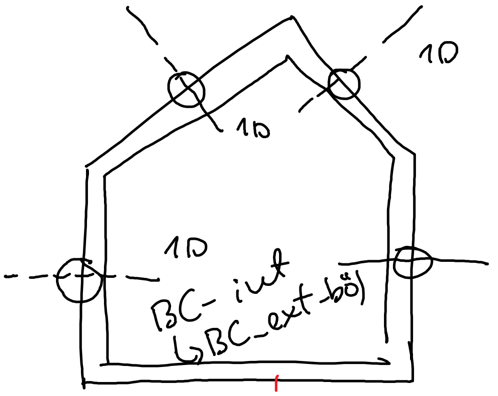
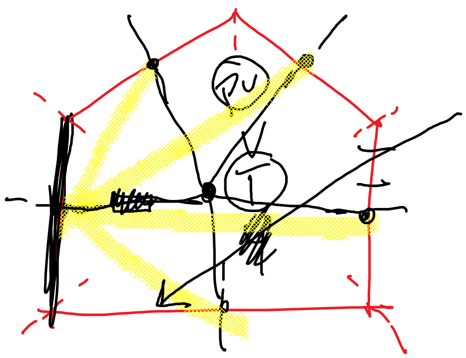
00 - Theory

2017. március 30.
9:28

BC-ext
↳ klimafile





$$\left.\begin{array}{l}\boxed{n \text{ db } 1D} \\ +\boxed{m \text{ db zóna}} \\ + \;\ldots\ldots\end{array}\right\}$$

Termikus zóna – T hőmérséklet

$$\underbrace{\boxed{\underset{m^3}{V_{zone}}\cdot\underset{\frac{kg}{m^3}}{\rho_{air}}\cdot\underset{\frac{J}{kgK}}{c_{p,air}}}\;\frac{d\underset{}{T_{zóna}}}{\underset{\frac{K}{s}}{dt}}}_{W} = \underbrace{\sum_{i=1}^{n}\underset{\frac{W}{m^2K}}{h_{conv,i}}\cdot\underset{m^2}{A_i}\underset{K}{(T_{s,i}-T_{zone})}}_{W} +$$

$$\underbrace{+\;\underset{\frac{1}{s}}{n}\cdot\underset{m^3}{V}\;\underset{\frac{kg}{m^3}}{\rho_{air}}\cdot\underset{\frac{J}{kgK}}{c_{p,air}}\cdot\underset{K}{(T_e-T_{zone})}}_{W} +$$

$$+ \underbrace{\dot{Q}_{SOURCE}}_{W} + \underbrace{\dot{Q}_{HVAC}}_{W}$$

i-dik időlépés

n iteráció

→ 1D-s számítás → $T_{si,i}$

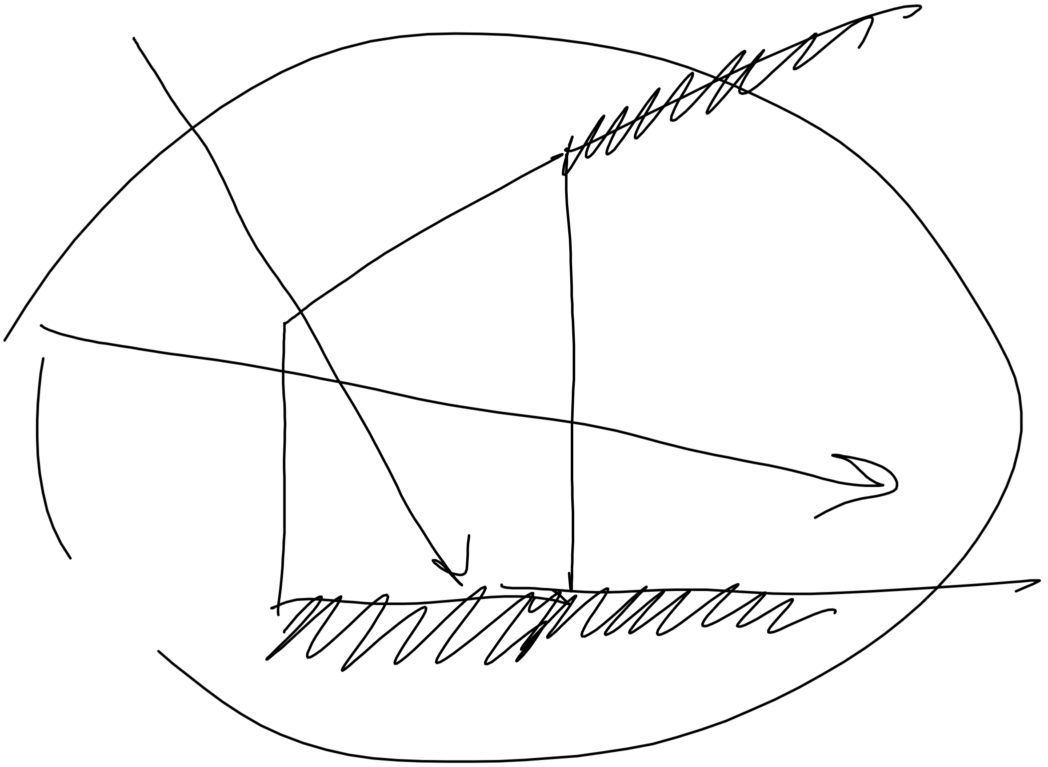
→ T_{zone}

→ 1D-s számítás

→ ....

✓

i+1-dik időlépés



$$\underbrace{\frac{V_{zone}}{R_v \cdot T_{zone}} \frac{d\rho_{v,zone}}{dt}}_{\frac{kg}{s}} = \underbrace{\sum \dot{m}_{SOURCE}}_{\frac{kg}{s}} + \underbrace{\sum \dot{m}_{HVAC}}_{\frac{kg}{s}} +$$

$$p \cdot V = m \cdot R_v \cdot T$$

$$\rightarrow m = \frac{p \cdot V}{R_v \cdot T}$$

$$+ \underbrace{n \cdot \frac{V_{zone}}{R_v \cdot T} \left(p_e - p_{zone}\right)}_{kg/s} +$$

$$\cancel{+ \underbrace{\sum_{i=1}^{n} \underbrace{A_i}_{m^3} \underbrace{\beta_i}_{\frac{kg}{m^2 s Pa}} \underbrace{\left(p_{surf,i} - p_{zone}\right)}_{Pa}}_{kg/s}}$$

① ∅ nedvesség puffer   ∅ fal

② EC modell

$$\frac{V_{zone}}{R_v \cdot T_{zone}} EC \frac{d\rho_{zone}}{dt} = \sum \dot{m} + \sum \dot{m} + n \cdot V \ldots$$

