CHC Technical Conference

DECC Solid Wall Research Project

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Part of the BRE Trust

Content

- The project outline
- The work packages
- Major Areas of Work
- Summary

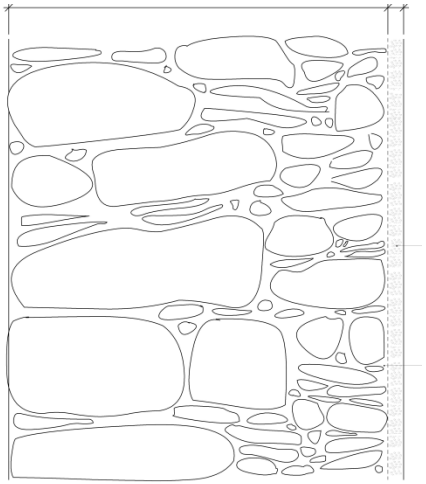
More than just bricks

– The project aims to look at the construction types in the UK of solid wall construction that make up the largest percentage

– More than just brick properties, with overlap into other construction forms

Work Package 1 - Literature review and data assessment

- what's already known
- heritage considerations
- understanding heat loss measurement
- un- intended consequences
- human behaviour
- solid wall performance actual v predicted

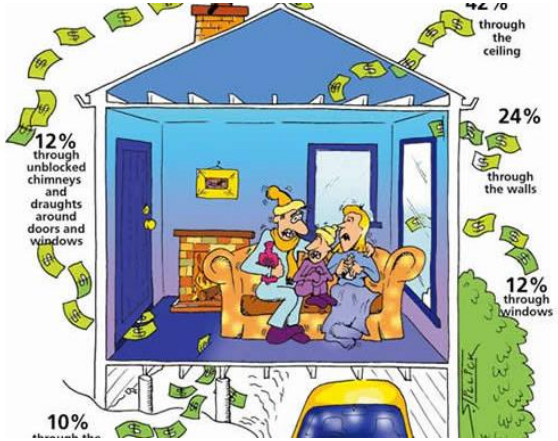


Work Package 2 - Understanding heat losses from solid walls

- Moisture content
- Micro cavities
- Continuity of mortar
- Unknown properties of materials within structures
- Exposure
- Hot boxing and in situ measurement of a range of configurations

Work Package 3 - Pre- and post- insulation survey: The performance gap

- What effect does the installation of solid wall insulation have on energy use behaviour in different types of dwellings?
- What are the typical energy savings that can be expected following the installation of solid wall insulation?
- What effect does it have on internal temperatures across the year? Is there evidence of overheating?

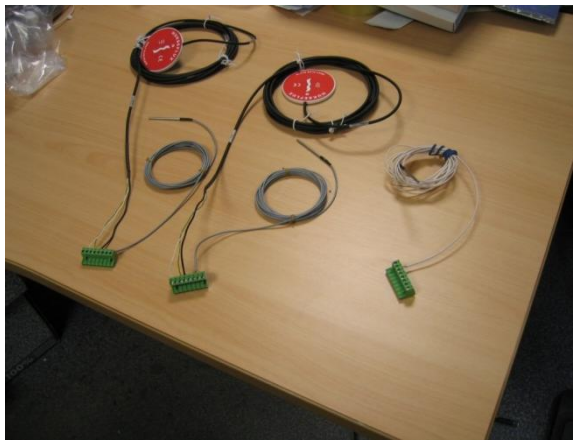


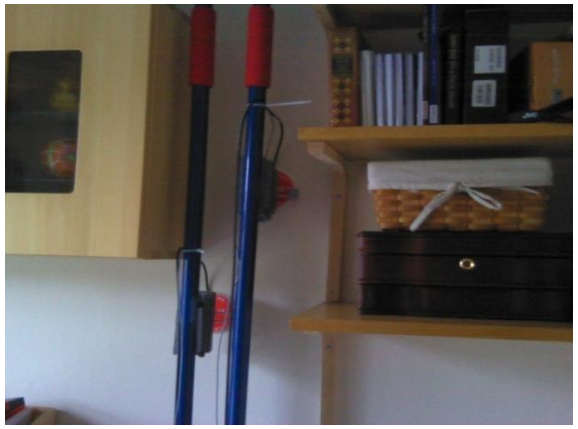
WP 3 – Cont'd

- What effect (if any) does it have on condensation levels and mould growth?
- Are there any other effects on other indicators of air quality?
- Is there any evidence of other un-intended consequences of refurbishment (for example on the structural integrity of the building caused by damp problems)? Covered in depth WP5

Work package 4 - Methodologies for measuring & calculating U-values

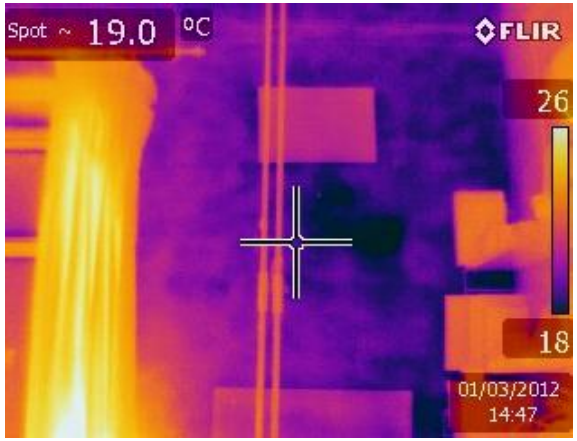
- This task will provide verification and validation of the methodology used to measure heat flux of walls *in-situ*. It consists of a number of laboratory and test-house experiments, and a summary validation report on the results of these tests including recommendations for any changes to the methodology.
- A range of testing and calibration of methods

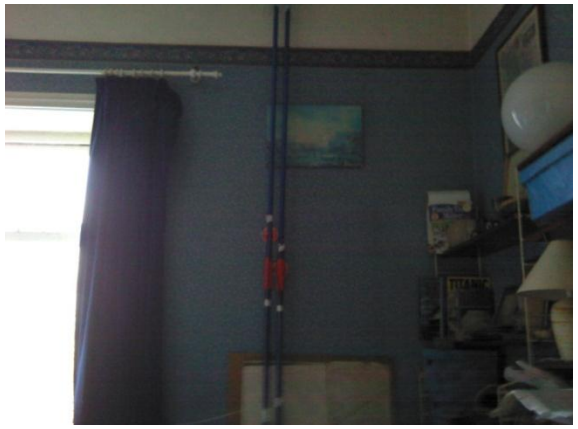




WP 4 Cont'd

- Tests 1a to 1e: Hot-box tests on heat flux plates
- Test 2: Reproducibility of measured U-value at a single measurement point
- Test 3: Testing the method of pressure-fixing
- Test 4: Determining the effect of sunlight:
- Test 5: Determining the effect of surface texture:
- Test 6: Effect of vertical temperature stratification on measured U-value:
- Test 7: Investigation into the effect of heat flux plate calibration and construction:





WP 5

– A process for surveying and understanding the risks of un-intended consequences.
  - Ø Systemic
  - Ø Design
  - Ø Human Behaviour
  - Ø Environmental Conditions
  - Ø Building Physics

WP 6

– A method of measuring a u-value of a building in situ.

-

Previous work

- Previous experience of the effect of inappropriate insulation.
- Previous experience of poorly assessed buildings being chosen for insulation
- Poor detailing on site – even if appropriate
- Understanding of the risk of insulating older properties, with many unknown factors being assumed.
- Understanding the effect of wind driven rain on buildings

SWI Performance Unintended Consequences

Early Findings

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Work Package 5

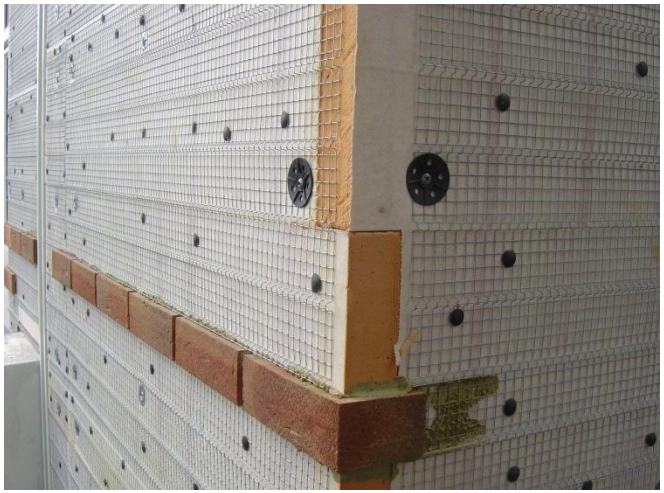
Unintended consequences emerging from previous studies

