Progress in Hout Bay House research project:

Thermal properties and wood degradation

HOUT BAY HOUSE

Eliska Oberhofnerova
Czech University of Life Sciences in Prague

WHAT IS THE HOUT BAY HOUSE PROJECT?

» 3 year **international** research project
» modern sustainable materials
» house built in **23 days**

GOALS

» finding an optimal solution for wood construction and wood exposed outdoors in SA

» awaken an interest in pleasant and ecological housing

HOUT BAY HOUSE
BASIC INFORMATION

» location

» construction

» materials used

» *disposition*

» *no heating, no air conditioning*

» *double glazing*

» **airtightness**

Research project

Objectives:

» thermal properties: comparing measured with modelled data determining an ideal wall composition for the climate

» calculating and comparing the carbon footprint of timber construction with brick and mortar construction

» testing the performance of treated and untreated wood species under local coastal climate

1st RESESARCH PART:
Thermal properties

Climate
Building geometry
Construction
Orientation
Glazing
Thermal insulation
Ventilation

» thermal comfort
» overheating vs. heat loss

AIMS

» EFFECT OF INSULATION THICKNESS

8 cm vs. 12 cm

» EFFECT OF VENTILATION

RESEARCH

» Theoretical part

Calculated data based on the material properties

» Practical part

Measured data from sensors

Evaluation for the specific climate of South Africa

λ Thermal conductivity (W/mK)

- material property to conduct heat
- depends on the moisture content. It increases with the increasing moisture. In the direction perpendicular to fibers wood has higher insulating properties than in the direction of fibers (1,4 - 3 x)

R – value: Thermal resistence (m^2K/W)

$$R = d/\lambda$$

- property of material or construction
- provides that the flow of heat (always from hot to cold) is impeded

U - value: Thermal transmittance (W/m^2K)

$$U = 1/R$$

- reciprocal of R-value
- lower U-values indicate better thermal insulation
- describes the ability of building element to transfer heat through one unit area of a structure divided by the difference in temperature across the structure

External walls thermal properties

R = 2,86 m^2K/W
U = 0,35 W/m^2K

R = 3,83 m^2K/W
U = 0,26 W/m^2K

SANS 10400-XA:2010

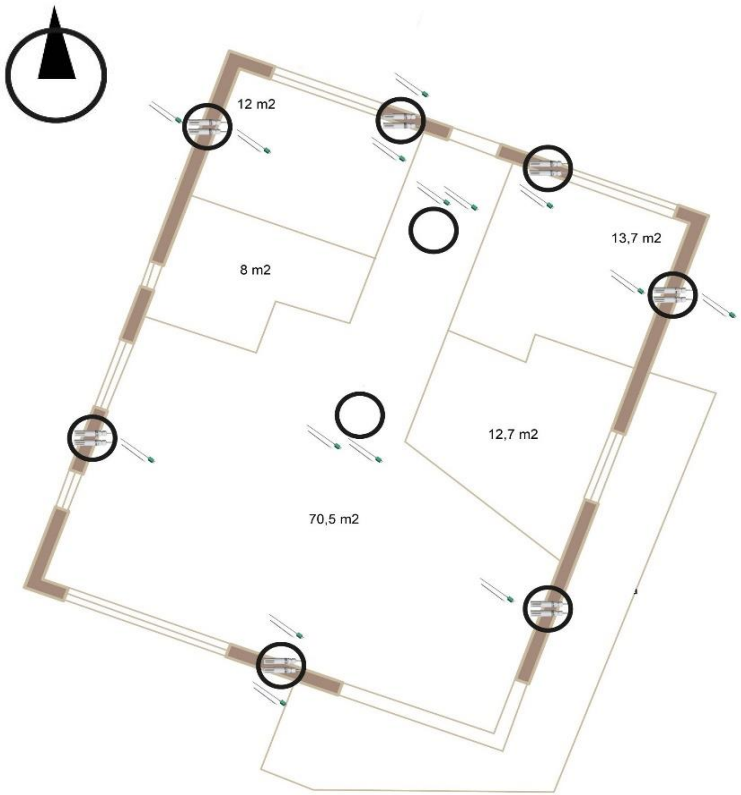
External walls requirements for total

min. R-value – 1.9 m^2K/W ✓

Which corresponds to

max. U-value – 0.53 W/m^2K ✓

Practical part

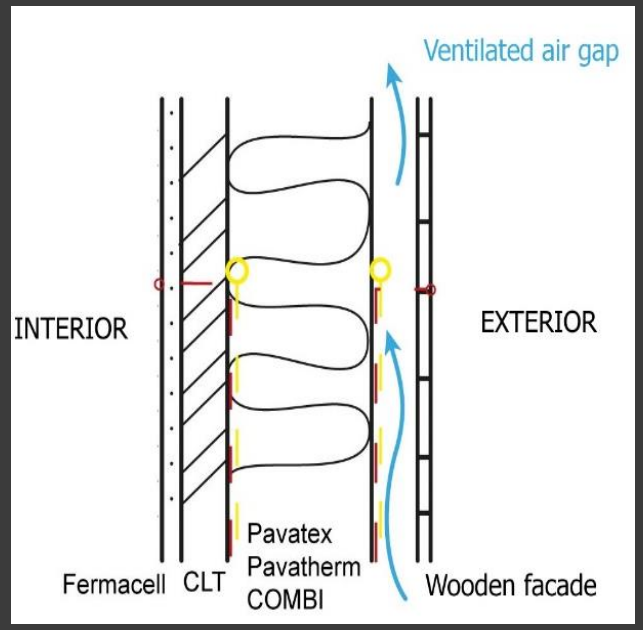


Measuring points

Sensors measuring temperature-humidity

Sensors measuring temperature

32 sensors



- sensors measuring temperature and relative humidity
- sensors measuring surface temperature

Channels

Click on channel to view history below

Channel	Low Alarm SP	High Alarm SP	Reading	Alarm Status
Insulation-Air Gap Humidity	0	90	37.6	no
Insulation-Air Gap Temperature	0	50	31.5	no
Novatop-Insulation Humidity	0	90	47.9	no
Novatop-Insulation Temperature	0	50	29.6	no

Edit...

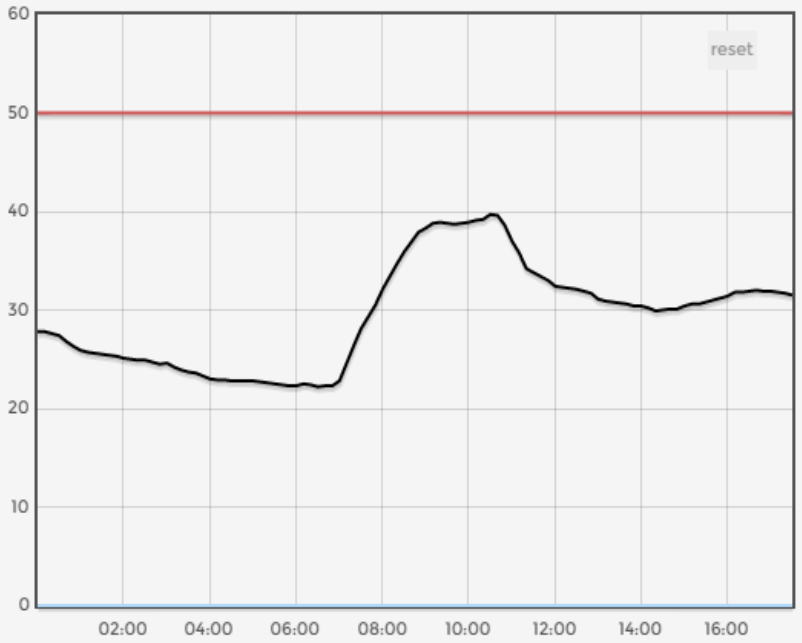
Notifications

Site	Person	SMS Notifications	Email Notifications
Bedroom East	Klara Popovova		

Edit...