Ru-Tzone dt

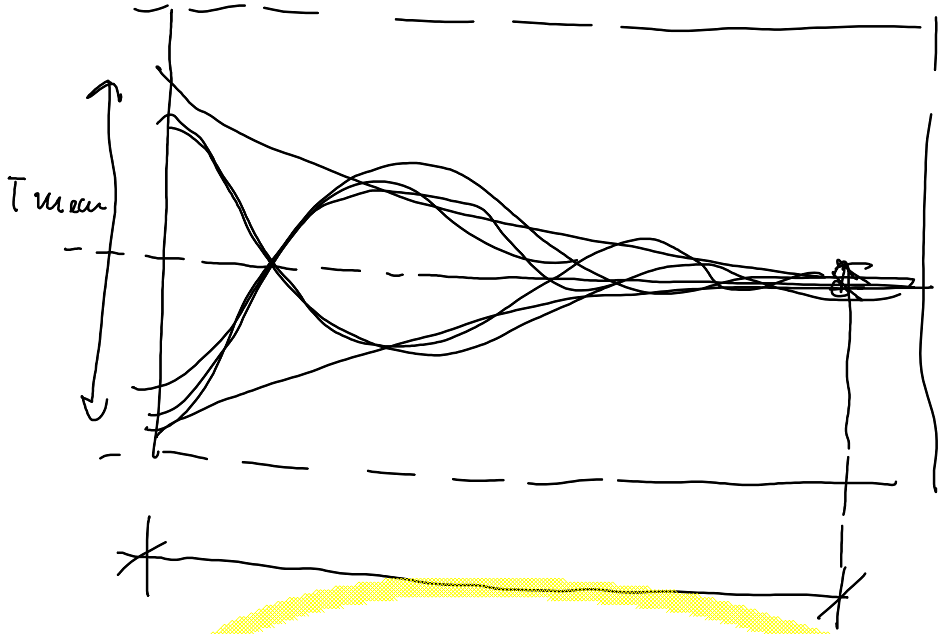
||

1

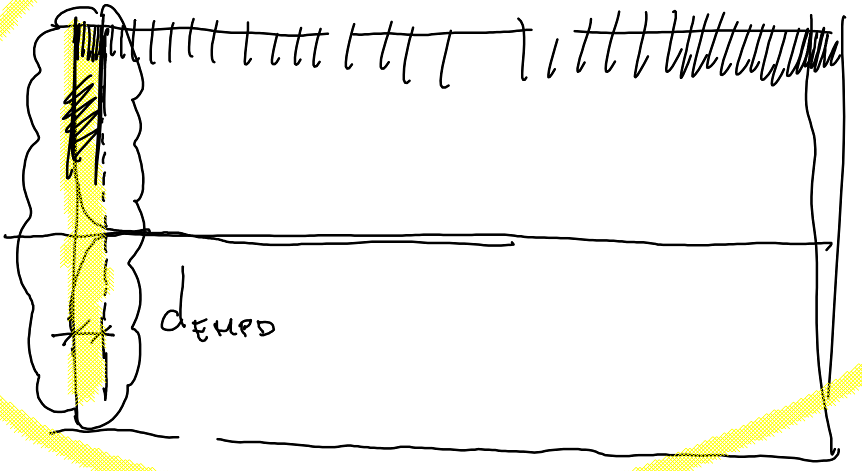
ϕ rel

EC = ? 10-20-25

③ EMPD modell



~ λ ~ $\rho \cdot c_p$ ~ τ



(T) |

$$\boxed{\delta_0(T) \cdot p_{sat}(T) \cdot \tau}$$

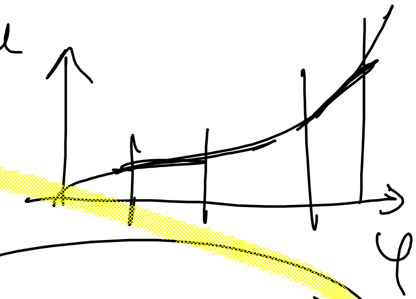
(I) $$d_{EMPD} = \sqrt{\frac{\delta_0(T)\cdot p_{sat}(T)\cdot \tau}{\mu\ \xi\ \cdot \pi}}$$