Scope of Study

- Various locations across the UK
- Previous involvement in projects
- All external wall insulation -
- Wall Constructions various
  - Brick
  - Stone (various)
  - Concrete
  - Timber – included

Early Findings

- Growing Evidence of
  - Wrong expertise
  - Incorrect assessment
  - Incorrect consideration of climatic conditions
  - Premature failure
  - High levels of unintended consequences
  - Standard detailing not fit for purpose
  - Workmanship often wanting



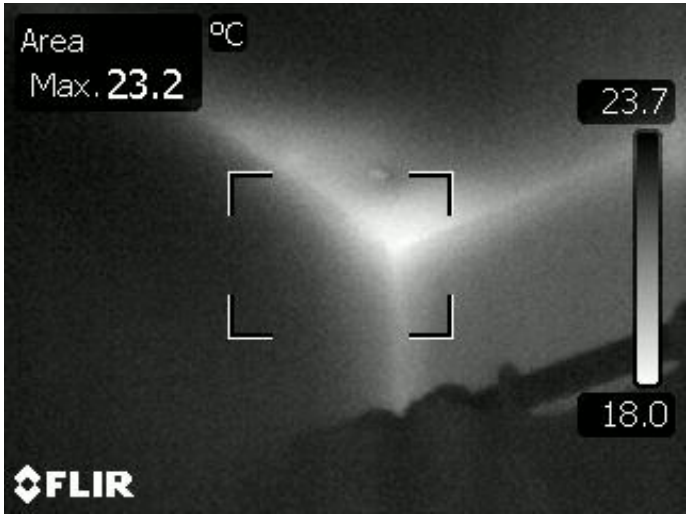
Lampeter

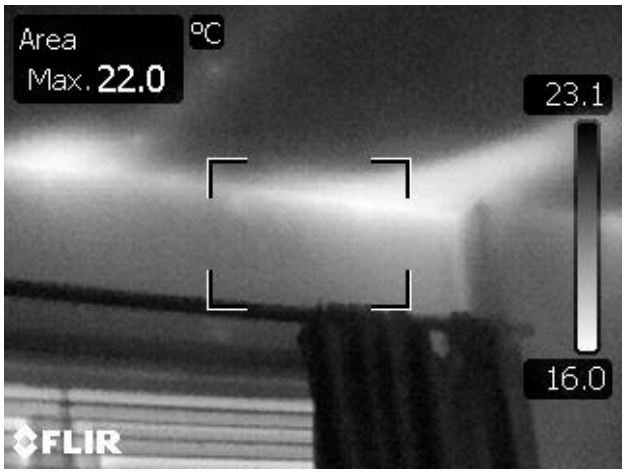
– The properties within this original work consisted of a number of construction types, but all of solid wall, and a 3 build forms, houses, bungalows and flats, with 45% (75) being bungalows, 20% flats (32) and 35% (60) houses.

– All off gas, all social housing

Lampeter

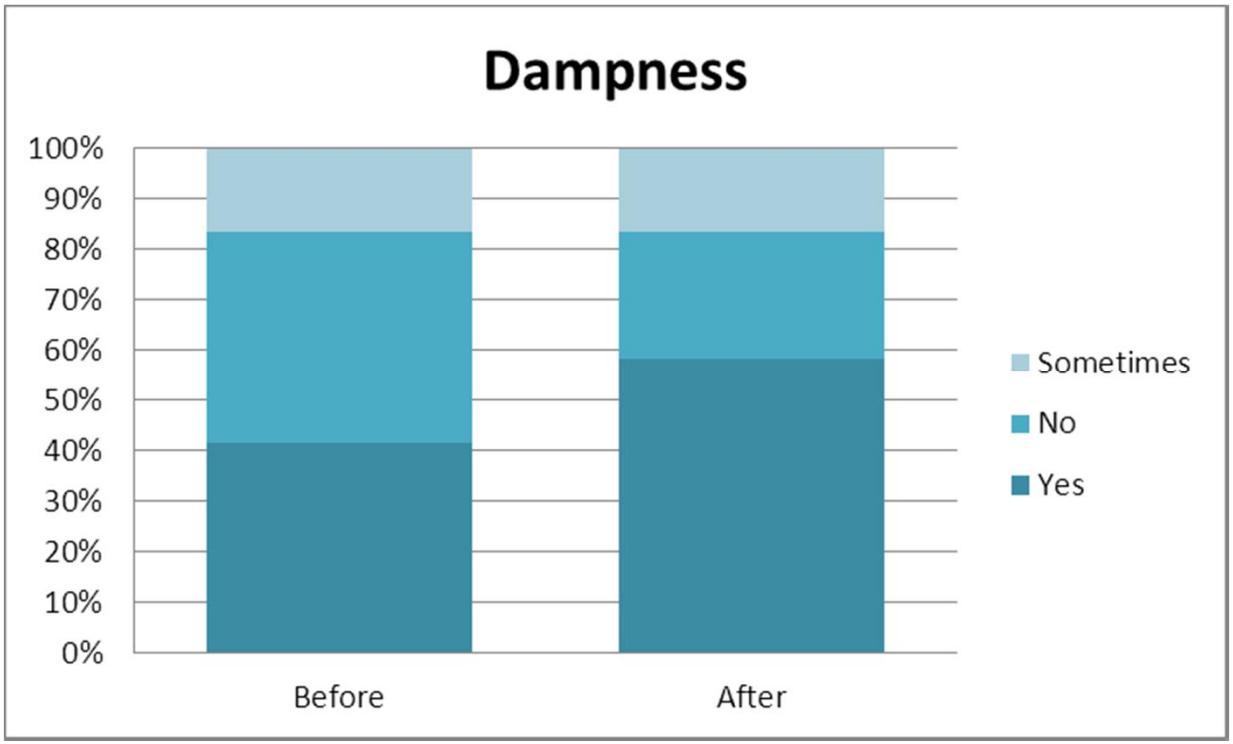
- Condensation where none before, no consideration of ventilation.
- Buildings more air tight than before
- Work poorly sequenced
- Lack of detailed surveying before work undertaken



