Evaluation of Wall Performance - Guidance

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Part of the BRE Trust

Content

– Detailed modelling and current practice

– Understanding condensation predictions

– Future Research

– Forthcoming Guidance Tool

Building Performance

– So what do we know

– How do we currently measure in use performance

– What mechanisms are in place

– How accurate are they

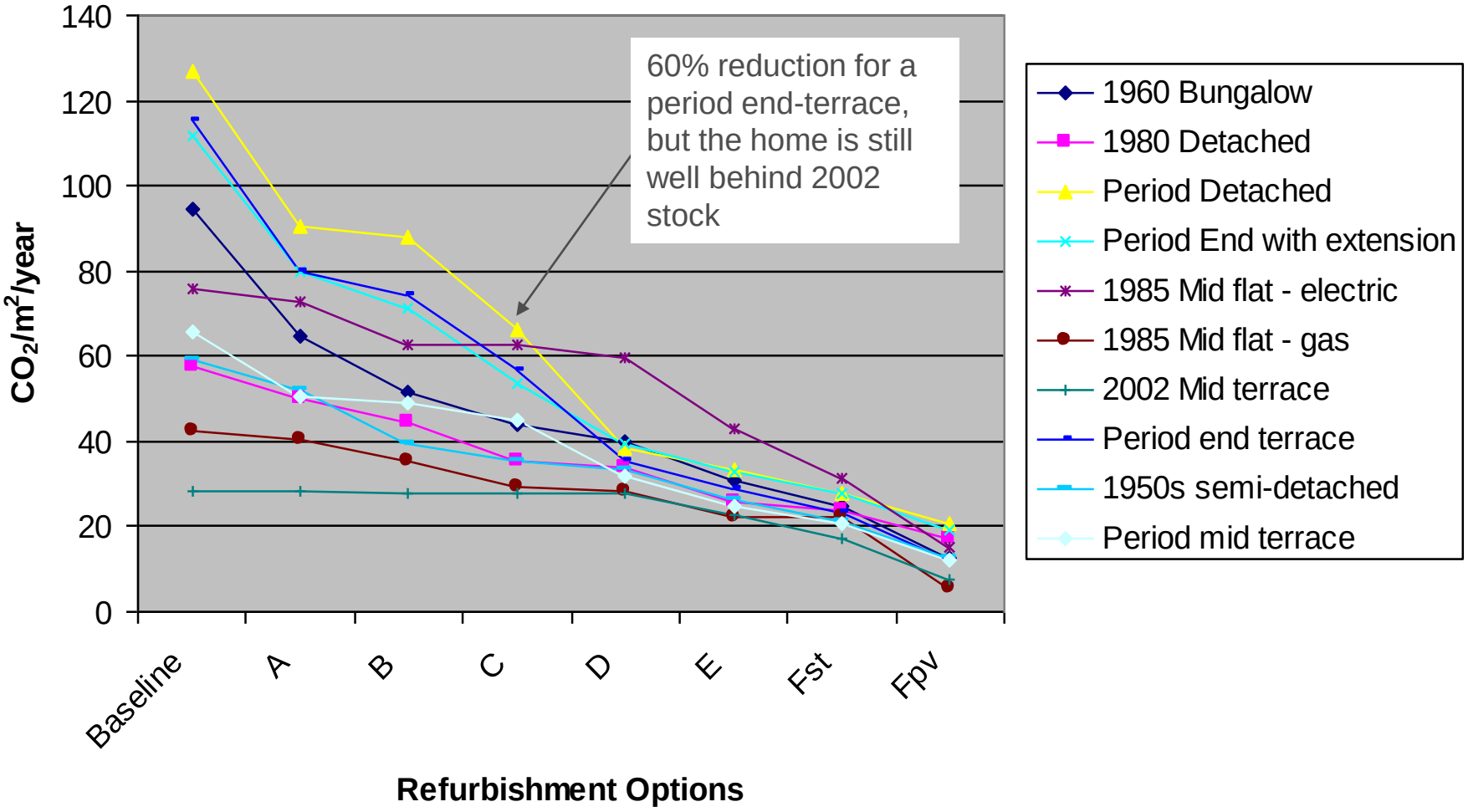
How do the Regulations Deal with it ?

Building Regulations

– Renewal of a thermal element

– Consequential Improvements

– Cost effective, technically feasible – Skills or guidance to assess ?

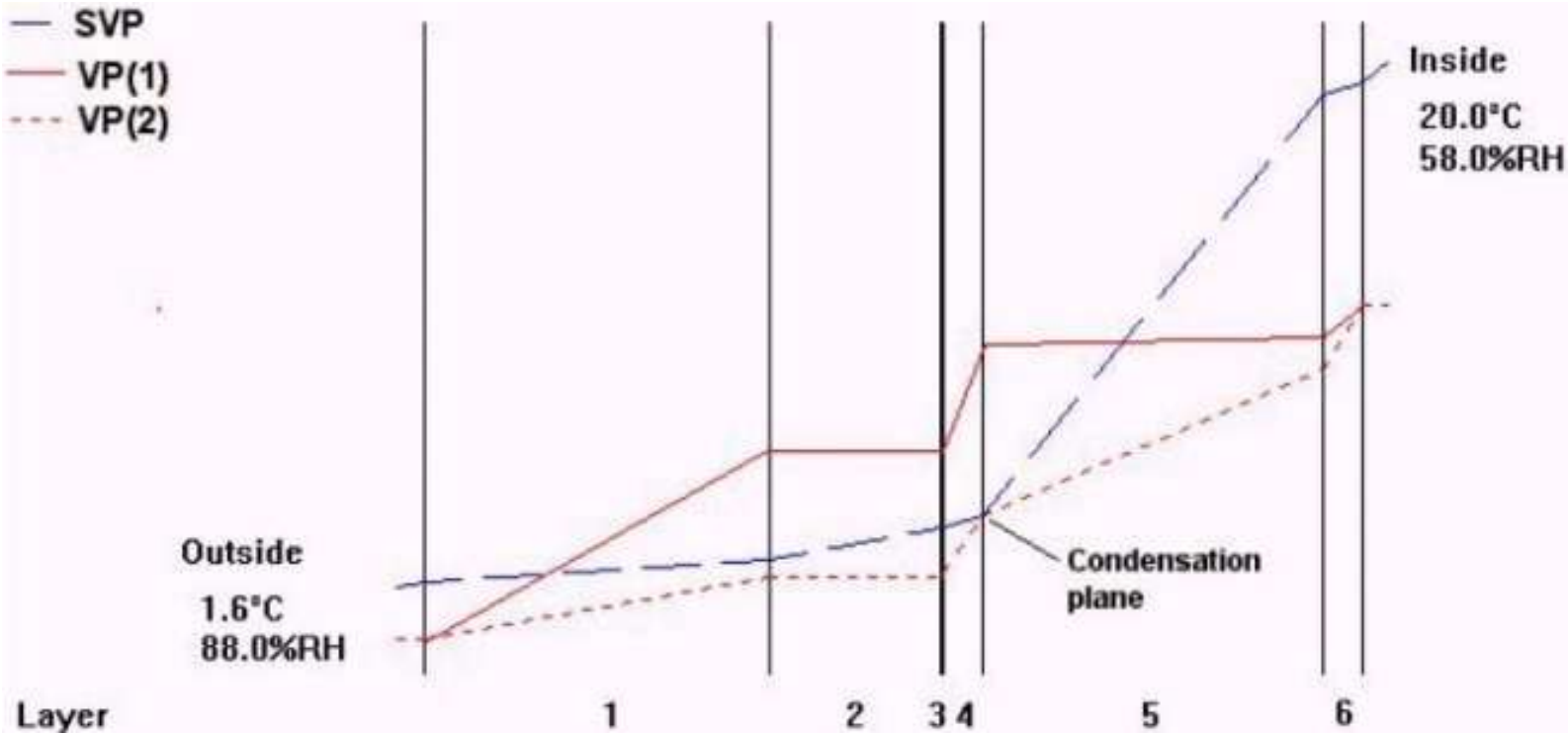

140
120
100
80
60
40
20
0
$CO_2/m^2/year$
60% reduction for a period end-terrace, but the home is still well behind 2002 stock
Baseline
A
B
C
D
E
Fst
Fpv
Refurbishment Options
1960 Bungalow
1980 Detached
Period Detached
Period End with extension
1985 Mid flat - electric
1985 Mid flat - gas
2002 Mid terrace
Period end terrace
1950s semi-detached
Period mid terrace