$$\xi \quad \frac{du}{d\varphi}$$

T ✓

τ ✓

$u = m\%$

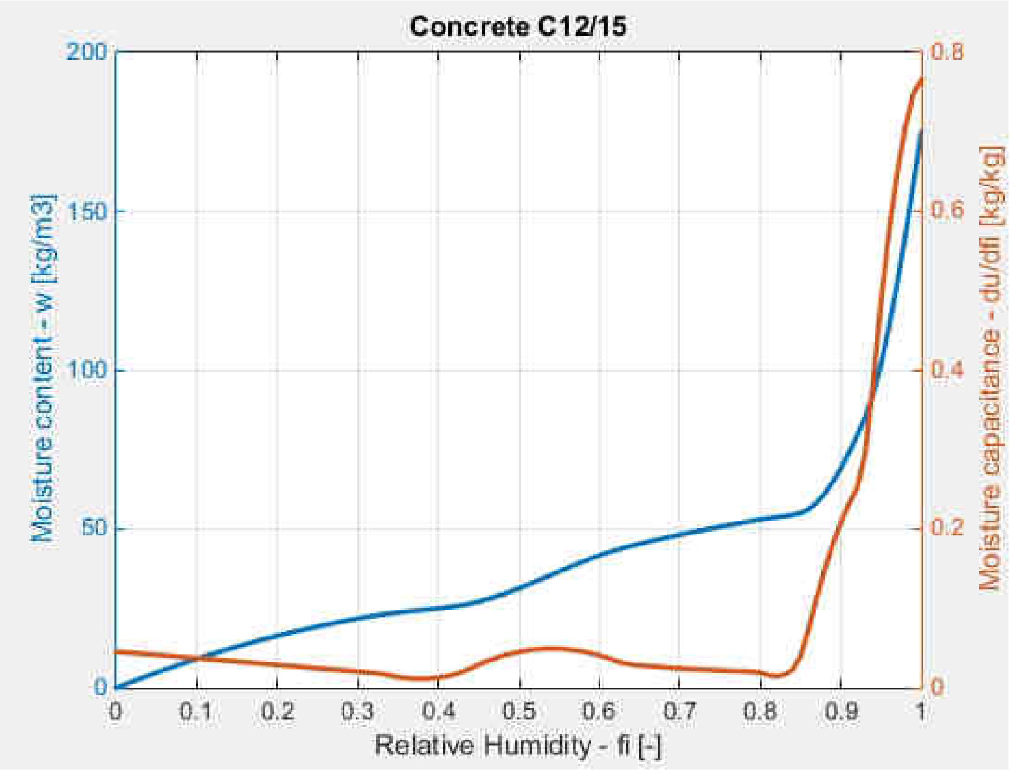


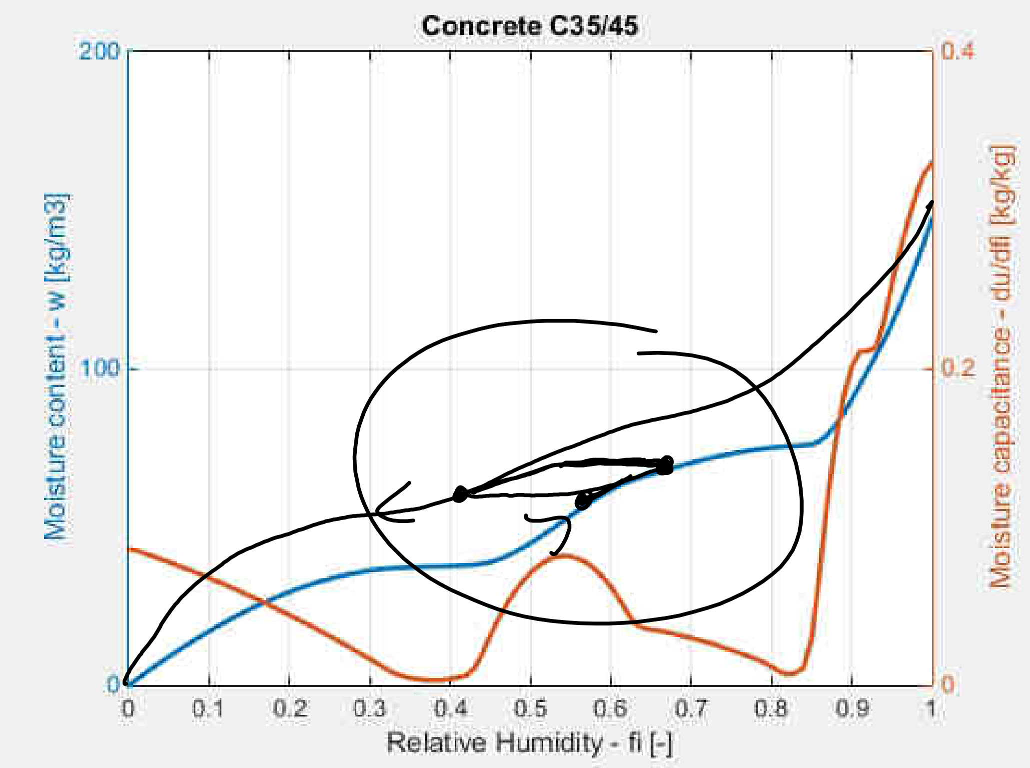
(II) $$\underbrace{\underset{\frac{kg}{m^3}}{\rho_{dry}}\cdot \underset{\frac{kg}{kg}}{\overset{\frac{du}{d\varphi}}{\xi}}\cdot \underset{m}{d_{EMPD}}\cdot \underset{\frac{1}{s}}{\frac{d}{dt}}\left[\underset{\frac{Pa}{Pa}}{\frac{p_v}{p_{sat}(T)}}\right]}_{\frac{kg}{m^2 s}} = \underbrace{\underset{\frac{kg}{m^2 s \cancel{Pa}}}{\beta}\cdot\underset{\cancel{Pa}}{(p_{zone}-p_v)}}_{\frac{kg}{m^2 s}}$$

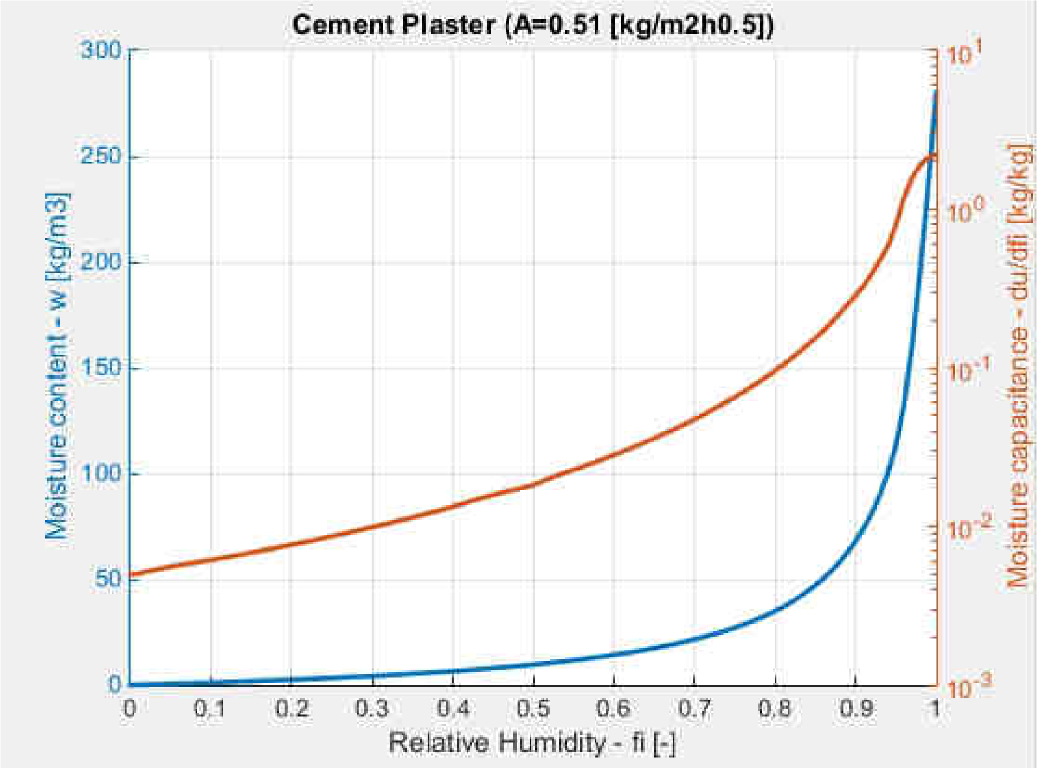
(III) $$\frac{V}{R_v\cdot T}\frac{dp_{zone}}{dt} = \sum \dot m + \sum \dot m + \frac{n\cdot V}{R_v\cdot T}(p_e - p_z) + \sum_{i=1}^{n}\beta_i A_i (p_{v,i}-p_z)$$