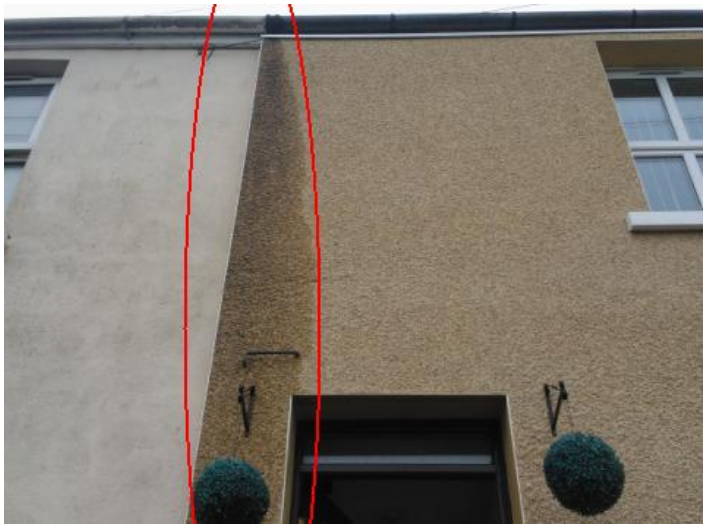


Arbed

– Total of 37 properties analysed, only EWI



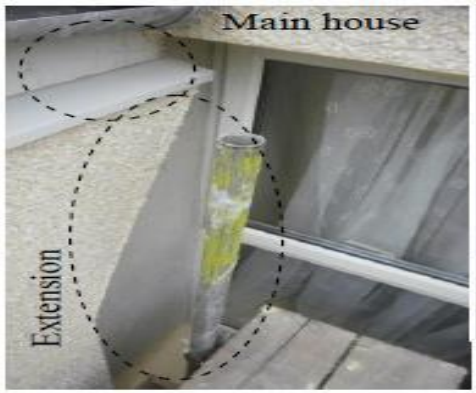
Arbed

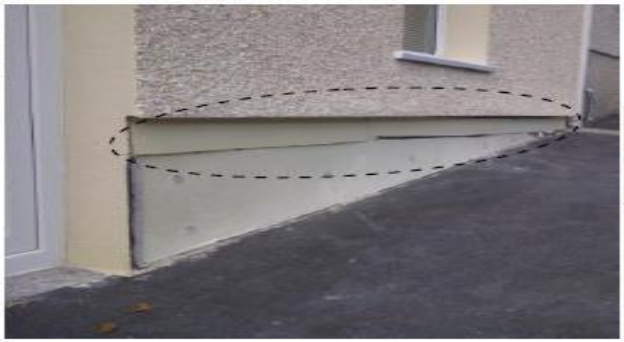


Arbed

Midlands

- Non insulated floor slab below plinth
- Condensation and mould in room corners





Problems with Moisture

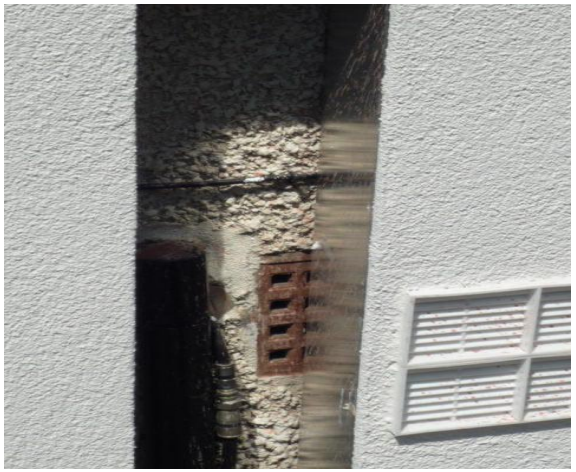
Timber Frame House

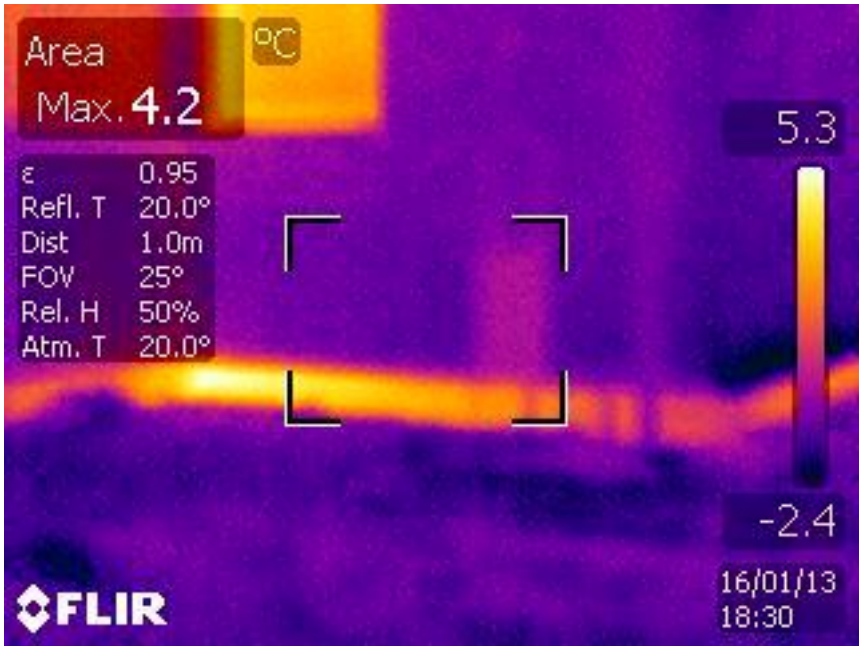
Built in 1967

Insulated in 2006

Wet rot, structural failure 2012

- water ingress
- poor detailing

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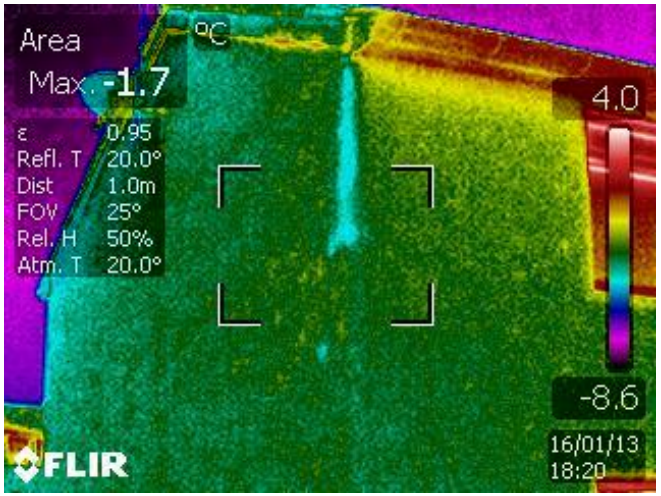
Max. 4.2
°C
5.3
ε 0.95
Refl. T 20.0°
Dist 1.0m
FOV 25°
Rel. H 50%
Atm. T 20.0°
-2.4
FLIR
16/01/13
18:30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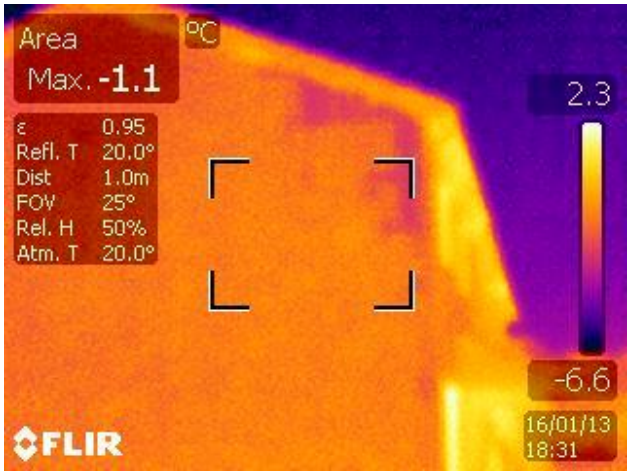
16/01/13
18:20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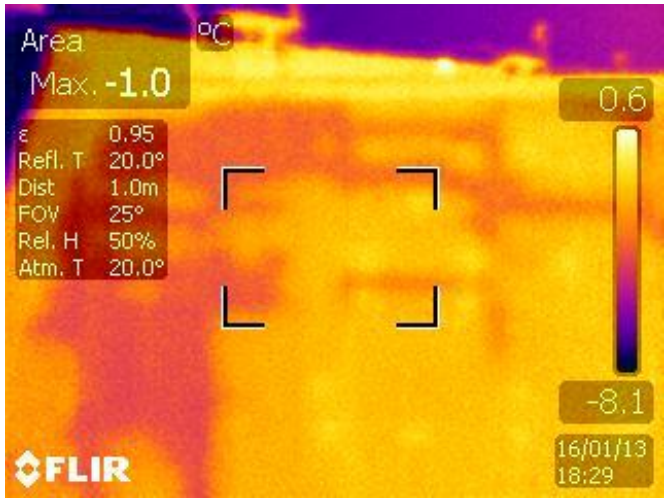
FLIR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°C
0.6
ε 0.95
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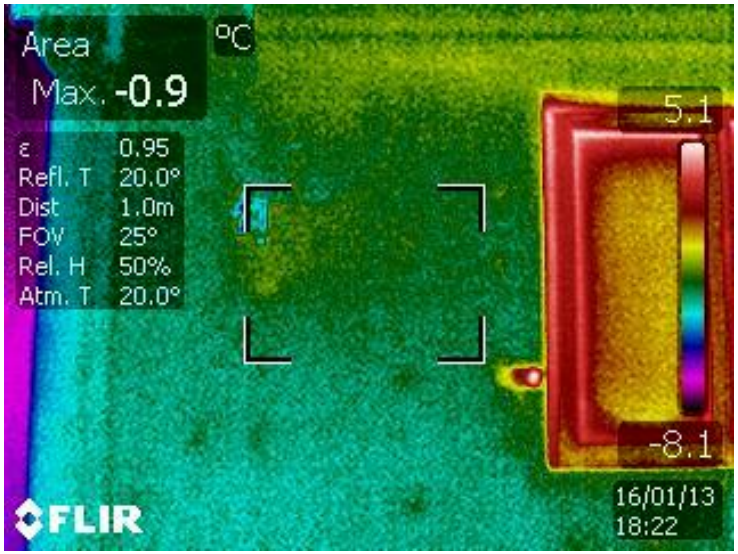
Rel. H 50%
Atm. T 20.0°
-8.1
16/01/13
18:29
FLIR