Calculation procedure

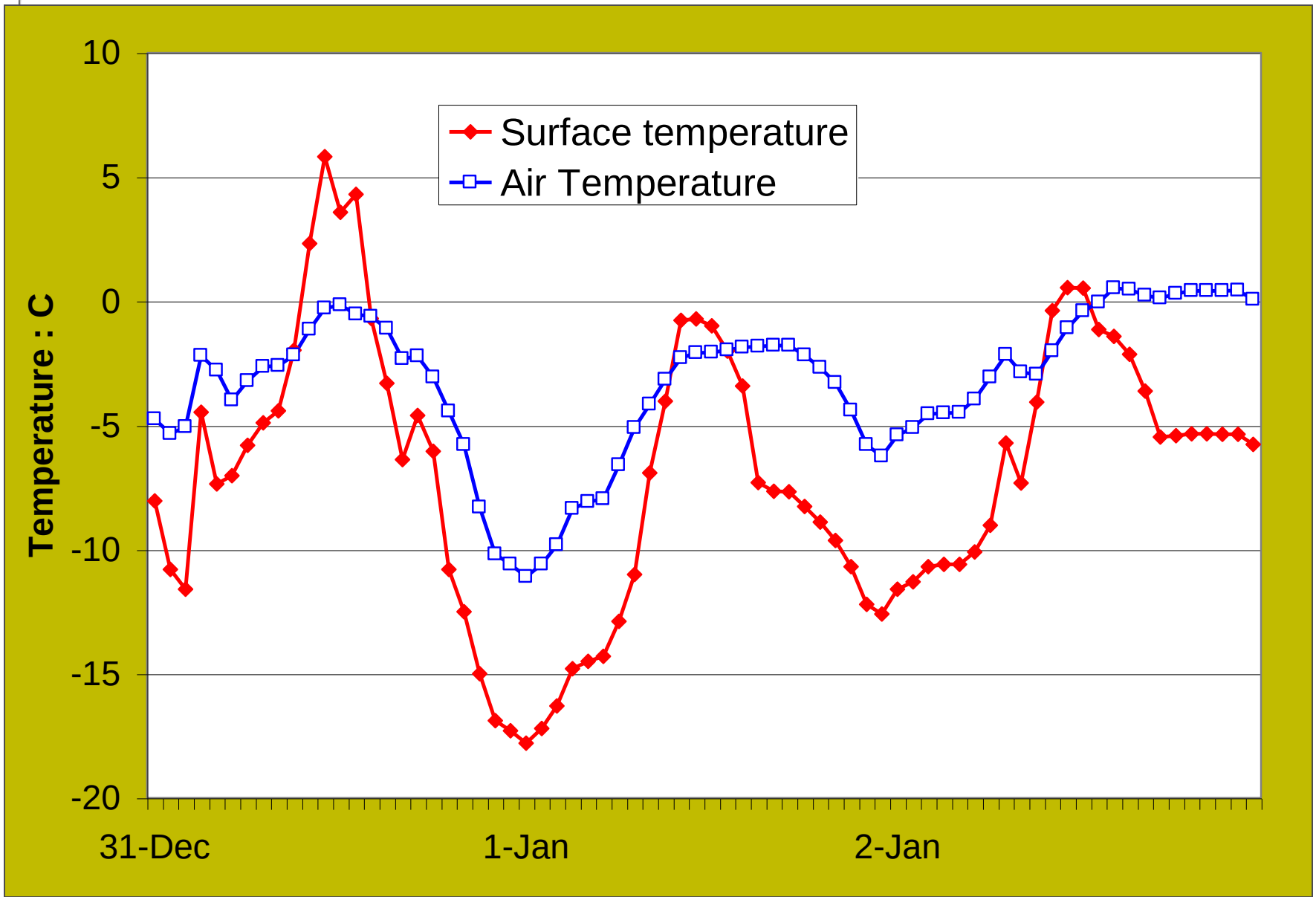
- Steady state
- Regional weather data
- No consideration for wind driven rain
- No measurement of Rh of the existing wall
- Limited evaluation of the actual wall construction.

Glaser profile through wall

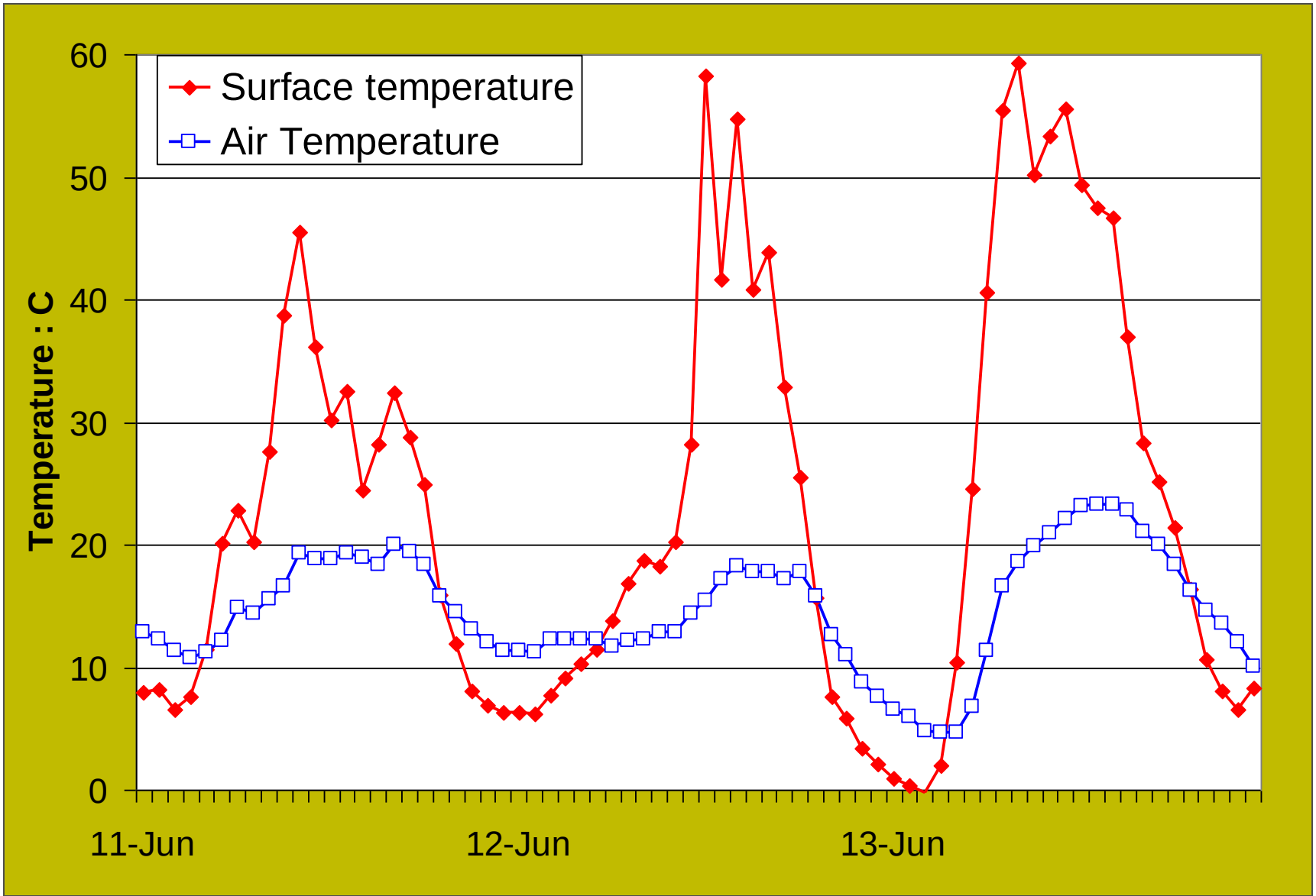
Layer Material Name	Thickness mm	Thermal Resistivity mK/W	Thermal Resistance m²K/W	Vapour Resistivity MNs/gm	Vapour Resistance MNs/g
External air surface	-	-	0.040	-	-
Brick, Medium wt external	102.0	1.330	0.136	50.00	5.10
Cavity >24mm, wall	50.0	-	0.180	0.00	0.00
Breather membrane	-	-	-	-	0.40
Plywood	12.0	7.000	0.084	450.00	5.40
Glassfibre	100.0	25.000	2.500	10.00	1.00
Plasterboard	12.0	6.000	0.072	45.00	0.54

