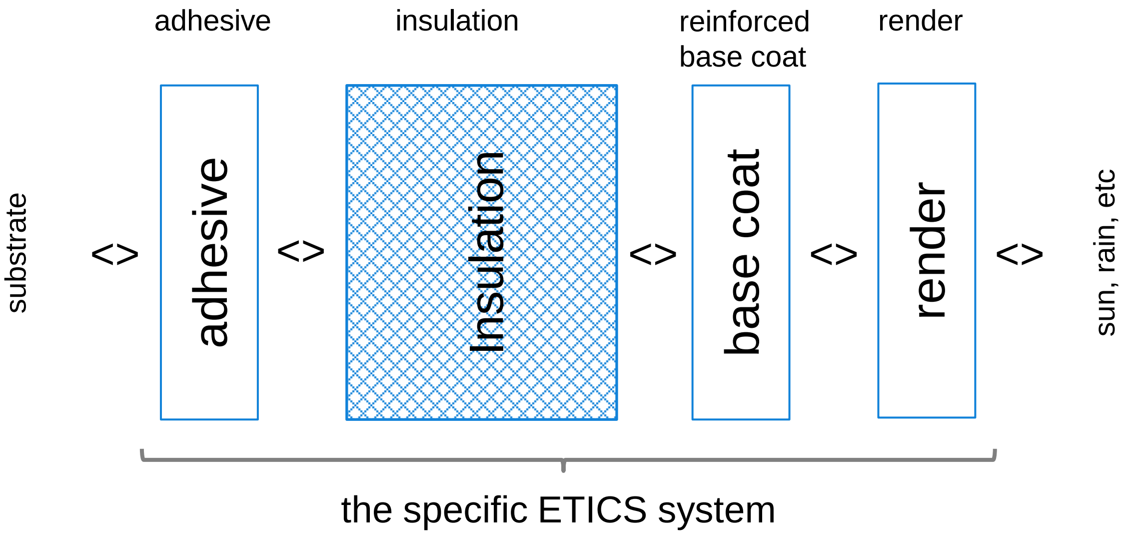
What is influencing the quality over time?

The set of components to the relevant characteristics

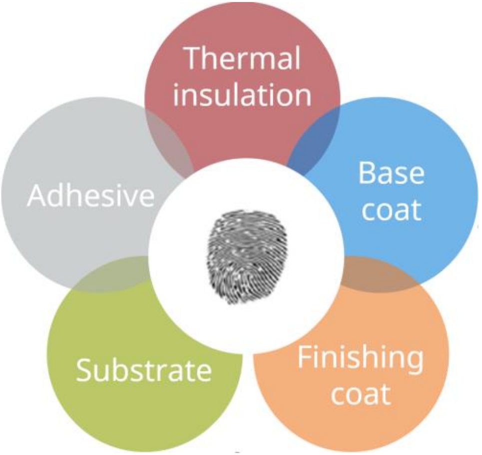
The ETICS system is a very simple system with only a few interconnecting layers that offer the overall performance.

The complexity is in the variability of various characteristics of all layers and their interconnection and the variability in the exposure (wind, dead load, sun, rain, etc.).





The “fingerprint” of an ETICS – a unique identification



A possible method for reproducing the systems quality

- On the material level, the relevant set of characteristics is based on declared values for the product identification based on technical regulation.
- The **Fingerprint can represent the specific performance of a specific product determined by a full set of tests on one batch. These are product properties that identify the product and allow regulations for sale and application.**
- But this identification does not necessarily give sufficient information to describe the building physics behaviour of the system. Therefore, additional parameters are needed.
- As an extension of the Fingerprint idea, the building physics fingerprint of a system deals with material properties that are based on chemical and physical structure of the components and their interaction in the system, considering typical impositions.
- Besides the role of describing the components and the system, the Fingerprint can be considered as the relation between the material properties or layer properties and the system performance.
- **By identifying the Fingerprint of an ETICS, it is possible to evaluate the tolerances of the products in relation to the performance of the system.**
- Therefore, the evaluation of this set of interlocking product- and layer performances show the mechanisms behind the success and failure of an ETIC-system.

Characteristics in relation to the performance of the ETICS

Quick look - only at the insulation material ...

thermal (I_D)	thermal (I_D)
density	density
compressive stress	compressive stress
bending strength	bending strength
tensile strength	tensile strength
shear strength	shear strength
shear modulus	
dimensional stability	dimensional stability
dimensional stability	dimensional stability
compressive creep	compressive creep
waterabsorbtion (immersion)	Water absorbtion (immersion)
Water absorbtion (diffusion)	waterabsorbtion (diffusion)
water vapour diffusion resistance factor	water vapour diffusion resistance factor
dynamic stiffness	dynamic stiffness
length	length
width	width
thickness	thickness
squareness (length & width)	squareness (length & width)
flattness	flattness
Reaction to Fire	Reaction to Fire
Deformation (spec. Load/temp)	Deformation (spec. Load/temp)
Deformation under cyclic loading	Deformation under cyclic loading
pull through	pull through

		declared value	test value	margin [value]	margin [%]
thermal (I_D)	20	0,032	0,031	0,001	3,13%
density	3	14	15	15	7,14%
compressive stress	3	70	80	80	14,29%
bending strength	3	100	150	150	50,00%
tensile strength	18	120	135	135	12,50%
shear strength	18	50	75	75	50,00%
dimensional stability	12	0,2	0,1	0,1	50,00%
Water absorption (immersion)	3	0,2	0,05	0,05	75,00%
squareness (length & width)	5	2	1	1	50,00%
Reaction to Fire	15	E	E	0	0%

Optimizing one characteristic influences the other 10

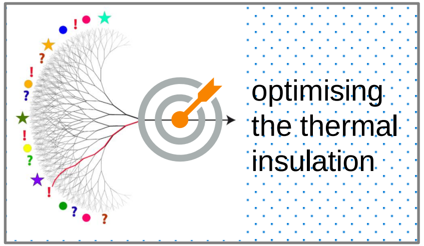
For the real performance only the insulation material offers more than 10 variables as parameter.

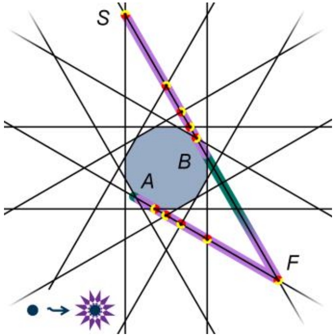
The importance in the right configuration.
The importance to have the right product-identification.