Area
Max. -0.9
°C
5.1
ε 0.95
Refl. T 20.0°
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FOV 25°
Rel. H 50%
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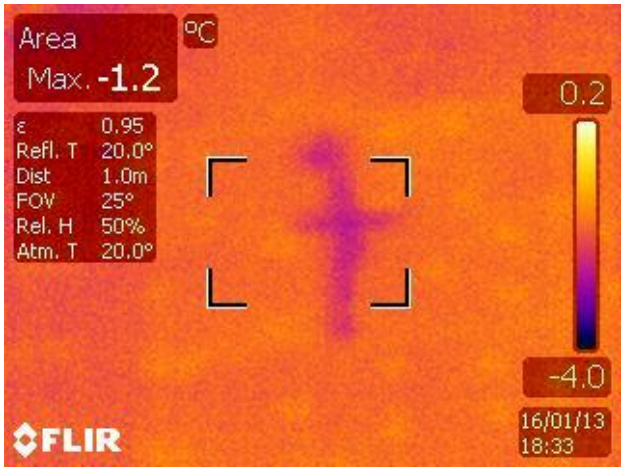
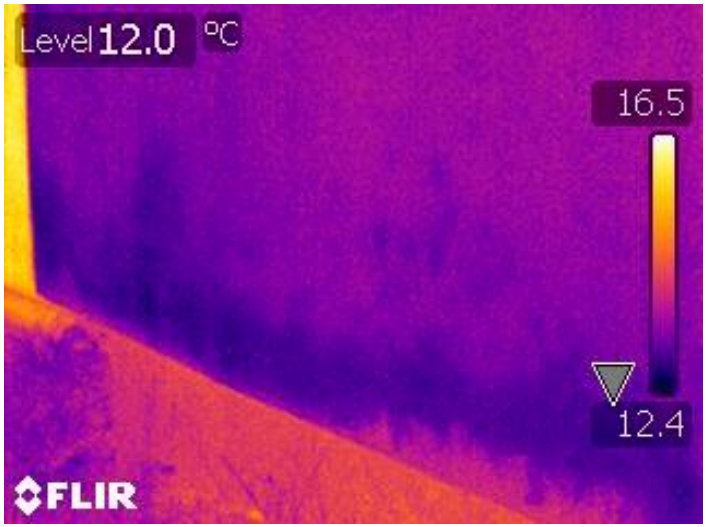
-8.1
16/01/13
18:22
FLIR

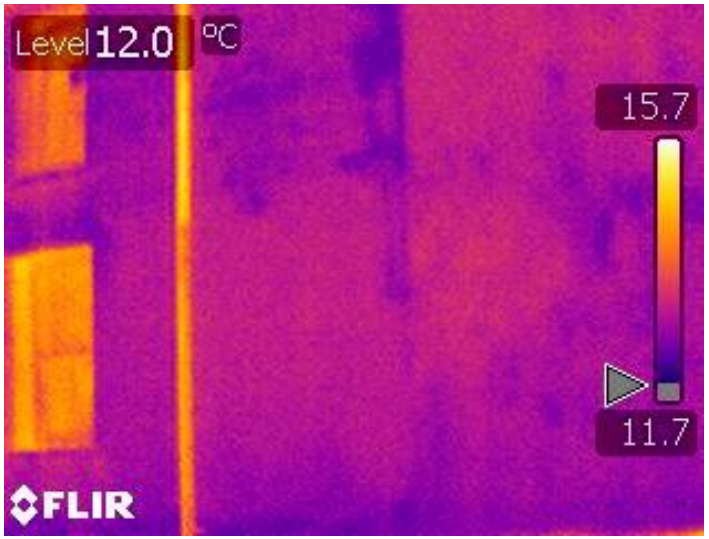

Area
Max. -1.2
°C
0.2
ε 0.95
Refl. T 20.0°
Dist 1.0m
FOV 25°
Rel. H 50%
Atm. T 20.0°
-4.0
16/01/13
18:33
FLIR

Solid Wall in Lake District

- 250 years old
- Completed in January of this year
- Not exposed to high winds, but in high exposure area.

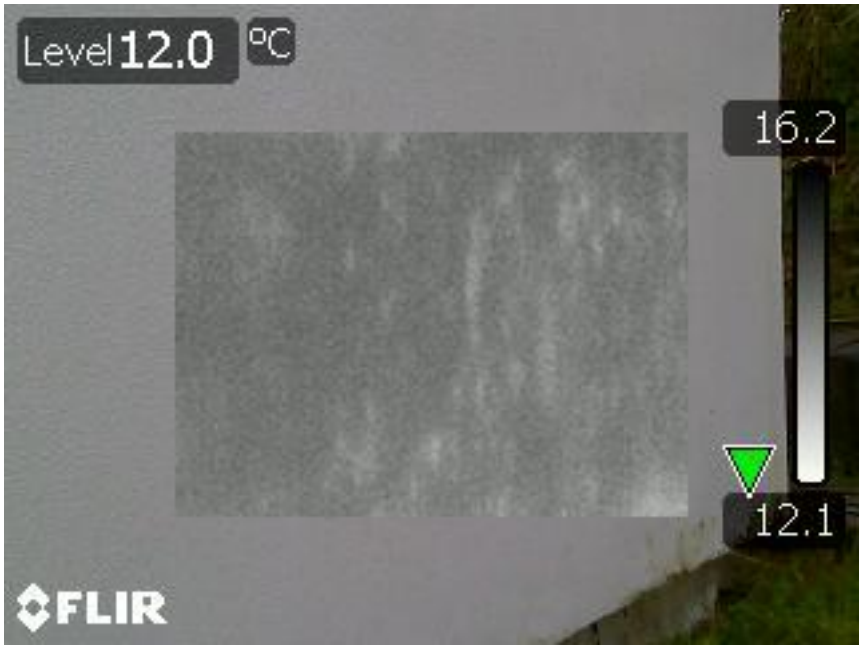


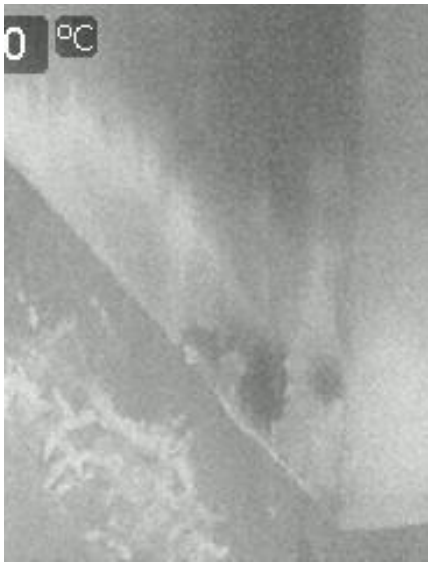
- System failing and saturated



- Starting to peel off

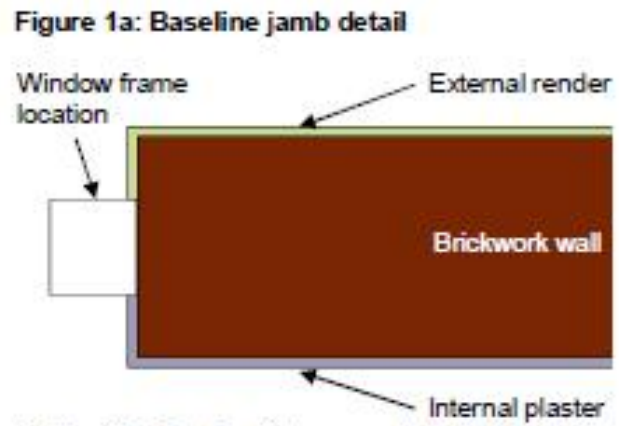
Workmanship – Decision to Insulate with this system ?

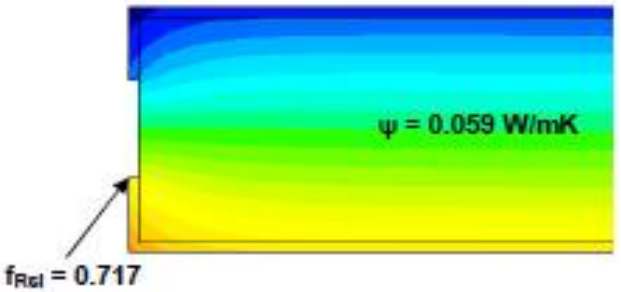




Thermal Bridging Modelling

- Standard Industry approach to detailing openings
- Difficult to insulate ? so rarely done.
- Impact of in-correct detailing

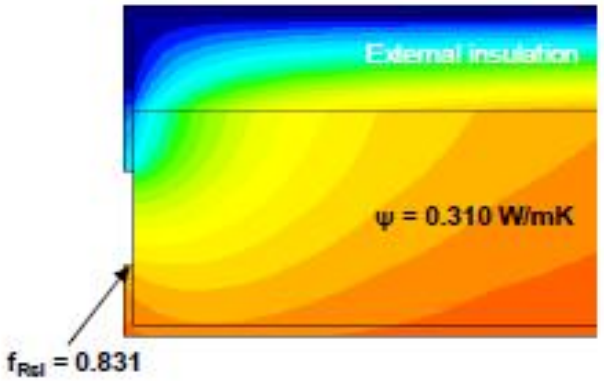




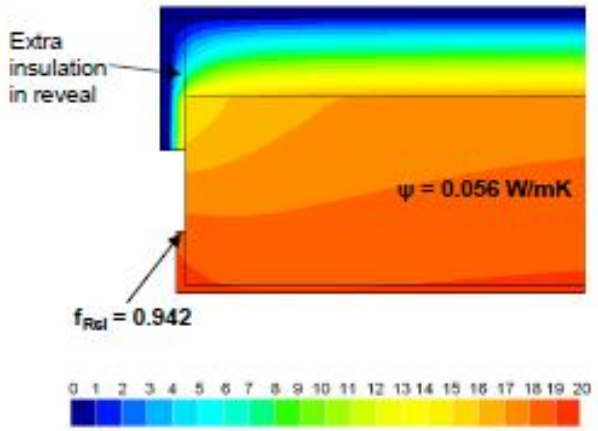
Thermal Bridging

- Initial modelling indicates if the reveals and heads etc are not insulated the psi value of the area becomes worse than before insulated.
- Risk shifted to areas least capable of dealing with them.
- Increased heat loss, and much higher risk of condensation and mould growth / failure.

