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L.2.3.3 | Production et adaptation des métadonnées des sites démonstrateurs

Spécifications relatives au site Saints Pierre et Paul

RUE SAINTS PIERRE & PAUL, 1120, NEDER-OVER-HEEMBEEK, BELGIUM

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1. GENERAL INFORMATION

1.1. Introduction

The present document collects all the notes, information and steps concerning the experiment undertaken within the framework of the project *Cam(b)bridge*. This specification is redacted with a dual purpose: sharing data sets enabling modellers to validate their simulation models and also information and process of the experiment to make future measurement campaigns easier and more efficient.

This research project is leaded by *Architecture & Climat* from *UCL University* and *Jacques Delens s.a. Company*. The purpose of the initiative is to develop methods that can be applied on site during the construction phase to assess the actual performance of buildings at a moment when it can still be improved to reach the target without entailing over costs. The measurements are performed in summer, during 9 days without occupancy.

1.2. Apartments A.216 & A.217

The experiment was undertaken in a building complex called Saints Pierre & Paul, which received the Passive House certificate. The site is located in Neder-Over-Heembeek, in the North part of Brussels, in Belgium. The construction, accomplished by "*Jacques Delens s.a.*" [JD], is divided into two blocks, A (20 apartments) and B (16 apartments). The measures have been taken in two apartment of the A block, illustrated in the following figures.

The apartments considered for the study are facing South and are located on the third floor, which place them higher than the nearby buildings and limit the effect of solar masks.

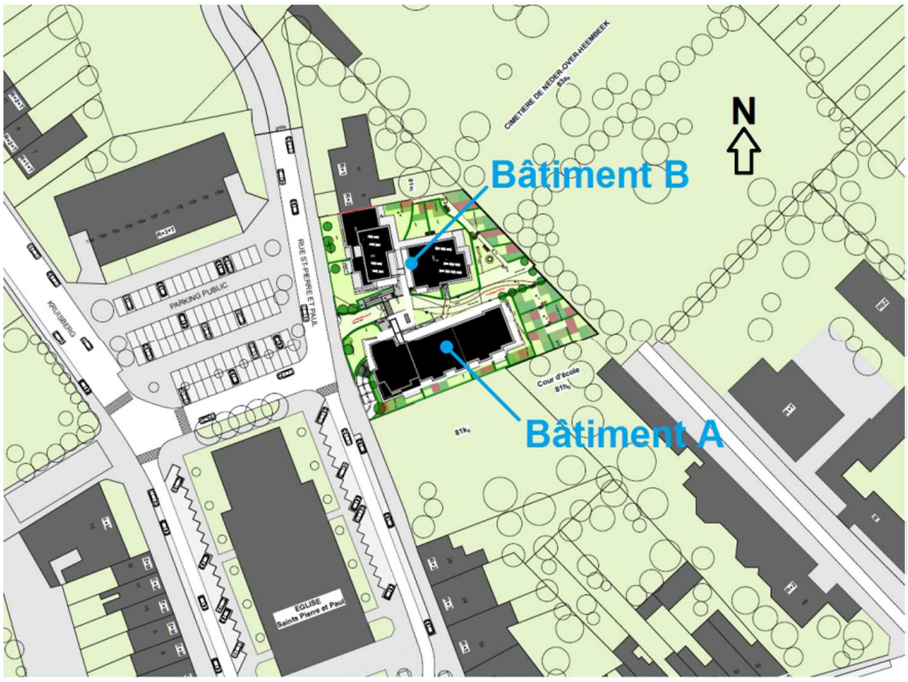


Figure 1 : Site St Pierre & Paul

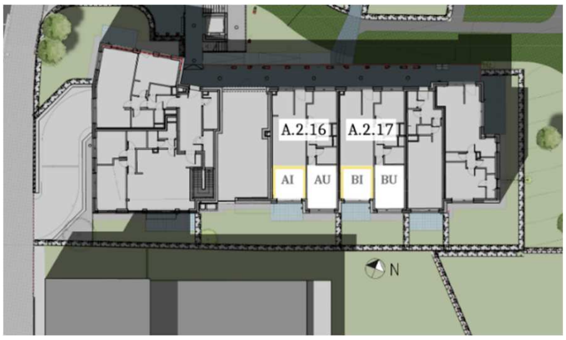


Figure 2 : Apartment location


Figure 3 : View of South façade


Figure 4 : North façade


Figure 5 : Projected view from street

The experiment has been undertaken in two rooms of two identical adjacent apartments, located on the third floor under the roof. The party walls and floors of the living rooms (AI and BI) as well as their ceilings have been covered by insulation panels on their indoor side and a provisory insulated wall has been added to delimit the zone. The 4 units are named “AI”, “AU”, “BI”, “BU” according to their location in apartments “A” for A.2.16 or “B” for A.2.17, and according to the presence “I” or the absence “U” of internal insulation panels. AI and AU units are respectively identical to BI and BU units.

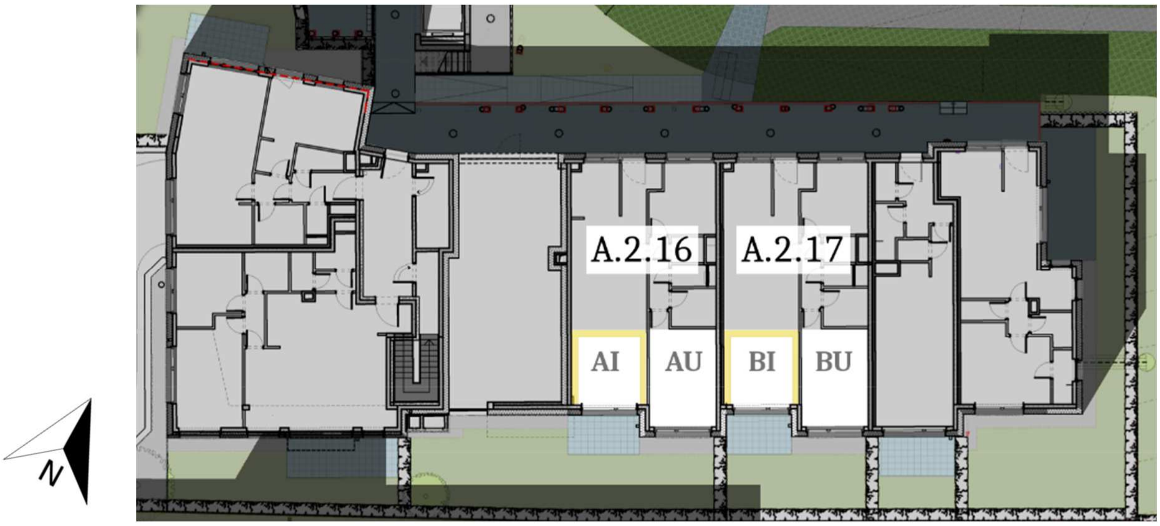


Figure 6 : Units location

2. EXPERIMENT

The conventional measurement procedure for the assessment of the Heat Loss Coefficient (HLC) is based on a coheating test. The coheating test is currently limited to winter month, as a significant internal-external temperature difference is needed. We intend to expand the time window allowable for the assessment of the Heat Loss Coefficient (HLC) by performing measurements in summer. Measurements of Saints Pierre & Paul units were performed from 18/08/2017 to 18/09/2017.

The measurement have been realized in identical units in parallel, in order to compare a co-heating test to a method based on the observation of the floating indoor temperature. A reference value of the HLC can be obtained by comparing the input powers and the difference of internal temperatures measured in two parallel identical units, one submitted to coheating and the other being in floating temperature mode, as they are submitted to identical solar heat gains (Figure 7).