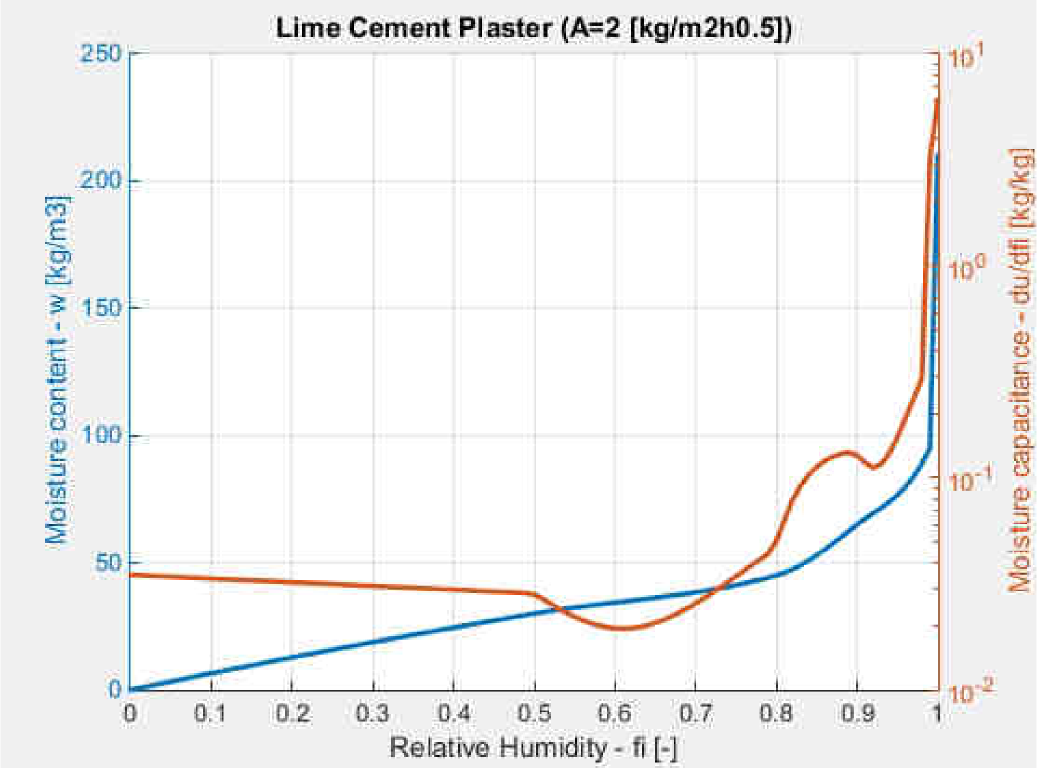
01 - Materials

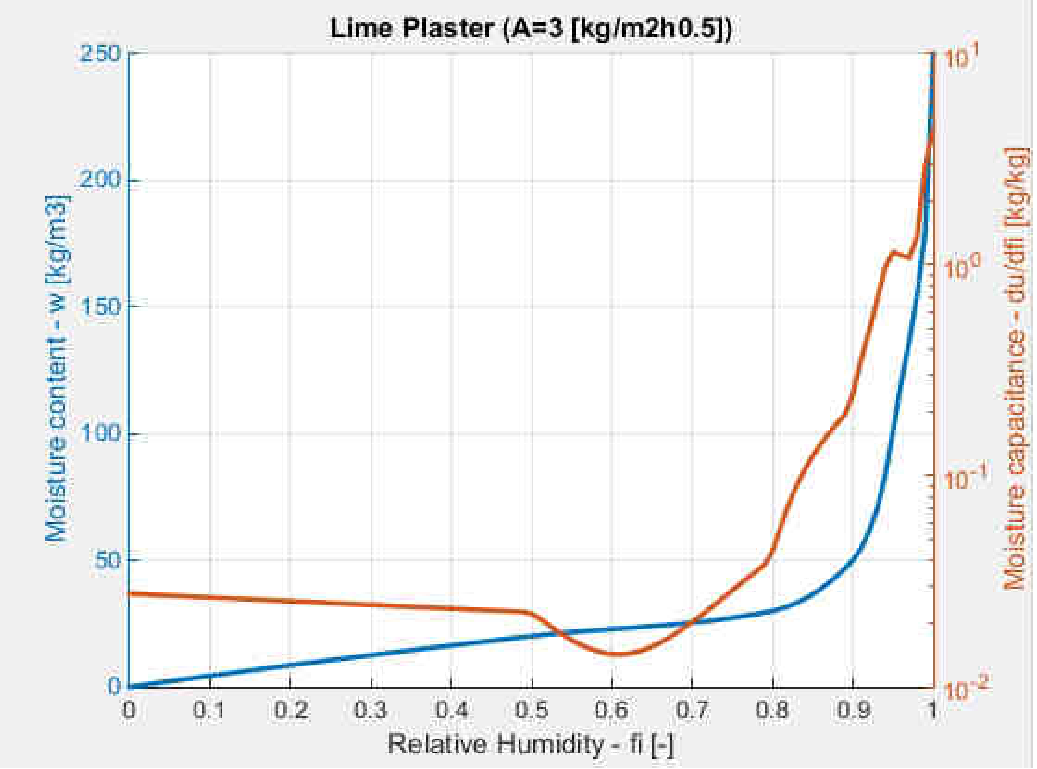
2017. március 30.
20:01

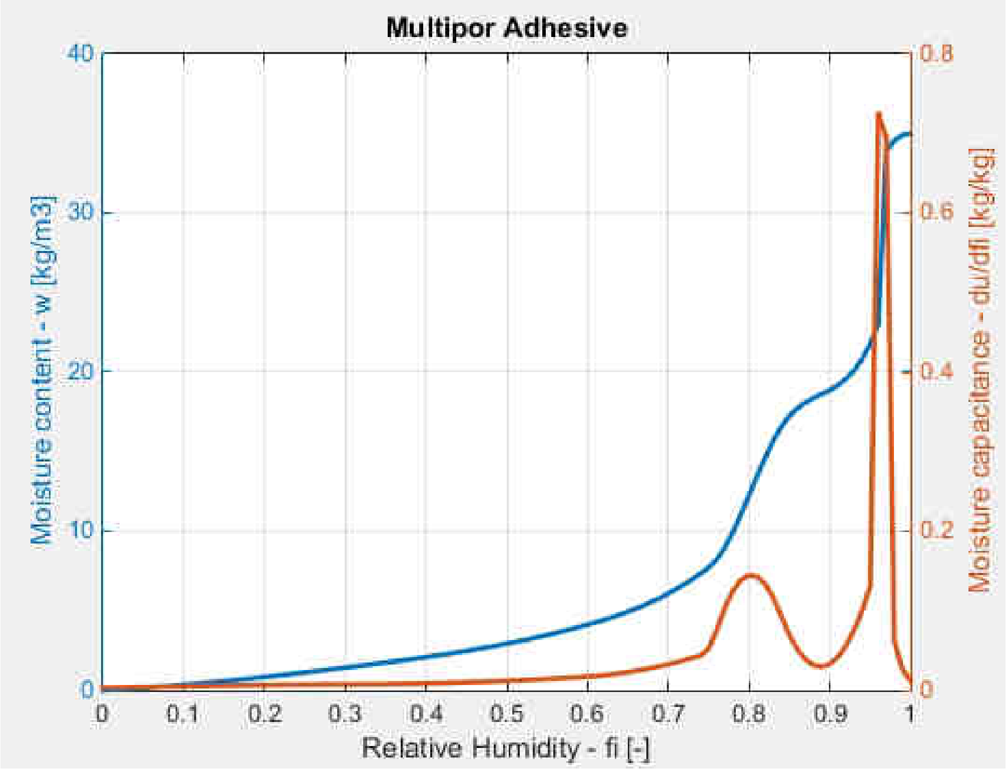


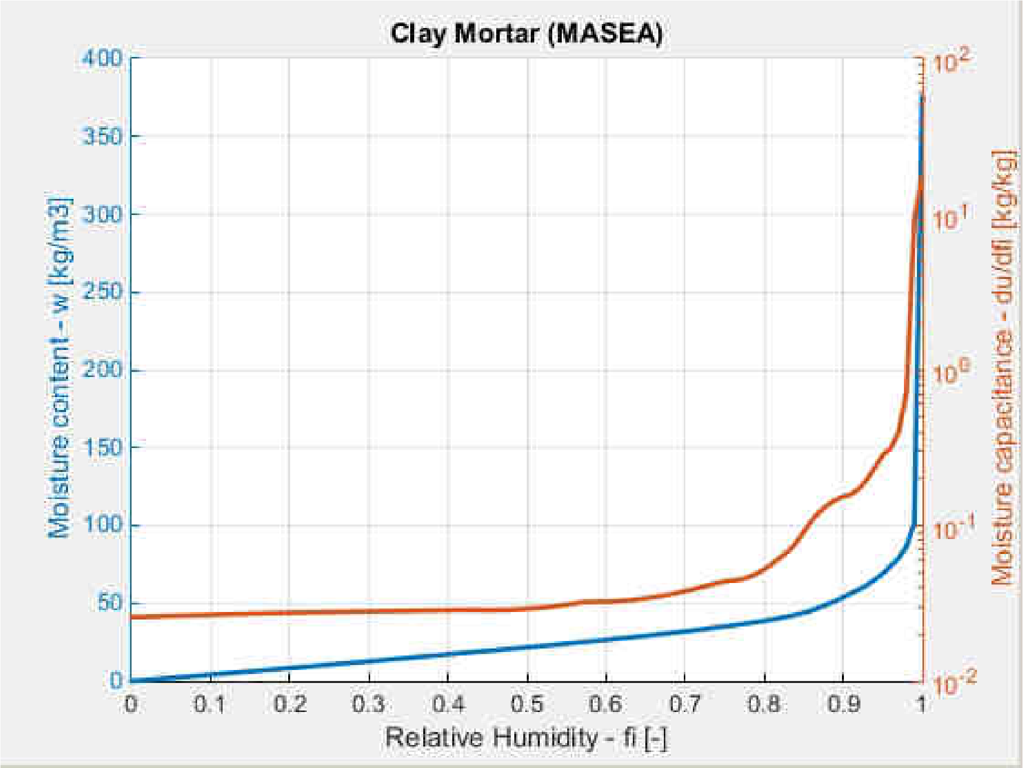



Cement Plaster (A=0.51 [kg/m2h0.5])
Moisture content - w [kg/m3]
Moisture capacitance - du/dfi [kg/kg]
Relative Humidity - fi [-]
300
250
200
150
100
50
0
10^1
10^0
10^{-1}
10^{-2}
10^{-3}
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1


Lime Cement Plaster (A=2 [kg/m2h0.5])
Moisture content - w [kg/m3]
Moisture capacitance - du/dfi [kg/kg]
Relative Humidity - fi [-]
250
200
150
100
50
0
10^1
10^0
10^{-1}
10^{-2}
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