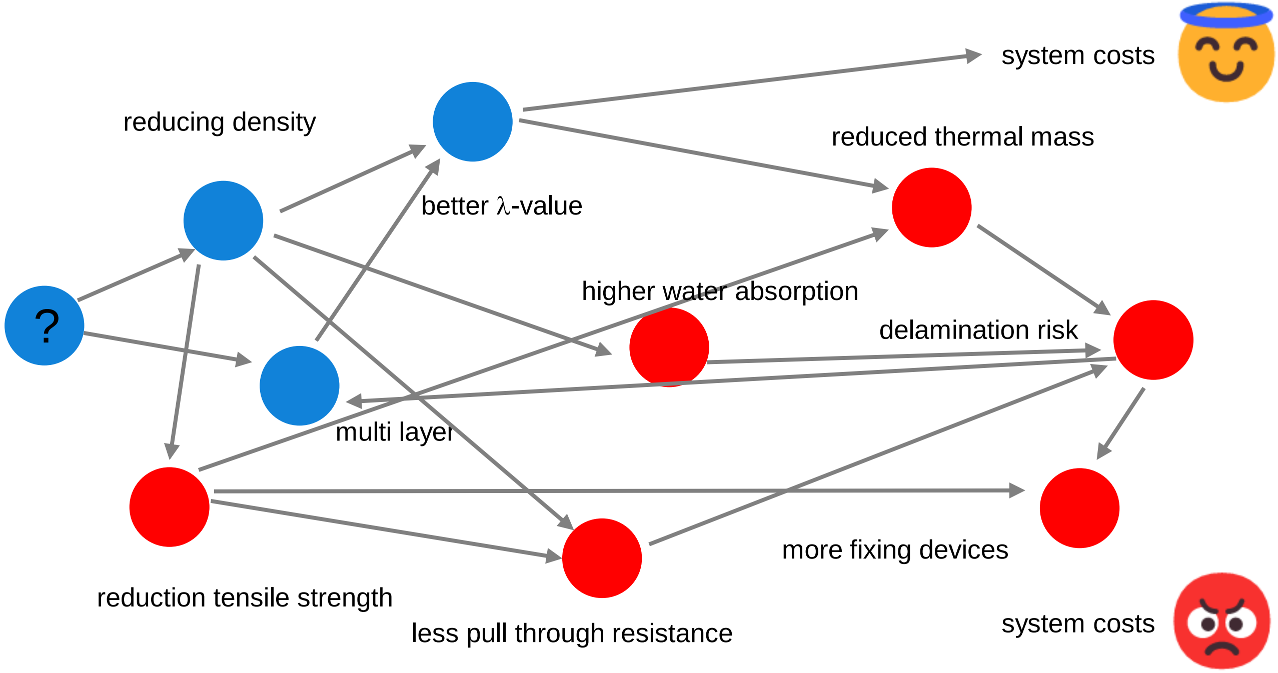
Optimizing a component within the unique set of relevant characteristics of an ETICS (example: insulation).

Possible challenges in the setting of performance of the ETICS.

Simple changes can have great impact on the costs and/or the performance







The "ETICS Project"

EUMEPS commissioned FIW (Forschungsinstitut für Wärmeschutz e.V. München) to execute an scientific and objective research project on ETICS.

The FIW project was finalised end of 2021 with 3 major reports.

(unfortunately not all issues could be handled, but some conclusions raise serious concerns).

Basic literature study – state of the art on materials, models and building physics

Forschungsinstitut für Wärmeschutz e.V. München

External Thermal Insulation Composite Systems ETICS – Basic literature survey and state of the art on materials, models and building physics

Forschungsinstitut für Wärmeschutz e.V. München

Chiara Cucchi
Christoph Sprengard
Stefan Sieber
Claus Karrer

This State of the Art report was commissioned by:

EUMEPS-European Association of
Weertersteenweg 158
3680 Maaseik
Belgium

Hygrothermal and mechanical simulations and analysis

External Thermal Insulation Composite Systems ETICS-Hygrothermal and Mechanical simulations and analysis

Sensitivity analysis for hygrothermal performance and evaluation of the mechanical forces

Forschungsinstitut für Wärmeschutz e.V. München

Chiara Cucchi
Holger Simon
Christoph Sprengard

This research report was commissioned by:

ETICS – Executive summary

...schungsinstitut für Wärmeschutz e.V. München

External Thermal Insulation Composite Systems ETICS – Executive summary

Forschungsinstitut für Wärmeschutz e.V. München

Chiara Cucchi
Holger Simon
Christoph Sprengard

Reports will be available at the EAE European ETICS Forum in Prague (19.05.2022) at the EUMEPS Booth.

1 - Basic literature survey and state of the art on materials, models and building physics

etc. etc. etc. etc.

The literature survey was performed through online sources. The main tools used were data bases such as ScienceDirect, IRB Fraunhofer and ResearchGate. Some journals were employed as well. Examples are: Construction and Building Materials, Building and Environment, Advances in Materials Science and Engineering and Procedia Engineering. Moreover, websites of International Conference on Durability of Building Materials and Components (ICDBM), European Association for External Thermal Insulation Composite System (EAE) and Verband für Dämmsysteme, Putz und Mörtel e.V. (VDPM) were also used.

From a huge amount of documents, reports, studies, scientific articles, books and presentations, descriptions, etc. etc. were more than 200 documents selected which had some promise of usable content.

Table 4: **Number of the documents that are public or not public**

Topic	Public	Not public
Description of ETICS	41	5
Mechanical analysis	19	4
Hygrothermal analysis	48	12
Durability aspects and common deficiencies	81	3

All documents must be publicly available

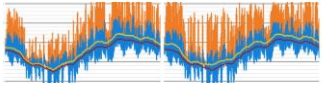
1 - State of the Art report – some of the conclusions

Most reports turned out to have al lot of *non-scientific content* and *one-off conclusions with limited validity.* Estimated 85% of the reports were on EPS, some 15% on MW … Hardly any scientific publication was found on other materials.....?