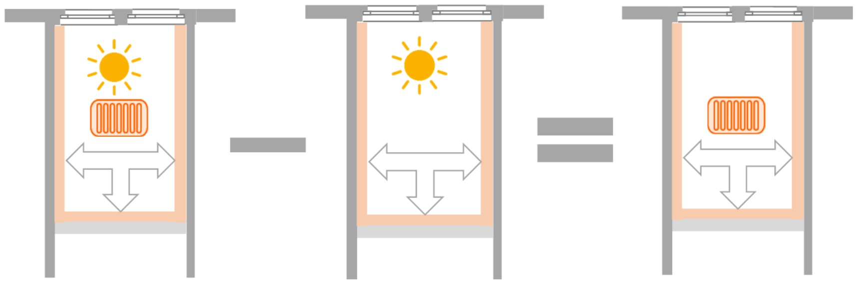


Figure 7 : Analysis process considering the temperature difference between two identical units provided with inside insulation panels: one of the unit is co-heated while both are submitted to identical solar heat gains

The heat loss by common walls and floor, shared with adjacent units, is hardly assessed as the surrounding spaces of the units are not accessible. For that reason, the placement of internal insulation on the party walls allows to focus on the heat loss coefficient of the external façade. It also reduces the heat losses to the neighbouring units and the thermal mass effect of the party walls, floor and ceiling. Moreover, the setup allows to reach higher values of internal temperatures and to obtain a sufficient internal-external temperature difference. Temperatures at the interfaces between inner insulation and original walls were monitored with temperature sensors, to assess the heat flow through the insulation layers.

Four South oriented units have been tested (Figure 8 and Figure 9): two identical units with insulation panels and two other identical units without insulation panels. In both pairs, one unit is co-heated while the other is in floating temperature mode.

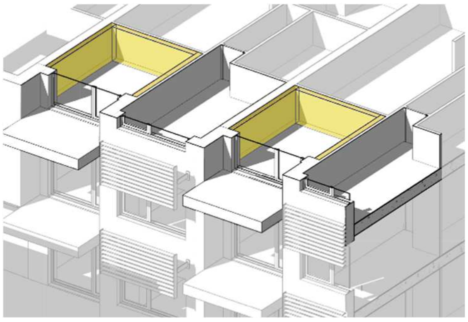


Figure 8 : Axonometric perspective of the four measured units

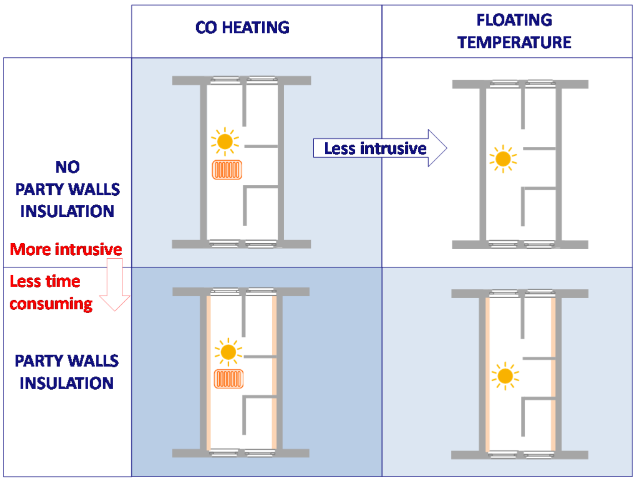


Figure 9 : Different boundary conditions and heat sources for the measurement of the Heat Loss Coefficient

The strong reduction of the thermal mass effect due to the placement of insulation enables to reduce the time period required to assess the façade HLC until 9 days of monitoring without occupancy.

Internal heat gains provided by electric radiators have been monitored. Access was denied during the monitoring. The door and the windows were closed during the whole process.

3. MODEL DETAILS

3.1. Location

The apartments are located in Neder-Over-Heembeek, a North part of Brussels in Belgium. The land plot is in town, surrounded by other construction and trees, which made it partially shaded. The latitude of the buildings is 50.897N and the longitude is 4.389E. The elevation above the sea level is approximatively 46m. The data were measured in local summer time, i.e. in Central European Summer Time (UTC/GMT+2h). They were averaged every 10 minutes and recorded at the end of those ten minutes intervals.

The building located at the South of the land plot partially shades the apartments units. However, the shading effect is limited as the apartments units under study are located on the third floor, i.e. higher than the neighbour building. The measurements of the global irradiation on two vertical planes located at the level of the balconies of both apartments show that the solar gain are almost the same in both apartments, despite their different positions with respect to the surrounding.

Figure 10 : Panoramic view from balcony of A.2.16 apartment, Unit A

Figure 11 : Site St Pierre et Paul

3.2. Geometry

Figure 13 shows the internal layout of one apartment (A.2.16). The studied places are the living room and the bedroom. The second apartment (A.2.17) is located next to the bedroom. The two apartments are exactly the same. The internal ceiling height is 2.66m.

All the wall dimensions are specified in the annexes at the end of this document. The reference surface considered for the assessment of the wall dimensions is the layer of interior finishing. The thermal bridges heat loss coefficients (chapter 3.7) are calculated according to this convention.

Living :
A temporary partition wall has been added to reduce the size of the heated zone located next to the living facade. Insulation layer panels has been attached to the three party walls, the party floor and the ceiling (in yellow on Figure 13). The South facing façade has a glazed door-window opening on a balcony.

Figure 12 : Movable partition between the living room and the kitchen

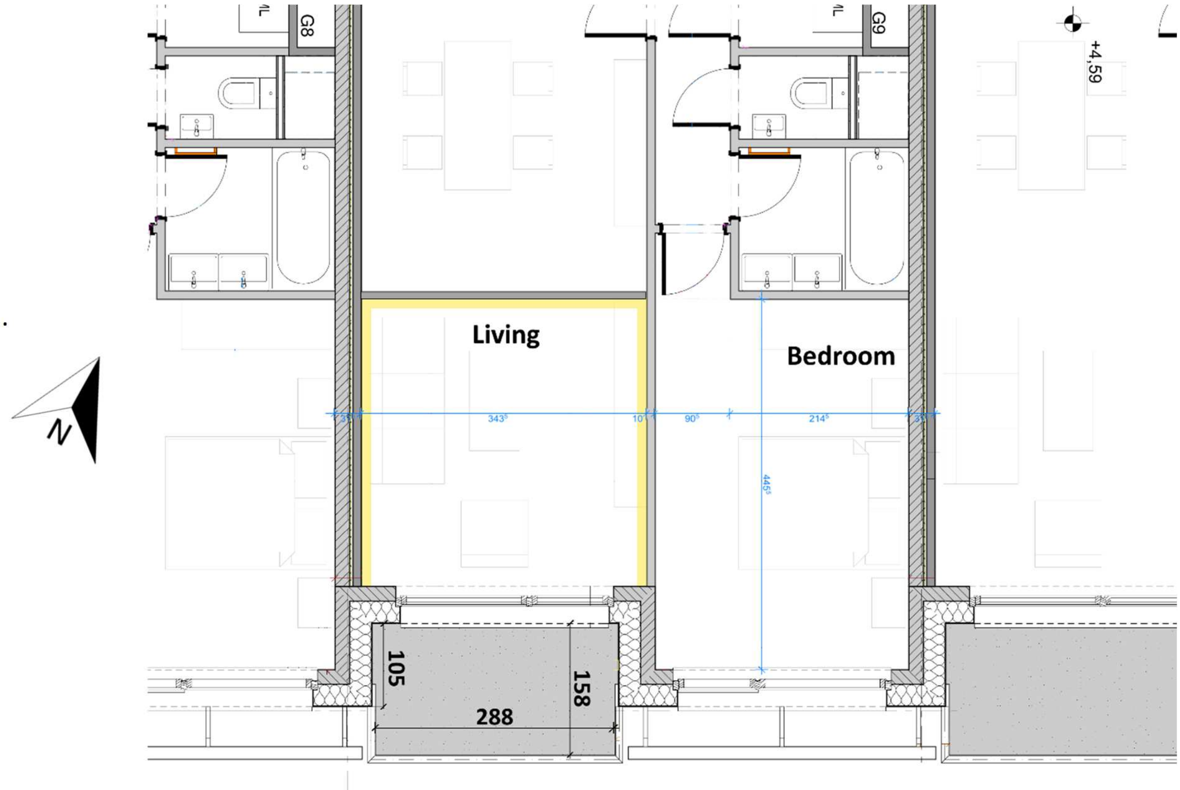


Figure 13 : Layout of apartment A.2.16[Furniture are not present in the apartment during the experiment/ in yellow: insulation layer]