Today | Week | Month | Range | Export to CSV | Print Trend

Device 6 - Insulation-Air Gap Temperature



Device 6 - Insulation-Air Gap Temperature

Time	Low	High	Value	Alarm
2016-01-18 17:30:29	0	50	31.5 C	no
2016-01-18 17:20:29	0	50	31.7 C	no
2016-01-18 17:10:29	0	50	31.8 C	no
2016-01-18 17:00:29	0	50	31.9 C	no
2016-01-18 16:50:29	0	50	31.9 C	no
2016-01-18 16:40:29	0	50	32 C	no
2016-01-18 16:30:29	0	50	31.9 C	no
2016-01-18 16:20:29	0	50	31.8 C	no
2016-01-18 16:10:29	0	50	31.8 C	no
2016-01-18 16:00:29	0	50	31.4 C	no

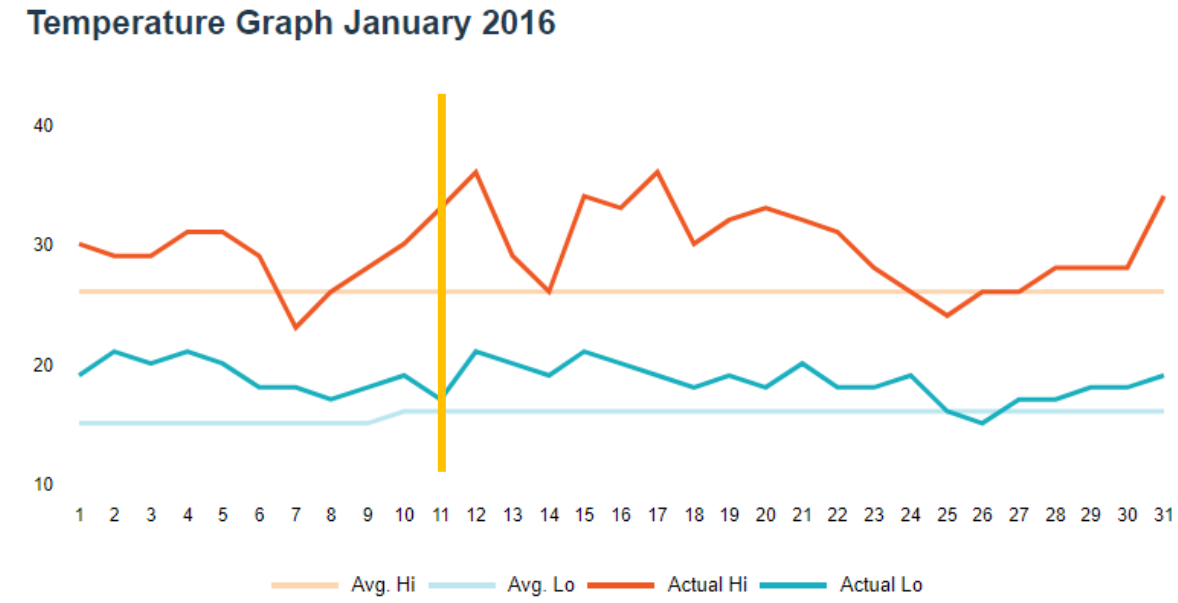
Showing 1 to 10 of 106 entries Show 10 entries

First | Previous | 1 | 2 | 3 | 4 | 5 | Next | Last

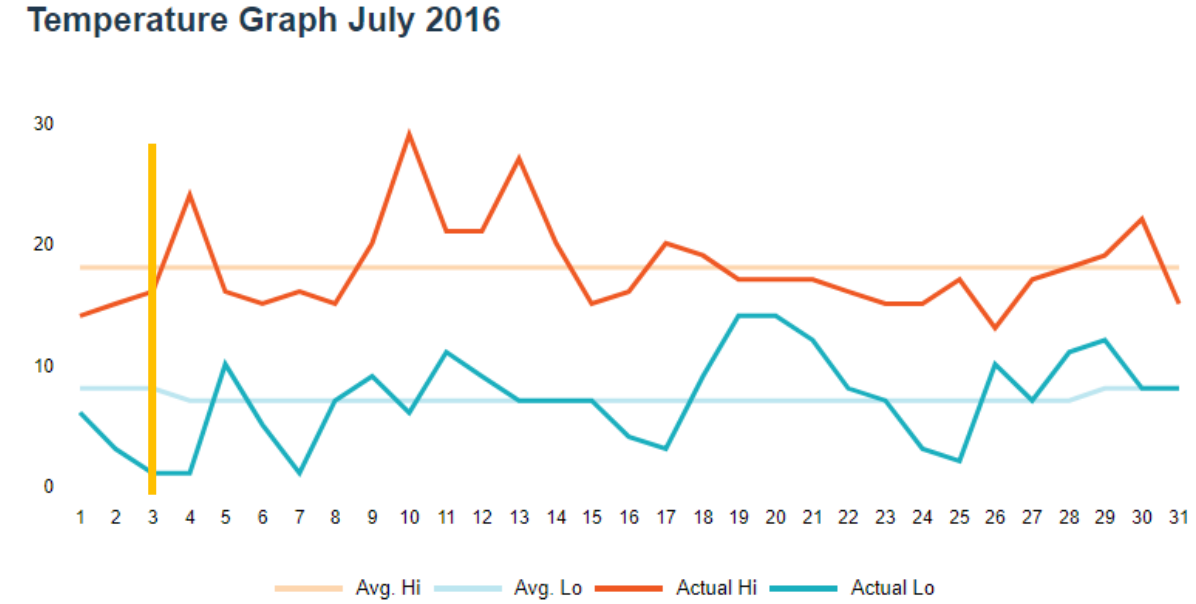
Measured data available online

The hottest and coldest day of the year 2016 (www.accuweather.com)