- Main focus on properties and function of individual components without consideration of the interactions between layers. >>> ***interaction missing***
- Analysis of single aspects/problems solving very specific questions and references to a specific application (boundary conditions and material properties >>> ***complete" model is missing***
- Difficulties to extend the validity of the results >>> ***extension of knowledge hardly possible***
- Lack of a comparison of the material properties used to feed the simulation models with properties for typical material on the market or with declared material properties >>> ***gap in regulations (e.g., definition of classes and declaration principle***
- Lack of information about the influence of changes in the material composition on the mechanical and hygrothermal performance of the thermal insulation in a system
- Assessment of spans of material values and limitations and the correlation between most of the properties are not known

Most of the starting questions were left unanswered

2 - Hygrothermal and Mechanical simulations



The goals of the analysis were:

- **Investigation of the main influencing factors for the functionality of ETICS**
- **Definition of a set of key properties and their appropriate span of values with focus on hygrothermal functionality of thermal insulation**
- **Definition of the areas in the system of potential concern**

Hygrothermal & Mechanical simulations - Overview

Sensitivity analysis - Objectives and goals

Sensitivity analysis – Results

Sensitivity analysis – Conclusion, Gaps and shortcomings

- The span of values assessed does not show potentially critical issues
- Changes in thermal conductivity due to moisture content do not jeopardize the quality of the thermal insulation according to ISO 10456
- The maximum water content within the thermal insulation is far less than 2 Vol.% which is a commonly used threshold value
- Further measurements and analysis needed on moisture transport mechanisms within and into an ETICS
- Further investigation and testing are also necessary to define the influence of the material parameters in terms of mechanical performance and bond strength under different moisture contents

Water distribution – Gaps and shortcomings

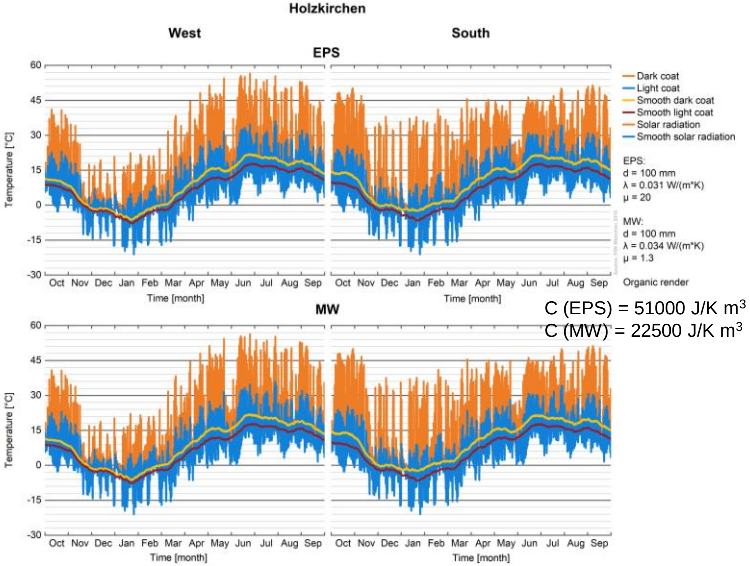
Findings and consequences

Findings and consequences

- Measurement is difficult and result is influenced by boundary conditions
  - Temperature level
  - Temperature difference
  - Dimensions of the samples
  - Moisture content and location
- Material characteristics define measurement procedure and boundary condition
  - μ-value
  - Microstructure (solid material with cells vs. fibers or particles)
- To-Do
  - Measurement abortion criteria needs to be revised
  - Wait for Moisture equilibrium
  - More sensitive criteria for heat-flux
- MUCH longer measurements
  - Use of fit-curves to predict end of measurements
  - Pre-conditioning of moist samples

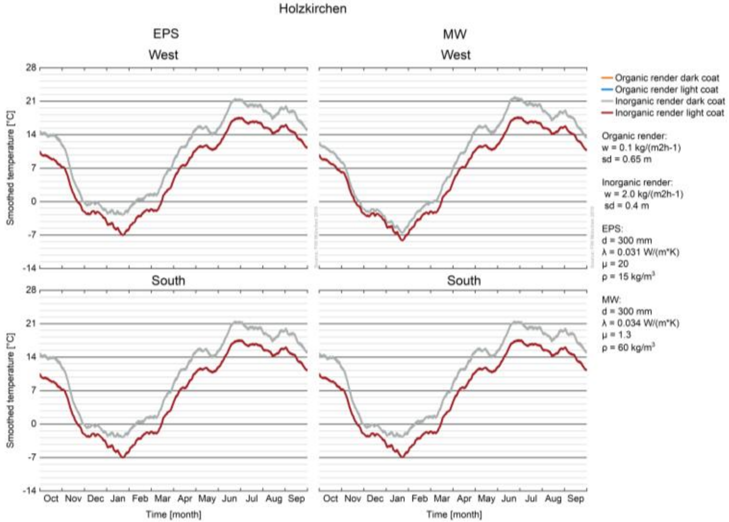
Surface temperature and insulation materials

Example: Holtzkirchen / finishing coat colour (dark: α = 0.7; light: α = 0.2).



C (EPS) = 51000 J/K m^3

C (MW) = 22500 J/K m^3

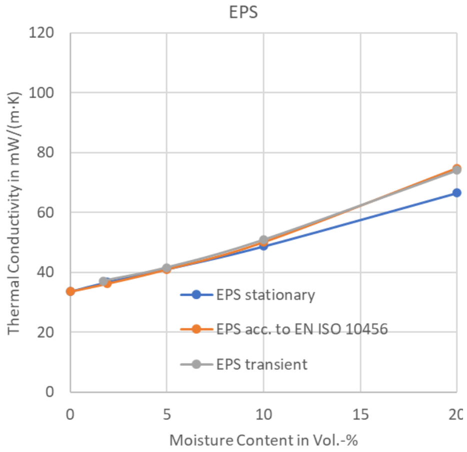


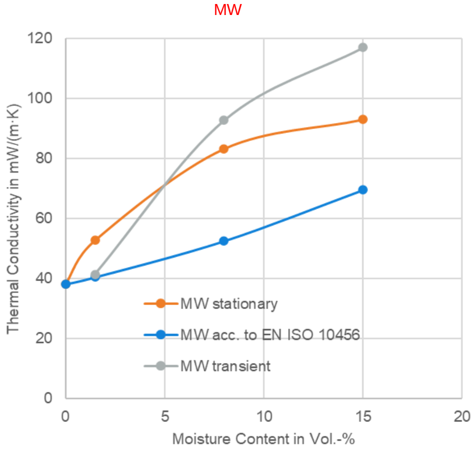
Sensitivity analysis on the results on temperature, relative humidity

- Main influence on Temperature: Moisture storage function and solar absorption of the rendering system
- Main influence on Relative Humidity: Sorption isotherm and render water vapour resistance

Influence of moisture on thermal performance

Stationary and transient vs ISO 10456





Important note: This is far more water than found in functioning ETICS!