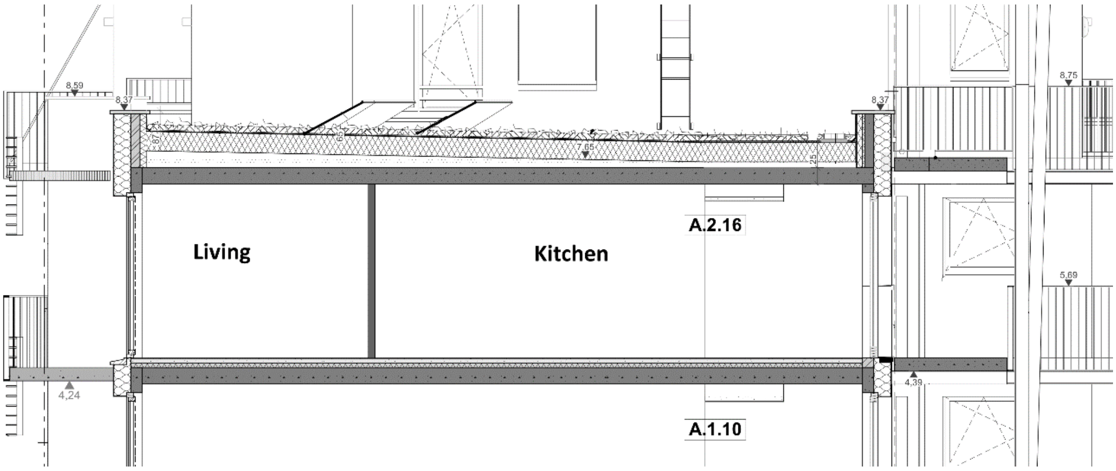


Figure 14 : Longitudinal section in the living room

3.3. Glazing and frame areas

The windows are the same for apartments A.2.16 and A.2.17. The dimensions are different for the living and the bedroom. They have two parts: a fixe window (1 and 4) and a tilting and opening window (3) for the bedroom or an opening glass door (2) for the living. During the experiment, the shade screen were already in position, but not the balcony railing. The situation is represented in the Figure 15.

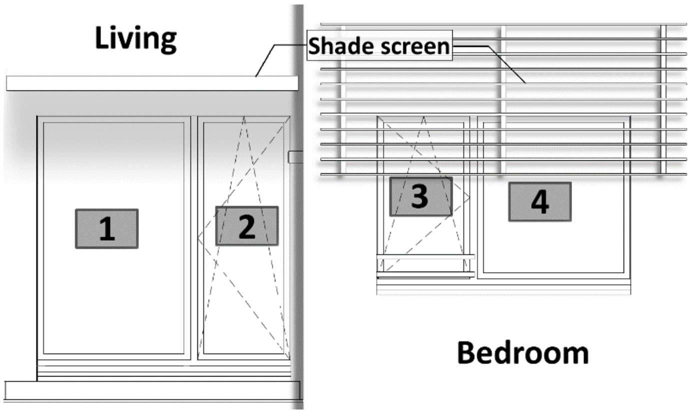


Figure 15 : Façade windows

Table 1 : Dimensions of the windows

Glazing ID	Overall dimensions				Visible Glass area	Glass edge length	Frame area
	l [m]		h [m]	A [m²]	A [m²]	[m]	A [m²]
G1	1.61	x	2.52	4.04	3.24	7.40	0.80
G2	1.02	x	2.52	2.55	1.90	6.22	0.64
Total living				6.59	5.14	13.62	1.45
G3	1.02	x	1.71	1.73	1.22	4.60	0.61
G4	1.61	x	1.71	2.74	2.09	5.78	0.55
Total bedroom				4.47	3.31	10.38	1.16

3.4. Constructions

The constructional properties are presented in the Table 2. The following figures present the wall numeration used in the table.

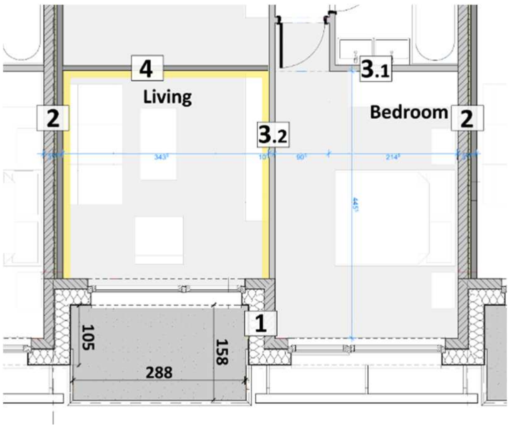


Figure 16 : Plan layout with wall numbering

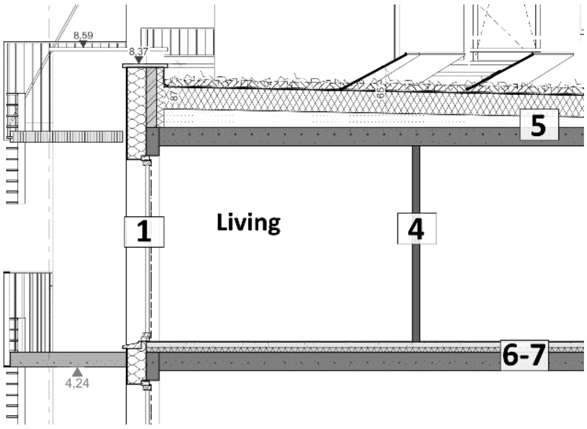


Figure 17 : Section with wall numbering

Table 2 : Construction thermo-physical properties (green color: Manufacturer's data or as built documents, blue color: assumptions)

	Thickness	Thermal conduct.	Density	Spec Ht	SW Absorbtion	LW Emission
Layer	m	W/mK	kg/m3	J/kgK	-	-
[1] External wall_S - *from outdoor to indoor // Rse = 0.04 m²K/W , Rsi = 0.13 m²K/W*						
Roughcast	0.01	1.5	1500	1000	0.21	0.9
Insulation PSE (graphité)	0.26	0.032	35	1450		
Silica blocks load-bearing wall	0.175	1.7	1800	1000		
Interior plaster	0.01	0.52	1200	1000	0.25	0.9
Total	0.455			U =	0.118	W/m²K
[2] Party walls between apartments - *from living zone to bedroom zone // Rsi = 0.13 m²K/W*						
Plaster block	0.1	0.5	1200	1000	0.25	0.9
Air	0.02	-				
Acoustic insulation Rockwool	0.025	0.035	100	1030		
Silica blocks	0.175	1.7	1800	1000		
Interior plaster	0.01	0.52	1200	1000	0.25	0.9
Total	0.33			U =	0.68	W/m²K
[3.1] Int. wall between bathroom/bedroom zone *// Rsi = 0.13 m²K/W*						
Plaster	0.1	0.5	1200	1000	0.25	0.9
Total	0.1			U =	2.17	W/m²K
[3.2] Int. wall between living/bedroom - *from living to bedroom // Rsi = 0.13 m²K/W*						
XPS	0.1	0.036	35	1450	0.55	0.9
Plaster	0.1	0.5	1200	1000	0.25	0.9
Total	0.2			U =	0.31	W/m²K

Int. door between bedroom & corridor zone						
Wood	0.05	0.14	1200	1000	0.25	0.9
Total	0.05			U =	2.80	W/m²K
[4] Int. wall between living/kitchen zone - *from living zone to kitchen // Rsi = 0.13 m²K/W*						
XPS	0.1	0.036	35	1450	0.55	0.9
Plaster	0.015	0.52	1200	1000	0.25	0.9
Total	0.115			U =	0.32	W/m²K
[5] Concrete roof - *from outdoor to indoor // Rse = 0.04 m²K/W , Rsi = 0.10 m²K/W*						
Bitumen	0.007	0.23	1150	1000	0.9	0.9
Insulation PIR	0.28	0.022	30	1400		
Concrete (slope)	0.04	0.15	700	1000		
Screed (reinforced)	0.07	1.3	2500	880		
Concrete/ Insultation EPS	0.12	1.7/0.04	2500/50	880/800		
Reinforced concrete	0.06	1.7	2500	880		
Interior plaster	0.01	0.52	1200	1000	0.25	0.9
Total	0.587			U =	0.07	W/m²K
[6] Party floors : Bedroom zone - *top down // Rsi = 0.17 m²K/W*						
Wooden floor	0.015	0.13	600	1600	0.44	0.9
Screed	0.065	0.6	2500	880		
Acoustic insulation Thermogran	0.07	0.04	50	800		
Screed (compression)	0.07	1.3	2500	880		
Concrete (1/3) / Insulation EPS (2/3)	0.12	1.7/0.04	2500/50	880/800		
Reinforced concrete	0.06	1.7	2500	880		
Interior plaster	0.01	0.52	1200	1000	0.25	0.9
Total	0.41			U =	0.38	W/m²K
[7] Party floors : Living zone - *top down // Rsi = 0.17 m²K/W*						
Floor tiles	0.015	1.2	2000	1000	0.76	0.9
Screed	0.065	0.6	2500	880		
Acoustic insulation Thermogran	0.07	0.04	50	800		
Screed (compression)	0.07	1.3	2500	880		
Concrete (1/3) / Insulation EPS (2/3)	0.12	1.7/0.04	2500/50	880/800		
Reinforced concrete	0.06	1.7	2500	880		
Interior plaster	0.01	0.52	1200	1000	0.25	0.9
Total	0.41			U =	0.40	W/m²K

Following figure represent a section in the bedroom, showing the composition of the roof, the floor and the external wall. The precast slabs (thickness of 25cm) for both ceiling and floor have a density of 600 kg/m³.

