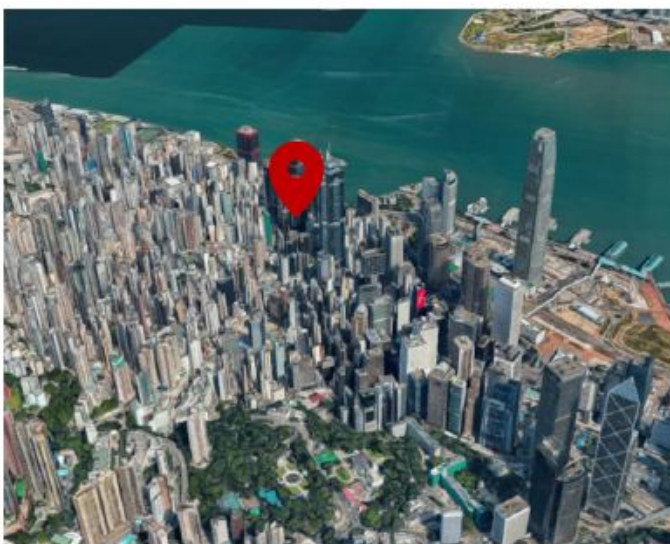


LOCATION INFORMATION

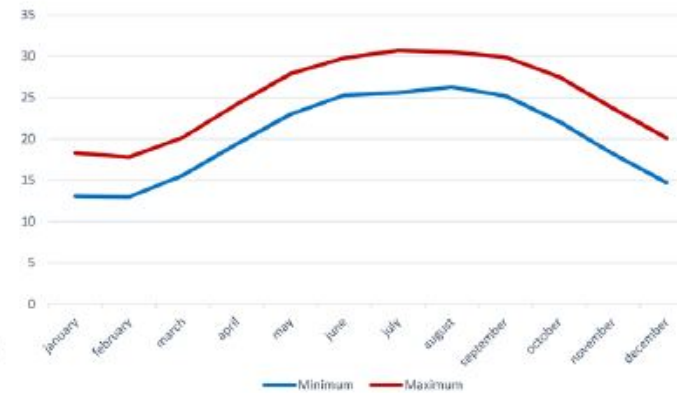
Location: Hong Kong, Central,
111 Wellington street

Coordinates: N 22° 17' 3.8953"
E 114° 9' 13.1589"

Koppen climate type: Cwa: Monsoon-influenced
humid subtropical climate

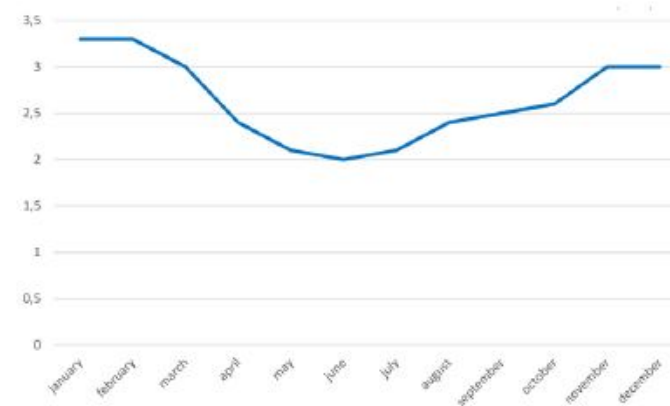


TEMPERATURE (%)



T Max: 30,7°C
T Min: 13°C

DAILY TEMPERATURE RANGE (%)



