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SUSTAINABLE TRADITIONAL BUILDINGS ALLIANCE

STBA Work with DECC

A *New Approach to Moisture Risk Assessment and Guidance*

Neil May

STBA, UCL, NBT

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Sustainable	For people & environment
Traditional	Pre 1919 (mainly masonry)
Buildings	Domestic and Non-domestic
Alliance	Not-for-profit organisations

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Who are we?

Three pillars of the Alliance

- Sustainability
- Heritage
- Industry

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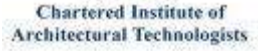
Supporting organisations



Why do we need a new approach?

- Drive to energy efficiency/ carbon reduction is creating new conditions and challenges in buildings, as is our life style and building use.
- However industry context has not changed
  - Lack of knowledge *(theory)*/ knowledge gaps
  - Lack of skills/ delivery capability/ joined up process (including user engagement) *(practice)*
  - Lack of interest or ethics *(intention)*
- Consequential effects are huge and negative

100 unintended consequences of policies to improve the energy efficiency of the UK housing stock*

Clive Shrubsole, Alexandra Macmillan, Michael Davies and Neil May
University College London. Email: clive.shrubsole.09@ucl.ac.uk

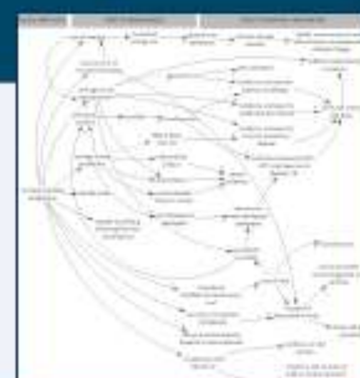
UCL

- Climate Change: Re-affirmed by the IPCC as a *"major global threat to human survival"*.
- Government Response: Legally binding targets to reduce emissions by 80% by 2050 relative to 1990 levels. Increasing interventions on housing; levels of insulation, draft proofing, double glazing, making homes more airtight and energy efficient.
- The Problem: Sole focus on CO_2 emissions reduction; little account taken of the wider impacts such policies inevitably have on buildings, people's wellbeing and the environment; policy resistance, failure to achieve the desired outcomes and even possibly making things worse.

We......

1. **Investigate the impacts of interventions on the domestic stock through a Housing, Health and Wellbeing lens**
2. **Explore the range of unintended consequences of current policy and the domains impacted**
3. **Highlight the need for a more integrative approach to policy formation in order to deal with the complexity involved**
4. **Suggest Participatory System Dynamics as a possible way forward involving a wide group of stakeholders whose role is to influence national policies about housing.**

A	B	C	D	E	F	G	H
No.	Policy Impact on Buildings			Impacts on People/Nature		+/-	Reference
				Unintended Consequence	Domain		
1	Airtightness		Quieter Environment	Peace/Wellbeing / Security	Mental Health Psychological Well Being	+	[illegible] D,R,P
2	Airtightness		Quieter Environment	Isolation / Disconnection	Mental Health Psychological Well Being	–	Lorenc et al., 2012 D,R,P
3	Airtightness		Quieter Environment	Anxiety: real and perceived threats	Psychological Well Being	–	Lorenc et al., 2012 D,R,P
4	Airtightness		Quieter Environment	Reduction in Noise	Mental Health	+	[illegible] et al., 2012 D,R,P
5	Airtightness		Quieter Environment	Absence of sound	Mental Health	–	[illegible] et al., 2012 D,R,P
6	Airtightness		Quieter Environment	Improvements in physical health, social, emotional, and behavioural outcomes	Child Development	+	[illegible] 2012 D,R,P
7	Airtightness	Lower air change rate	Increased RH [illegible]	Increase in HDM and [illegible] severity of asthma and allergies	Physical Health	–	[illegible] et al., 2011 [illegible] et al., 2010 B,C,D,R,P
8	Airtightness	Lower air change rate	Increased RH [illegible] drying issues	Increase in and exposure to [illegible] pathogens and infectious diseases	Physical Health	–	[illegible] et al., 2012 [illegible] et al., 2011 B,C,D,R,P



The Housing, Energy and Wellbeing (HEW) Project works at the interface between research and policy. It allows government and non-government

Domain	Direction of influence			
	+ve	-ve	+/-ve	Totals
Physical health	16	47	13	76
Mental health	4	4		8
Psychological wellbeing	9	5	2	16
Child development	1	1		2
Social cohesion		3		3
Social inequalities		1		1
Social mobility		2		2
Occupant behaviour		1	2	3
Household finances		2	1	3
General economic	9	1	2	20
Building fabric	1	17	2	20
Legal		3		3
Environmental	7	31	9	47
Totals	47	118	31	196

Responsible Retrofit of Traditional Buildings

- Commissioned by DECC
- Concerns with
  - unintended consequences
  - liabilities and costs
  - opportunities
  - **gaps in knowledge**
- Completed Sept 2012
- Authors N May and C Rye

with 8 other researchers and 12 STBA orgs

Responsible Retrofit of Traditional Buildings Project

- Gap analysis of research and guidance about energy performance of traditional buildings both as existing and as retrofitted
- Guidance structure framework to collate the best practice research and guidance

Added during work:

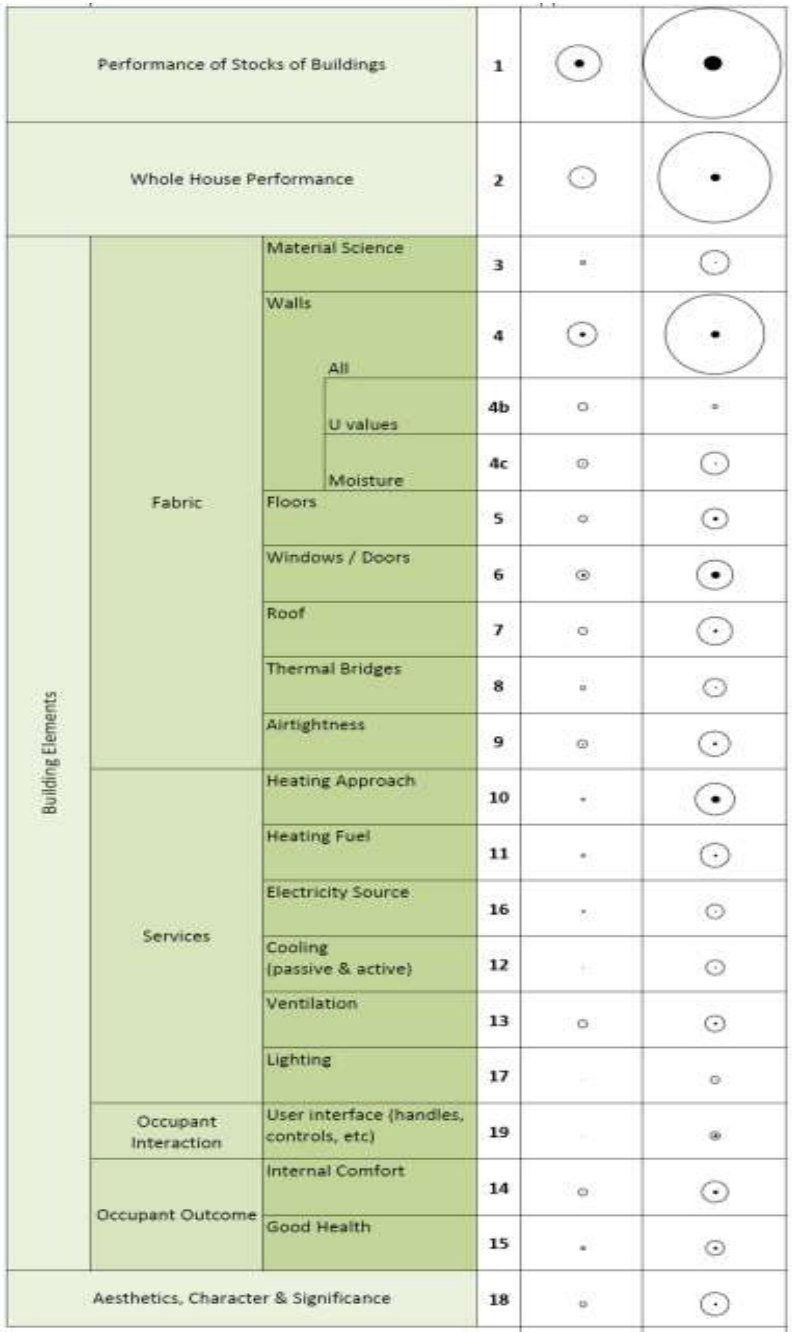
- Implicit Guidance research

Research papers

- UK experts – 104
- International – 52
- Further Academic search – 167
- Call for Research – 120 (incl books, technical reports, and other documents)
- Also 17 active unfinished research projects (including TSB, EST, LEAF, SUSREF, EH, HS, and UCL work).
- Total 460 documents found for analysis

Guidance documents

- Search included in Research Gap Analysis method
- Additionally search from statutory bodies, councils, local energy trusts, other advisory bodies and on internet
- 102 documents were found worthy of analysis



- 512 documents with 1241 references mapped
- 79% are on retrofit only 21% on traditional building performance
- 3 main areas of research – all modelling!
- Some areas of real significance have almost no research or guidance

In nearly every category there are major knowledge gaps

- Real lack of data in regard to traditional materials, construction, air permeability/ ventilation rates and systems, and weather. *Gaps in data.*
- Over-reliance on modelling which has been shown to be unreliable in many cases. *Gap between models and reality*.
- Current thermal (BR443 and RdSAP) and moisture conventions (BS5250) are not correct for traditional buildings in most cases. *Gap between conventions and reality.*
- Lack of understanding of moisture physics. *Knowledge gap*
- Windows knowledge and research is good! But the information is not getting into mainstream guidance (*gap!*).

Linkages and opportunity gaps

- Retrofit of individual fabric elements (ie walls, windows, floors, roofs, draught proofing) to each other and the whole shell
- Retrofit measures to Indoor Air Quality, ventilation and health
- Lifestyle to energy use and the possible rebound effects of retrofit
- Thermal mass to energy and comfort
- Retrofit to heritage values and community
- Built environment to social, economic and natural environment

Implicit Guidance

- Evident that most guidance is not from research or official guidance documents but from standards, certifications, and commercial technical and marketing literature
- This workstream was an attempt to understand whether Implicit Guidance is aligned with the best research and guidance (ie Tier 1 and 2) and what the main causes for concern might be.
- Very limited study

Examination of implicit guidance

- Building Regulations
- British Standards (BSI)
- Product Certification (BBA)
- CE Marking
- Trade Literature
- Warranties/ Guarantees

How are traditional buildings dealt with?
Answer - hardly at all.