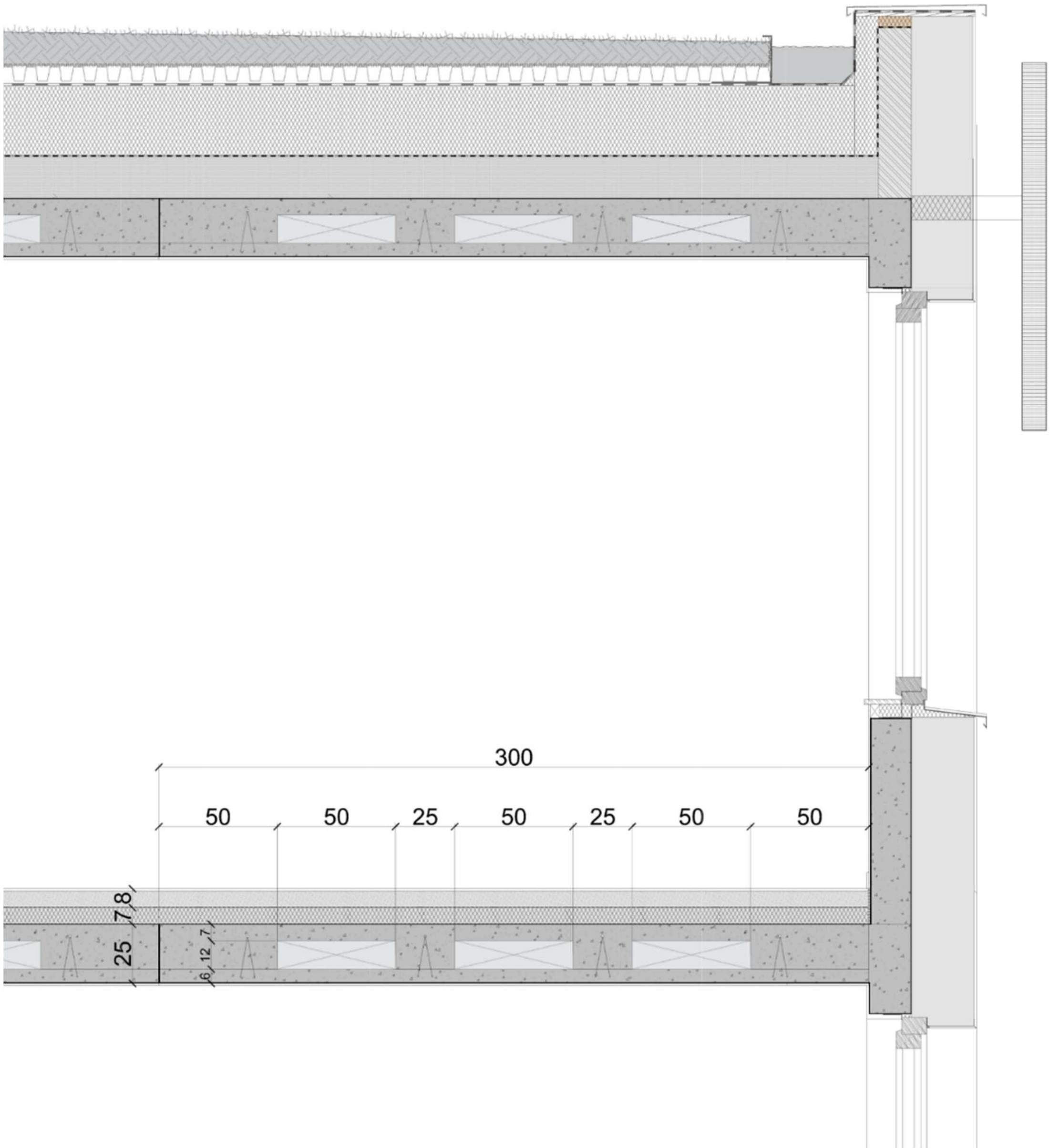


Figure 18 : Details of wall and floor compositions

3.5. Glazing thermal and optical properties

The triple glazing is composed by three glass layers of 4mm, separated by 14mm of gas (not specified by the manufacturer).

The different thermal properties are specified in the Table 3.

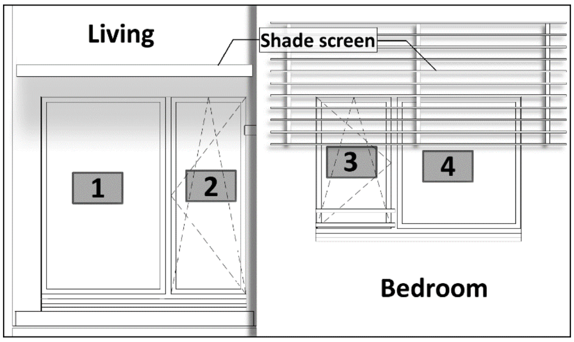


Figure 19 : Façade windows description

Table 3 : Windows thermal properties

Glazing ID	Ugl	Ufr	Ψ glass spacer	Uwd	SFgl	Reduction factor	LT
	W/(m²K)	W/(m²K)	W/mK	W/(m²K)	%	-	
G1	0.60	0.79	0.029	0.69	52	1	
G2	0.60	0.88	0.029	0.74	52	1	
Total living	0.60	0.83	0.029	0.71	52	1	
G3	0.60	0.88	0.029	0.81	52	1	
G4	0.60	0.79	0.029	0.68	52	1	
Total bedroom	0.60	0.84	0.029	0.73	52	1	

3.6. Shade screen

The shading screens surrounding or facing the windows have a high influence on the solar heat gains.

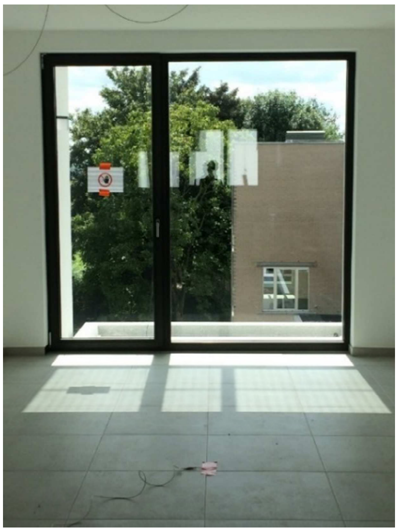


Figure 20 : Internal view in the living room unit B, effect of the shade screen

Figure 21 : Shade screen on top of the living room window, Unit B

Figure 22 : Shade screen facing the bedroom windows, Unit B

Figure 23 : View from the bedroom, Unit B

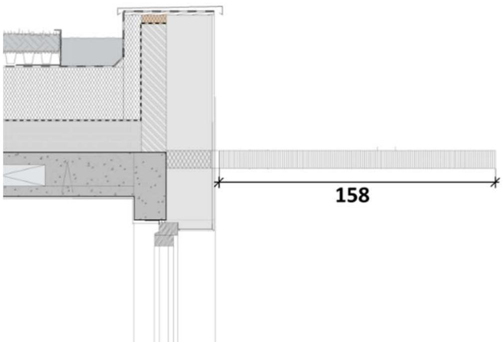


Figure 24 : Dimension of the living shading screen

Figure 25 : Panoramic view from balcony of A.2.16 apartment, Unit A.

3.7. Thermal bridges

The thermal bridges Ψ values were assessed via the THERM software. The thermal loss calculation is performed on the basis of internal wall dimensions. The main thermal bridges are illustrated in Figure 26.

Details of the thermal bridge calculation are given in the THERM_ThermalBridgeCalculation.xlsx. Final results are specified in Table 4.