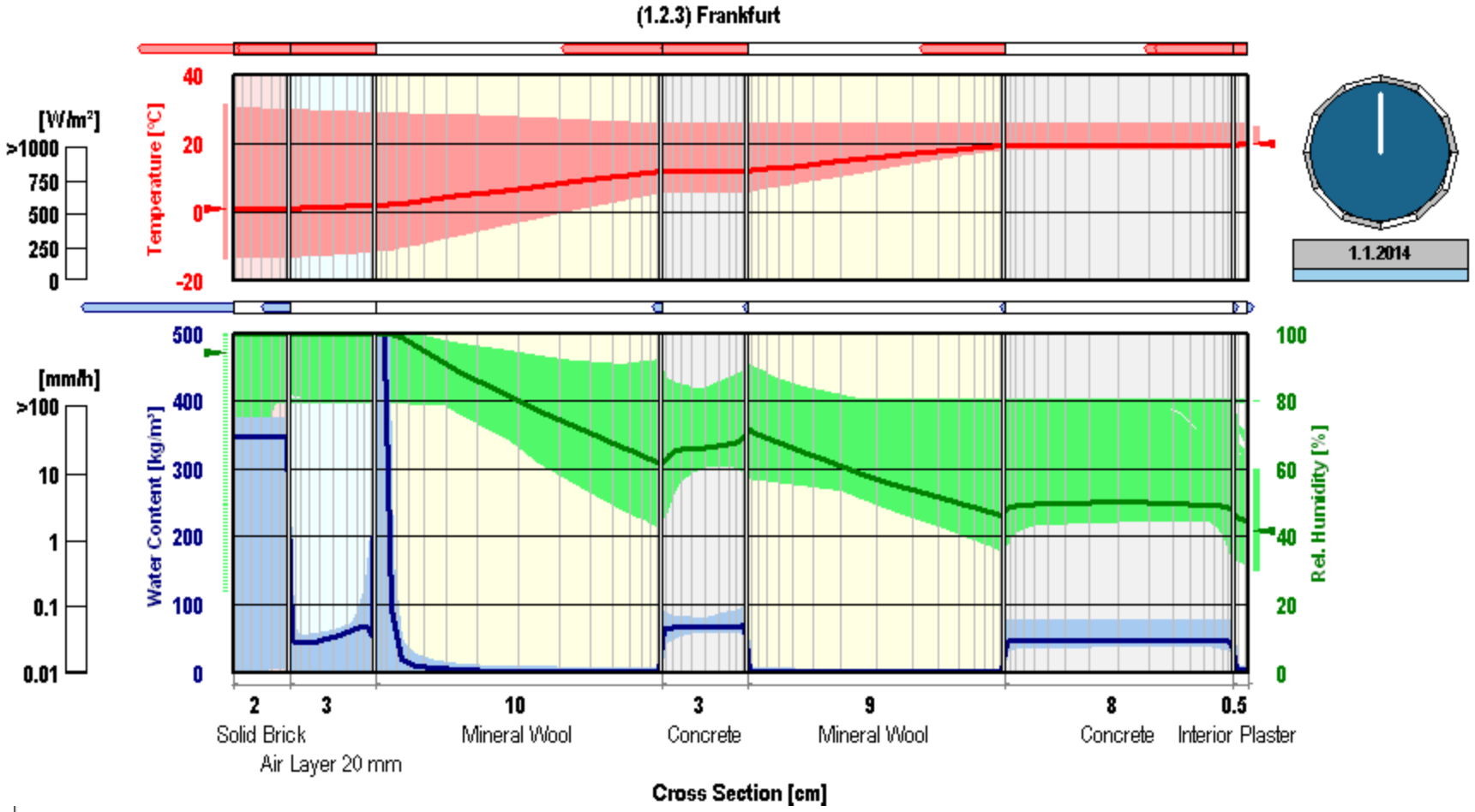


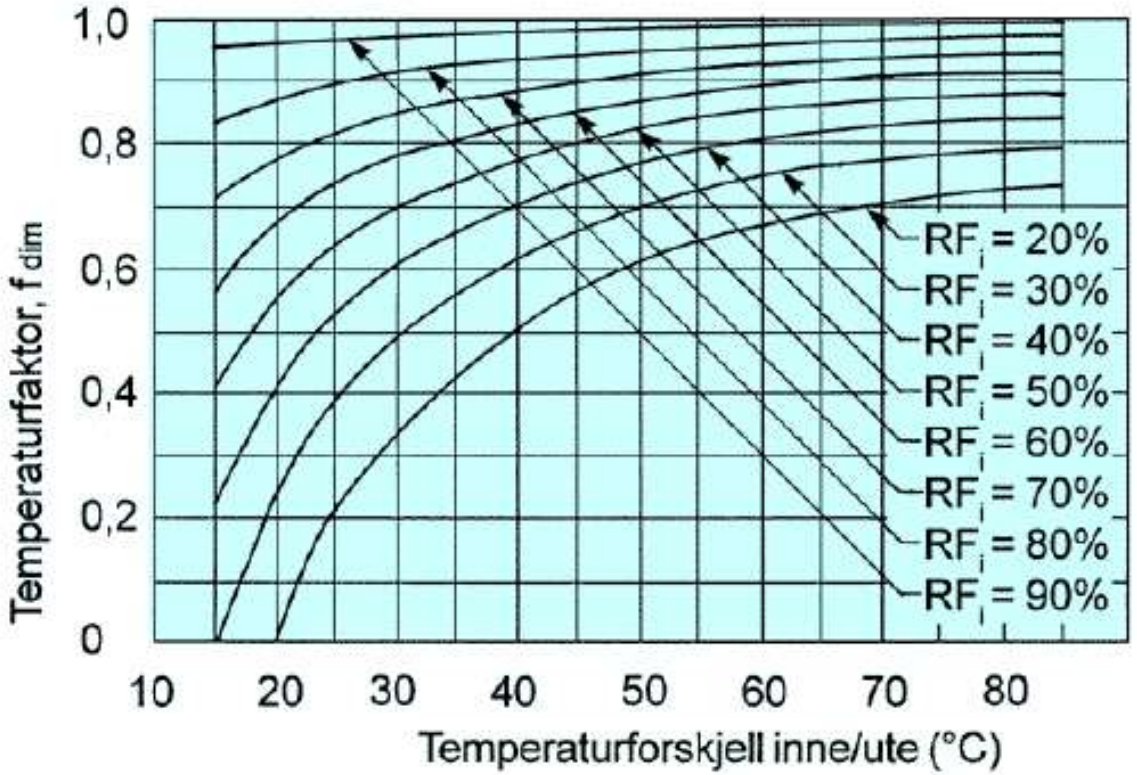
Three winter days

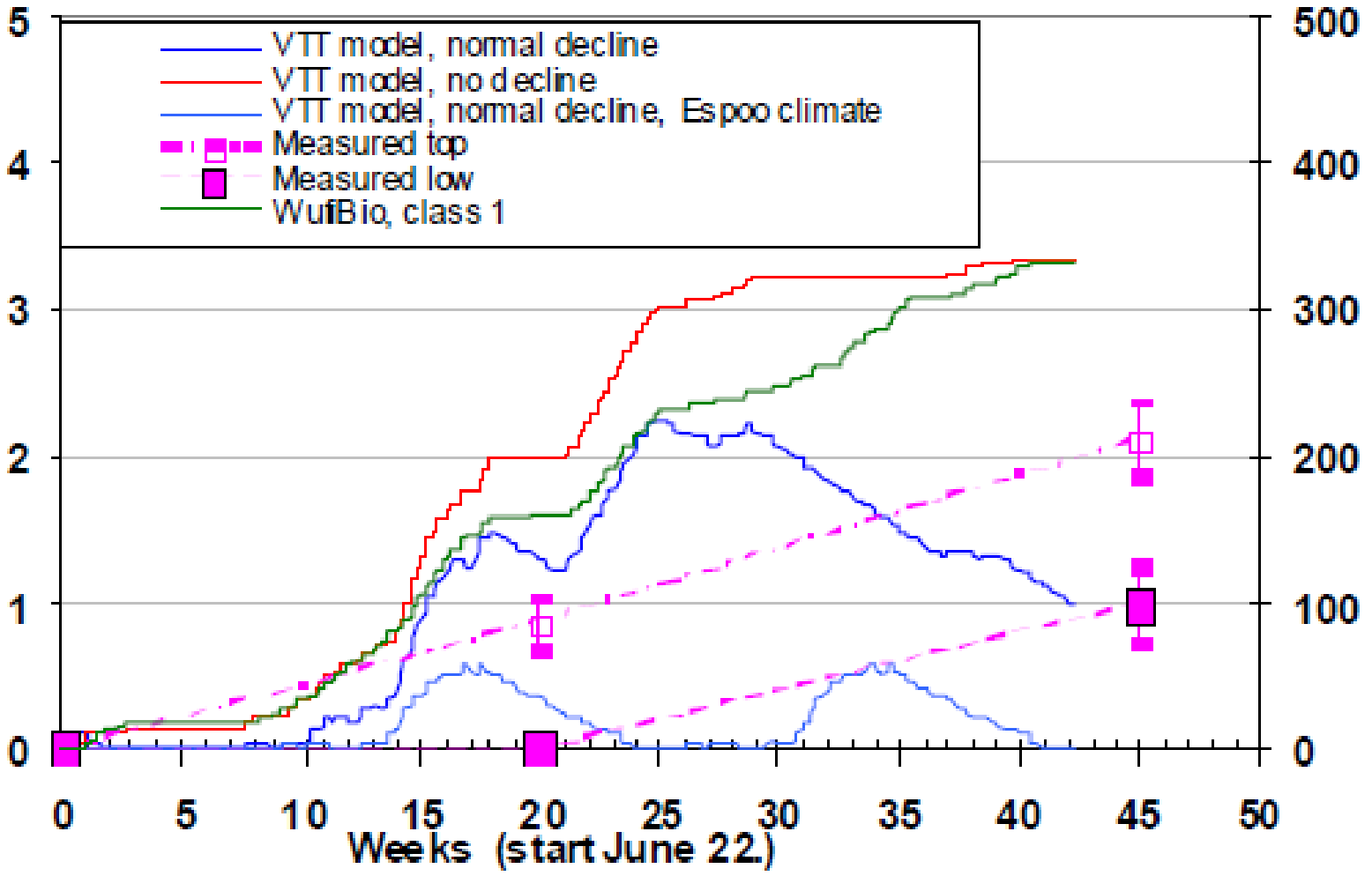


Three summer days




(1.2.3) Frankfurt
[W/m²]
>1000
750
500
250
0
Temperature [°C]
40
20
0
-20
1.1.2014
[mm/h]
>100
10
1
0.1
0.01
Water Content [kg/m³]
500
400
300
200
100
0
Rel. Humidity [%]
100
80
60
40
20
0
2
3
10
3
9
8
0.5
Solid Brick
Air Layer 20 mm
Mineral Wool
Concrete
Mineral Wool
Concrete
Interior Plaster
Cross Section [cm]


1,0
0,8
0,6
0,4
0,2
0
Temperaturfaktor, f dim
10
20
30
40
50
60