The hottest day – 12.1.2016 – **36/21°C**



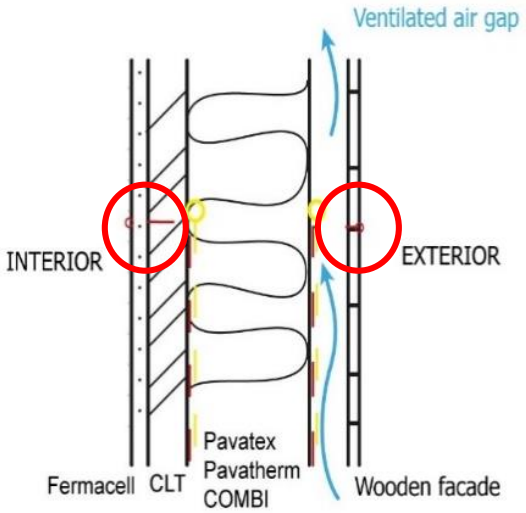
The coldest day – 3.7.2016 – **16/1°C**

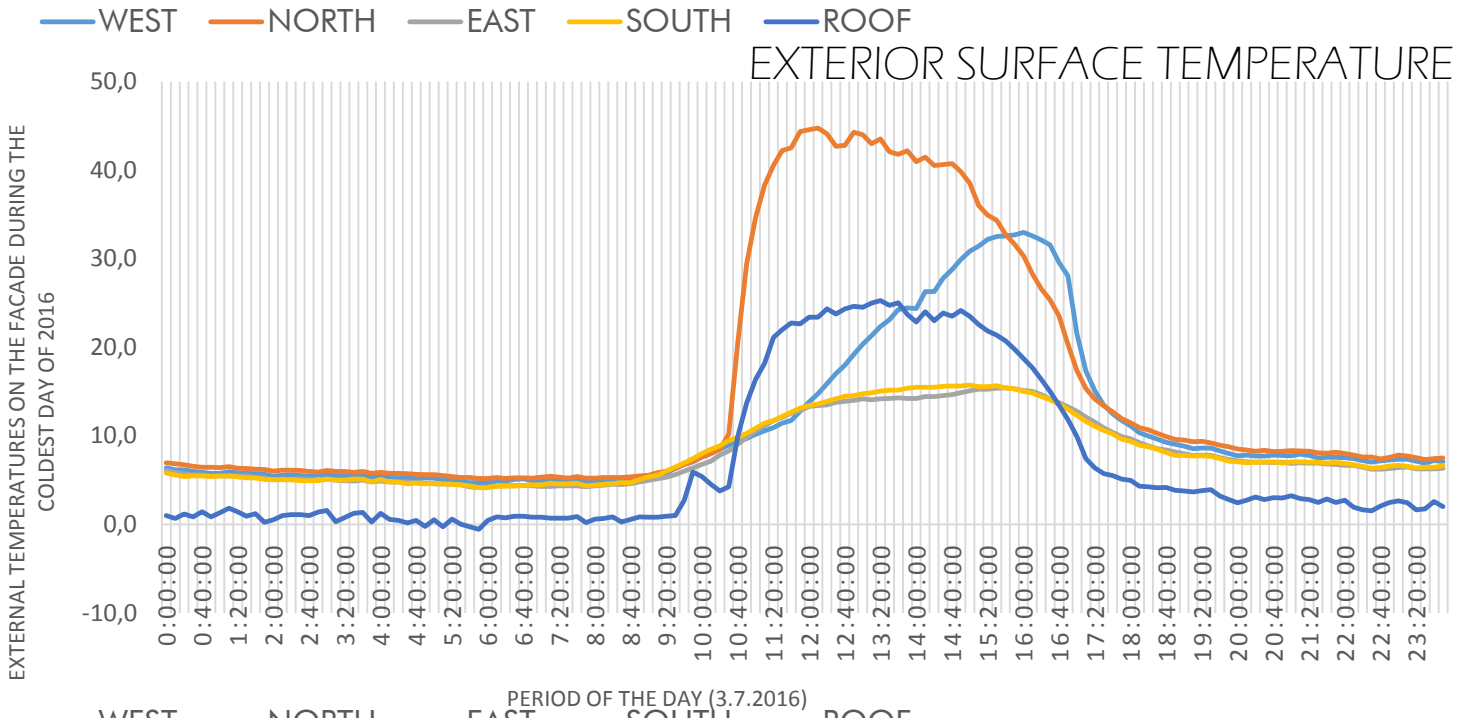


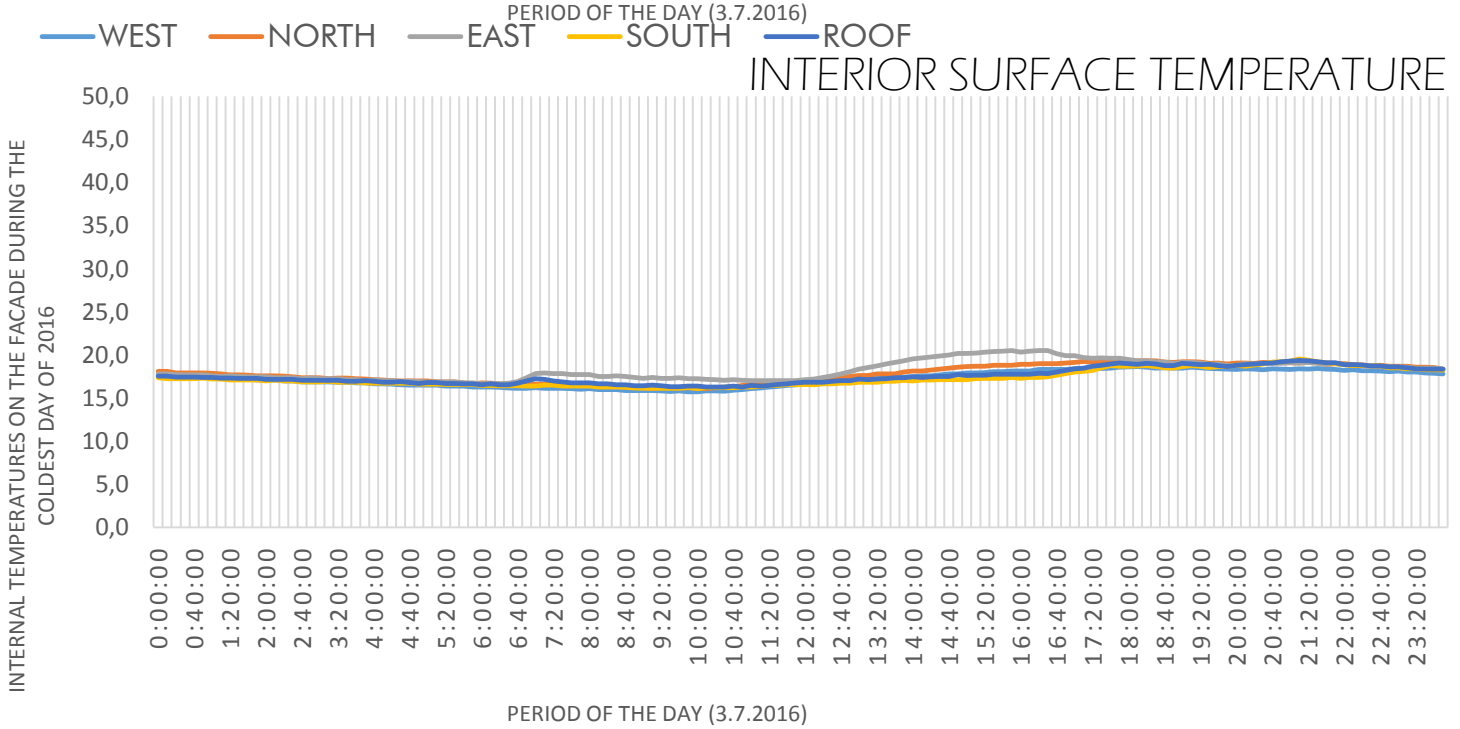
EFFECT OF ORIENTATION

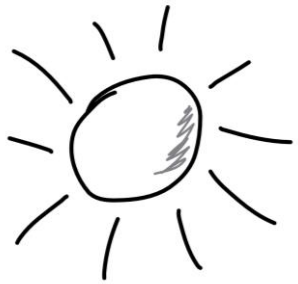
Surface temperatures based on the orientation during the **coldest day** of 2016