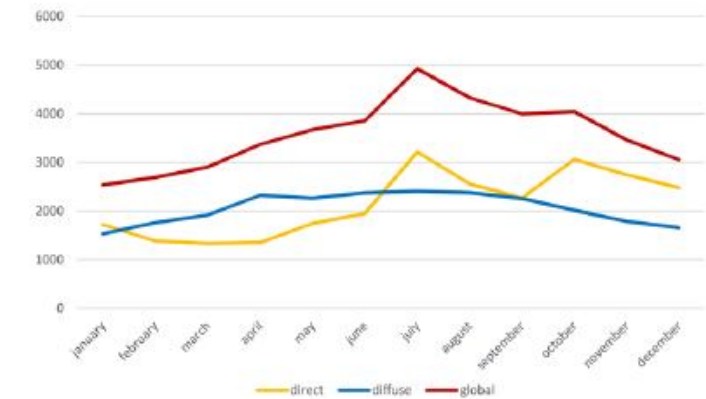
dT Max: 3,3°C

Climate in Hong Kong is always warm: temperature during the year is always between 13°C (dicember-february) and 31 °C (may-september). The thermal excursion during single days is very low (around 3°C), that means that the temperature is almost the same during the day and the night and it changes only month by month.

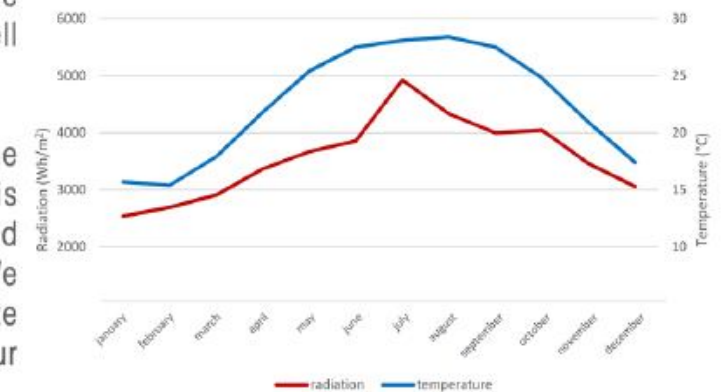
The graphs on the right show the contribution of direct and diffuse radiation on the amounth of global horizzontal radiation and the relationship between temperature and radiation. From february to june, due to the cloudiness, the contribution of diffuse radiation is bigger than the one of direct radiation, while from july to january, the direct radiation becomes more relevant. We can also see that both the curve of temperature and global horizzontal radiation have a "bell pattern" that grows in summer months.

In the lower schemes it is possible to see the amounth of hours in which the project site is struck by solar radiation, both at the ground level and at 17 meters from the ground. We note that during winter, a big part of the site is struck by solar radiation less than 1 hour per day.

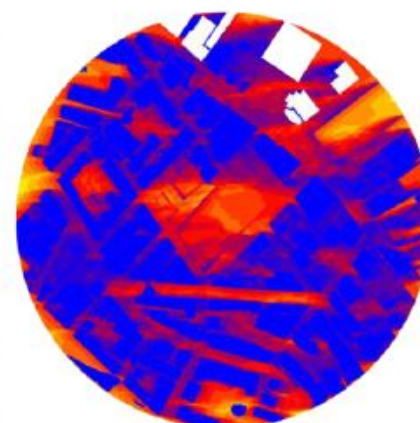
RADIATION (Wh/m²)