Case Study on Solid Wall Insulation

- Examination of Building Regulations, BBA certification and trade technical and other literature for EWI and IWI (46 BBA EWI certificates and 12 IWI certificates)
- Examination particularly of thermal and moisture issues in relation to Tier 1 and 2 research and guidance

- Very large gaps and misalignment found

Gaps between Tier 1 and Implicit Guidance

- Without exception all certifications, technical literature and advertising use BR 443 (BS 6946) or the RDSAP default values for solid wall U values and cost savings. This is incorrect.
- Thermal bridging in both EWI and IWI not properly dealt with. Limitations and risks in IWI not understood.
- All use BS5250 (EN13788) rather than EN15026 (except where BS5250 doesn't allow use!) for moisture analysis. This is wrong.
- No understanding of context or need for contextual approach

STBA Report Recommendations

- Policy issues
  - New conventions
  - New standards
  - New assessment and training
- Delivery issues
  - A new approach based on learning and systemic thinking
  - Training and skills
  - An emphasis on quality, repair and maintenance
  - A guidance tool and knowledge centre
- Development issues
  - A wide ranging research programme
  - Action based research and feedback

The challenges

- Uncertainty of data/ mechanisms
- Complexity of interactions
- Difference of values

- Lack of understanding, skills, or interest
- Lack of time
- Lack of money

Immediate work

- Standards work
  - BR443 and RdSAP issues
  - Internal Wall Insulation
  - Moisture standards
- Guidance tool and Knowledge Centre

Moisture Standards

Moisture Conventions/ Standards

- Work by Chris Sanders, Neil May
- Issues raised by STBA accepted by Govt
- BS5250 accepted as partial and inadequate for assessment of solid wall moisture performance (including “in service conditions”) leading to
  - Fabric decay
  - Human health issues
  - Waste of financial and material resources
  - Long term risks and liabilities

Moisture Conventions and Standards Paper

- Written by Chris Sanders and Neil May
- Contrasts BS5250 and EN13788 with EN15026
- Case study of Glasgow building with Internal Insulation under BS5250 and EN 15026
- Illustrates context and key variables in
  - Systems (particularly in regard to VCLs)
  - Location
  - Orientation
- The need for a wider view of moisture risks

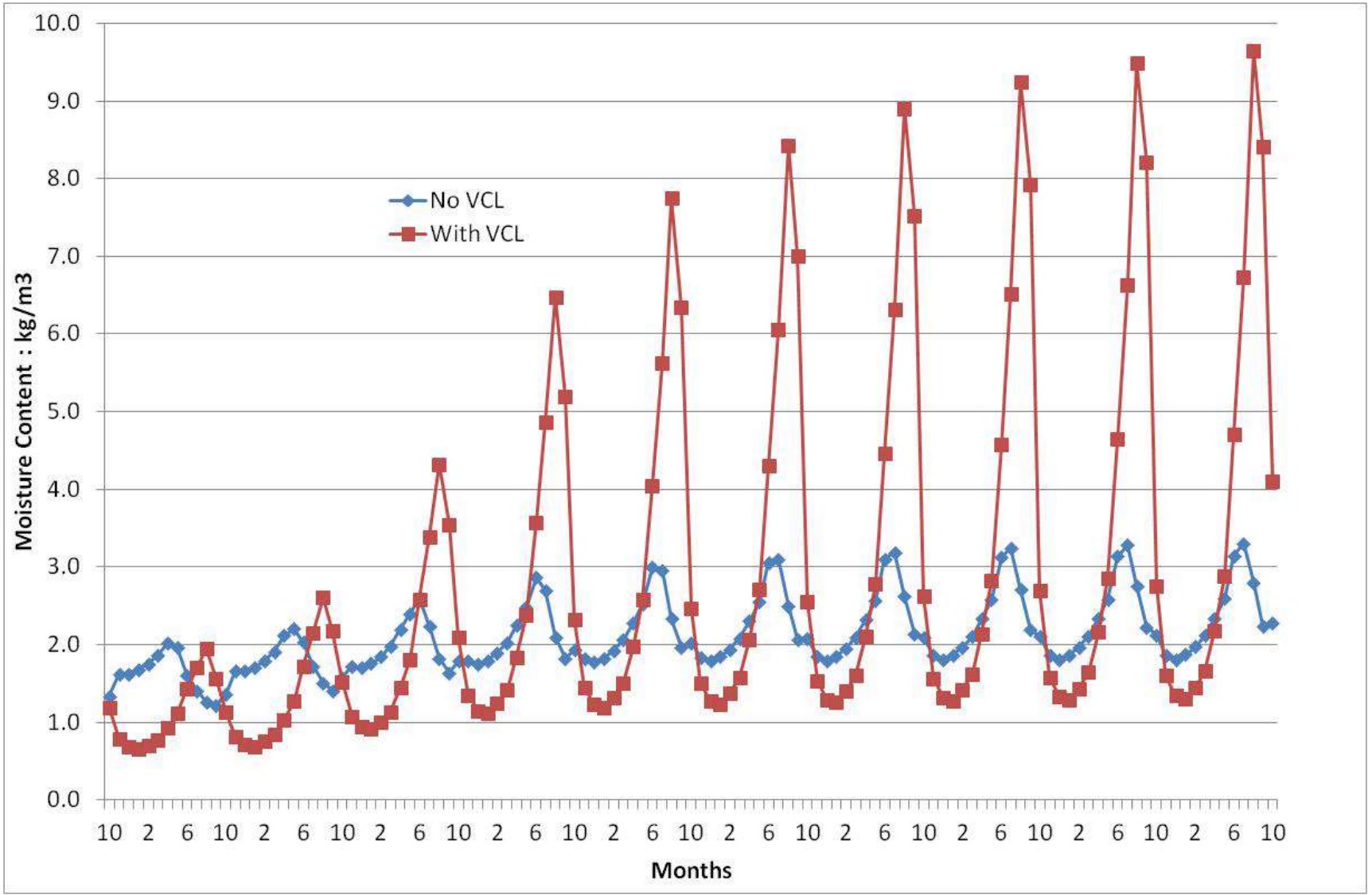
Modelling Protocols

EN 13788 compared to EN 15026

EN 13788	EN 15026
Steady state	Dynamic
Monthly (averaged)	Hourly
Limited materials criteria	Full materials criteria
No driven rain	Driven rain
No orientation	Orientation