3.7.2016



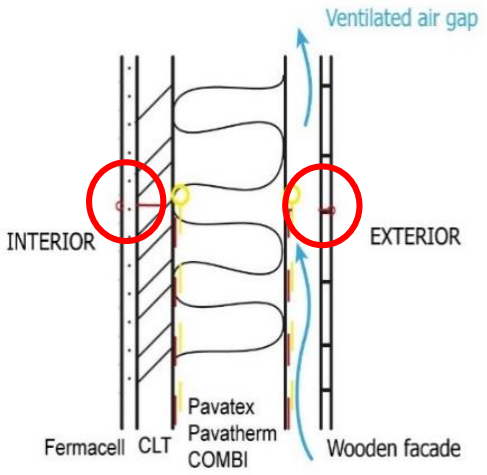


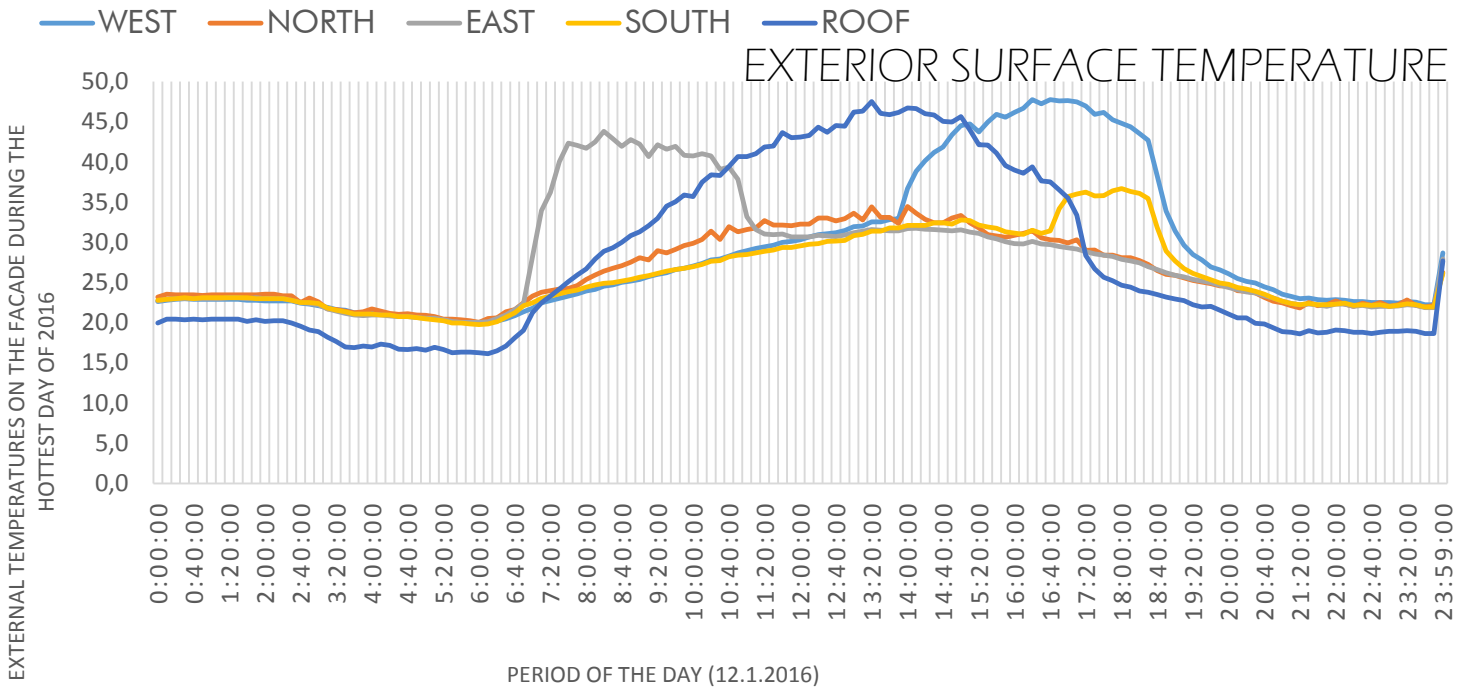


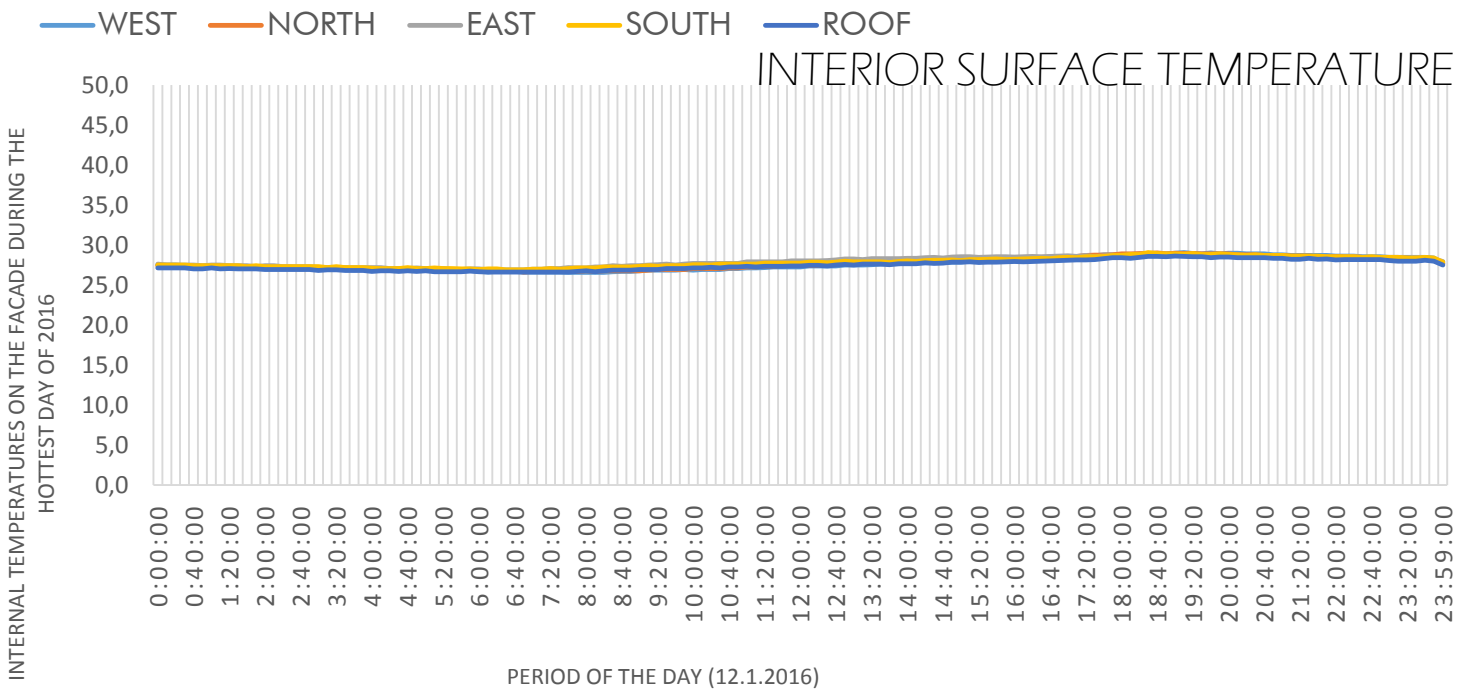


Surface temperatures based on the orientation during the **hottest day** of 2016

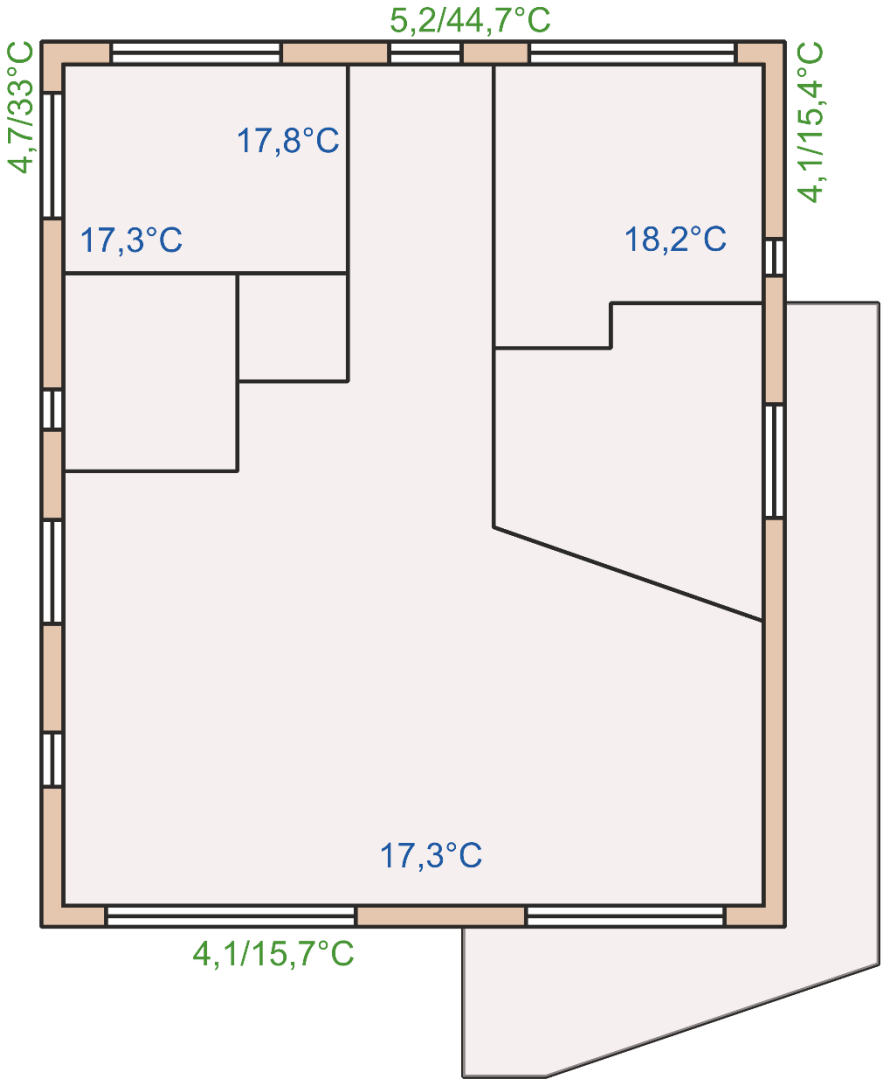
12.1.2016



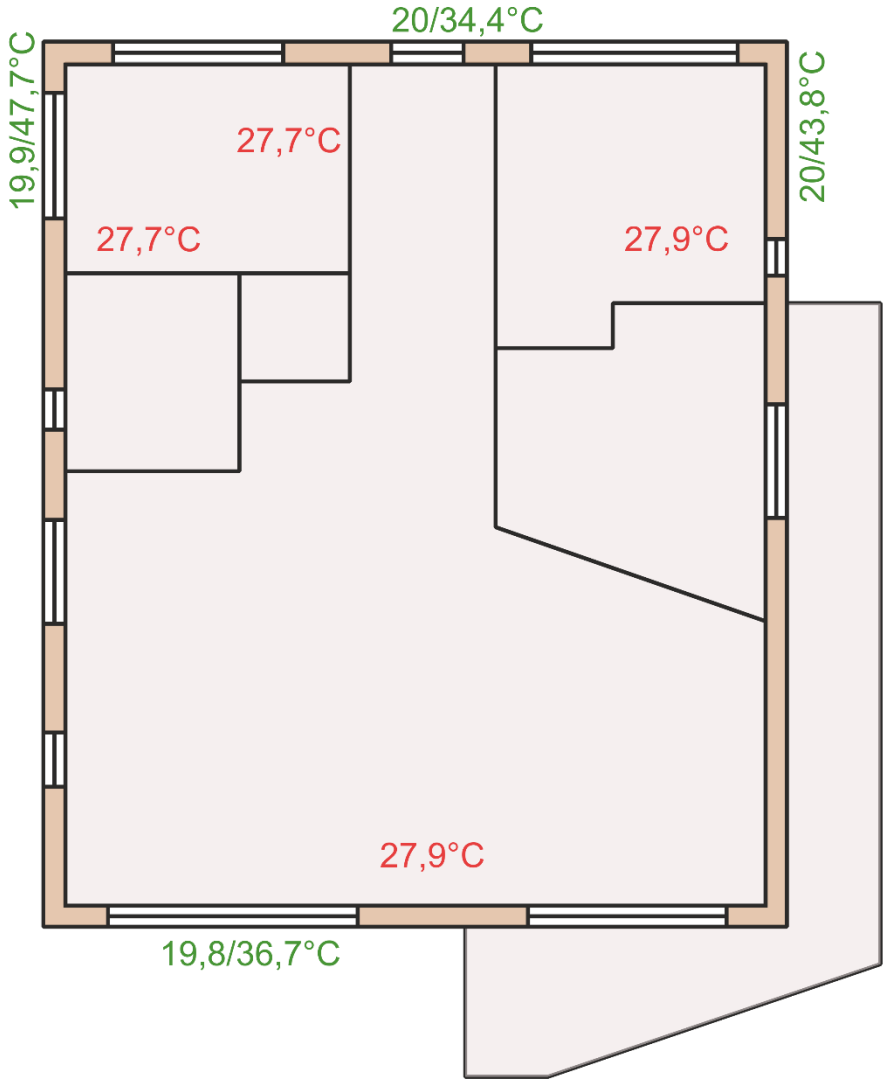




Temperatures during the **coldest day**