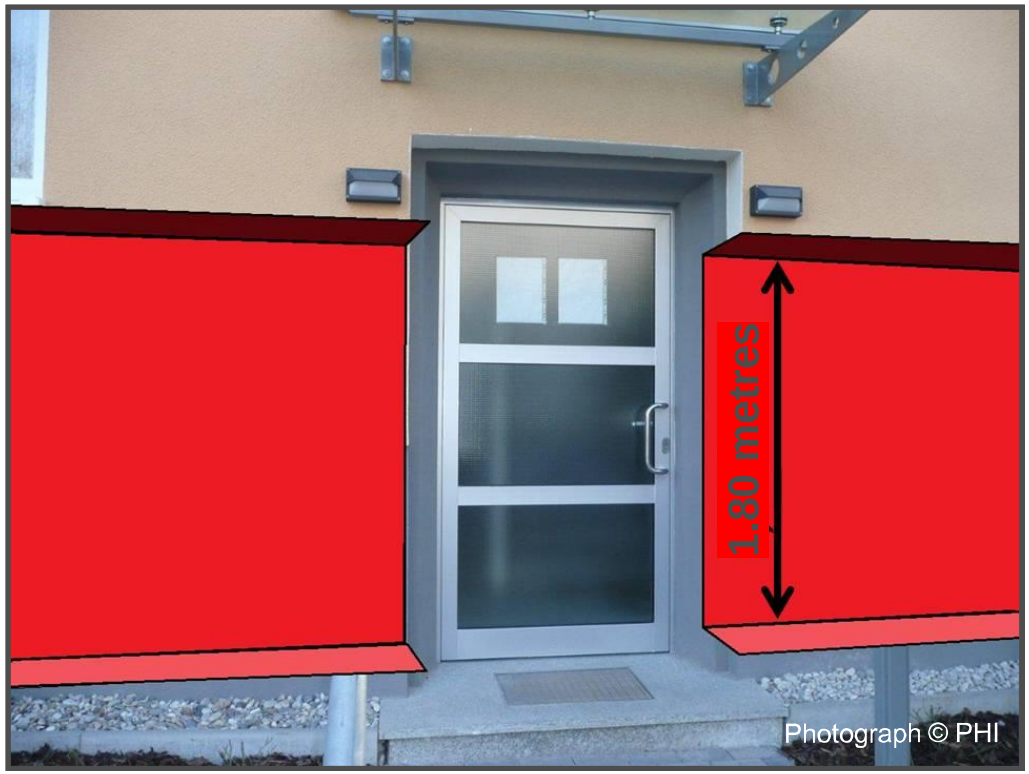
c: Jamb with 'typical' external insulation



d: Jamb with improved insulation detailing



Example: Aluminium profile at the plinth penetrating the insulation layer



Equivalent impact to leaving out 1.80 metre high strip of insulation!