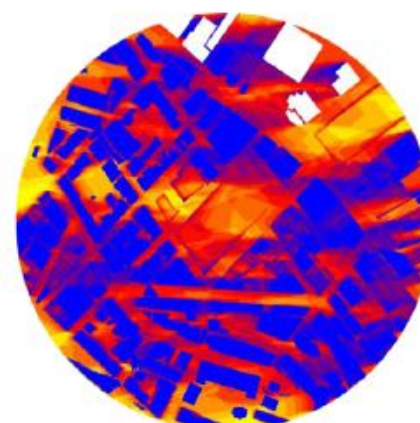
RELATIONSHIP BETWEEN TEMPERATURE AND RADIATION



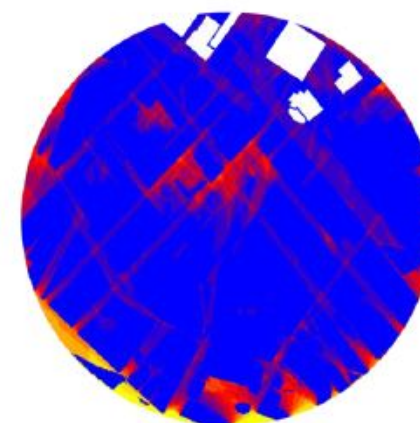
GRAPHICAL RAPRESENTATION OF SOLAR RADIATION



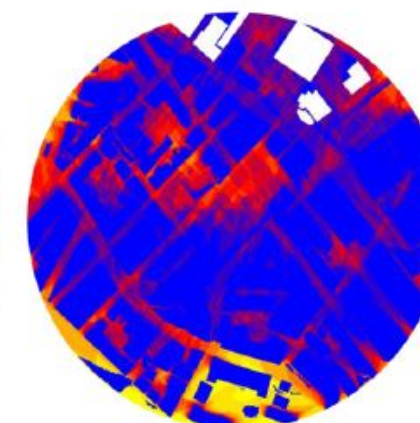
summer h=0 m



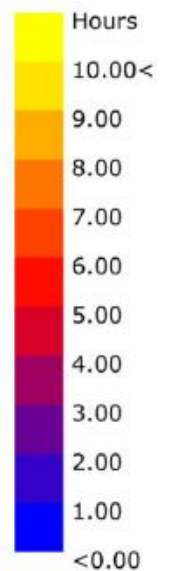
summer h=17 m



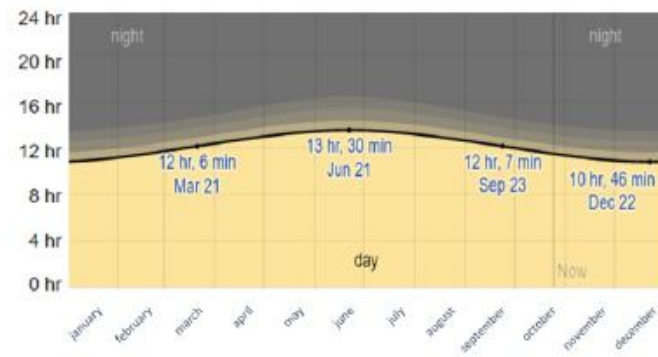