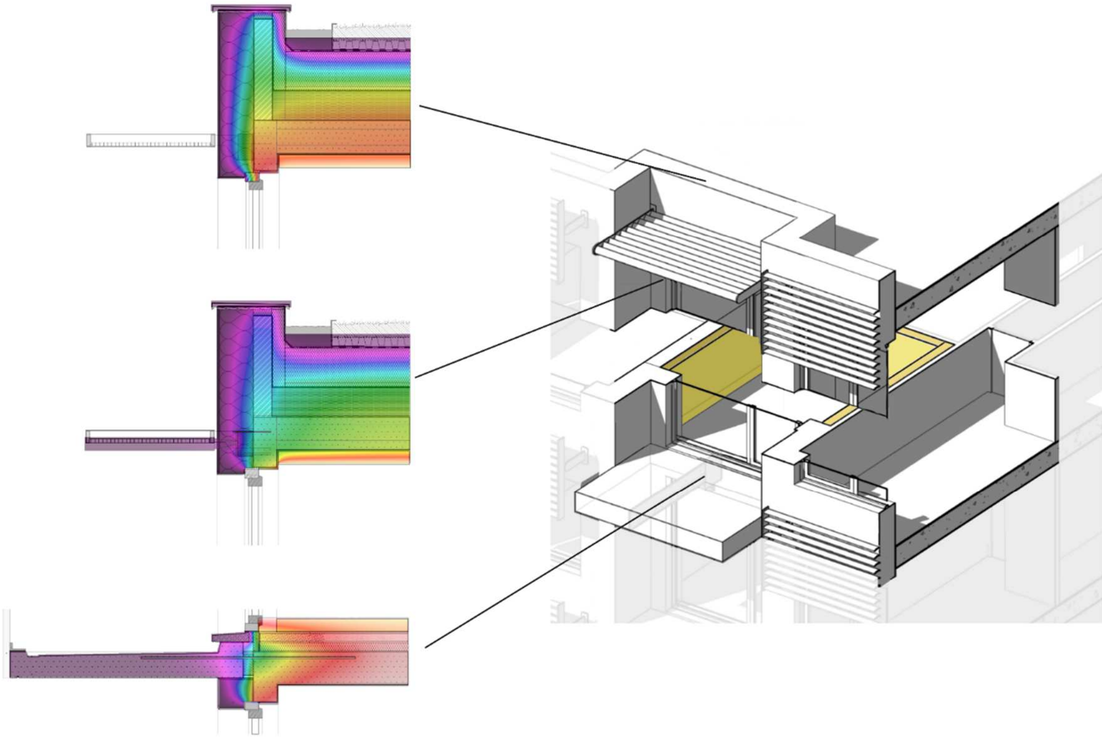
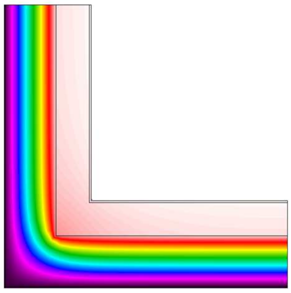
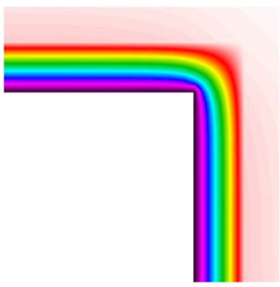
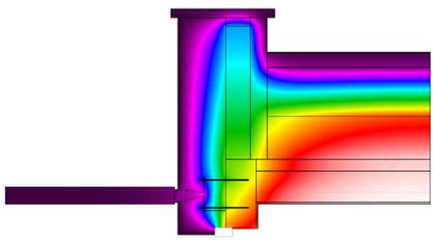


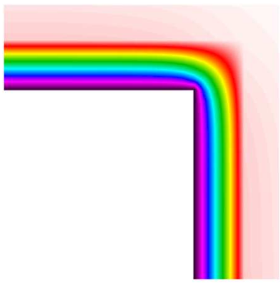
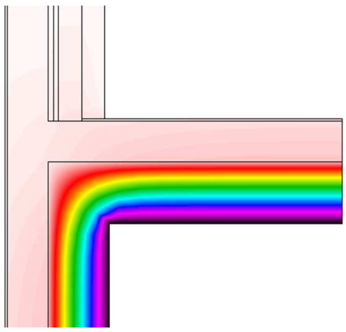
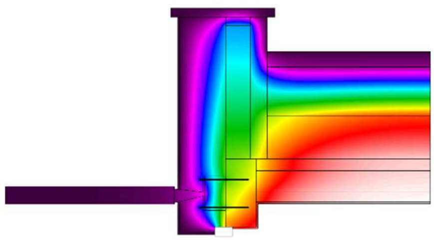
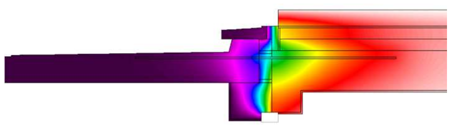
Figure 26 : Locations of the main thermal bridges

Table 4 : Thermal bridges dimensions and heat losses

1 : Bedroom

	Dimension	Ψ	TB heat loss
Outgoing angle 	5.32 m	0.06 W/Km	0.31 W/K
Reentrant angle 	5.32 m	-0.04 W/Km	-0.21 W/K
Roof parapet + shading screen 	5.05 m	0.34 W/Km	1.72 W/K
Total thermal bridges heat losses			1.82 W/K

2 : Living room

	Dimension	Ψ	TB heat loss
Angle 1 	2.66 m	-0.04 W/Km	-0.12 W/K
Angle 2 	2.66 m	-0.01 W/Km	-0.03 W/K
Roof parapet + shading screen 	3.67 m	0.32 W/Km	1.16 W/K
Balcony anchorage 	2.62 m	0.04 W/Km	0.10 W/K
Total thermal bridges heat losses			1.11 W/K

3.8. Internal thermal bridge

There are additional thermal bridges leading to heat loss between internal rooms. There are two types of internal thermal bridges:

- Thermal bridges in the uninsulated units, at the junctions between the party walls and floor/ceiling ;
- Thermal bridges in the insulated units, through the silica blocks from the insulated units toward adjacent uninsulated units.

In the same way as the other thermal bridges, they have been evaluated by the use of the Therm 7.5 software.

3.8.1. Thermal bridges between party walls and floor/ceiling

They are pictured in the Figure 27 and Figure 28. The results are gathered in the Table 6.

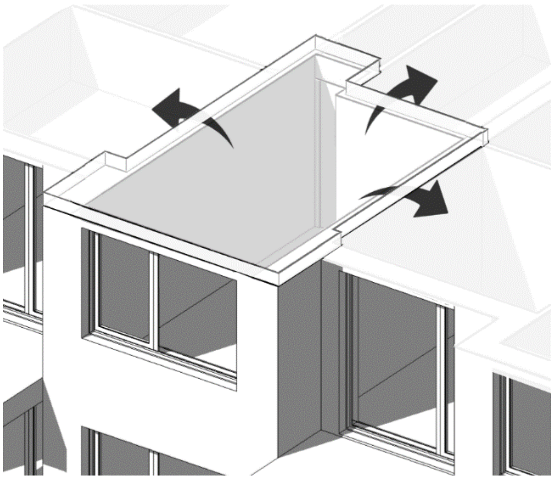


Figure 27: Internal thermal bridges in the uninsulated units

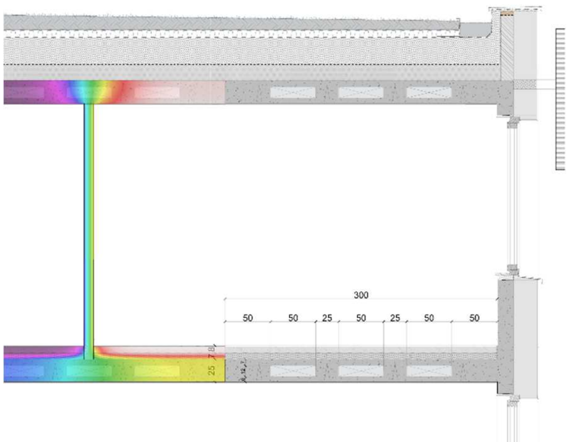


Figure 28: Internal thermal bridges in the uninsulated units

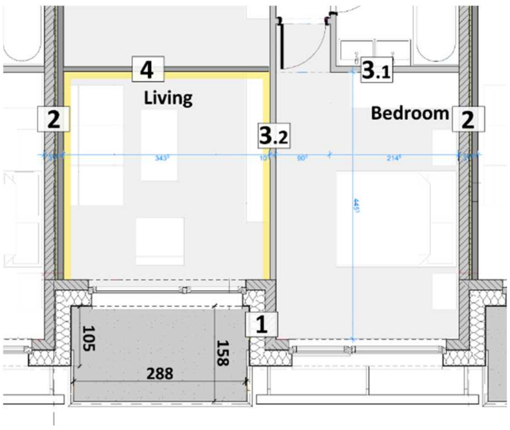
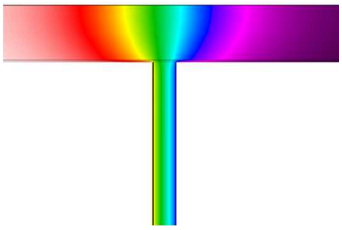