70
80
Temperaturforskjell inne/ute (°C)
RF_i = 20%
RF_i = 30%
RF_i = 40%
RF_i = 50%
RF_i = 60%
RF_i = 70%
RF_i = 80%
RF_i = 90%


VTT model, normal decline
VTT model, no decline
VTT model, normal decline, Espoo climate
Measured top
Measured low
WufiBio, class 1
5
4
3
2
1
0
500
400
300
200
100
0
0
5
10
15
20
25
30
35
40
45
50
Weeks (start June 22.)

State of the structure

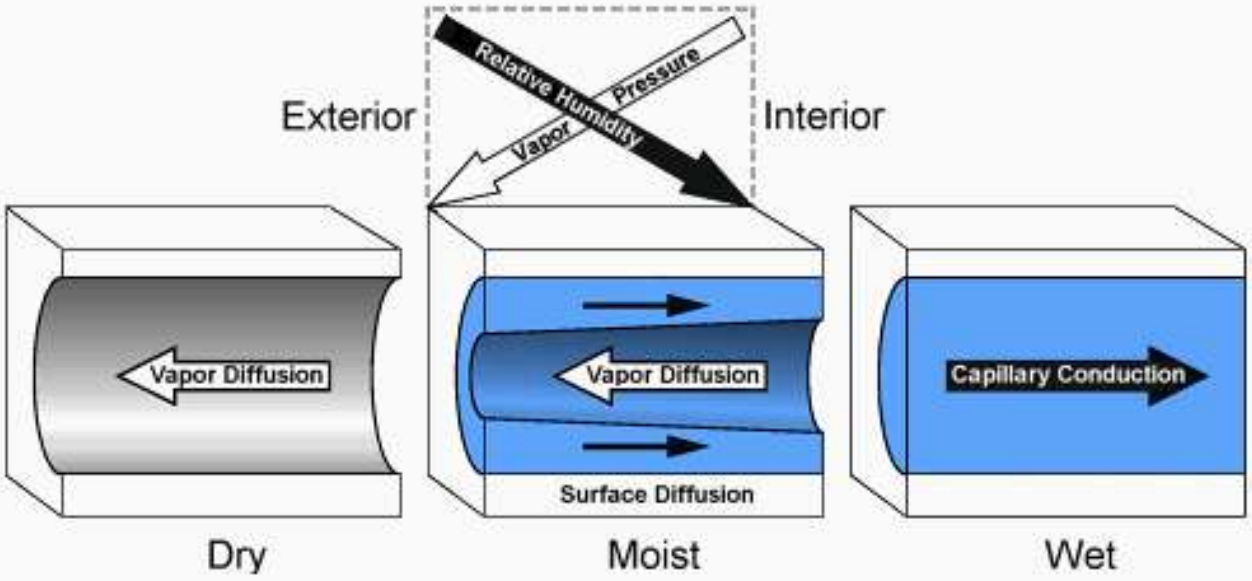


Fig. 4: Moisture transport phenomena in the pores of a massive exterior wall in winter, for different levels of moisture content