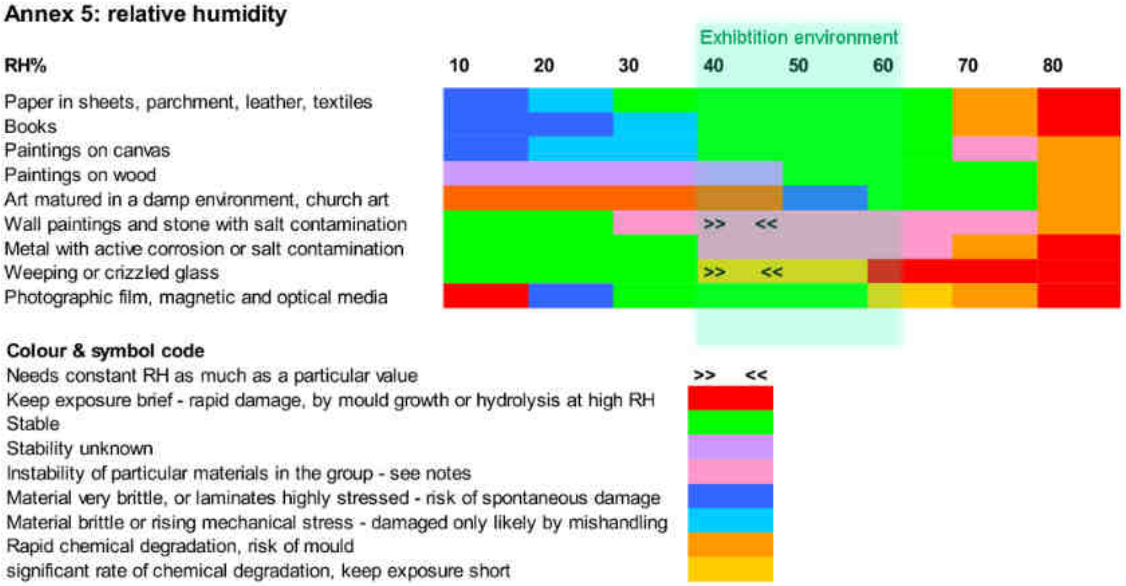

Lime Plaster (A=3 [kg/m2h0.5])
Moisture content - w [kg/m3]
0
50
100
150
200
250
Moisture capacitance - du/dfi [kg/kg]
10^-2
10^-1
10^0
10^1
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Relative Humidity - fi [-]


Multipor Adhesive
Moisture content - w [kg/m3]
0
10
20
30
40
Moisture capacitance - du/dfi [kg/kg]
0
0.2
0.4
0.6
0.8
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Relative Humidity - fi [-]


Clay Mortar (MASEA)
Moisture content - w [Kg/m3]
400
350
300
250
200
150
100
50
0
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Relative Humidity - fi [-]
Moisture capacitance - du/dfi [kg/kg]
10^2
10^1
10^0
10^{-1}
10^{-2}