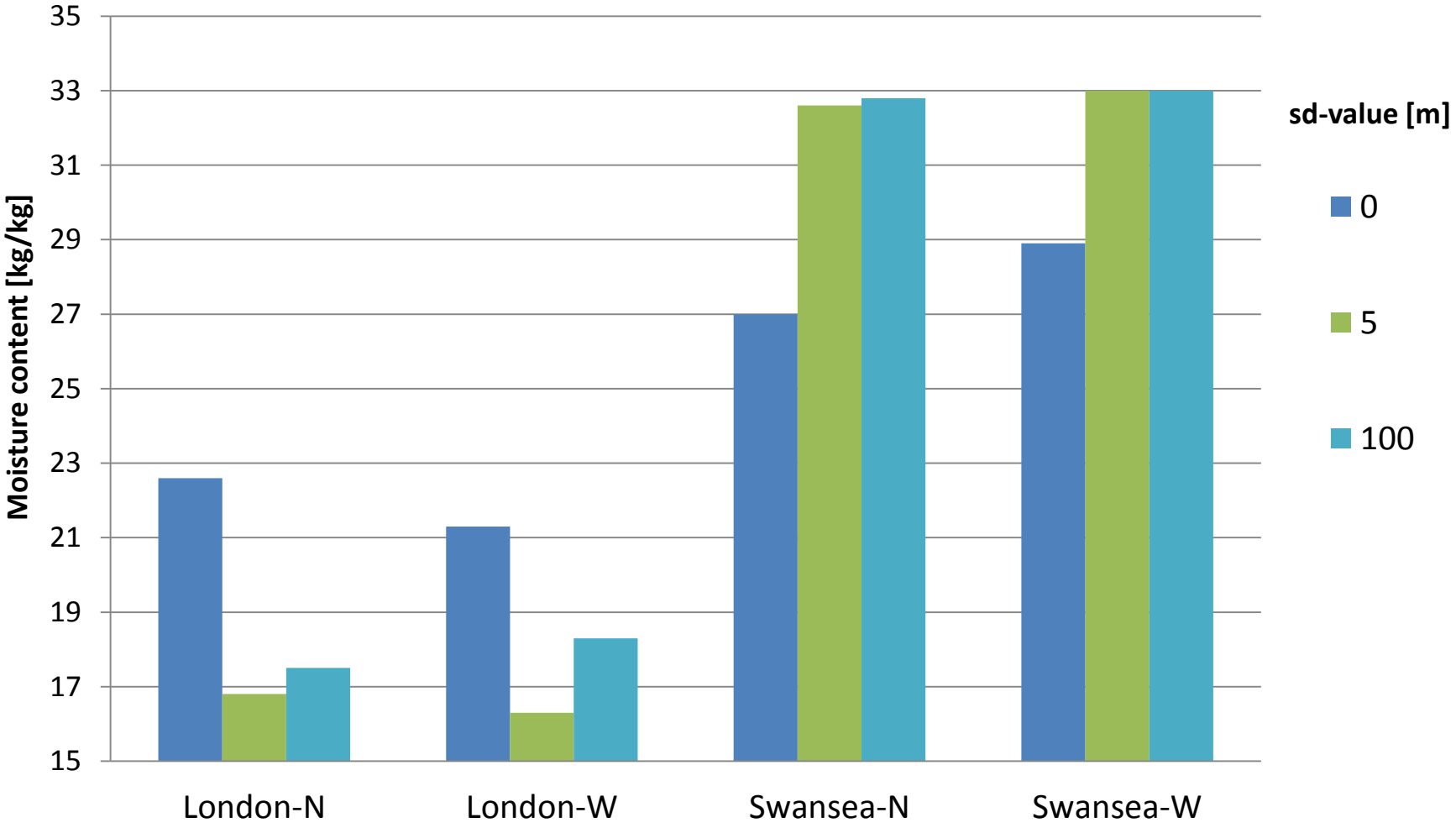
Nearly all (implicit) guidance uses EN13788

Example of how VCL affects internally insulated sandstone wall in Glasgow if En15026 (WUFI) is used. According to BS5250/EN13788 a VCL should be installed on the inside to prevent condensation