Up to 5 vol.% very good agreement between the steady-state, transient and normative values
At higher moisture contents, the transient measurement is almost congruent with ISO 10456
The steady state values are slightly lower
Heat loss occurring under transient conditions is well captured with the standard values
Calculated influence of moisture is on the safe side
All stationary dots represent phase C
Higher influence than expected – both for stationary and transient measurements
Transient even higher than stationary
Measurement cannot be unaffected by moisture movements
Incompatibility with range from Table 4 in EN ISO 10456 – restriction to lower moisture contents needed
Alternatively: much higher coeficient needed, but more data needed...

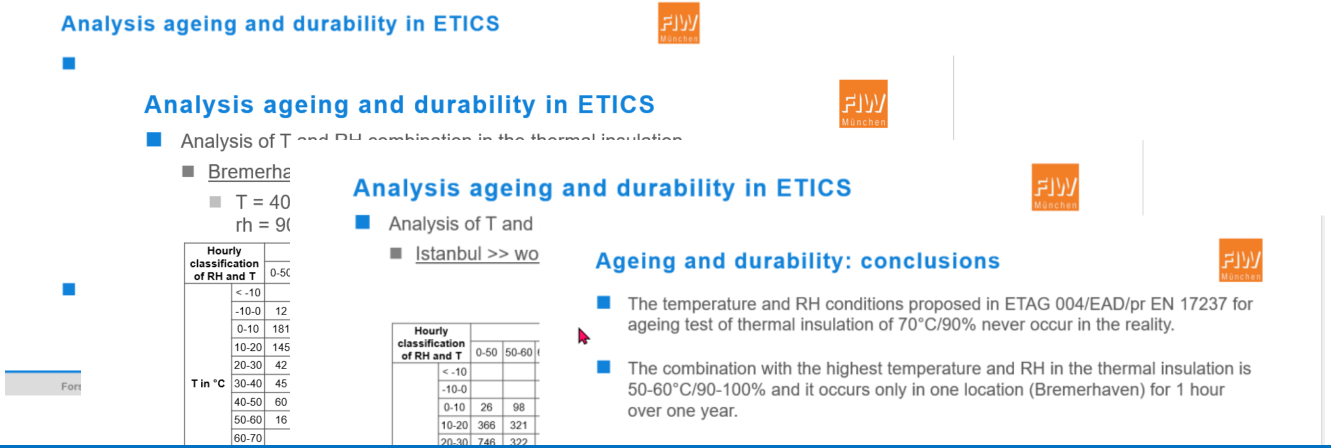
Findings and consequenses

- Moisture has a huge effect on thermal transport (and thermal conductivity)
- Heat transfer vs term „thermal conductivity“ and practical relevance
- Measurements influenced by boundary conditions and material characteristics (type adopted test)

Hygrothermal test for ETICS – most important test ?

There is NO GENERIC CLIMATE that fits all systems at the hygrothermal wall

Missing real definition of hygrothermal behavior.



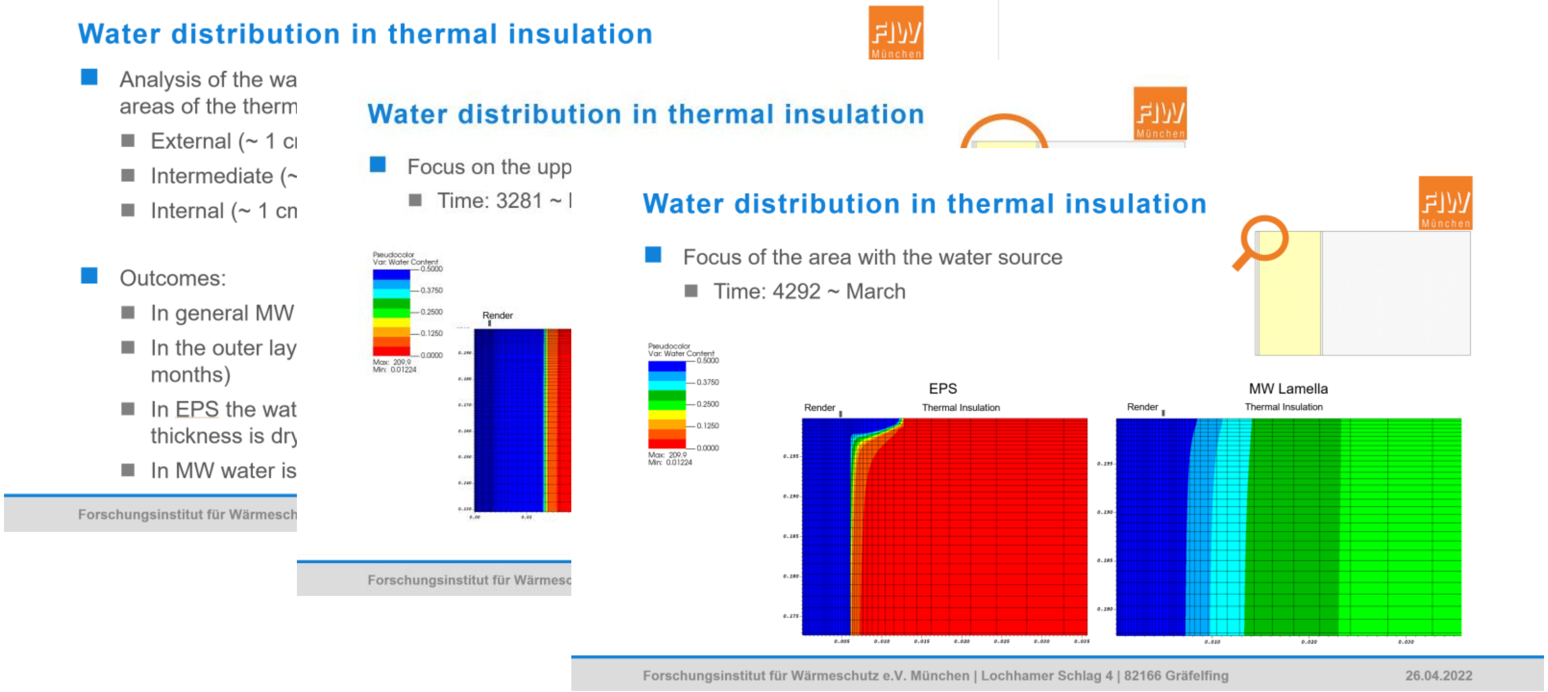
Findings and consequences

- over-estimation of the temperature and an underestimation of the relative humidity.
- suggest to use 40-50°C and 80% RH