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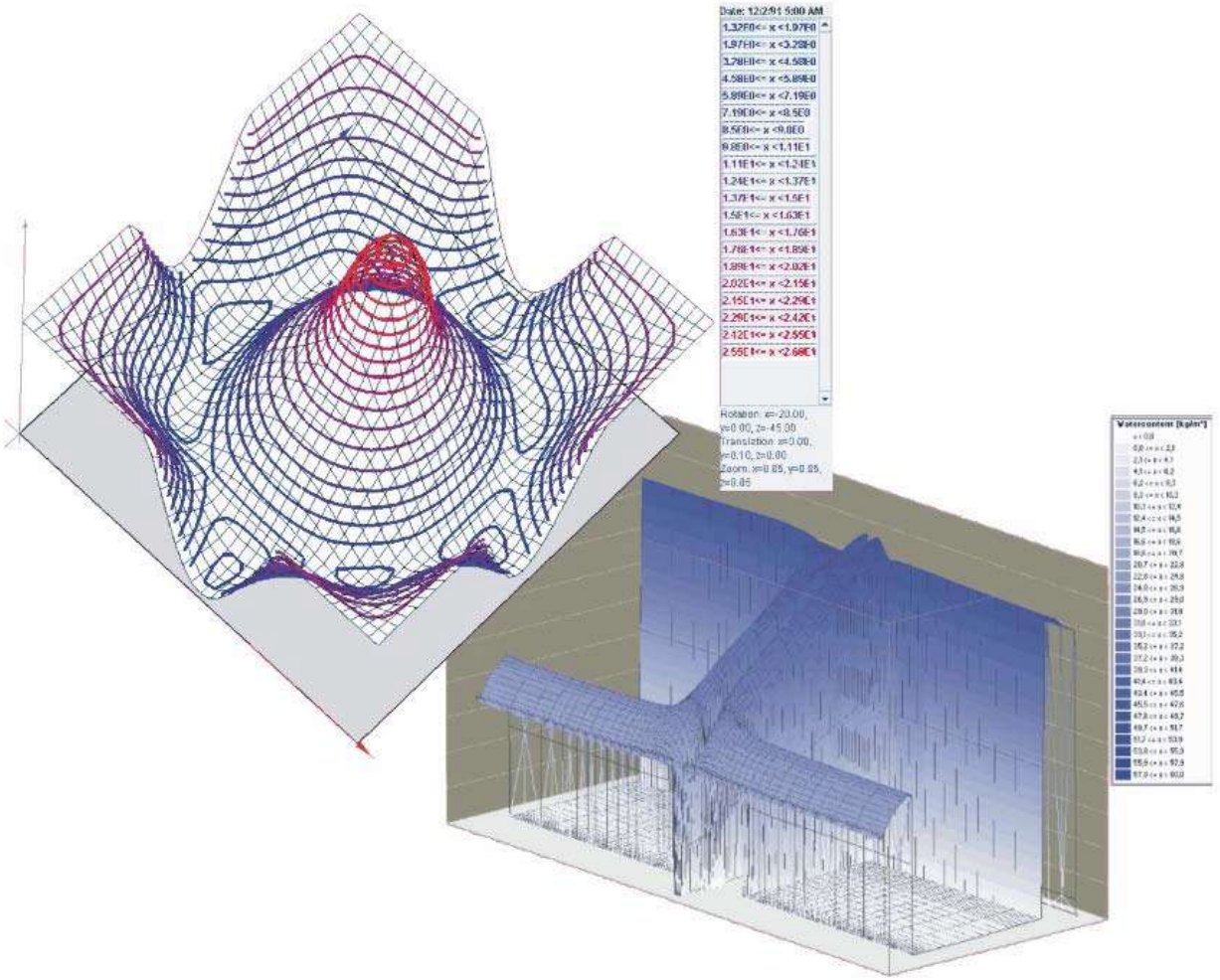