Modelling with real climate data & wall condition

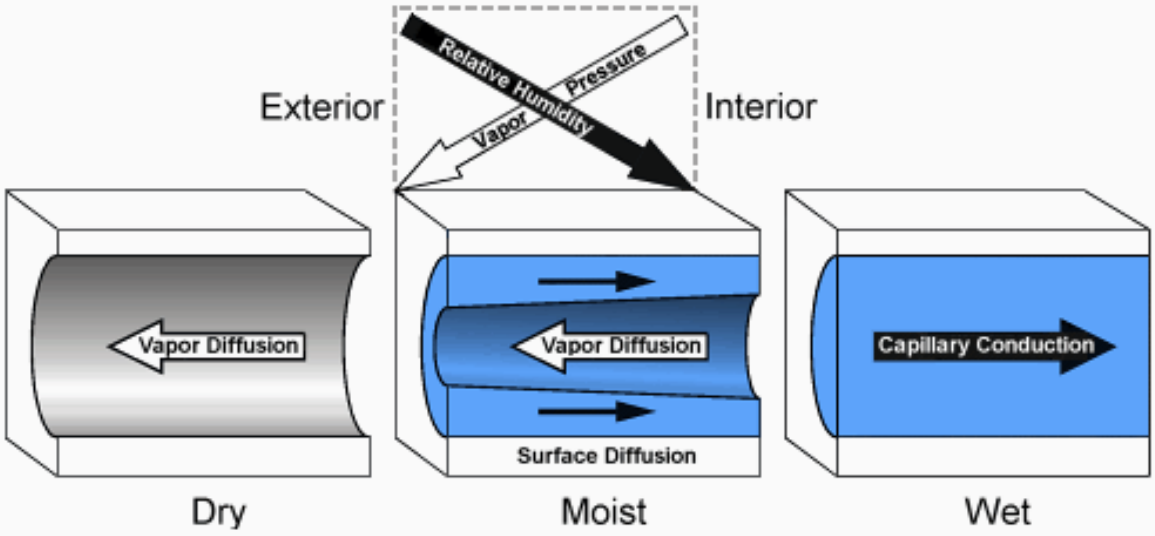
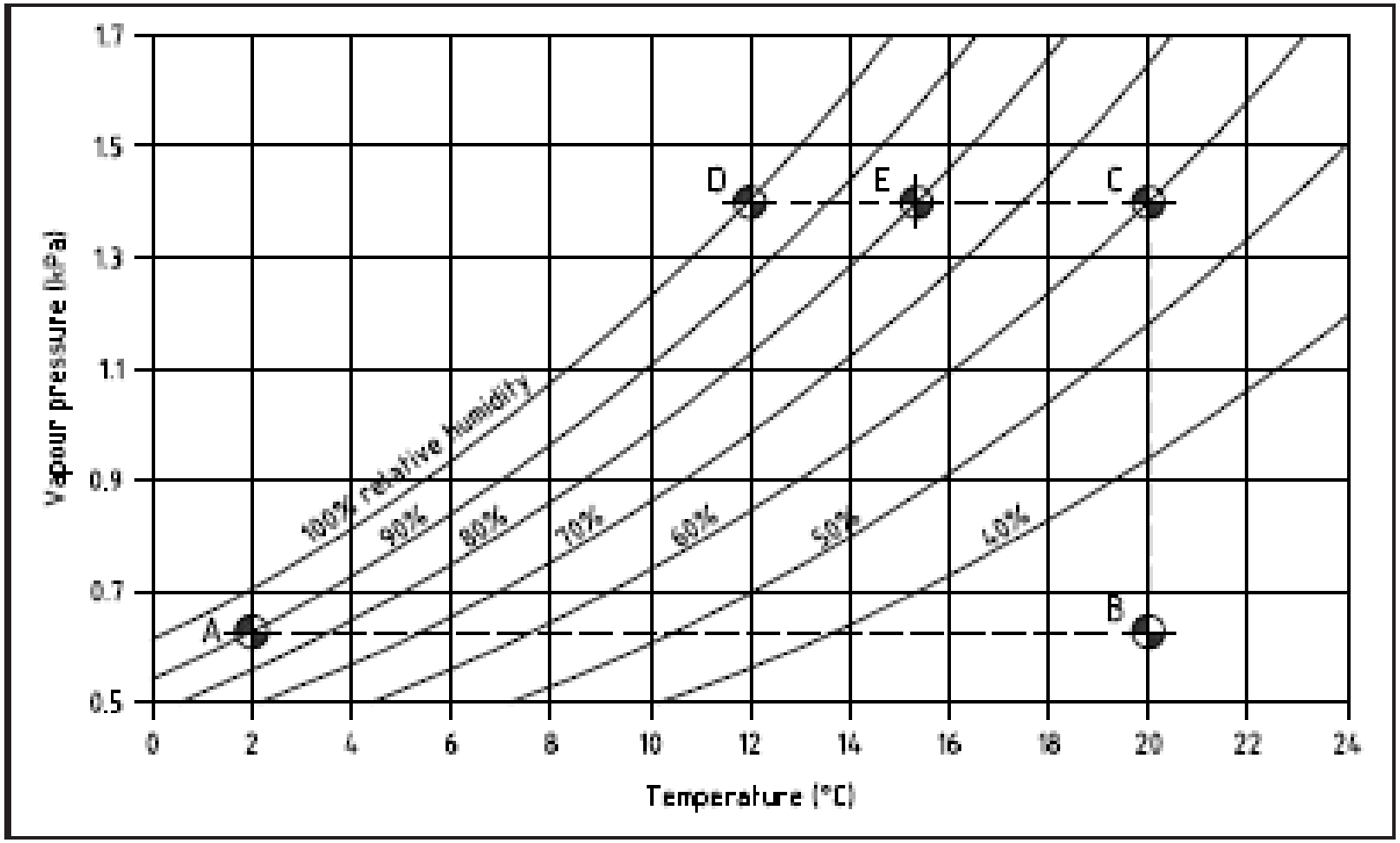
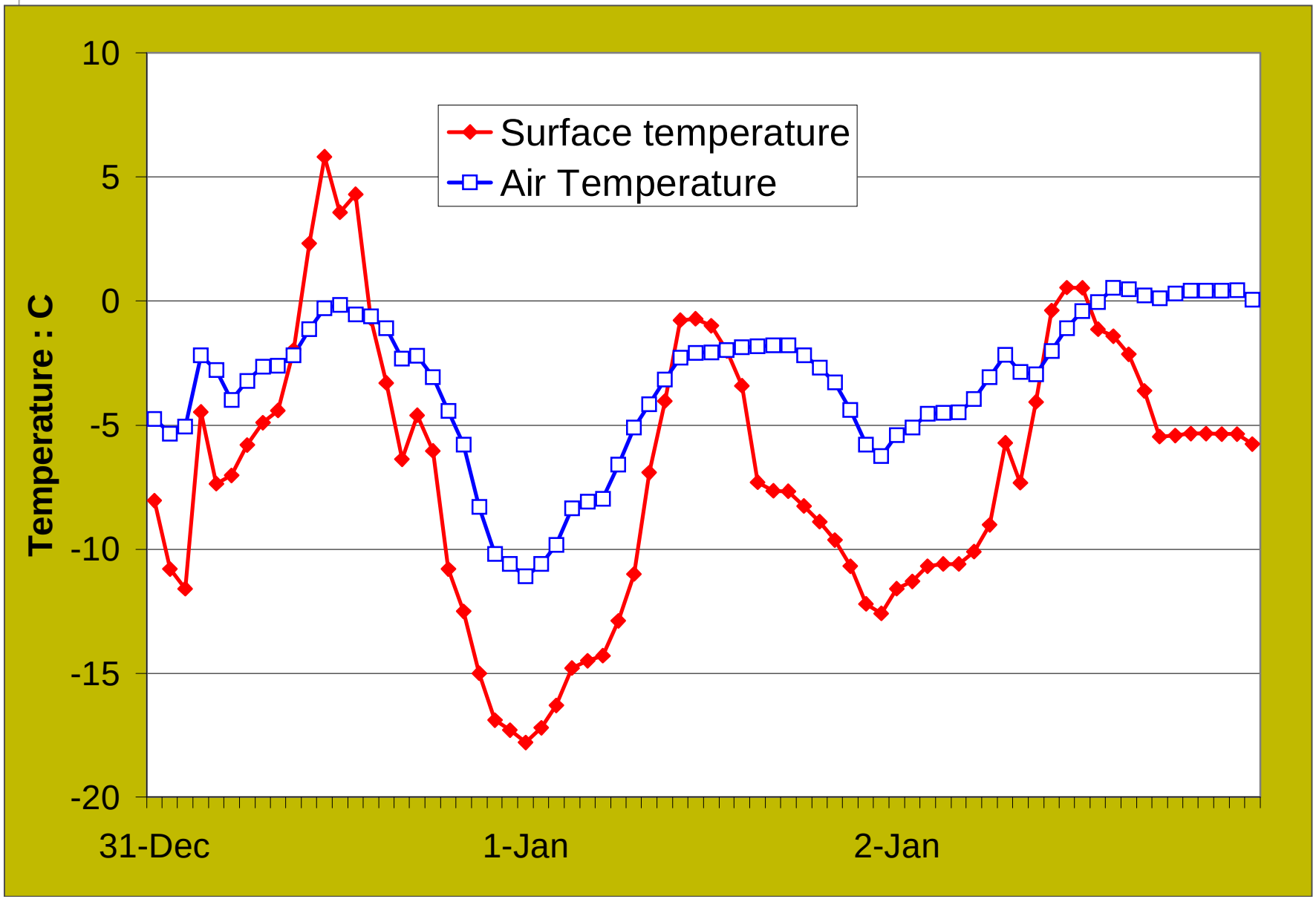


Fig. 4: Moisture transport phenomena in the pores of a massive exterior wall in winter, for different levels of moisture content