02 - Examples

2017. március 31.
10:42



Annex 5: relative humidity

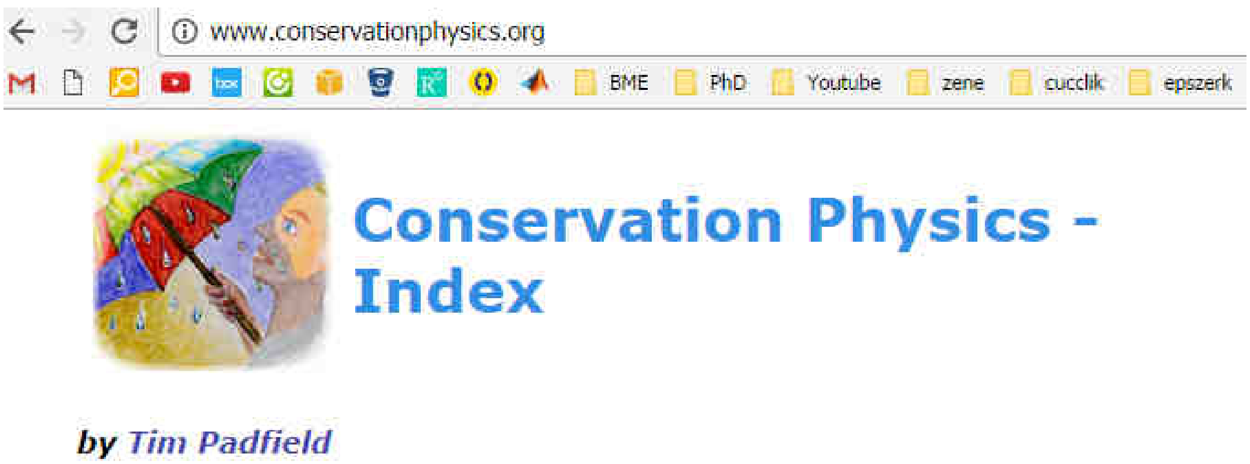
Exhibtition environment

RH% 10 20 30 40 50 60 70 80

Paper in sheets, parchment, leather, textiles
Books
Paintings on canvas
Paintings on wood
Art matured in a damp environment, church art
Wall paintings and stone with salt contamination
Metal with active corrosion or salt contamination
Weeping or crizzled glass
Photographic film, magnetic and optical media

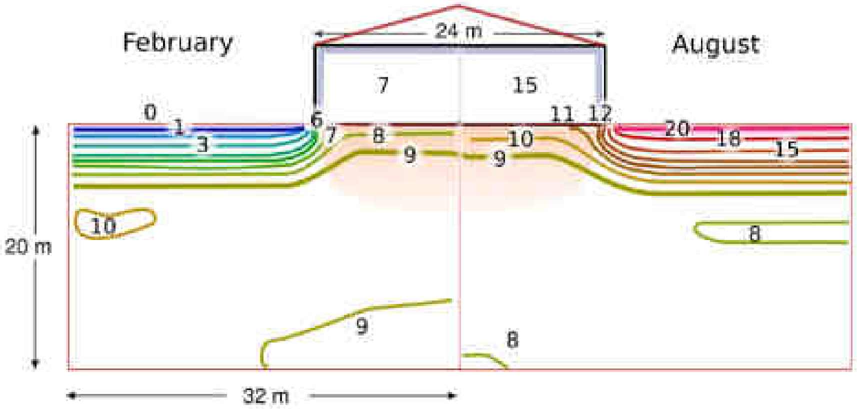
Colour & symbol code

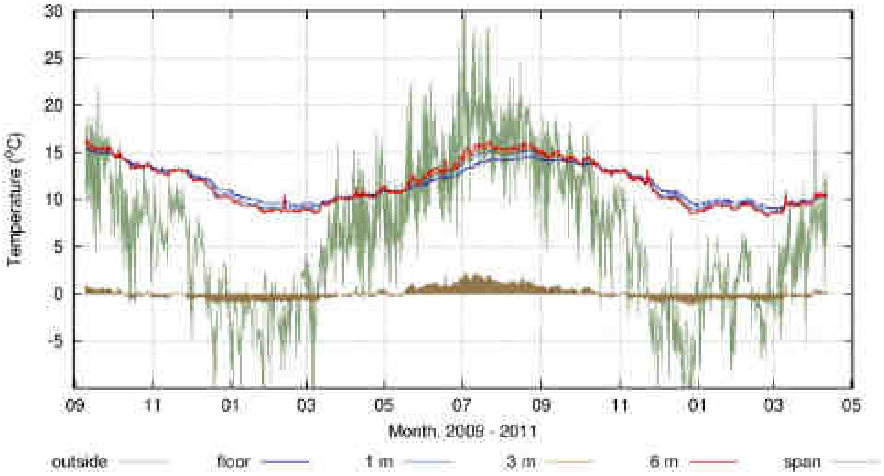
Needs constant RH as much as a particular value	>> <<
Keep exposure brief - rapid damage, by mould growth or hydrolysis at high RH	🟥
Stable	🟩
Stability unknown	🟪
Instability of particular materials in the group - see notes	🟪
Material very brittle, or laminates highly stressed - risk of spontaneous damage	🟦
Material brittle or rising mechanical stress - damaged only likely by mishandling	🟦
Rapid chemical degradation, risk of mould	🟧
significant rate of chemical degradation, keep exposure short	🟨