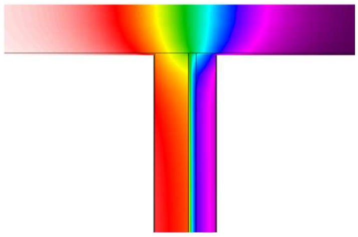
Figure 29 : Plan layout with wall numbering

Table 5 : Internal thermal bridges

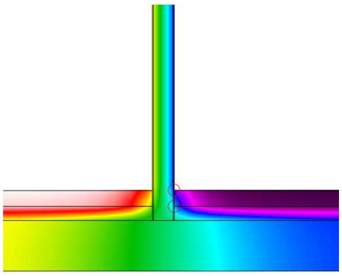
[3.1] + [3.2]
North party wall + Single party wall



[2] Double party wall



[3.1] + [3.2]
North party wall + Single party wall



[2] Double party wall

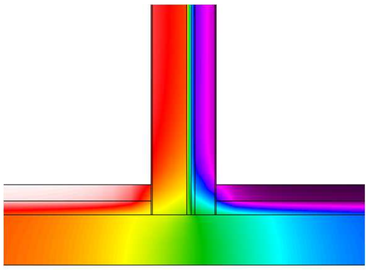


Table 6 : Internal Thermal bridges dimensions and heat losses

		Ψ [W/mK]		Dimension [m]	TB heat loss [W/K]
		Floor	Ceiling		
[2]	Double party wall	0.47	0.61	3.46	3.74
[3.1]	North party wall	0.24	0.28	4.65	2.42
[3.2]	Single party wall	0.27	0.45	3.46	2.49

3.8.2. Thermal bridges through the silica blocks of the facade

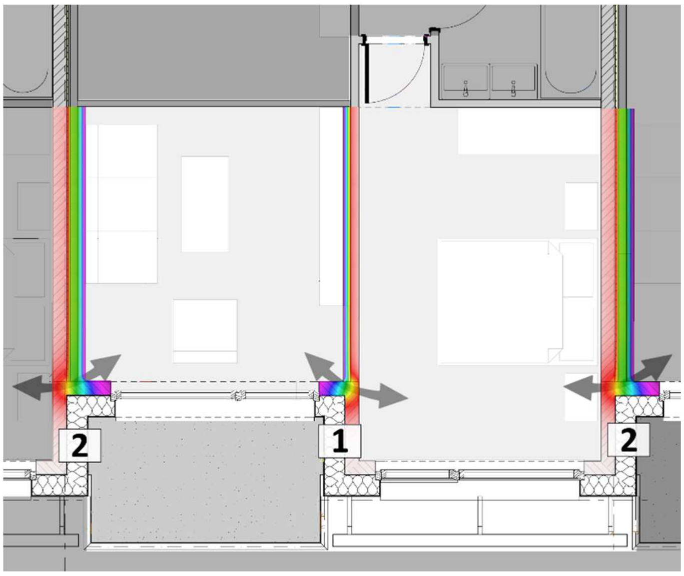


Figure 30 : Thermal bridges through the silica blocks of the façade

Table 7 : Internal thermal bridges

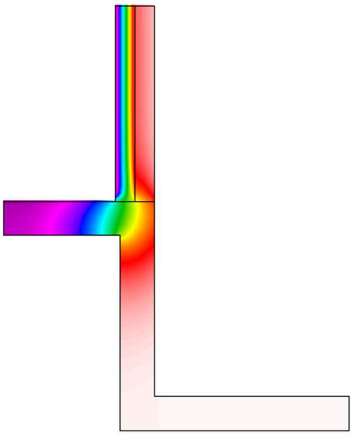
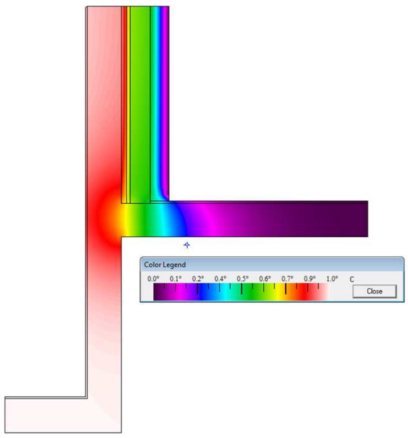
[1] Single party wall	[2] Double party wall
	

Table 8 : Internal Thermal bridges dimensions and heat losses

	Ψ [W/mK] Floor	Dimension [m]	TB heat loss [W/K]
[1] Single party wall	0.996	2.66	2.65
[2] Double party wall	0.69	2.66	1.83

3.9. Ventilation

Mechanical ventilation was shut off during the whole measurement period. The ventilation inlets/outlets were sealed with tape to limit heat exchanges due to infiltration.

3.10. Heating

Co-heating was performed with an electric radiator, with the configuration shown in Figure 31. The power of the radiator is directly controlled by the indoor temperature measured by the temperature sensor located at the center of the room.

Figure 31 : Electric radiator in the insulated unit (living)

The goal of the experiment is to perform side by side experiments with a time duration of 9 days as illustrated in Figure 33.

To fit that goal, different phases have been performed :

- 2 days from 2017/08/23 to 2017/08/25: all units in floating temperature mode.
- 11 days from 2017/08/25 to 2017/09/05: units BI and BU heated with a 27°C set point while units AI and AU in floating temperature mode.
- 2 days from 2017/09/05 to 2017/09/07: units AI and AU heated with a 27°C set point while units BI and BU in floating temperature mode.
- 11 days from 2017/09/07 to 2017/09/18: units AI and AU heated with a 29°C set point while units BI and BU in floating temperature mode.

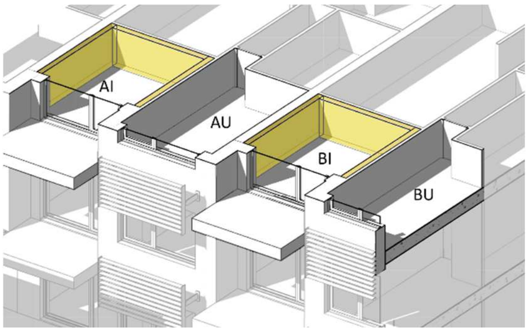


Figure 32 : Axonometric perspective of measured units in Saint Pierre et Paul

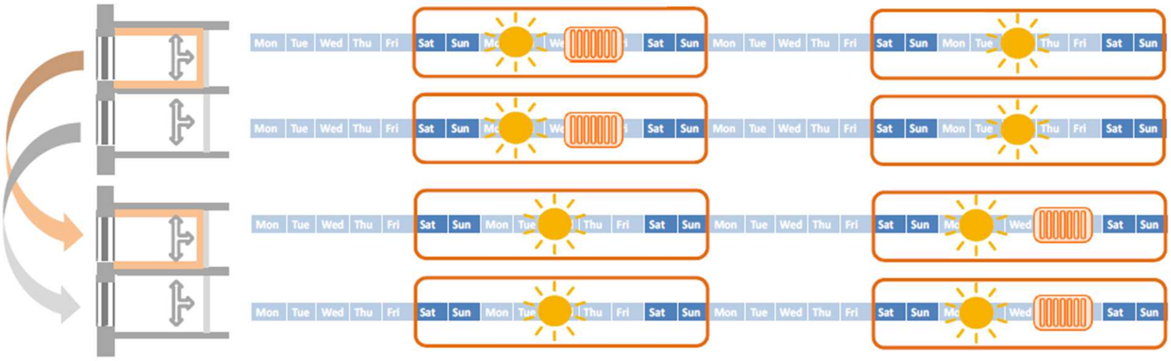


Figure 33 : Measurement schedule including co-heating and floating temperature experiments

3.11. Air leakages

Pressurisation tests (blowerdoor) were carried out on construction site on the 18/09/2017. Different air leakages values for each unit have been obtained, gathered in the following table:

Table 9 : Air leakage results

Blowerdoor test 50 Pa	AI	AU	BI	BU
V50 [m³/h]	270	76.5	280	145

For AI and BI (living room): the blower door was placed in the exterior window frame. For AU and BU (bedroom), it was placed in the internal door, separating the bedroom and the corridor. During the test, the air ducts were sealed with tape.