winter h=0 m



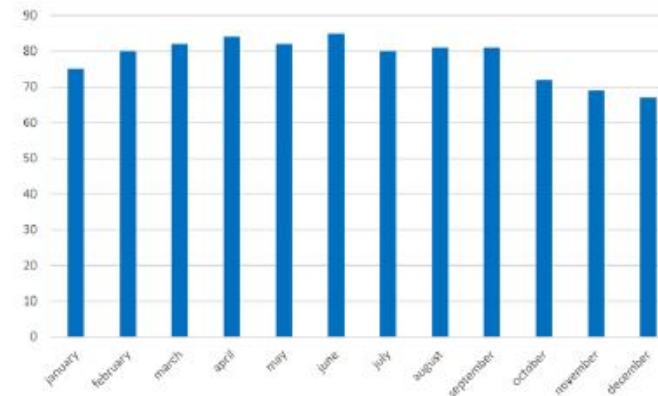
winter h=17 m



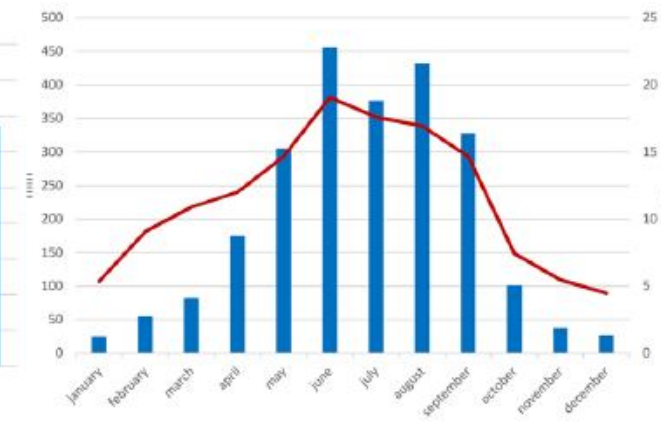
HOURS OF DAYLIGHT AND TWILIGHT



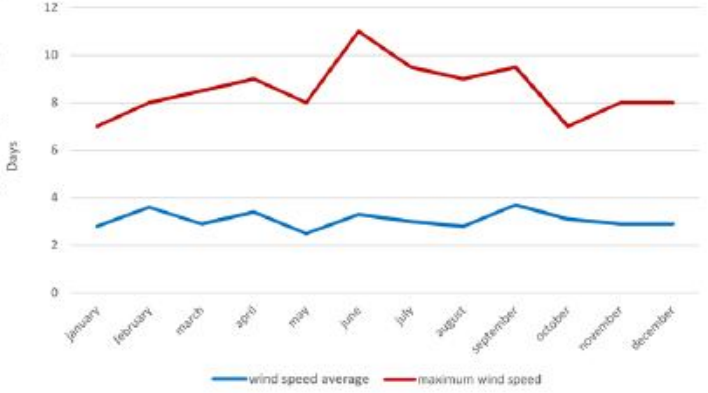
HUMIDITY (%)



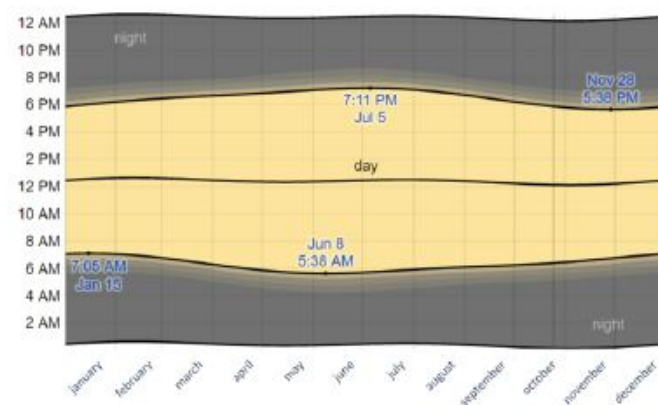
RAINFALL AND RAINY DAYS



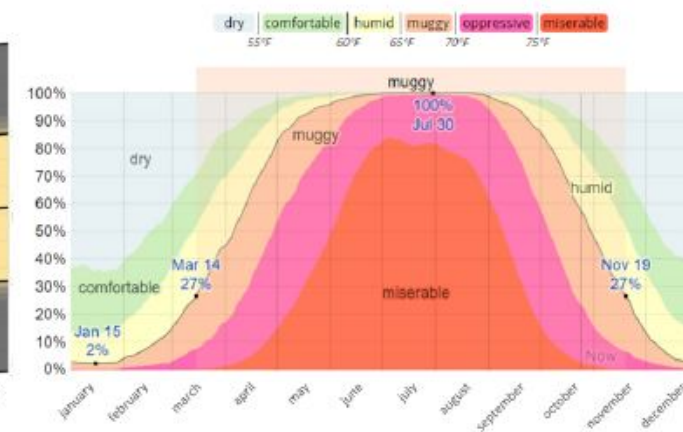
WIND SPEED (m/s)