Temperatures during the **hottest day**



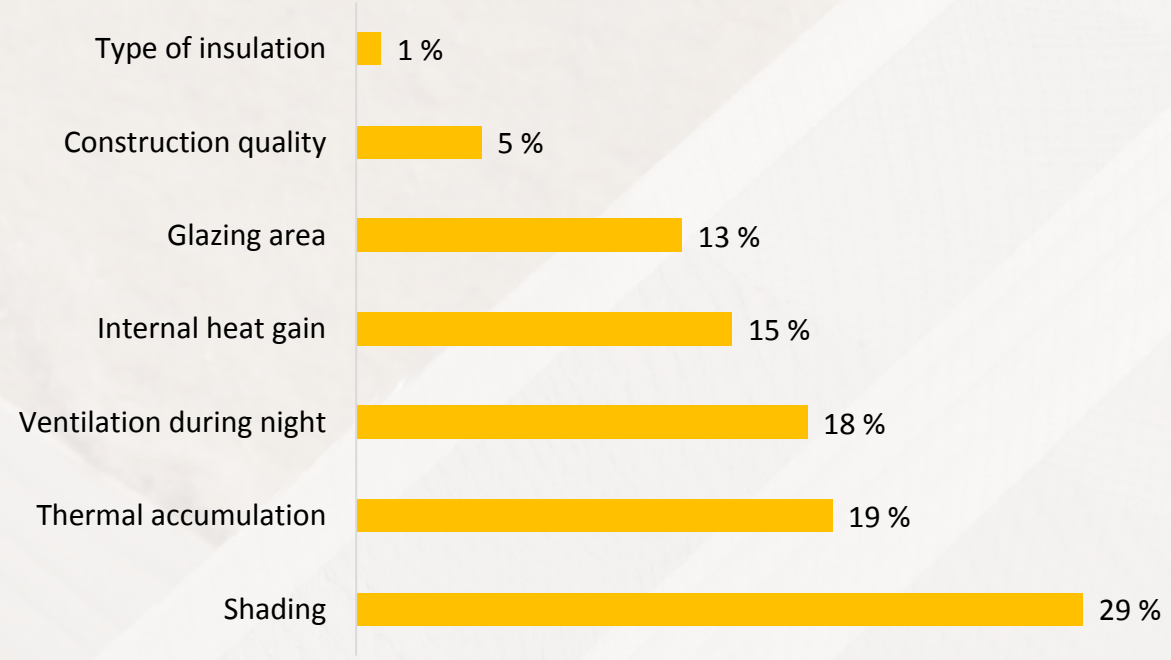
Minimal/maximal surface temperatures

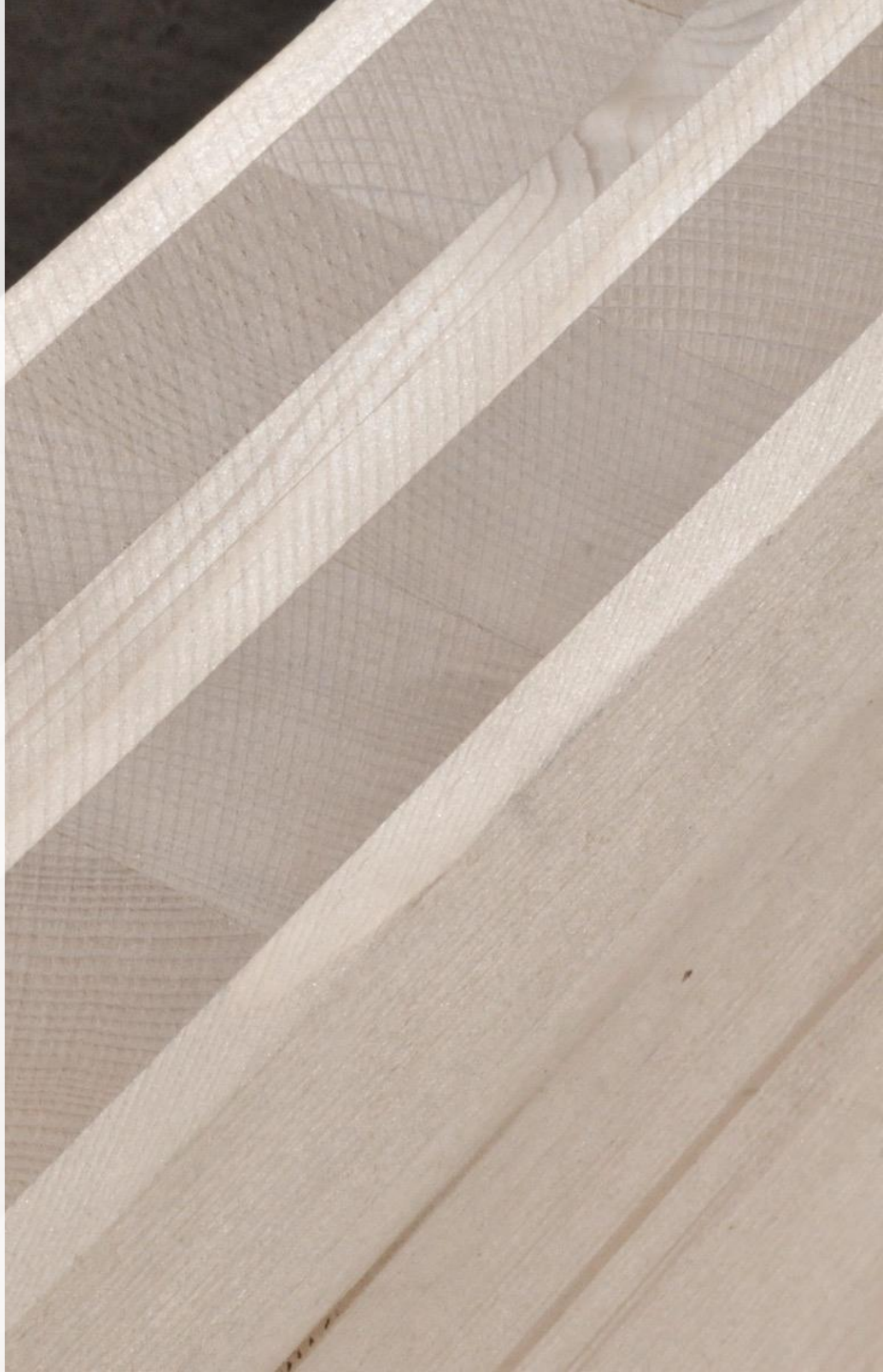
Average temperature

» WINTER: *heat losses are minimalized by the quality and* thickness *of thermal insulation, quality of windows and whole* airtightness *of the building*