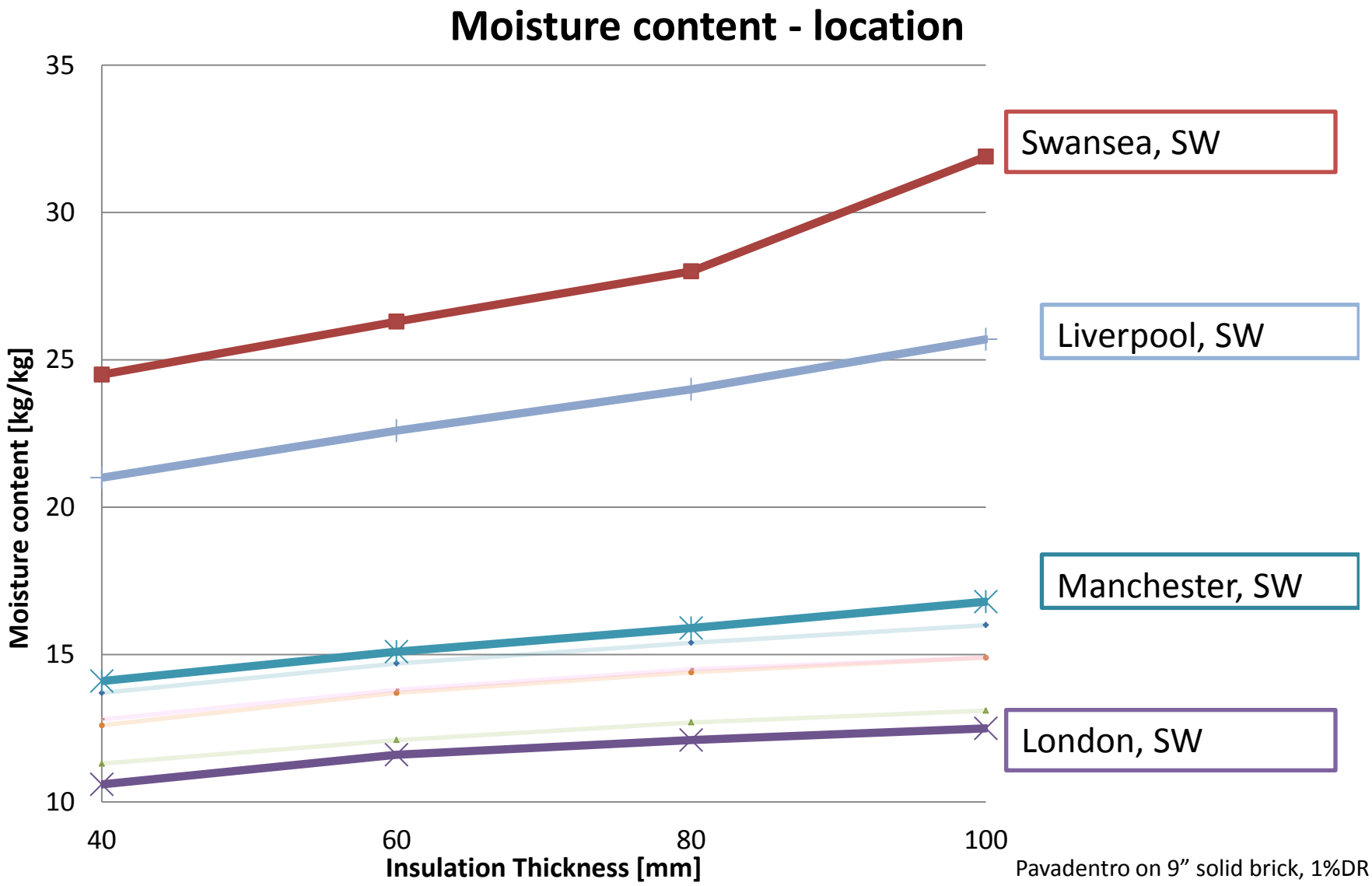
Consequences for systems

Moisture content – different membranes



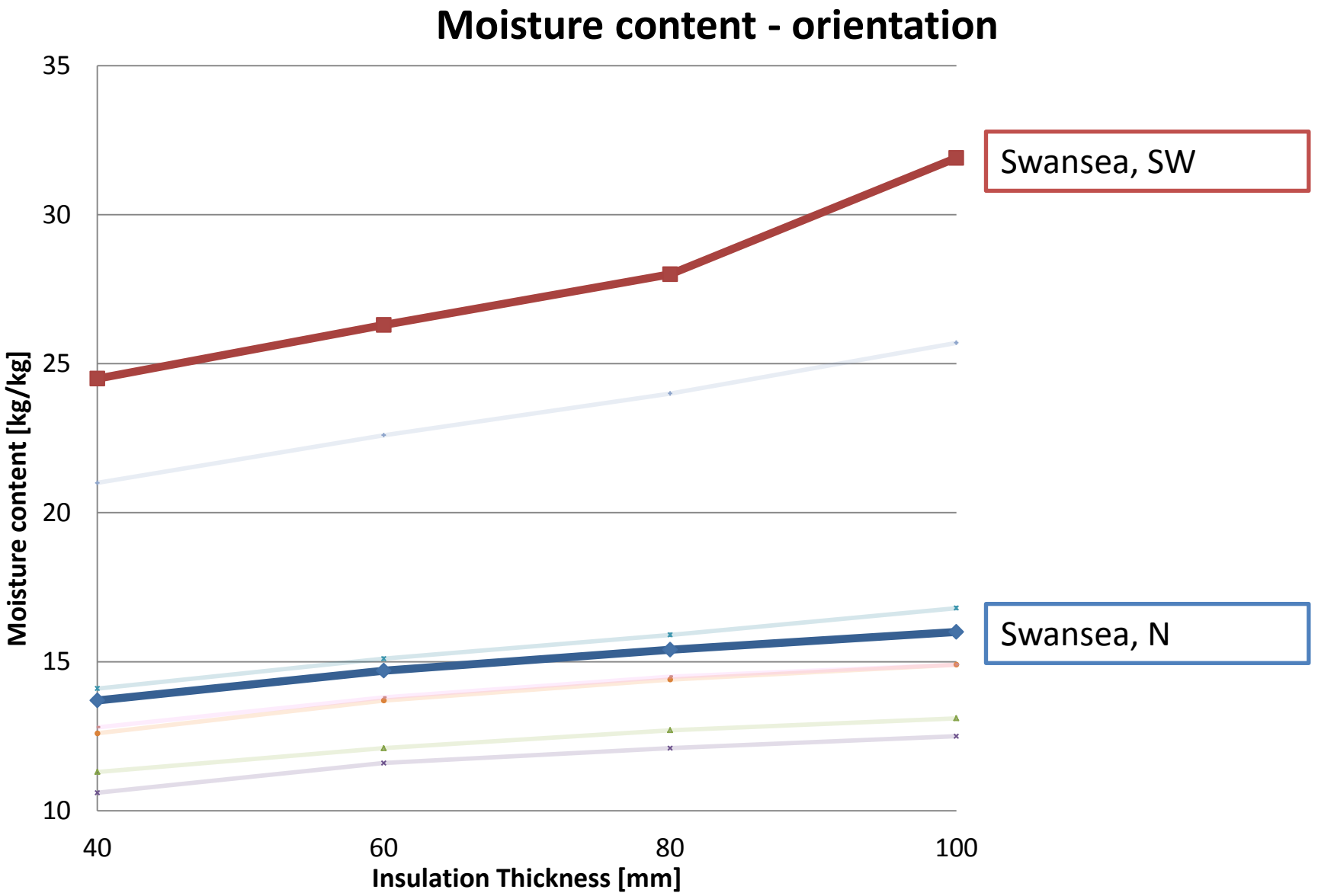
100mm Pavaflex on 9”solid brick, 0 DR

Consequences for locations



Pavadentro on 9” solid brick, 1%DR

Consequences for orientation



Not just about condensation in one bit of a building element

Short paper conclusions

- Inadequacy of EN13788 and BS5250 for some conditions.
- However EN15026 not yet ready – lack of material & weather data and also skills to use
- EN 15026 any way is not a complete method – 1D, no air movement, no systemic effects.
- Other guidance also inadequate at present
- Urgently need new approach to moisture risk assessment and guidance