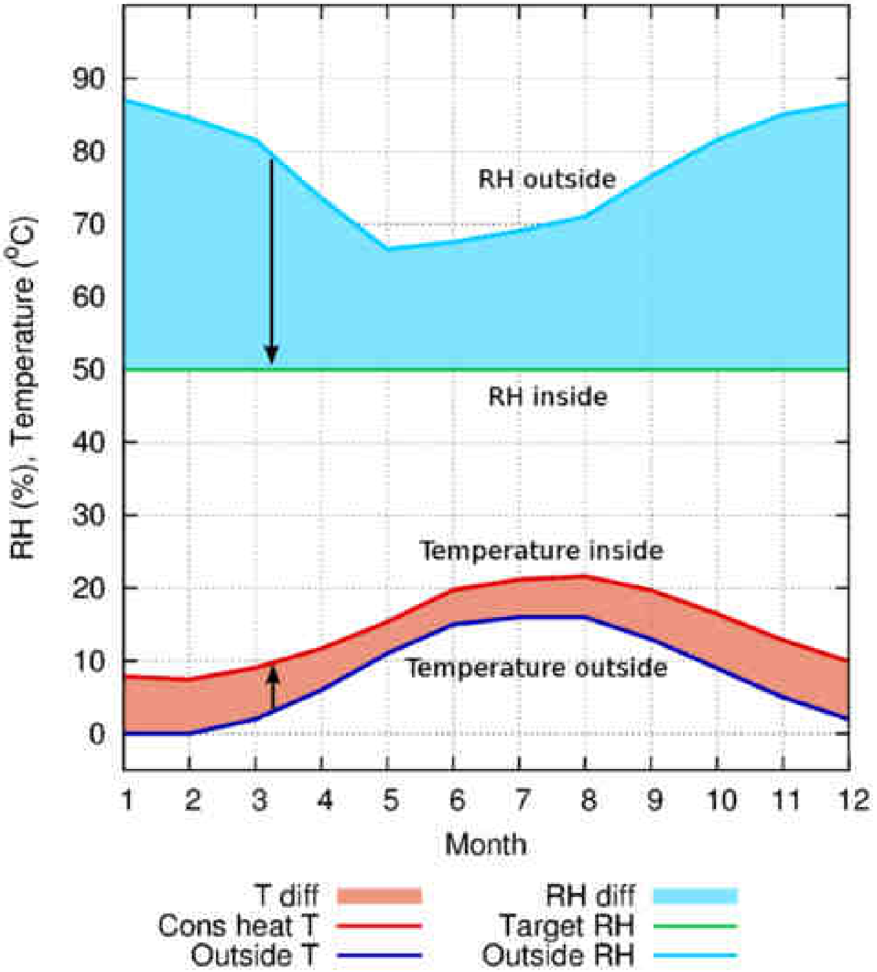


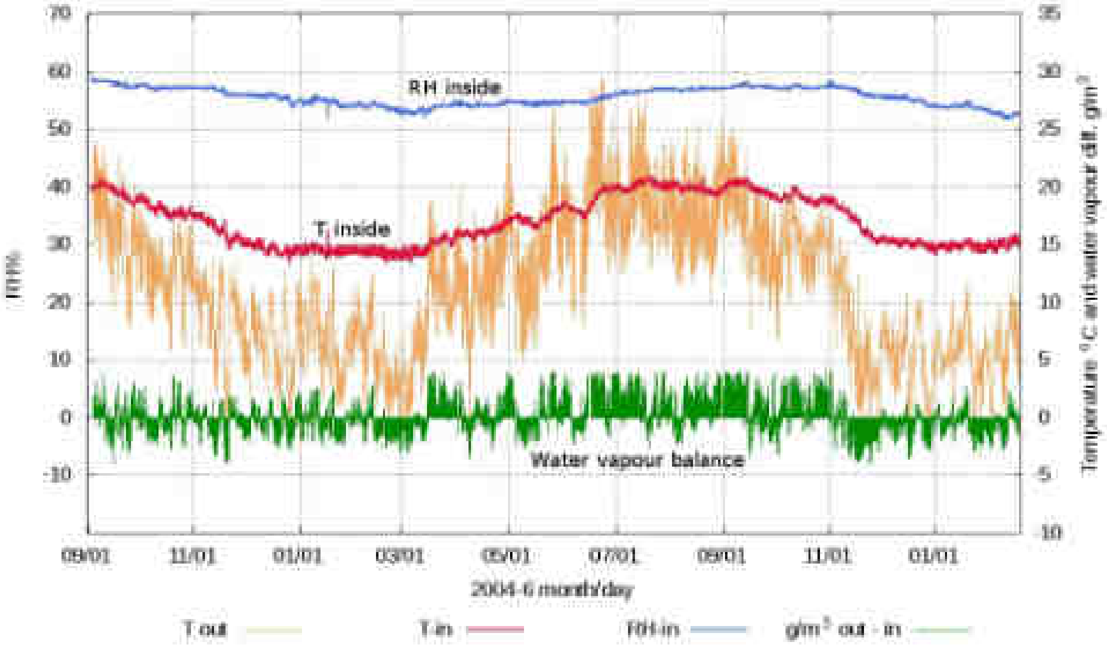
Conservation Physics - Index

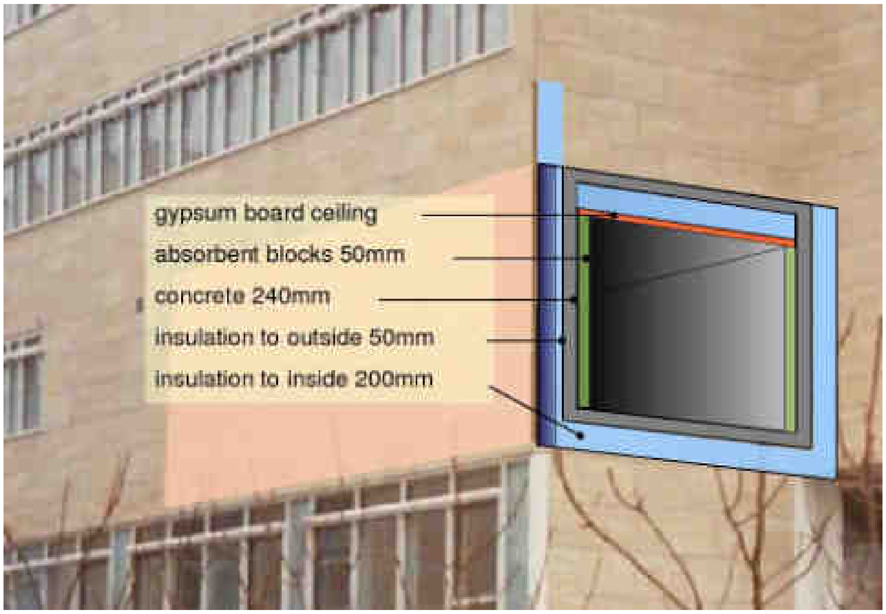
by Tim Padfield

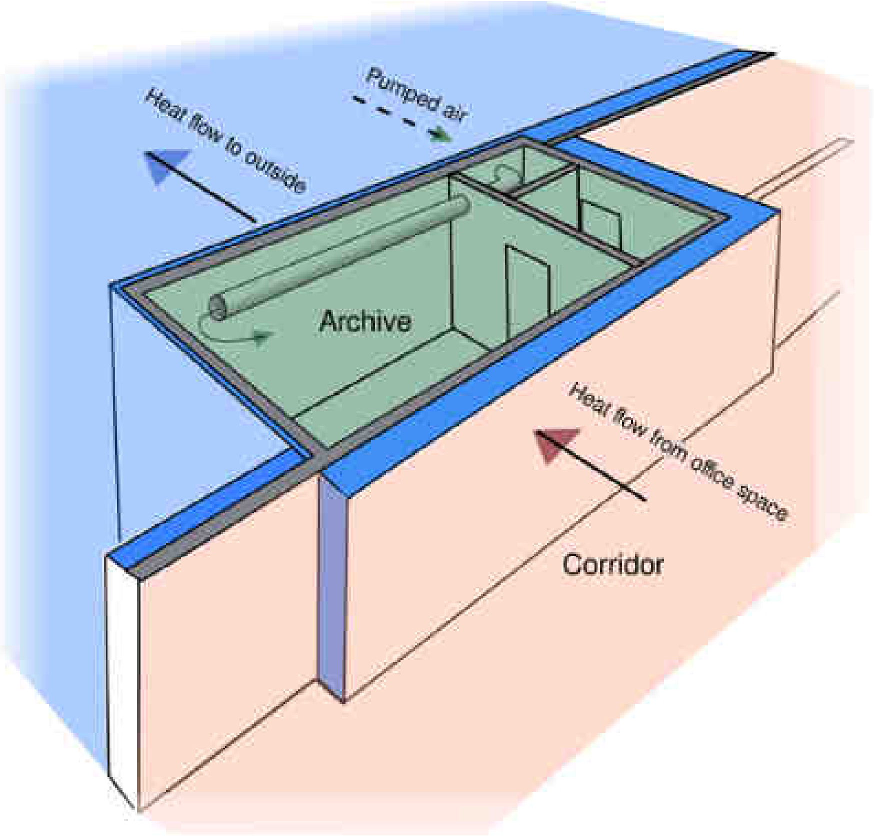

February
24 m
August
7
15
0
1
3
6
7
8
9
9
10
11
12
20
18
15
10
20 m
8
9
8
32 m


Temperature (°C)
30
25
20
15
10
5
0
-5
09
11
01
03
05
07
09
11
01
03
05
Month, 2009 - 2011
outside
floor
1 m
3 m
6 m
span


RH (%), Temperature (°C)
90
80
70
60
50
40
30
20
10
0
RH outside
RH inside
Temperature inside
Temperature outside
1
2
3
4
5
6
7
8
9
10
11
12
Month
T diff
Cons heat T
Outside T
RH diff
Target RH
Outside RH


RH%
70
60
50
40
30
20
10
0
-10
35
30
25
20
15
10
5
0
-5
-10
Temperature °C and water vapour diff. g/m³
RH inside
T inside
Water vapour balance
09/01