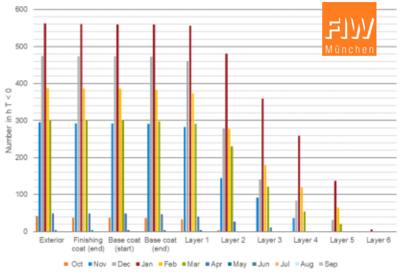
Forschungsinstitut für Wärmeschutz e.V. München | Lochhamer Schlag 4 | 82166 Gräfelfing 26.04.2022

Hygrothermal test ETICS – most important test ?

Water absorption and water distribution important for the test result.



Risk of frost damage – concerns and gaps



Greatest risk of frost in the west-façade / in January

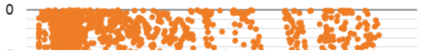
When would thermal insulation suffer performance deterioration?

We have no idea which properties are influenced by frost.

Present cycles are at different water content of the insulation, but is this OK?

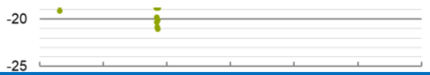
EPS White

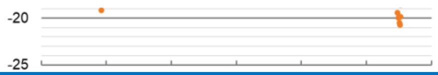
MW Lamella

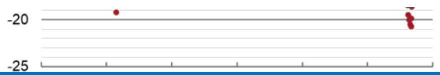


MW Normal Board

Greatest loss for MW insulation in pull-off strength occurs in the first few months of the service life.





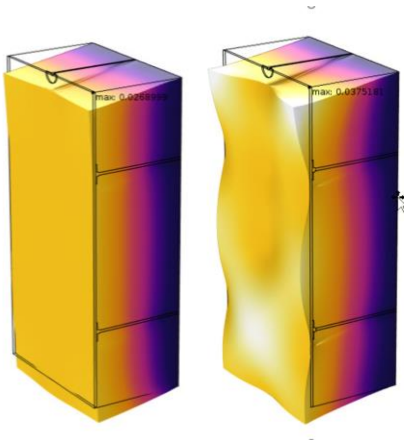


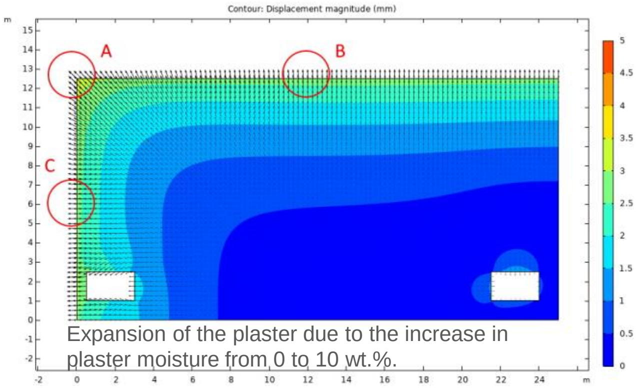
Findings and consequences

- Limit values where insulation would be safe for deterioration of mechanical performance are missing
- All in all – a risk function for thermal insulation is missing

Basics of stability of the ETIC kit

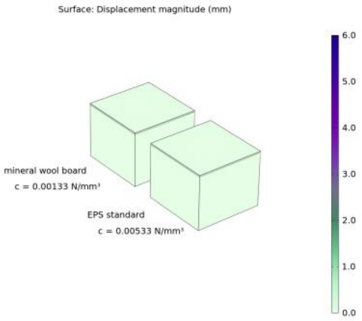
Impact of dead load, wind load, hygrothermal influences, moisture, insulation thickness





Expansion of the plaster due to the increase in plaster moisture from 0 to 10 wt.%.

The animation demonstrates the **different displacements** regarding one model with two different materials, namely **EPS and MW boards**
Comparison of two ETIC blocks, 240 mm insulation, rendering.
Bedding stiffness
MW: c = 0,00133 N/mm³
EPS: c = 0,00533 N/mm³



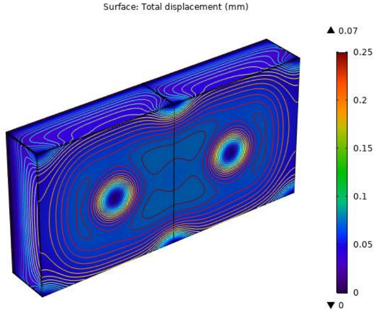
Moisture induced expansion, *the so called hygric swelling*,
takes place when there is a change in the moisture content of the rendering

Findings and consequences

- Combination of wind load and hygrothermal influences critical - has **much, much** influence
- The trend towards thicker systems leads to greater deformations due to the lower bedding stiffness
- Risk for low-TR insulation at high insulation thickness