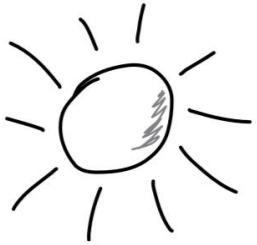
» SUMMER: *actual danger of possible overheating during summer in SA* (large windows, airtightness)

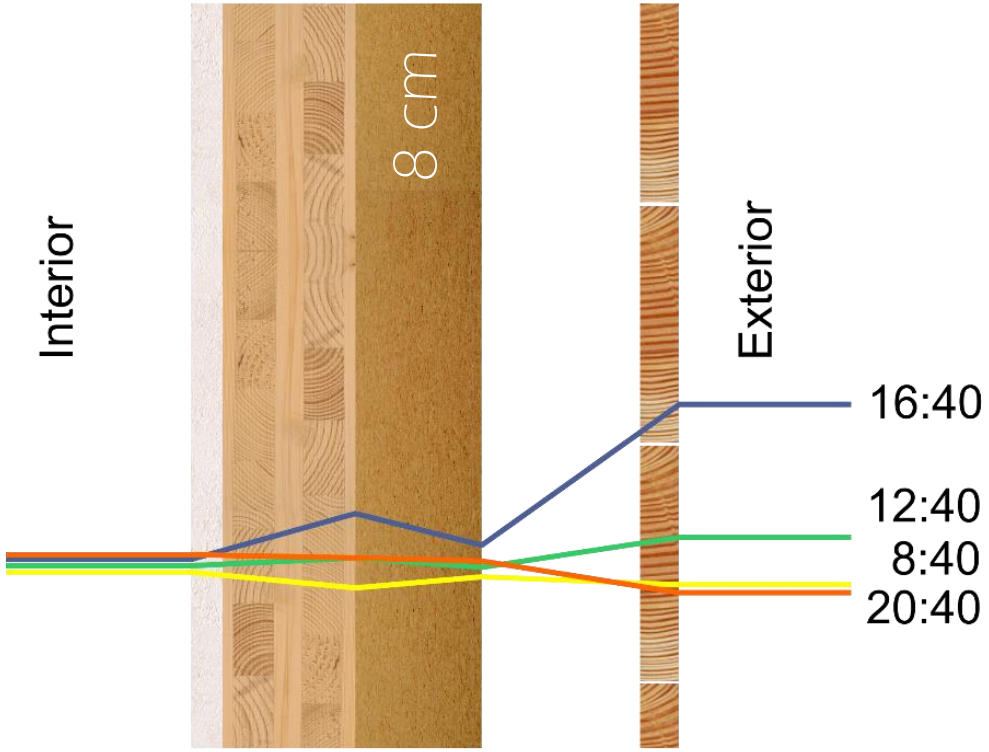
According to EMPA (Swiss Federal Laboratories for Materials Science and Technology), the intensity of ventilation can effect the temperature in the interior by 4,5 °C and the shading by 3° C.