Living room (AI – BI):
Since the blower is placed in the exterior window frame, air leakages occurred through the window frame and through the temporary partition wall toward the kitchen zone and the rest of the apartment. The measured values are assumed to represent the air leakages through the whole apartment.

Bedroom (AU –BU):
The blower is placed in the internal door of the room, therefore the test outlined the air leakage occurring through the bedroom zone alone. The main leakages were identified to occur through:

- The external window frame and frame/wall junction
- The doorframe around the blower
- The sockets in the party walls

There are few information in literature allowing to specify accurate values for those leakage. Interactions between adjacent apartments seem to have a considerable impact as the test condition were almost the same for both units but the results are showing considerable divergence.

Another blowerdoor test has been conducted on six apartments located in the same building block at the same time. The block includes the both apartments under study and the corresponding pairs of apartments located on the two other floors (A.2.17, A.2.16, A.1.11, A.1.10, A.0.04, A.0.03). The result was a V50 value of 673 m³/h for the six apartments. Those results are supposed not to be influenced by the interactions between the adjacent apartments so that they allow an assessment of the air leakages occurring through the external façade. The main air leakage of the façade are supposed to occur through the window frames and since the roof has an important thickness, we can assume that the value of air leakage are almost the same for the six apartments. The V50 value of 673 m³/h is equally shared between the six apartments so that each apartment has an air leakage of 112.2 m³/h. Assuming that the windows frames junctions are the main cause of those leakage, we weight the total value according to the junction perimeters of each window:

Living room windows :	28.4 m³/h
Bedroom windows :	22.7 m³/h
North façade door and windows :	61.1 m³/h
Total :	112.2 m³/h

The difference between the air flows measured on each apartment (Table 9) and the estimated air flow through the façades, is assumed to be directed towards adjacent apartments:

Table 10 : Distribution of different air leakages

		A.2.16	A.2.17
Total V50	[m³/h]	270	280
Leakage through window frames	[m³/h]	112.2	112.2
Leakage towards adjacent apartments	[m³/h]	157.8	167.8

Table 11 outline the distribution of the different air leakage for each units and a calculation of the n50 value:

Table 11 : Adjustment of the V50 value for each units

	Units	AI	AU	BI	BU
Total apartment leakage	[m³/h]	270	270	280	280
Leakage through window frames	[m³/h]	28.4	22.7	28.4	22.7
Leakage towards adjacent apartments	[m³/h]	241.6	247.3	251.6	257.3
Apartment volume	[m³]	201.0	201.0	201.0	201.0
n50	[ac/h]	1.34	1.34	1.39	1.39

3.12. Weather

The weather data during the experiment were collected on site with a weather station located on roof. This station collected the data of wind speed and direction (at approximatively 11 m above the ground), atmospheric pressure, air temperature, relative humidity, rain fall and intensity, global and direct solar radiation on a horizontal plane. The data were recorded as average values every 10 minutes. Supplementary stations were placed on the balcony of both living room. They collected global solar radiation on a vertical plane at the same frequency than the station on the roof.

Figure 34 : Weather station on the roof

Figure 35 : Solar radiation sensor on the balcony

3.13. Ground reflectivity

The ground reflectivity wasn't measured. The South part of the land plot is mostly occupied by a neighboring building. The ground surfaces are mainly grass. The eastern and South Eastern parts of the land plot are occupied by trees.

Figure 36 : Plan of the surrounding

Figure 37 : View from the bedroom, A.2.16 apartment

3.14. Predicted HLC

The calculation of a theoretical heat loss coefficient is summarized in the following table. It takes into account:

- External wall heat loss coefficient: depending on the U-value of the external wall and windows
- Thermal bridges heat loss coefficient: the values were described in chapter 3.7
- Infiltration heat loss coefficient: the blower door test shows air leakages resulting from a wind pressure of 50 Pa. In real conditions, a mean value of 2 Pa is assumed.

	Bedroom							Living					
Wall loss													
	Dimension		U		TB loss [W/K]		Dimension		U		TB loss [W/K]
External wall	8.97	m^2	0.12	W/Km^2	1.06		2.55	m^2	0.12	W/Km^2	0.30
Roof	14.31	m^2	0.06	W/Km^2	0.88						
Window	4.47	m^2					6.59	m^2			
Window - glass	3.31	m^2	0.60	W/Km^2	1.99		5.14	m^2	0.60	W/Km^2	3.09
Window - frame 1	0.55	m^2	0.79	W/Km^2	0.43		0.64	m^2	0.79	W/Km^2	0.51
Window - frame 2	0.61	m^2	0.88	W/Km^2	0.54		0.80	m^2	0.88	W/Km^2	0.71
Window - glass edge	10.38	m	0.03	W/Km	0.30		13.62	m	0.03	W/Km	0.39
Total wall loss				[W/K]	5.19					[W/K]	5.00

Thermal Bridge loss											
	Dimension		Ψ		TB loss [W/K]	Dimension		Ψ		TB loss [W/K]
Outward angle	5.32	m	0.06	W/Km	0.31					
Inward angle	5.32	m	-0.04	W/Km	-0.21					
Roof parapet + screen shade	5.05	m	0.34	W/Km	1.72					
Total thermal bridges				[W/K]	1.82					

Angle 1						2.66	m	-0.04	W/Km	-0.12
Angle 2						2.66	m	-0.01	W/Km	-0.03
Roof parapet + screen shade						3.67	m	0.32	W/Km	1.16
Balcony + anchoring						2.62	m	0.04	W/Km	0.10
Total thermal bridges									[W/K]	1.11

Infiltration loss						
	V50 obtained by test [m^3/h]	ACH conversion [m^3/h]	TB loss [W/K]	V50 obtained by test [m^3/h]	ACH conversion [m^3/h]	TB loss [W/K]
	22.70	1.14	0.38	28.40	1.42	0.47
Total infiltration loss		[W/K]	0.38		[W/K]	0.47

Total heat loss	[W/K] 7.39	[W/K] 6.59

4. EXPERIMENTAL SCHEDULE

The experiment was undertaken in parallel in 4 similar units so that all units were submitted to the same weather conditions. The time schedule of the experiment is shown in Table 12 :

Table 12 : Experimental schedule

	AI	AU	BI	BU
Days 1-3 08/23 to 08/25	Floating temperature	Floating temperature	Floating temperature	Floating temperature
Days 3-14 08/25 to 09/05	Floating temperature	Floating temperature	Coheating : 27°C	Coheating : 27°C
Days 14-16 09/05 to 09/07	Coheating : 27°C	Coheating : 27°C	Floating temperature	Floating temperature
Days 16-27 09/07 to 09/18	Coheating : 29°C	Coheating : 29°C	Floating temperature	Floating temperature

The set point increase from 27°C to 29°C was required to provide a sufficient indoor temperature difference between the co-heated units and the units left in floating temperature.

5. INSTRUMENTATION

5.1. Internal sensors

Sensors are named with 5 letters, to identify in which apartment they are located and where precisely. The following table summarizes the meaning of letters composing the name of the sensors.