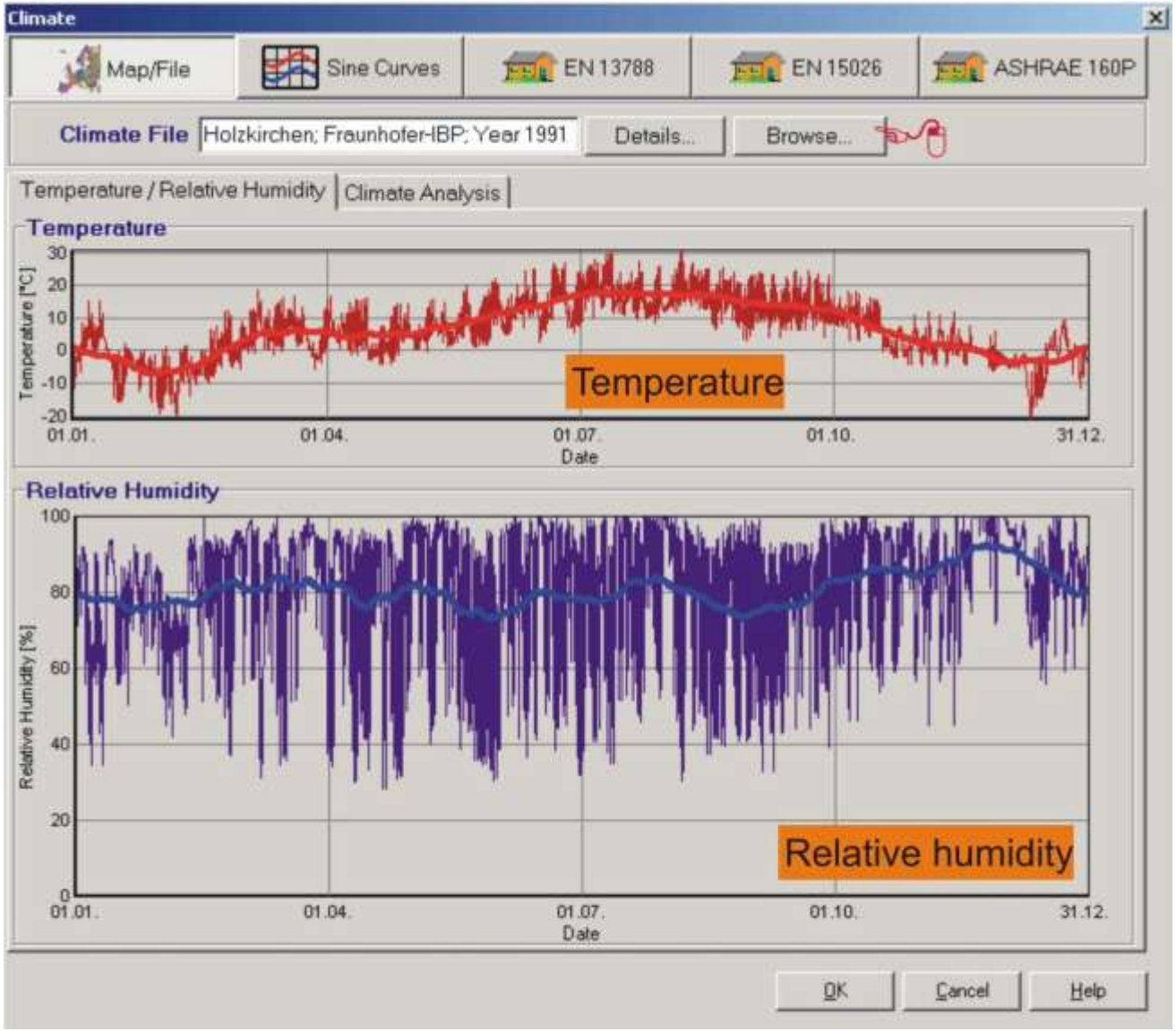
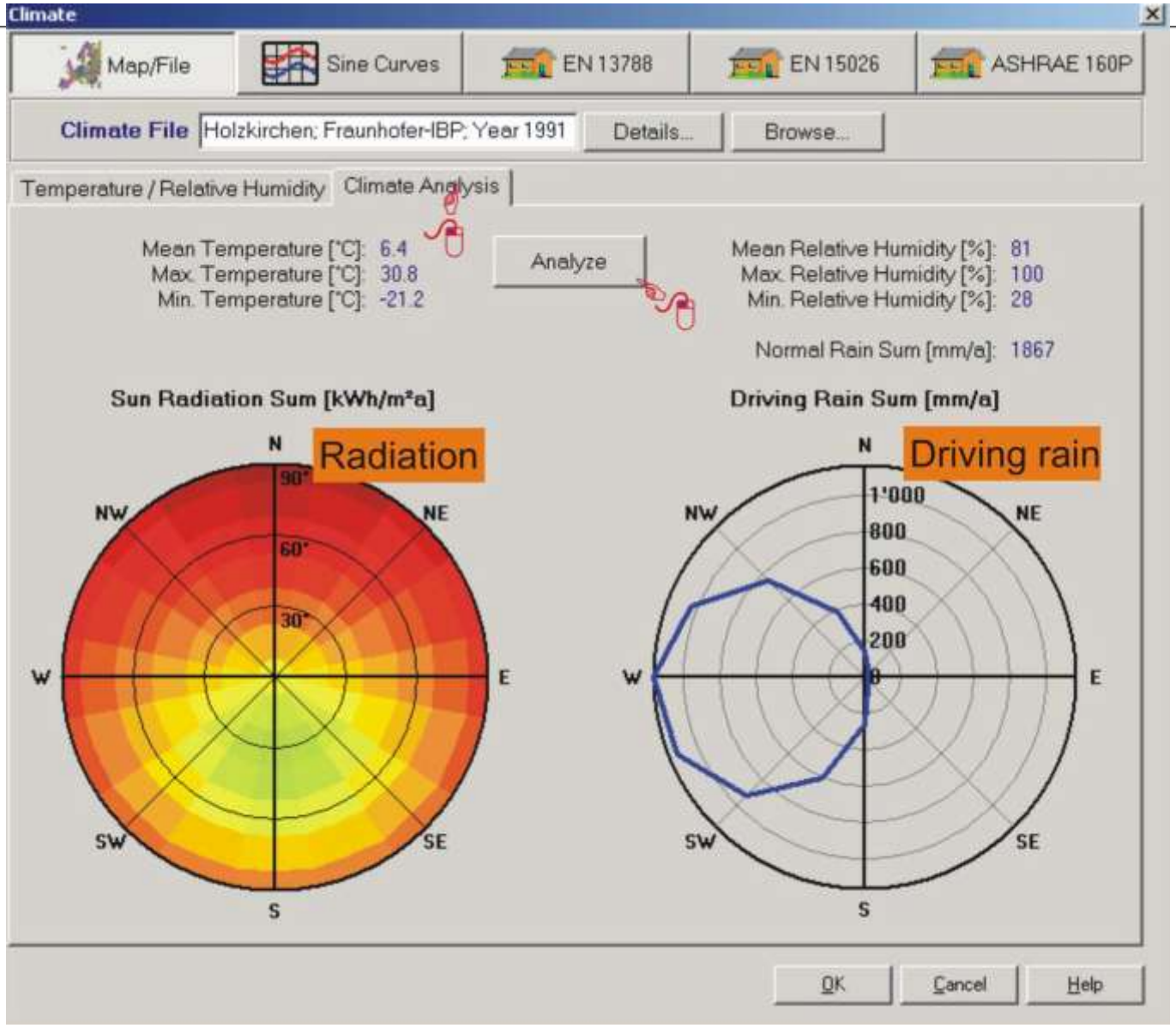
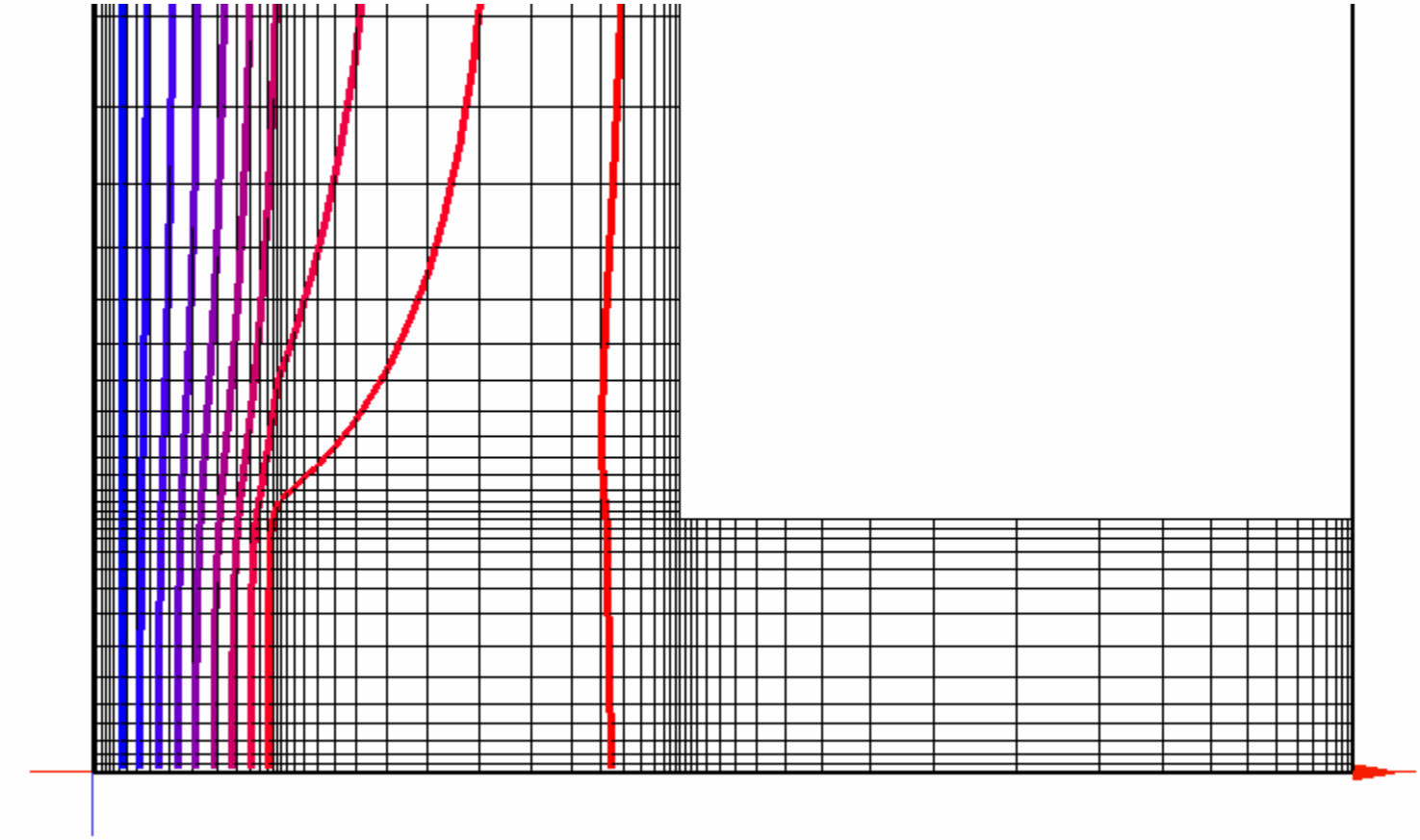
WUFI® 2D