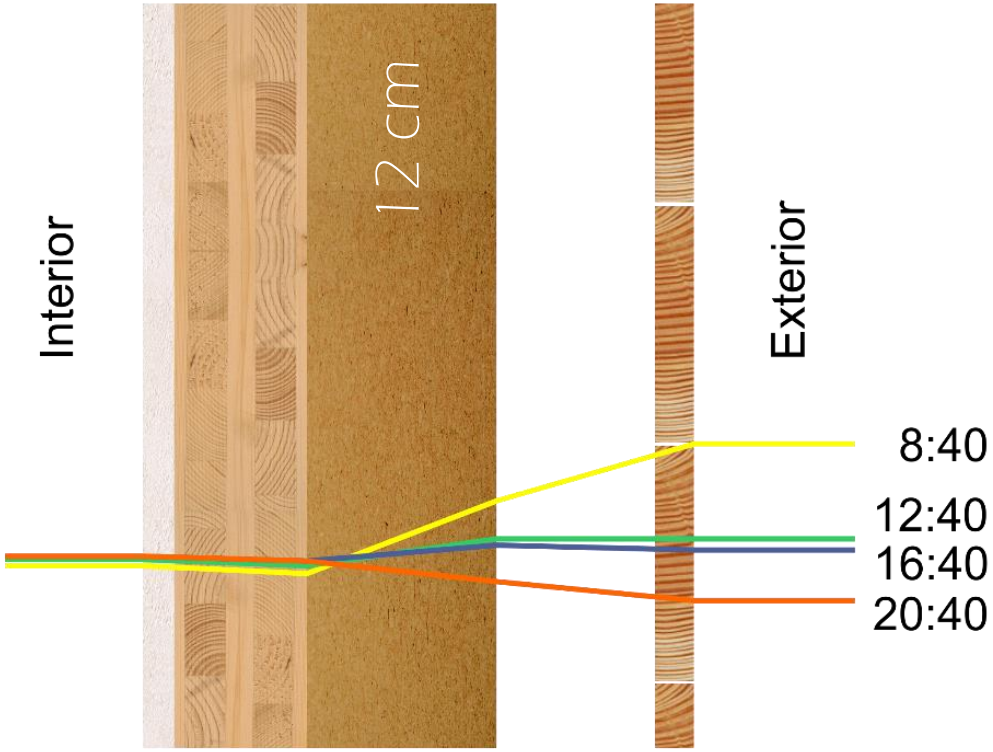




The effect of insulation thickness during summer day



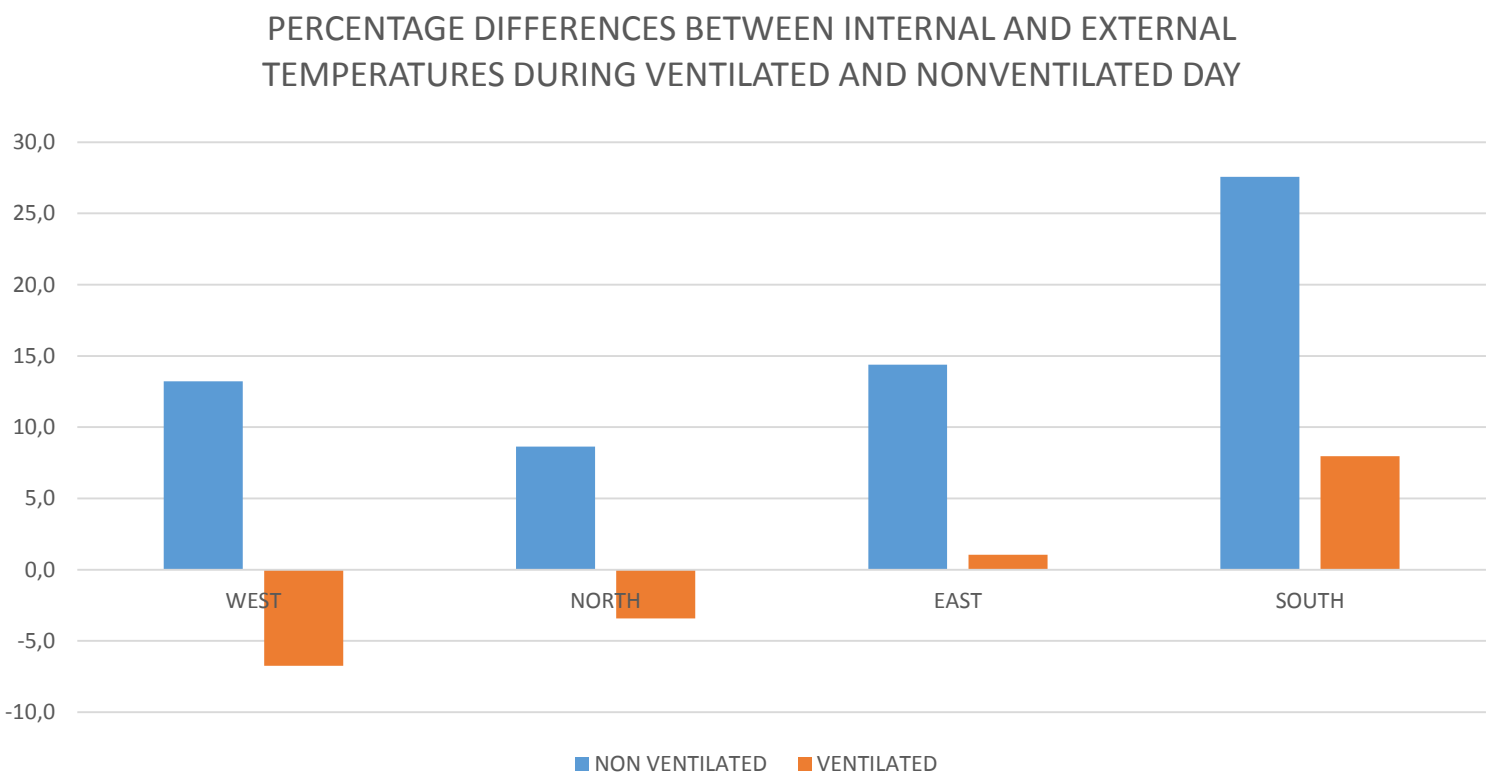




» West facade – insulation thickness 8 cm

» East facade – insulation thickness 12 cm

The effect of natural ventilation during summer day



» Naturally ventilated

The average temperature in interior is **lower** than in exterior or does not exceed the **8%** increasement

» No ventilation

The average temperature in interior is higher than in exterior up to **8-27 %**

CONCLUSIONS

WINTER

» the house works well in the winter (**airtightness, quality of materials and windows**)
» thickness of **8 cm** of wood fibre insulation in combination with **NOVATOP** is sufficient (R,U)
» temperature fluctuations during the day are minimal in the interior

SUMMER

» the house is overheated in the summer (large windows, airtightness)
» **wood fibre insulation 8 cm** in combination with **NOVATOP** is able to prevent temperature fluctuations during the in the interior
» the effect of ventilation during summer day

How to work with the house?

» TO VENTILATE

- when external temperature is lower
- one of the best advantages is actually low accumulation of heat by NOVATOP (rapid cooling)

» TO MINIMALIZE OVERHEATING

- shading (ideal combination of adjustable and fixed shading elements)

2nd RESEARCH PART: Wood degradation

What is wood degradation?

» weathering process and factors

» surface degradation vs. structural degradation

» change of surface properties (graying, plastic structure)

How to decrease wood degradation?