Logger zone	Unit	Sensor type	Sensor location - 1	Sensor location - 2
A *Apart. A.2.16* B *Apart. A.2.17*	I *Insulated* U *Uninsulated*	T *Temperature* R *Radiation*	B *Back* F *Front* M *Middle* I *Interface* S *Sanitary*	E *East* W *West* C *Ceiling* G *Ground* M *Medium* H *High*

Notes:

Sensor location 1:

- (B, F, M): according to the depth from the façade (B: back of the room, F: next to the façade, M: middle of the room)

- (I) : interface between wall and insulation
- (S) : neighbor Northern zone

Sensor location 2:

- (M,H): If air temperature sensor: at medium height (M) or near the ceiling (H)
- (E,W,C,G): If interface temperature sensor: at the East (E) or West (W) wall surface or at the ceiling (C) or floor (G) surface

Description of different sensors:

- 8 Temperature sensors per unit: 4 sensors located on the ceiling, floor and party walls either on the wall surfaces in uninsulated units, or at the interface between walls and insulation panels in insulated units, 3 air temperature sensors in the tested unit (2 near the façade, 1 in the center of the room), 1 temperature sensor in the adjacent Northern zone in the same apartment.
- 1 pyranometer per unit: located on the ceiling roof of the insulated and uninsulated zones in order to collect the total amount of reflected solar irradiance, when those zone are in floating temperature mode.
- Pyranometers named AIRMC and AURMC have been monitored in unit A from 23/08/2017 at 16:04:51 to 5/09/2017 at 11:51:03.
- Pyranometers named BIRMC and BURMC have been monitored in unit B from 5/09/2017 at 13:34:47, to 18/09/2017 at 07:42:48.
- Co-heating consumptions were monitored in kWh. NOTE: The recorded powers are computed from the differences of the recorded consumptions. As data were recorded with a 10 minutes interval, recorded power must be multiplied by 6 to be expressed in Watt.

The following figure show the location of the internal sensors used (NOTE : the figure represents a unit in the *Printemps* site, but the configuration is the same in *Saint Pierre & Paul*).

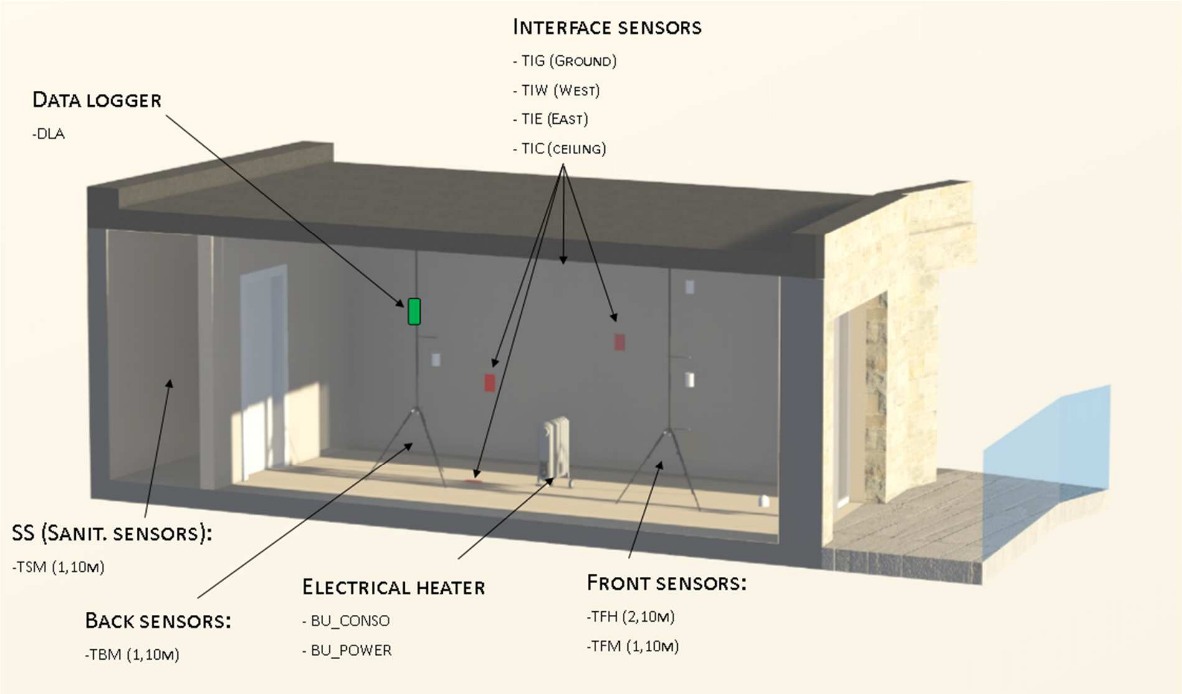


Figure 38 : Location of different internal sensors

5.2. Weather sensors

A weather station located on the roof collected:

- Solar radiation data: direct and global on a horizontal plane + calculation of the difference for diffuse radiation in W/m2 ;
- Wind: speed in m/s / orientation and maximal speed in degree from North ;
- Temperature in °C ;
- Relative humidity in % ;
- Atmospheric pressure in Pa;

On each balcony, a sensor measured the solar radiation on a vertical plane in W/m²

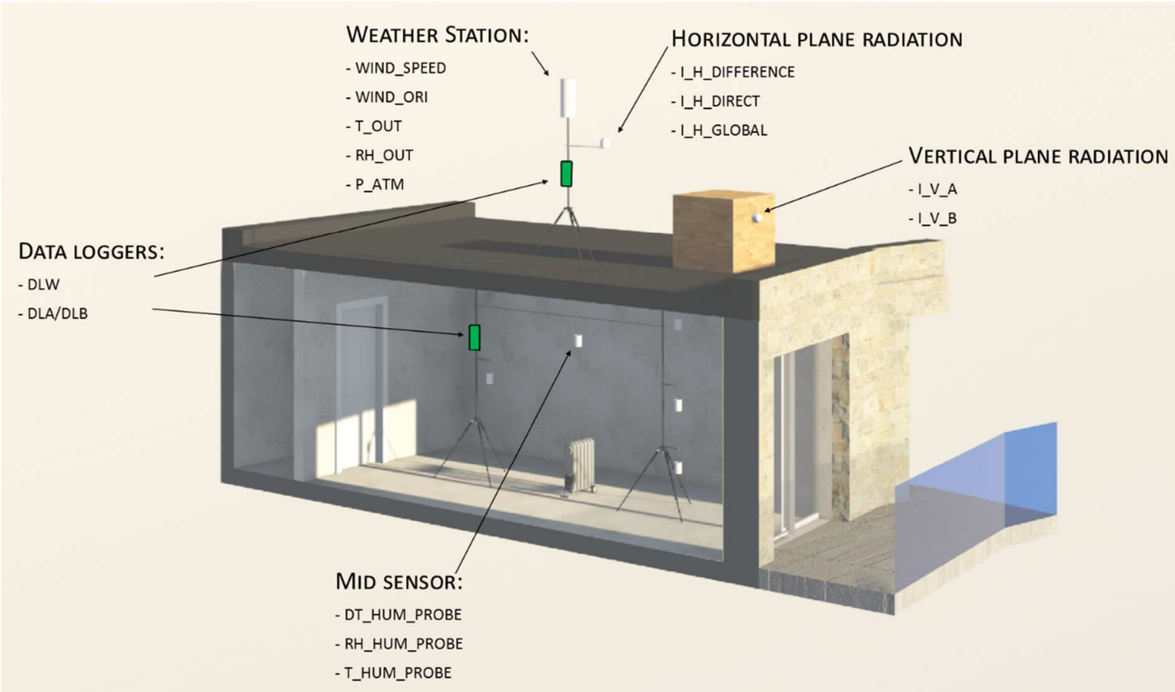


Figure 39 : Configuration of sensors emplacement for weather datas

6. PROVIDED MEASURED DATA

All the data are provided in three Excel files, with a10 minutes time step:

- A_170823_170918.xlsx : for data in unit A (apartment A.2.16)
- B_170825_170918.xlsx for data in unit B (apartment A.2.17)
- W_170822_170918.xlsx for weather data

INTERNAL DIMENSIONS

A.2.16 and A.2.17		Room	
		Living	Bedroom
Floor area	m²	11.868	14.312
Interior ceiling height	m	2.660	2.660
Volume	m³	31.569	38.069
[1] External wall_S	m²	2.548	8.966
[1] Windows	m²	6.589	4.467
Glass	m²	5.142	3.311
Frame	m²	1.448	1.156
Glass percentage	%	74%	70%
Glass edge	m	13.620	10.380
[2] Party walls between apartments	m²	9.190	9.190
[3.1] Int. wall between bathroom/bedroom zone	m²	-	8.250
[3.2] Int. wall between living/bedroom	m²	9.190	11.318
Int. door between bedroom & corridor zone	m²	-	1.991
[4] Int. wall between living/kitchen zone	m²	9.137	-
[5] Concrete roof	m²	11.868	14.312
[6-7] Floor area	m²	11.868	14.312

LIST OF FIGURES

LIST OF TABLES