Next phase of work

- STBA to produce a guidance document for DECC and CLG, which will be linked to
  - BS and EN standards processes
  - BR 262
  - Approved documents C and L in Building Regulations
- Not just traditional buildings but all existing and new. Important to link these.
- To be widely promoted and circulated to all key stakeholders

MOISTURE
RISK ASSESSMENT AND GUIDANCE

Department of Energy & Climate Change

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Key points

- The need for a new approach is due to
  - New understandings of moisture mechanisms
  - New types of buildings being considered for risk assessment – ie renovation of existing buildings
  - New conditions in all buildings due primarily to increased airtightness (following from new understanding of effect on energy use)
  - New awareness of relation of moisture to health of occupants and fabric
  - Awareness of uncertainty and complexity

Changes from old process

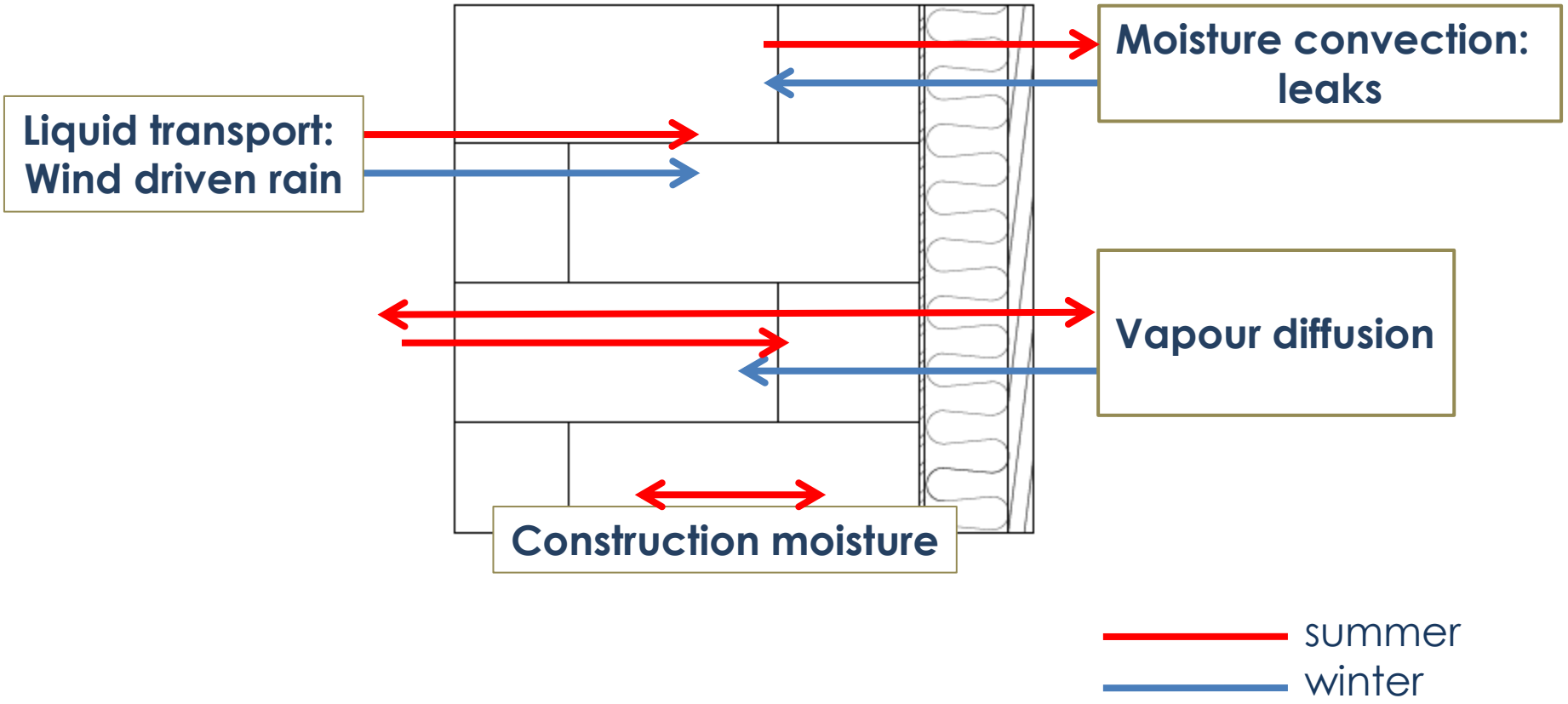
Wider type of moisture risk

- Moisture risk in buildings relates not only to the fabric, but also to IAQ and occupant health.
- Moisture risk in buildings relates not only to interstitial condensation but to surface condensation, high relative humidity and liquid water effects.