» material selection
» proper construction solution
» surface treatment

RESEARCH

» Siberian larch

» thermally modified pine

» natural oil woodstain UV OSMO

» inclination of 45° (faster degradation)

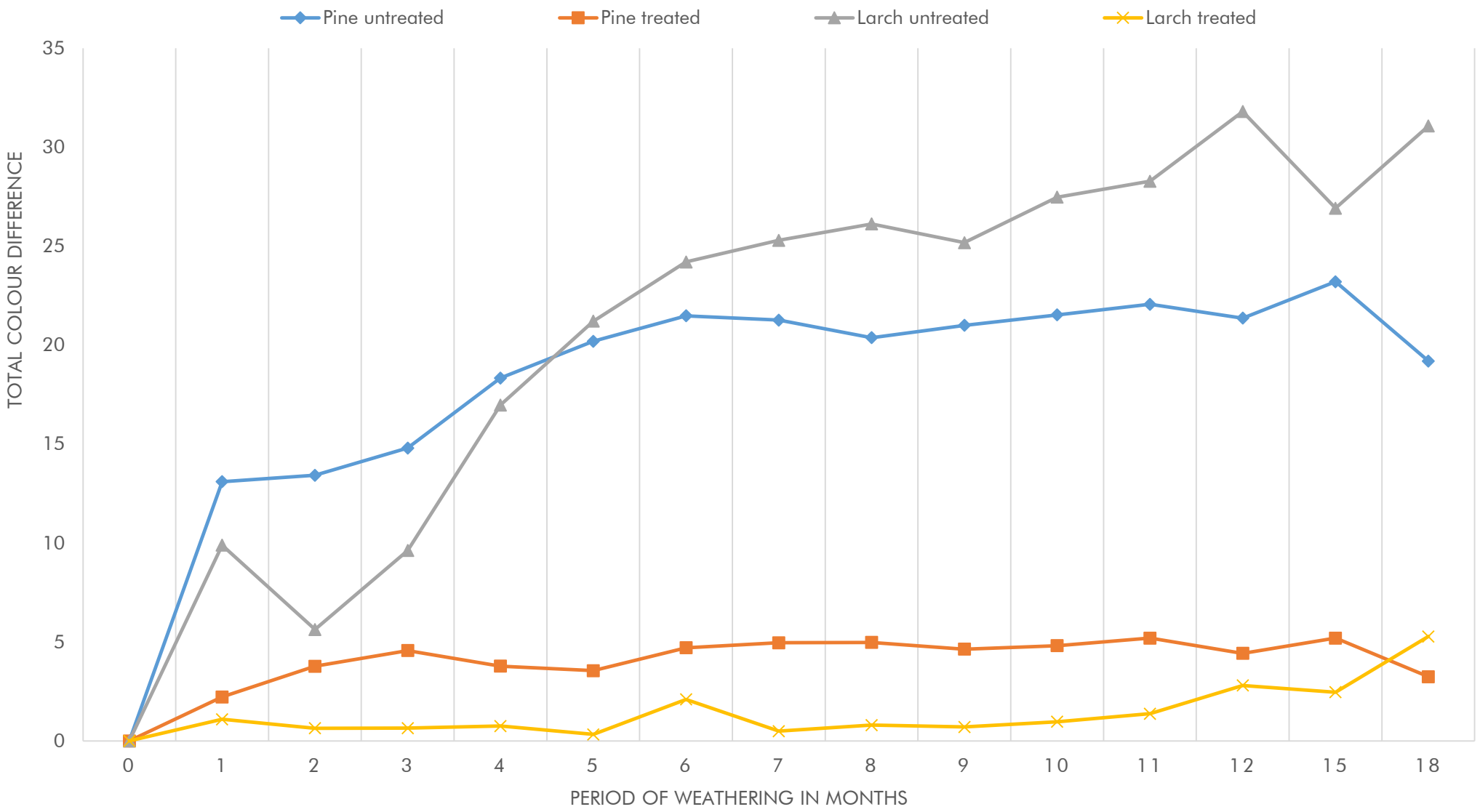
» regular measurement of properties

» exposure for 18 months

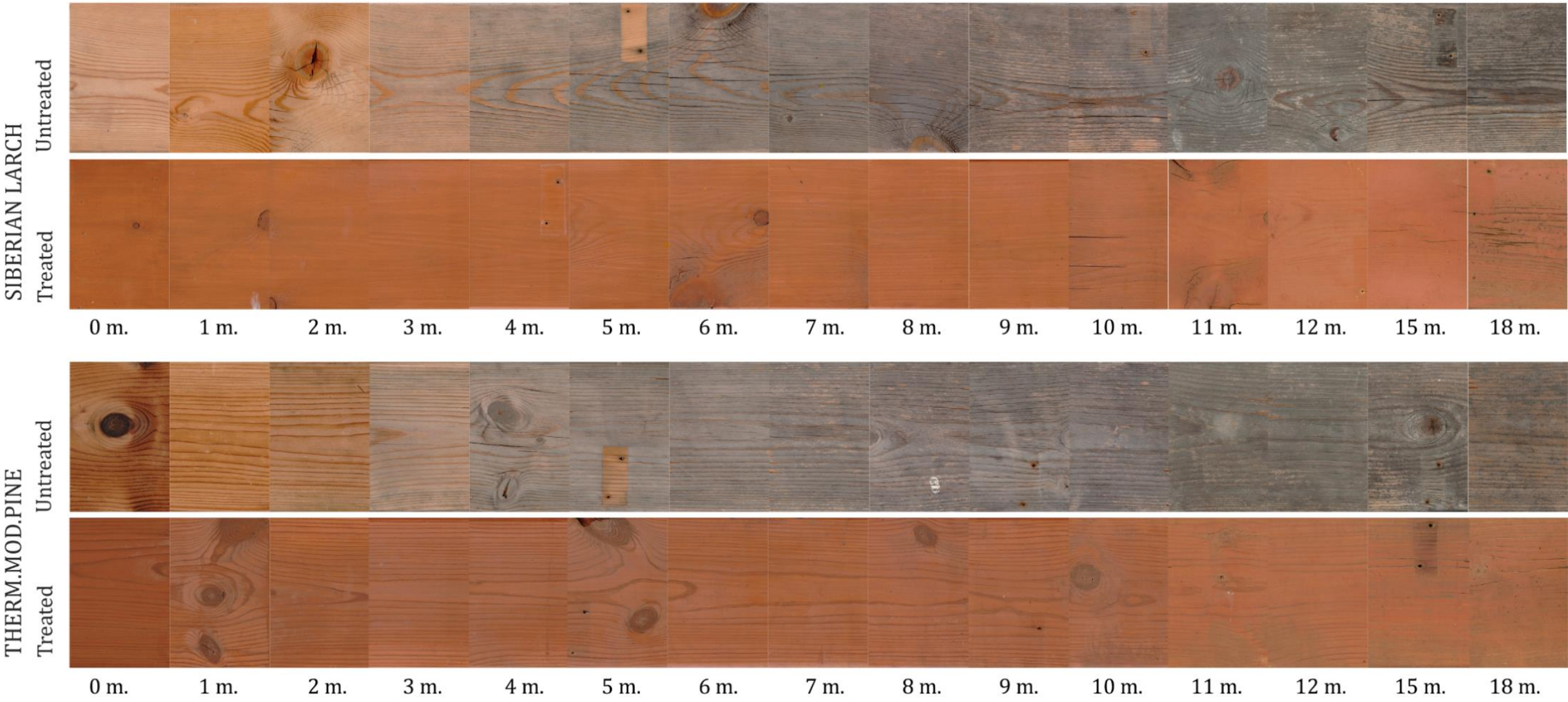
» Thermal modification:

controlled process with high temperatures (185-215 °C) → lower dimensional changes, increased resistance to rotting and cracking

Total colour changes during 18 months of weathering



Performance of samples during 18 months of weathering



CONCLUSIONS

- Increasing change of colour and surface roughness
- More stable results in the case of treated samples
- Starting degradation of treatment after 1 year of exposure
- Graying already after 4 months of weathering of untreated samples

The service life of proper designed wooden construction in exterior is not affected by weathering. It is our decision if we do accept the fact that untreated wood eventually turns grey and gets typical plastic structure. If we do not, it is necessary to use suitable surface treatment which has to be renewed after several years.

The research still continues.

► The results will be regularly published on Facebook and in various journals.

► Follow our project at Facebook pages and visit us in Hout Bay House!

www.houtbayhouse.info

Thank you for your attention!