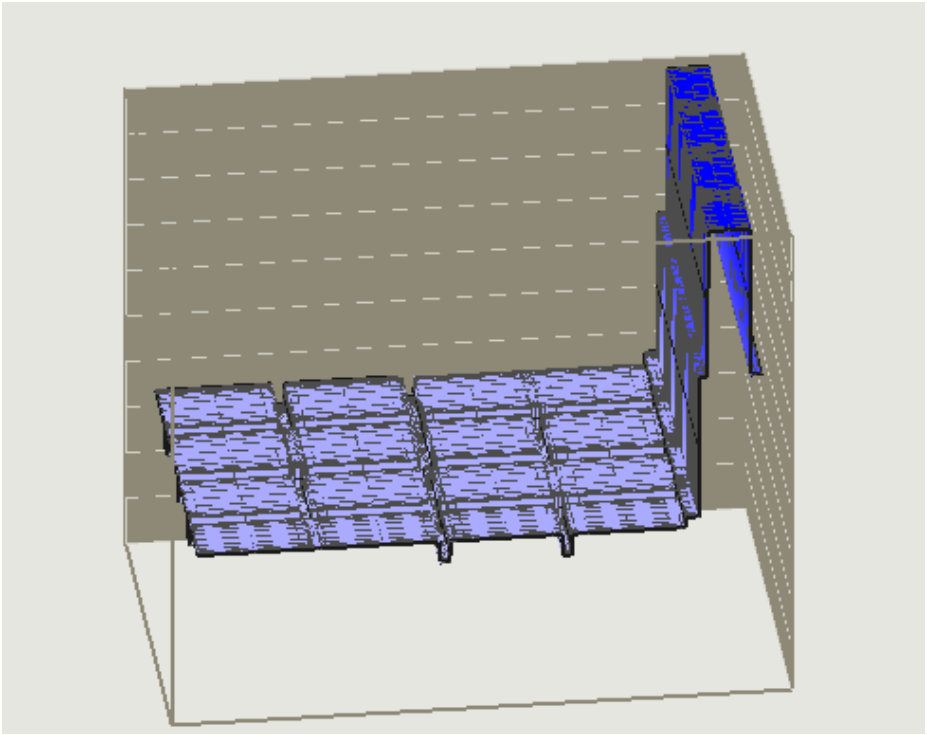



Climate
Map/File
Sine Curves
EN 13788
EN 15026
ASHRAE 160P
Climate File
Holzkirchen; Fraunhofer-IBP; Year 1991
Details...
Browse...
Temperature / Relative Humidity
Climate Analysis
Temperature
Temperature [°C]
30
20
10
0
-10
-20
Temperature
01.01.
01.04.
01.07.
01.10.
31.12.
Date
Relative Humidity
Relative Humidity [%]
100
80
60
40
20
0
Relative humidity
01.01.
01.04.
01.07.
01.10.
31.12.
Date
OK
Cancel
Help


Climate
Map/File
Sine Curves
EN 13788
EN 15026
ASHRAE 160P
Climate File
Holzkirchen; Fraunhofer-IBP; Year 1991
Details...
Browse...
Temperature / Relative Humidity
Climate Analysis
Mean Temperature [°C]: 6.4
Max. Temperature [°C]: 30.8
Min. Temperature [°C]: -21.2
Analyze
Mean Relative Humidity [%]: 81
Max. Relative Humidity [%]: 100
Min. Relative Humidity [%]: 28
Normal Rain Sum [mm/a]: 1867
Sun Radiation Sum [kWh/m²a]
Radiation
N
NW
NE
W
E
SW
SE
S
90°
60°
30°
Driving Rain Sum [mm/a]
Driving rain
1'000
800
600
400
200
0
OK
Cancel
Help