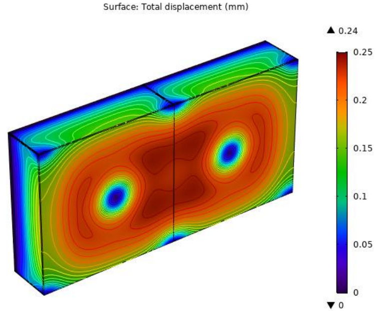
Wind load and displacement

Wind Load 1.55 kN/m²

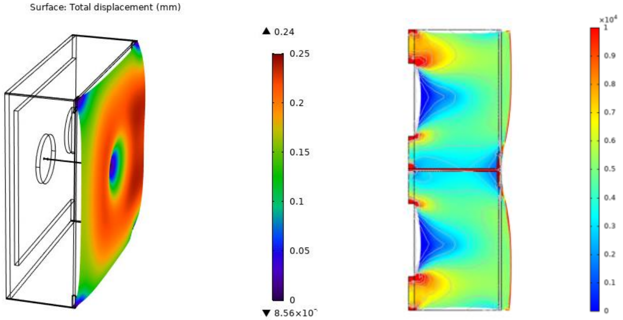


8 anchors / m² + adhesive mortar 40 %

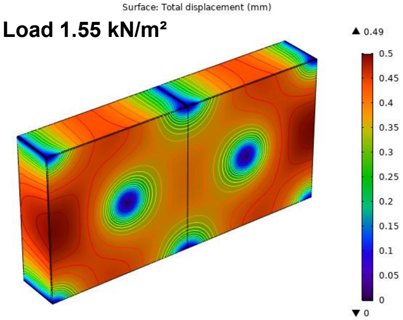
Wind Load 5.0 kN/m²



Wind Load 5.0 kN/m²

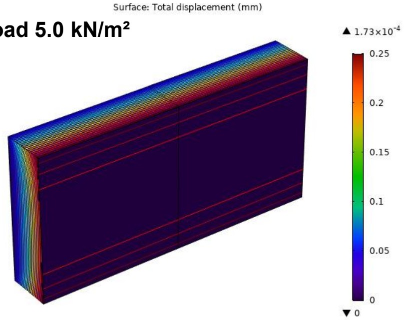


Wind Load 1.55 kN/m²



8 anchors / m²

Wind Load 5.0 kN/m²



adhesive mortar 100 %

High deformation around the anchor-zones

Wind is not a static load …

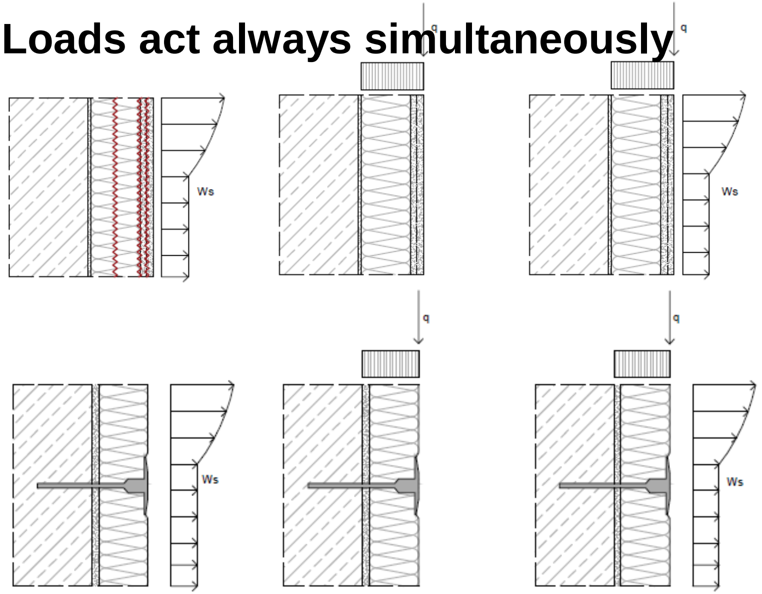
Relevant material parameters

- Number of anchors
- Adhesive material (adhesive strength)
- Youngs Modulus

The trend towards thicker systems leads to greater deformations due to the lower bedding stiffness and this must be taken into account

Interactions between substrate, insulation and render

Loads act always simultaneously

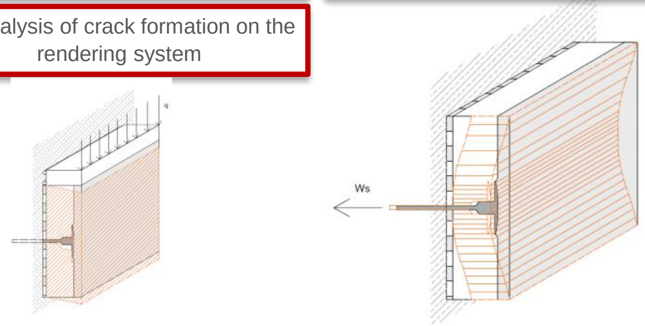


Wind load

Dead load

Combination of dead load and wind load (possible worst-case evaluation)

Standard tests	New tests
No analysis of load combination	Analysis of loads combination
No dynamic load application	Application of dynamic loads
No fatigue determination	Possible fatigue determination
Only forces to the break/elongation	Screening of initial cracks
No analysis of crack formation on the rendering system	



Findings and consequences

- Higher thicknesses easily lead to greater deformations due to lower bedding stiffness
- For insulation the weakest point is the tensile strength and the shear strength

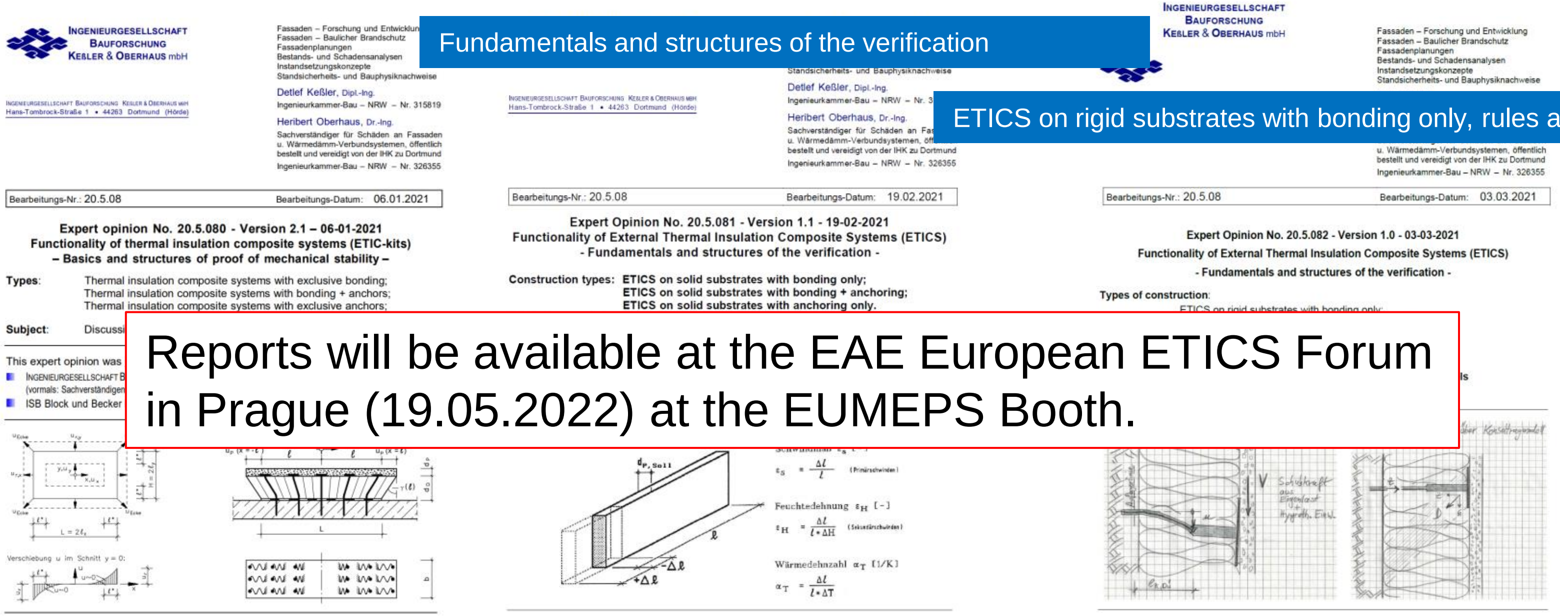
Oberhaus & Keßler, Block & Becker - Mechanical analysis