11/01
01/01
03/01
05/01
07/01
09/01
11/01
01/01
2004-6 month/day
T out
T-in
RH-in
g/m³ out - in


gypsum board ceiling
absorbent blocks 50mm
concrete 240mm
insulation to outside 50mm
insulation to inside 200mm



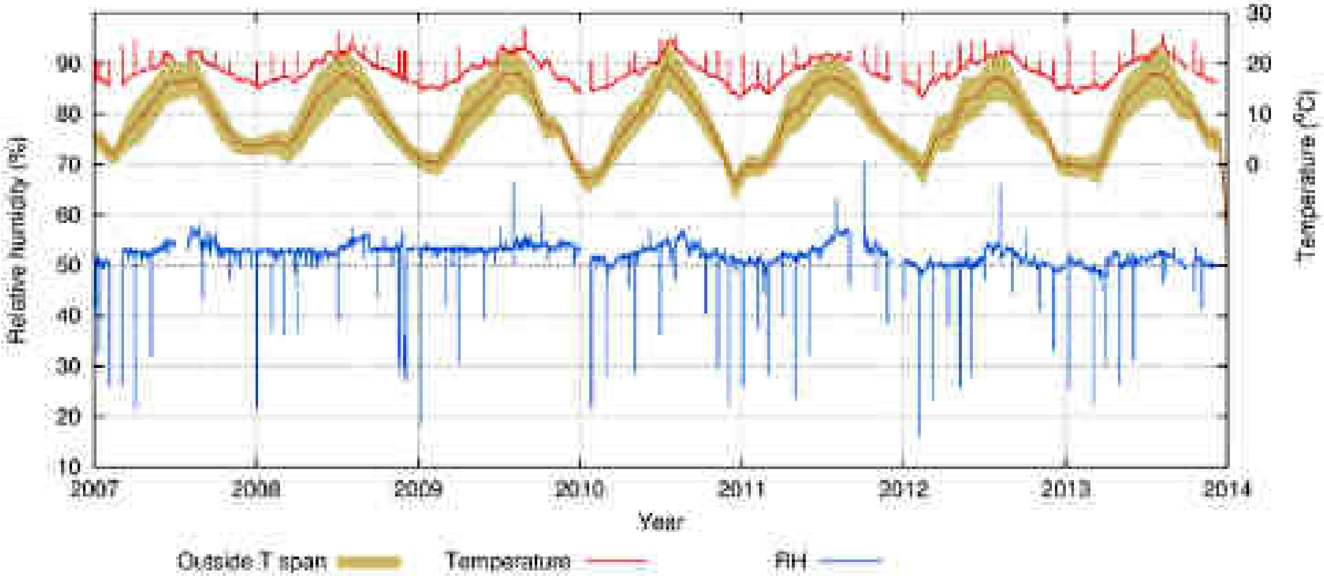


Figure 6: A record of the archive climate over the last seven years, compared with the monthly average outside temperature and the outside temperature span. The spikes show the climate in the conservator's office when the logger was retrieved to extract its data.

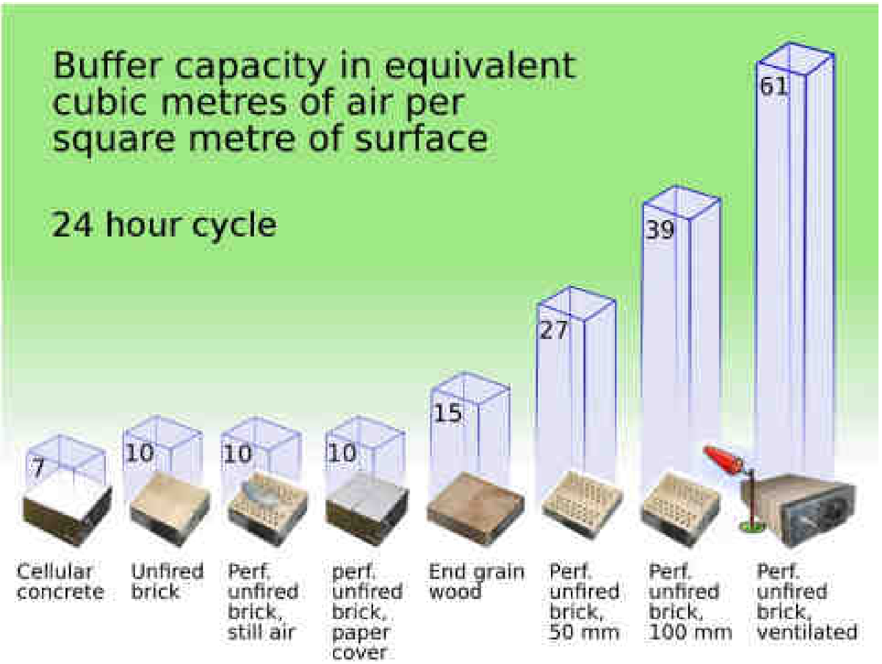


Figure 9: A graphical display of the tabular data for the 24 hour cycle. Notice the large effect of obscuring the perforation in the brick with paper and the much lower B–value of the perforated brick in stagnant air.