Water properties

- Moisture states
  - As solid, liquid and gas
- Moisture mechanisms
  - Vapour diffusions
  - Liquid flow through pores
  - Capillary flow
  - Hygroscopic buffering
  - Air movement
- Forces on moisture movement
  - Temperature and vapour pressure gradients
  - Gravity

Moisture movement is dynamic and complex

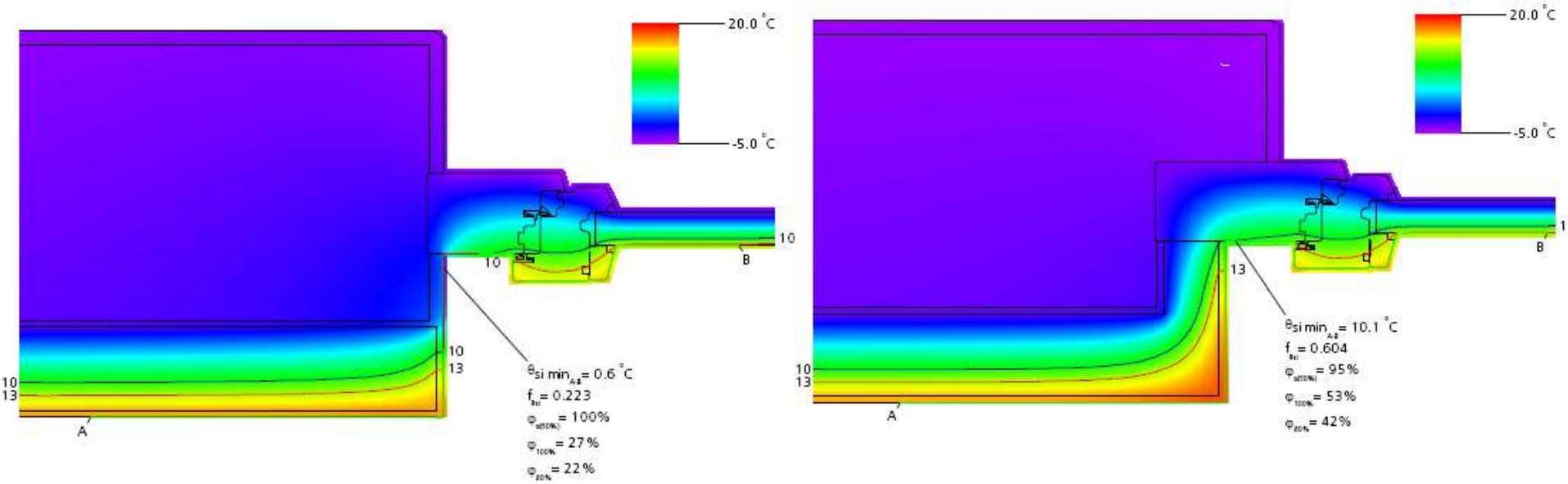


New areas of risk assessment

Not only elemental assessment but

- *Connective effects:* Moisture problems occur mainly at interfaces/ junctions between elements or materials.
- *Systemic effects* :Moisture problems also increasingly occur at a whole house level because of the increasing airtightness in buildings. They arise from interaction of fabric measures with planned and unplanned heating and ventilation.

Thermal Bridges: Moisture issues



Refurbishment of a traditional stone wall with 60 mm insulation on the inside

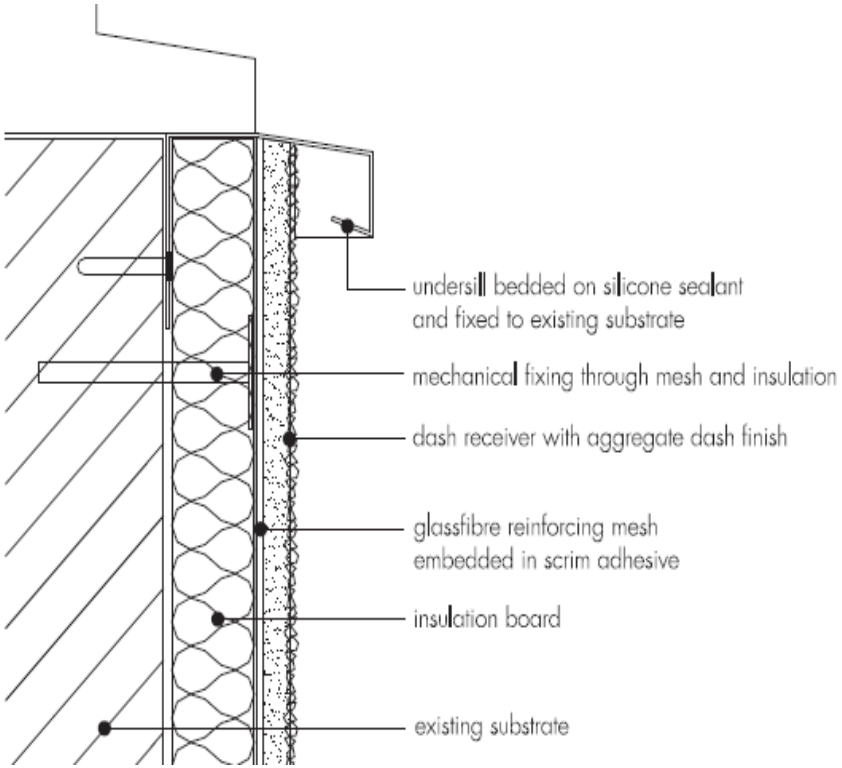
- Reveal not insulated
- Reveal now insulated with 40 mm insulation
- Note importance of internal RH and ventilation