Expert opinion by civil engineers on the mechanical performance of ETICS

Basics and structures of proof of mechanical stability

Fundamentals and structures of the verification

ETICS on rigid substrates with bonding only, rules and test methods



Reports will be available at the EAE European ETICS Forum in Prague (19.05.2022) at the EUMEPS Booth.

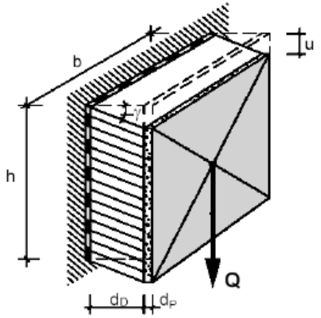
Mechanical analysis - alarming concerns

Systems today are different from the past and much more challenging from the structural integrity point of view.

- Current insulation materials as such and with increased thickness, are not the same in performance as those 20 years ago. Insulation optimized for better lambda, but with lower mechanical properties (e.g., reduced tensile strength), **might fulfill the requirement in individual tests, they will almost certainly lead to failures in handling the combined load.**
- Expert described test methods in the draft EN 17237 are based on **old know how** looking at the new insulation types and higher thicknesses.
- **Unidentified risks** for insulation that is too rigid or with high spread of homogeneity in combination with the accepted limitations in the present draft.
- **The old ways of assessment do not cover these recent developments, and especially not for the resistance to wind load in combination with hygrothermal loads for the new insulation materials.**
- The evaluation of the total load capacity of the system is not easy, but **the simple "add-up" of individual assessments in EN17237 will likely lead to unsafe systems**, particularly as most assessments are done and declared by mean values, and in "adding up" the possible tolerances, **the margin for safety disappears**.

Basics of stability of the ETIC kit

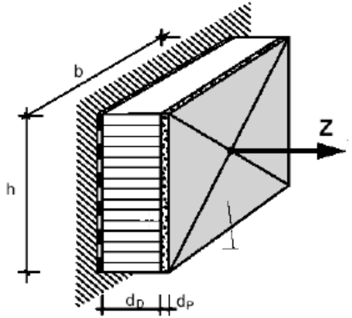
ETICS – bonded system (with supplementary anchors)



Dead load

- The weight of the system
- Hygrothermal influences
- Shrinkage of the system

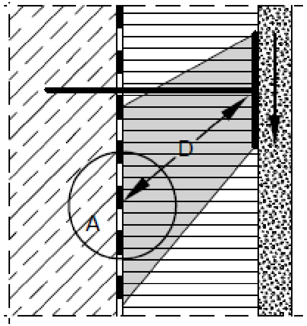
- Adhesive
- Supplementary anchors
- Anchors



Wind load

- Wind pressure
- Wind suction

- Adhesive
- Supplementary anchors
- Anchors



Console support model
NOT A DESIGN MODEL
But a model on failure

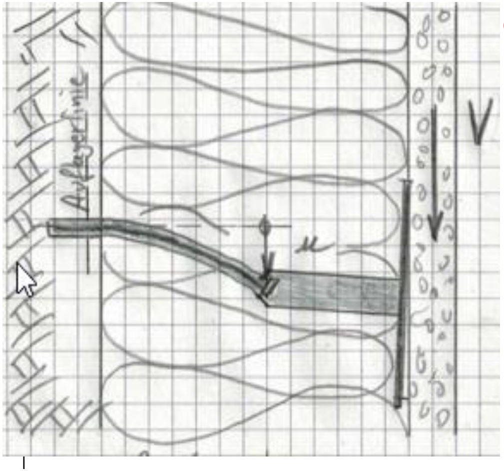
- Without adhesive
- When failing of the adhesive

Property values – insulation

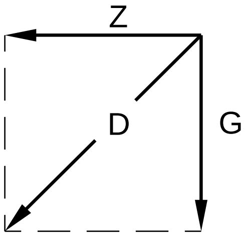
- Transverse tensile strength σ_{mt}
- Bonding strength between insulation and base coat σ_{HZ}
- Bending stiffness and Bending strength σ_b
- Punching resistance
- Shear strength f_{tk}
- Shear modulus G_m
- Ageing
- Thermal conductivity λ

Role of the anchor in the load transfer

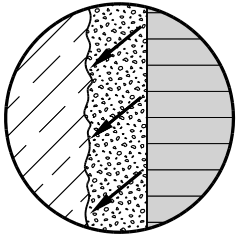
Anchors in accordance to ETAG 014 are designed for taking wind load (and wind load only).
Anchors in accordance to ETAG 020 can take wind loads and shear loads and bending effects.



Console support model = NOT A DESIGN MODEL
But a model on failure



Detail A



Load distribution of the mechanically fixed ETIC kit for impacts parallel to the surface through the "console support model“.
Wind loads often govern lateral load scenarios.