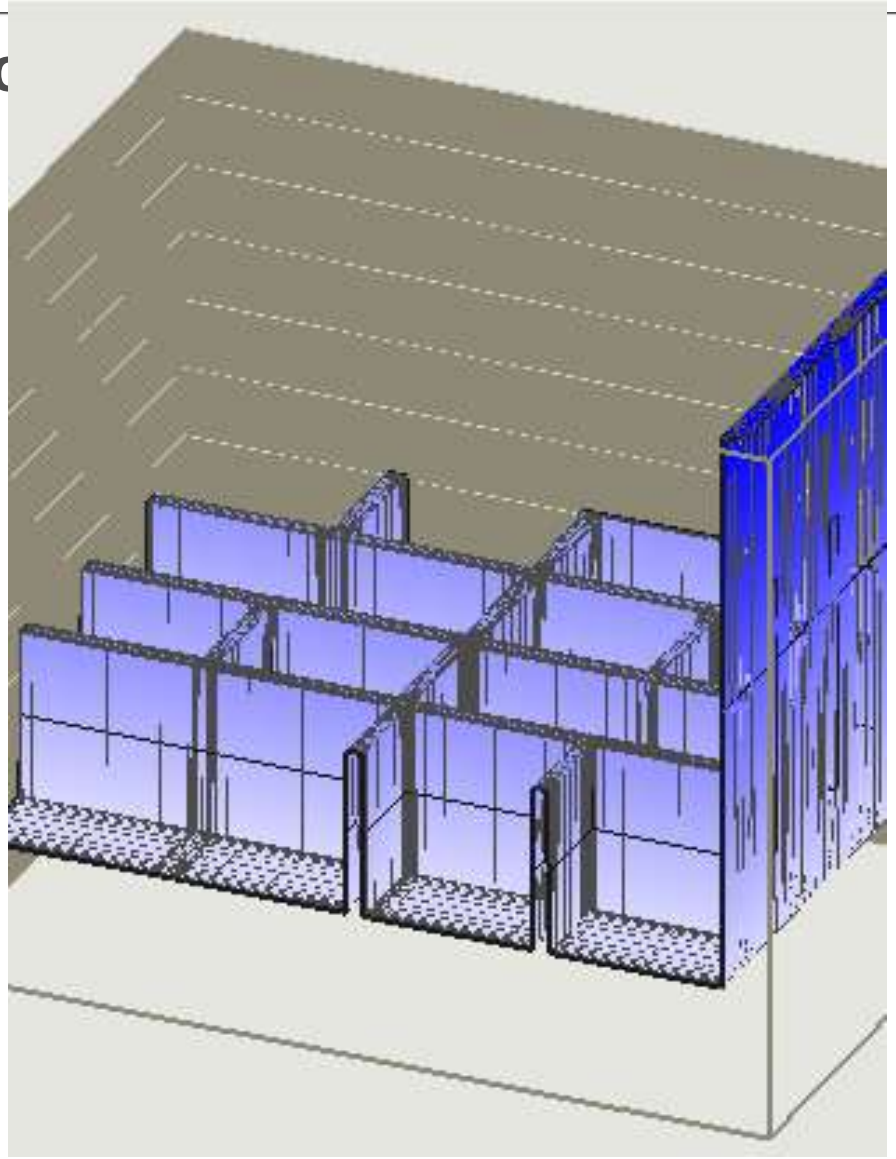


- Existing performance
- Moisture in the mortar
- Surface evaporation



Non open fibre Insulatio

- Increased Rh
- Surface condensation
- Moisture trapped behind insulation

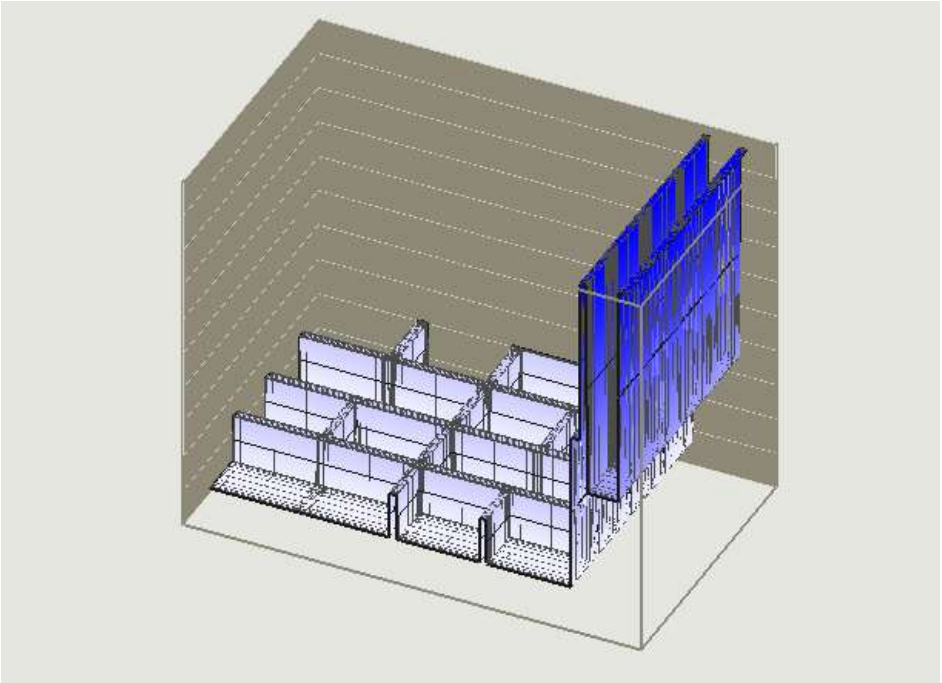


Open Fibre Insulation

– Stabilises wall over time

– Build up at interface passes through insulation

– Proper design and materials used – evaporation of moisture



Guidance

- Looks at the existing stock profile in Wales
- Construction types
- Age Band
- Location

Predominant type of wall structure	Dwelling Age					Total
	Pre 1919	1919 - 1944	1945 - 1964	1964 - 1980	Post 1980	
Mixed types	28683	1917	3346	1616	1755	37317
Masonry cavity	29053	110218	202286	219722	207429	768708
Masonry single leaf	2293	0	405	1602	1211	5511
9 inch solid	99795	14013	4973	0	0	118781
>9 inch solid	198918	9579	1716	632	1747	212592
In situ concrete	0	781	17522	8075	533	26911
Concrete panels	0	581	14452	4532	518	20083
Timber panels	2091	478	803	5547	4637	13556
Metal sheet	248	237	3990	736	391	5602
Total	361081	137804	249493	242462	218221	1209061

Table 7 Wall type against dwelling age Wales

Material and Construction of House Module	Dwelling Age					Total
	Pre 1919	1919 -	1945 - 1964	1964 - 1980	Post 1980	
Masonry/Boxwall/Solid	335660	27737	7384	5767	3097	379645
Masonry/Boxwall/Cavity	23241	106496	197691	210964	199967	738361
Masonry/Cross wall	0	795	1868	3902	3206	9791
Concrete/Boxwall/In-situ	0	948	17698	6579	533	25758
Concrete/Boxwall/Precast <1m	0	280	609	624	0	1513
Concrete/Boxwall/Precast >1m	0	222	6686	1195	518	8621
Concrete/Cross wall/In-situ	0	0	2656	2094	0	4750
Concrete/Cross wall/Precast panel	0	0	436	499	0	935
Concrete/Frame/In-situ	0	0	2958	934	0	3892
Concrete/Frame/Precast	0	359	3905	414	0	4678
Timber/Frame/ Pre 1919	1382	0	0	0	0	1382
Timber/Frame/ Post 1919	0	715	803	5080	9790	16388
Metal/Frame	0	249	6778	3638	391	11056
Unknown	798	0	0	768	719	2285
Total	361081	137803	249492	242458	218221	1209055

Table7a Construction Type against dwelling age Wales

- Buildings that are sheltered by surrounding buildings and trees can be considered to be in an exposure category one lower in 'sheltered' parts. For example if 'sheltered' in Zone 4 consider it as Zone 3.
- External cladding can improve the exposure rating and give resistance to rain penetration.
- Assess the exposure of the wall using BS 8104.
- See BRE Report 262: 'Thermal insulation: avoiding risks' for guidance.

Key to map

Exposure zones	Approximate wind-driven rain litres/m² per spell
1	Less than 33
2	33 to less than 56.5
3	56.5 to less than 100
4	100 or more

- House Type
- Guide to construction
- Issues with construction type
- Opportunities for improvement
- Risk indication

- Risk assessment
- Getting it wrong
- Type of approach to improvement

- Format
- Type of content
- Technical appendix
- Pull out sheets or other

Future Research

Technical

- To carry out an initial comprehensive review and consolidate the existing knowledge base on factors affecting the efficacy of solid wall insulation in the UK (and other countries).

- To carry out appropriate investigations to understand the key factors affecting the heat losses from solid walls.

- To collect empirical data on energy consumption in solid wall houses, savings from SWI, heating patterns and building properties, using it to improve modelling assumptions, and if possible improve overall self-consistency of the data and the predictability of the models; monitoring SWI installations for energy consumption and temperatures pre and post installation.

- To investigate any remaining gap between modelled and actual energy consumption data, and better understand the role of occupant behaviour on energy consumption and more particularly savings (e.g. comfort taking) across occupant groups (eg fuel poor, high energy users).

- To investigate the methodologies for both measuring and calculating U values; and to make recommendations for their improvement;

- By examining reports from current post-insulation monitoring projects (eg CESP, TSB), to develop an approach to monitoring and investigating unintended consequences.

- To develop a rapid and accurate method for measuring solid wall U-value in-situ (eg an instrument that GD assessors could use within 1-2 hours to determine the U-value of a particular wall).

Final Thought


Problems
Solutions

Questions