Systemic effects of partial solutions

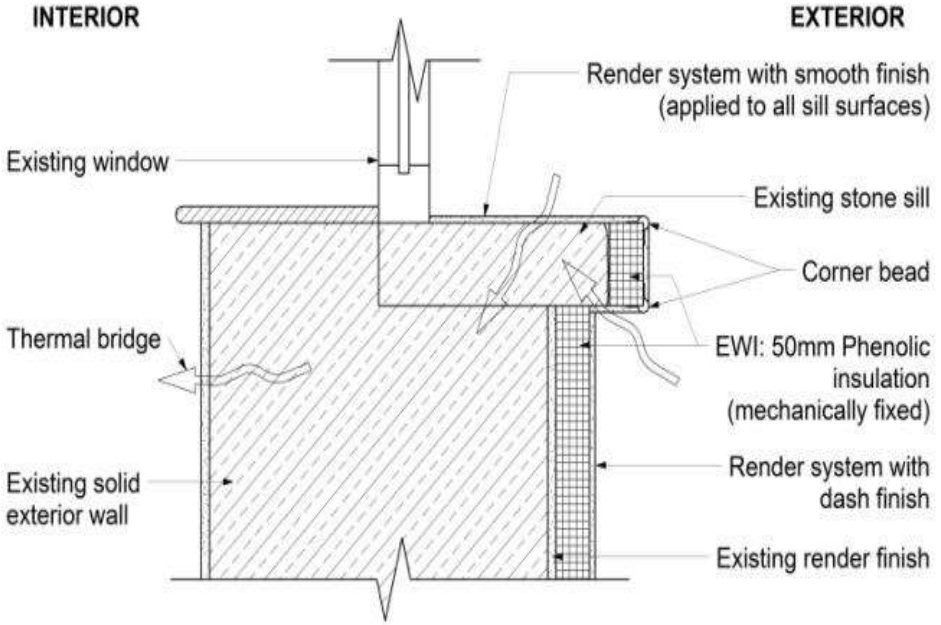
- Testing of improvement of air tightness (draught proofing)
- UCL research found an increase in dust mites in beds of 2500 x base case house when air permeability 10m/hr was decreased to 3m/hr.
- Decrease by 60% at 20m/hr
- Also 350 x increase over base case when one type of MVHR was installed

From theory to reality

- Moisture problems occur in the real world and must take into account the “as built” and “in service” conditions (here called *ABIS conditions)* which exist (in existing buildings) or which are likely to exist (in new buildings). The assessment of buildings or building elements under “as designed” or theoretical conditions (here called *ADT conditions*) can only be a partial risk assessment.



Detail in BBA Certificate



As applied on site

Assessing the execution of retrofitted external wall insulation for pre-1919 dwellings in Swansea (UK); Joanne Hopper et al 2011

3 types of assessment/ guidance

- *Prescriptive guidance* based on experience (for commonly used applications where there is good evidence of success over many years); much of BS5250 is of this nature (ie pitched cold roofs).
- *Modelling* (where there is uncertainty in regard to experience, but sufficient certainty of data and parameters); assessment can then be of two types:
  - according to standards ISO 13788 or EN 15026;
  - non-standardised assessment. (i.e. 2D, models for air flow).
- *Principles-based assessment* (where there is uncertainty in regard to experience, and data and/or parameters)

Key Principles

- Ensure a good **quality** design, construction and use **process**
- Understand the **context** of the building and the building project and ensure **compatibility** of the design with this context
- Ensure **coherence** in approach and detailing.
- Build in **capacity** for errors, uncertainties and future challenges
- Ensure that **caution** is taken where there are uncertainties

Quality Process	
Compatibility with Context	Geographical
	Form
	Materials and construction method
	Condition
	Use
Coherence	Moisture approach
	Thermal coherence
	Airtightness
	Weathering/ waterproofing
	Ventilation, heating and insulation
Capacity	Assessment
	Process
Caution	Usability
	Maintenance
	Monitoring
	Feedback

Coherence of moisture approach

- Distinguish between
  - Moisture closed
  - Moisture open
- Not technical definition, but a guiding principle
- Coherence of approach recommended, but not always possible
- In this situation additional capacity and caution
- Context is all

Resulting tables

Moisture-closed	ADT	ABIS	Connective/ systemic
Ground bearing floors of concrete **Suspended concrete floor** **Suspended timber floor**	Prescriptive Guidance: Annex F of BS5250	Prescriptive Guidance: Annex F of BS5250	Prescriptive Guidance (Accredited Details) for connective effects.
Moisture-open	ADT	ABIS	Connective/ systemic
Ground bearing floors	EH Energy Efficiency in Historic Buildings: Insulating Solid Ground Floors	Principles based approach	Principles based approach. Refer EH Energy Efficiency in Historic Buildings: Insulating Solid Ground Floors
Suspended floors	EH Energy Efficiency in Historic Buildings: Insulation of Suspended Timber Floors	Principles based approach	Principles based approach. Floor wall junctions and placement of air barriers, void ventilation and ground cover must be detailed correctly. Systemic effects should be considered particularly in retrofit

Moisture-closed	ADT	ABIS	Connective/ systemic
Solid masonry walls with and without insulation	Standardised modelling to EN15206	Principles based approach supported by Standardised modelling to EN15206 Non-standardised modelling (ASHRAE 160 method)	Principles based approach supported by Modelling to test for connective effects (ie 2D or 3D analysis of junctions to EN 10211) For solid masonry with external insulation prescriptive guidance in Accredited Details for thermal bridging and air leakage connective effects. Systemic effects should be considered particularly in retrofit
Moisture-open	ADT	ABIS	Connective/ systemic
Solid masonry walls with and without insulation	Standardised Modelling: EN15206	Principles based approach supported by Standardised modelling to EN15206 Non-standardised modelling (ASHRAE 160 method)	Principles based approach supported by Modelling to test for connective effects (ie 2D or 3D analysis of junctions to EN 10211 to test for thermal bridging connective effects) Systemic effects should be considered particularly in retrofit.

Other enabling actions: Appendix 1

- Training for designers, surveyors and contractors (where relevant)
- Protocols for use of EN 15026
- Protocols for non-standardised modelling for ABIS conditions and connective effects
- Protocols for product and system certification
- Harmonised and coherent methods for undertaking risk analysis
- The production of better material and weather data for modelling
- Improved and extended Accredited Details
- The integration of new research into moisture into moisture risk assessment on an ongoing basis, particularly in the area of retrofit where multiple uncertainties exist.

Need for a new approach

- Joined up/ holistic
  - Research, standards and practice
  - Fabric, people and services
  - Design, construction and use
- Realistic
  - Based upon reality not incorrect assumptions
  - Buildable and affordable
- Learning based
  - Accepting uncertainty and avoiding false certainty
  - Integrating learning into standards and regulation
  - Proper training and education

Thank you for listening

www.stbauk.org