Bonded systems (with supplementary anchors):

- In case the adhesive fails, the mechanical fixings have to take both tensile and shear forces (although they are not a part of the load transfer-model)

Mechanically fixed systems on an adhesive bed:

- the mechanical fixings have to take both tensile and shear forces (the adhesive bed is not in the calculation).

The bedding load cases (dead load + hygrothermal effects): "consol carrying effect" with screw as "pull belt", insulation material as "pressure strut" and "push gearing" on the substrate

A mechanical model usually is necessary to evaluate the stress distribution

Mechanical analysis – alarming concerns

- **Possible rejection of some systems that are in the market at this moment**
- **Non-public technical (mostly oral) info on "experience" looks like a "trial and error project"**

Findings and consequences

- alarming concerns about the consequences of the EN 17237 in practice
- the simple "add-up" of individual assessments in EN17237 will likely lead to unsafe systems
- Using mean values and high tolerances in production has a negative effect on safety margins
- Realistic and controlled tolerances for steadiness in production and FPC are vital to the margins
- No real scientific back up on most data to be used for assessing the actual performance
- specific risks when using insulation materials other than EPS and MW in combination with the accepted limitations in the present draft. (nonhomogeneous, too rigid, etc.)

Mechanical analysis – alarming concerns

- **Failures occur as a result of the actual load combination.**
- **Shear load and loads from hygrothermal influences ignored for mechanically fixed systems.**

Findings and consequences

- alarming Insulation types with a low TR performance are **close to the maximum acceptable load bearing capacity**.
- Resistance to loads is assessed individually and **not in combination no insight on the ultimate limit state for failure** / calculation.
- Assessment does not give clear information of the **total deformation at actual load combination.**
- Mechanical performance **should be tested for any insulation at any thickness**; simplification and grouping can lead to wrong conclusions.
- **No rules for combination** high deformation and high wind loads at facades

Mechanical analysis – alarming concerns

- **Difference between systems "bonded" and "mechanically fixed" not in line with practice.**

- **Anchors for mechanically fixed systems are not designed or assessed on shear load.**

Findings and consequences

- **Risk of shear failure** in the insulation is **unknown for mechanically fixed systems. Assessing shear strength on only 60mm thickness** will provide results which for some insulation types are not representative for higher insulation thicknesses.
- Role of the adhesive in bonded systems is clear, for mechanically fixed systems on **adhesive bed role is unclear** (cannot be calculated).
- **No relation between the apparent density / compressive strength** and the "clamping effect" by the anchors (compression struth)

EN 17237 - main concerns identified by the Expert group

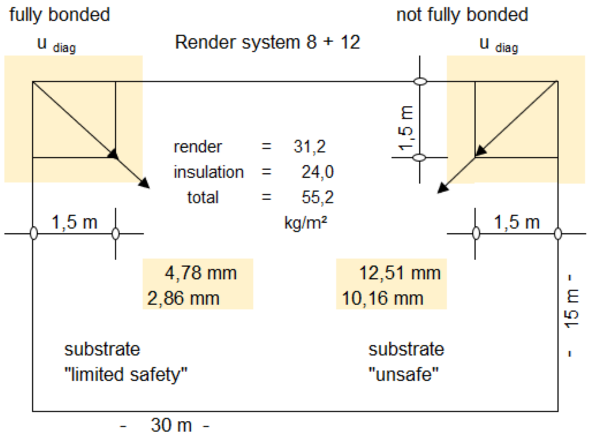
- **Lack of clear rules to pull-through resistance with double density insulation, insulation with treated surface, facings, countersunk or helix anchors**
- **Insulation types with a high rigidity (like XPS, CG, …) will lead to cracks earlier. Test by EN 17237 will not inform you about this.**

Findings and consequences

- Real differences between insulation materials are ignored (there is no “copy paste” possible)
- Risk of shear failure in the insulation is unknown for mechanically fixed systems
- Shrinkage/swelling and hygrothermal deformation are not a part of the assessment
- Mechanical performance should be tested for any type of insulation at any thickness
- Anchors for mechanically fixed systems are not designed or assessed on shear load.
- Insulation types with a high rigidity (like XPS, CG, …) will lead to cracks earlier

Impact of a combination of loads on a MW system (example)

Displacement by wind load, dead load, hygrothermal influences and shrinkage



Calculated displacement in the upper corner of a façade 30 m1 wide and 15 m1 high:
fully bonded: 2,78/4,78 mm and not fully bonded: 10,16/12,51 mm

ETIC kit

- Mineral Wool insulation / 200 mm thickness
- bonded and mechanically fixed by anchors

  EJOT ejotherm STR-U (2G) / plate diameter Ø 90 mm or Ø 112,5 mm

  Anchors flush on the panel surfaces; $N_{Rk,WDVS}$ = 0,77 kN
- 8 mm base coat / 12 mm mineral render

If the regular anchor is limited to a transversal load of 28 N per anchor with a dead load (weight of the system – insulation + render) of 55,2 kg – 10 anchors would absorb not even 50% of the load.

Not fully bonded / failing adhesive >>> result: a pretty large deformation, *and you will never find this in a test situation*

A mechanical model usually is necessary to evaluate the stress distribution inside the insulation to see whether the displacement is within the allowable limit(s).

ETICS – impact of durability and moisture

Food for thought / conclusions / suggestions / discussion

1. We see well performing ETICS systems and some failures, but we do not really know why they are well performing
2. Components really have changed and we are unaware of the possible risks by updating components

3. We test on mechanical performance with the same tests as 40 years ago
4. Most of the mechanical performance does not stay the same at increased insulation thickness – differences per insulation type – in need of a mechanical model to evaluate stress distribution and to evaluate the displacement
5. Wind load in combination with hygrothermal influences are the worst case in load
6. Assessing performance on 60 mm thickness will provide non-representative values for higher insulation thicknesses
7. Moisture content and -distribution influence the mechanical properties, but in an uneven way per insulation type and thickness

8. For hygrothermal testing there is an over-estimation of the temperature and an underestimation of the relative humidity
9. We do not have a real risk-model for deterioration / decline of mechanical performance by ageing
10. The design ETICS by the manufacturer should foresee the possible failures and must have “build-in margins” to cover the risks and the unexpected load influences

Thank you for your attention

Questions …
Actions …

Ir. H.E. (Eric) Las
eric.las@noviocon.nl
+31 (6) 22971566