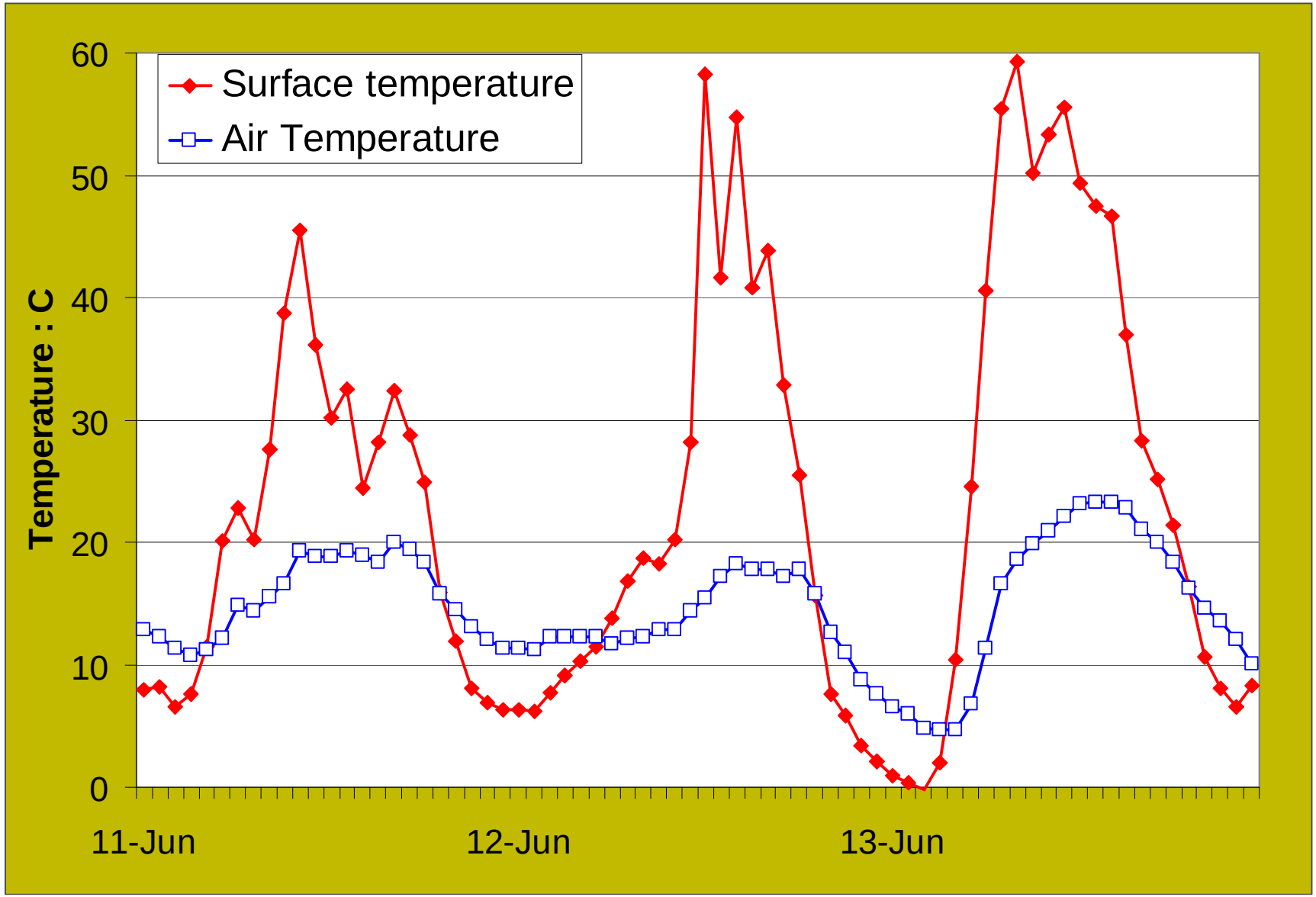
Steady State Calculation



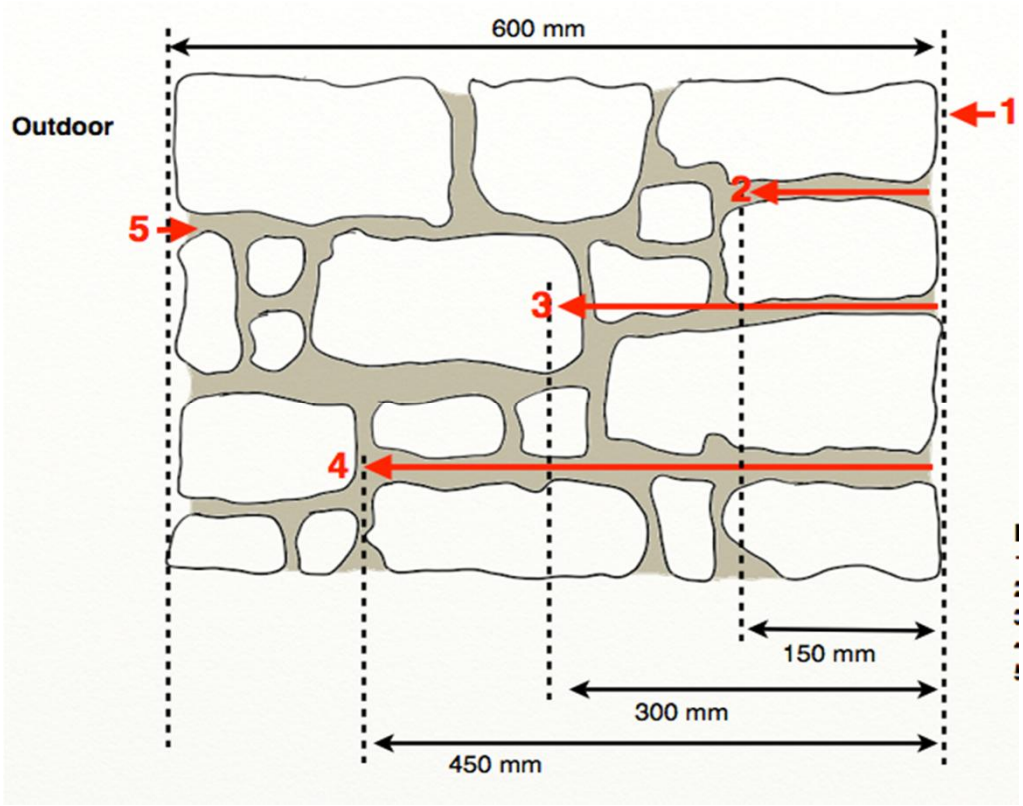
Three winter days



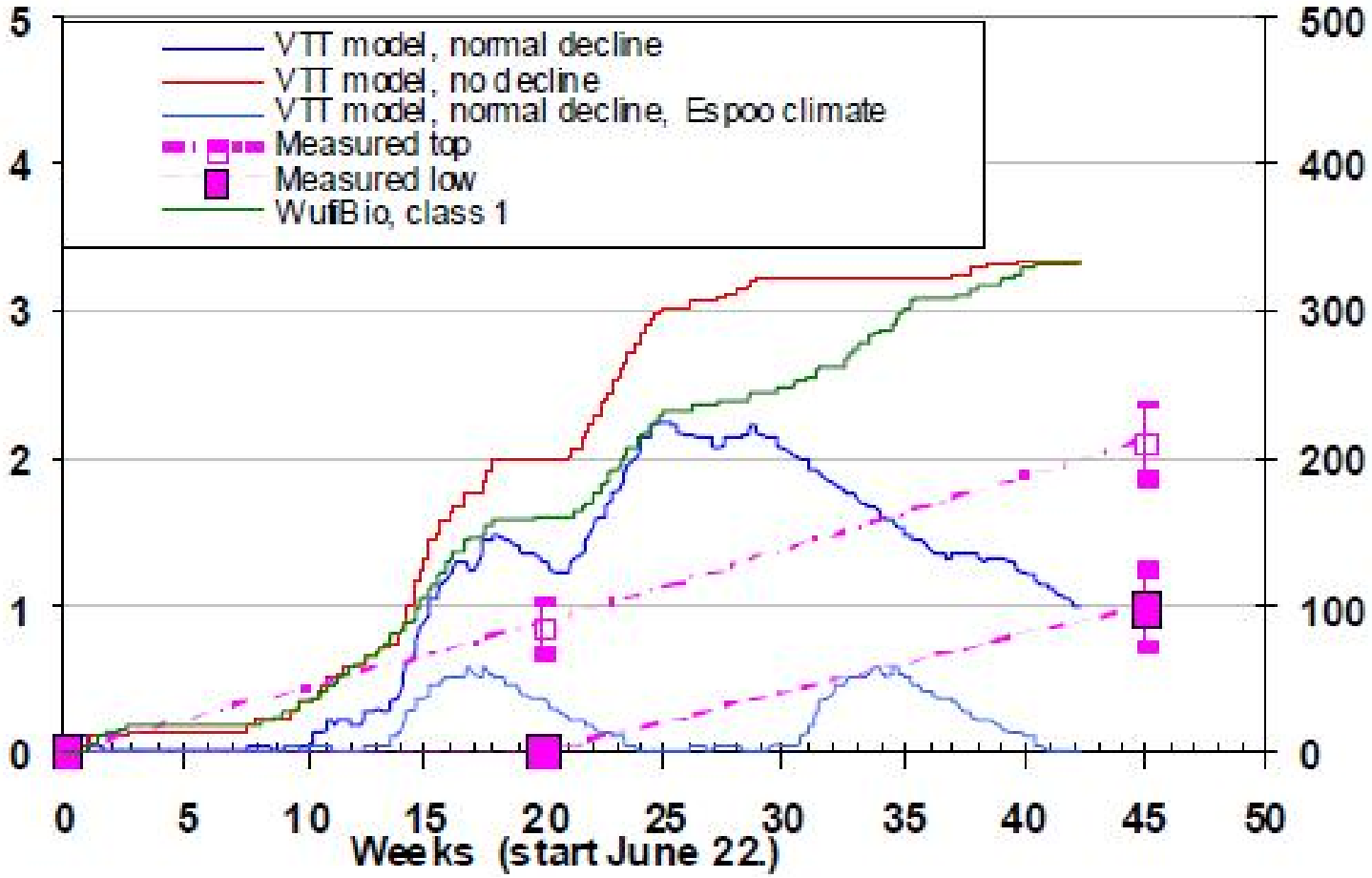
Three summer days



Data Collection Field Trial

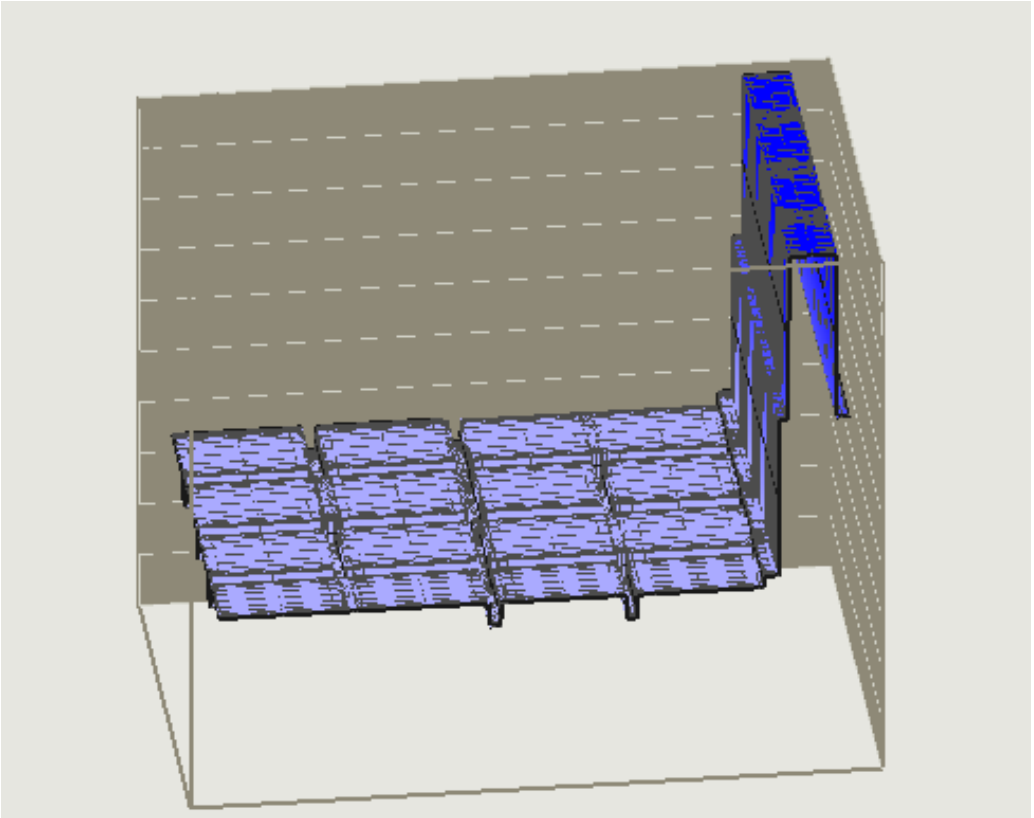


Real time moisture content in 4 wall constructions within 3 miles of each other



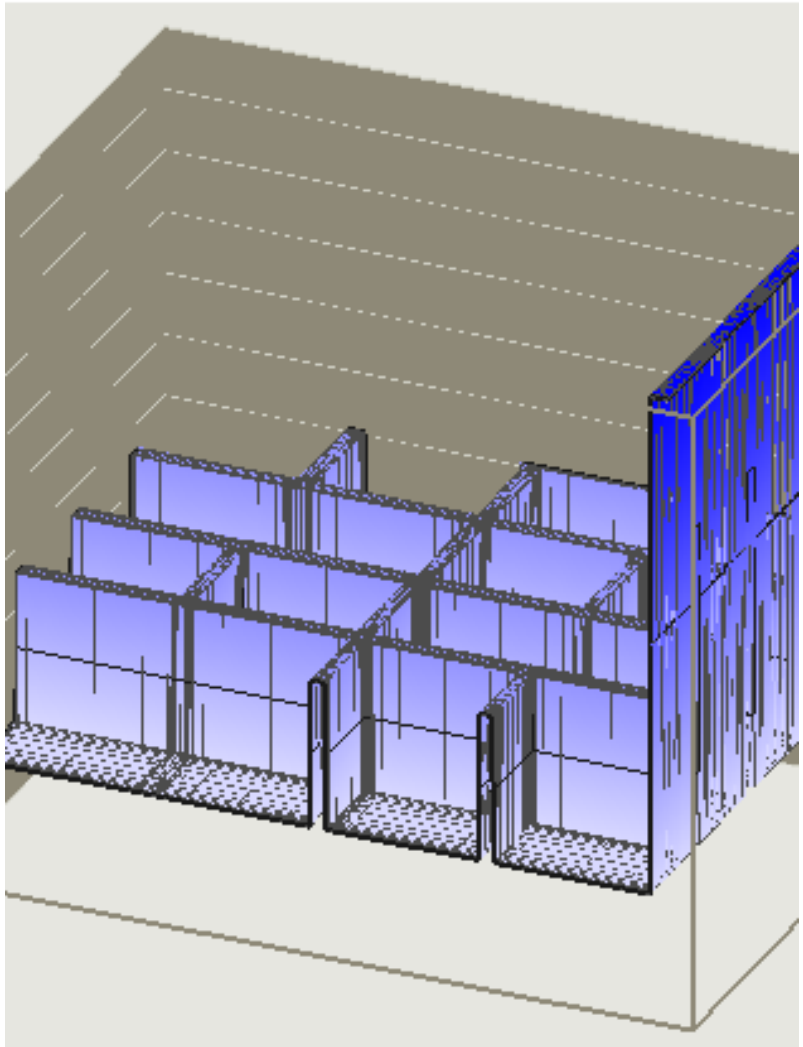
Brick Properties – Wufi 2D

- Actual model, Manchester weather data and extensive material knowledge
- Existing performance
- Moisture in the mortar
- Surface evaporation both surfaces



Non open fibre materials used

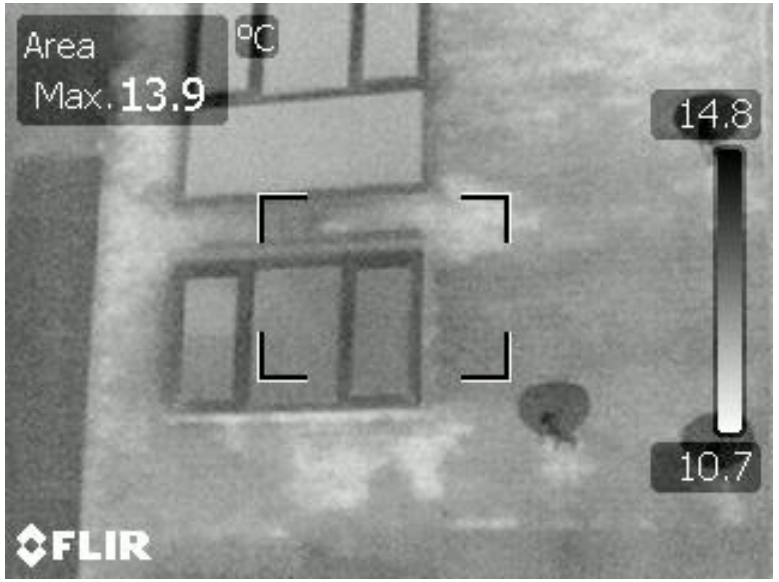
- Increased Rh
- Surface condensation
- Moisture trapped behind non open layer
- Risk of freeze thaw frost damage to surface predicted by year 7, toxic mould growth at interface of lining and wall.

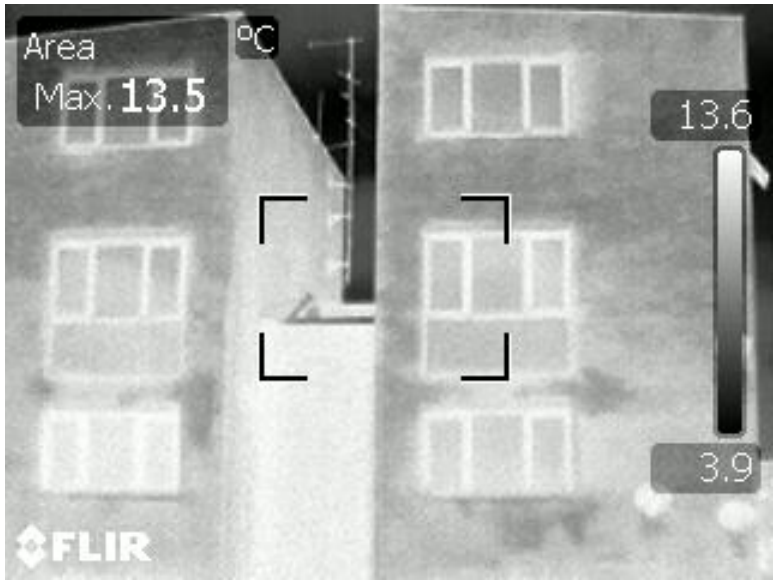


Issues

- Not considered the effect on multiple other areas yet
  - Character
  - Over heating
  - Day lighting
  - Disturbance
  - Indoor air quality
  - Health

  - Etc , etc





Early Indications of Unintended Consequences

Classification of UI

- Assessment process
- Systematic / Workmanship
- Occupant behaviour

Scale of Consequence

- Minor
- Major
- Subjective

Assessment

– Process to decide that insulation is the right measure. Understanding risk, exposure, condition of wall.

– Collection of the right data for the installers

– Choosing the right system – moisture, condensation, wind driven rain, pollution, aesthetics including heritage

Systematic / Workmanship

- Weakness in the system , over reliance on sealant between 18 and 36 tubes per property.
- Insufficient checking of key stages
- Poor installation, poor standard industry details that cretae cold bridges
- Lack of understanding on correct application

Issues

- Wrong expertise in the decision making
- Testing of materials in un realistic or unachievable conditions
- No consideration of actual UK climatic conditions
- Poor workmanship
- Little quality control evident on site – limited data
- Premature failure and underperformance of measures

Questions