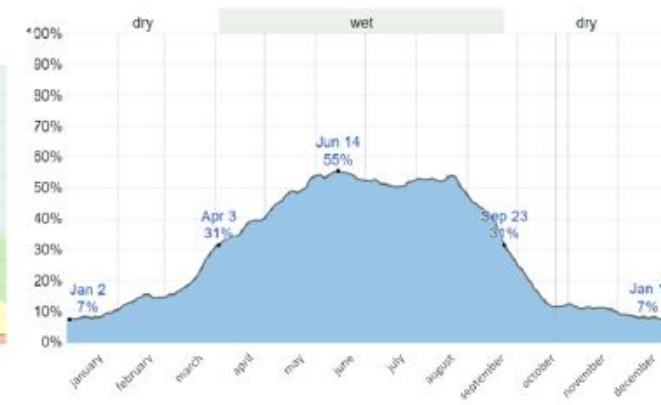
SUNRISE AND SUNSET WITH TWILIGHT



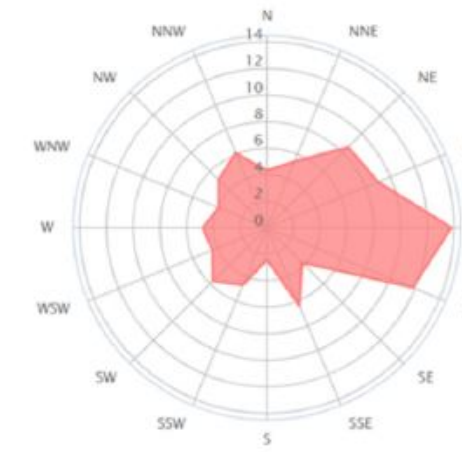
HUMIDITY COMFORT LEVELS



DAILY CHANCE OF PRECIPITATION



WIND DIRECTION DISTRIBUTION (%) - YEAR



AVERAGE PERCENT OF SUNSHINE



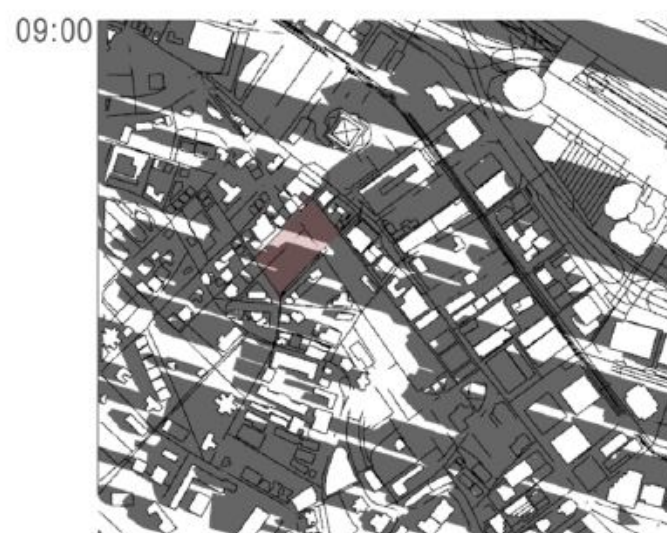
Hong Kong average is 1709 hours of sunshine per year. On average, November is the most sunny month, while March has the lowest amount of sunshine.

From the graph above we can see that the relative monthly average of humidity is around 70%-80% during the whole year. It is an high level of humidity and it means that perceived temperature is always higher than the real one. As we can see in the second graph, the time in which the combination of temperature and humidity leads to a comfortable humidity condition is very few. In our project we will focus on strategies that can improve the situation of humidity comfort level.

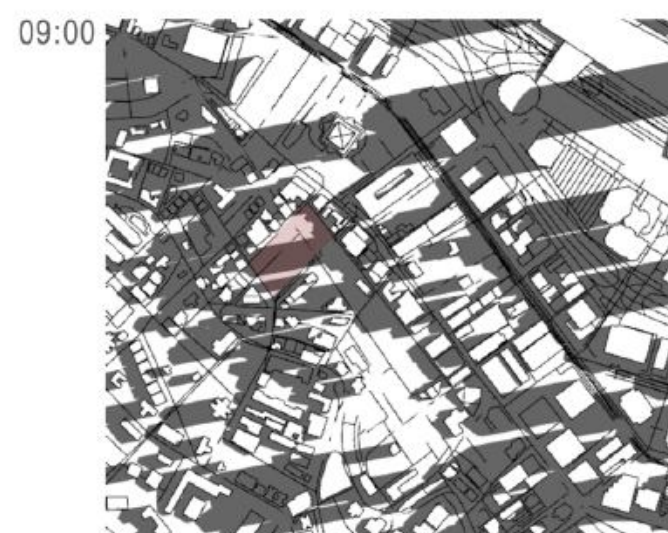
As we can notice from the graphs both the amount of rainfall, the rainy days and the daily chance of precipitation are greater from April to September; the peak is on June, with more than 450 mm of rain, 23 rain days and 55% of daily chance of precipitation. From November to February the amount of precipitation is very low.

The wind rose shows that, during the year, the wind comes predominantly from East, while the graph shows that the average speed of the wind is almost the same during the whole year (around 3m/s) and the maximum wind speed can reach 11 m/s so that the wind is an important factor to consider especially for the high buildings.

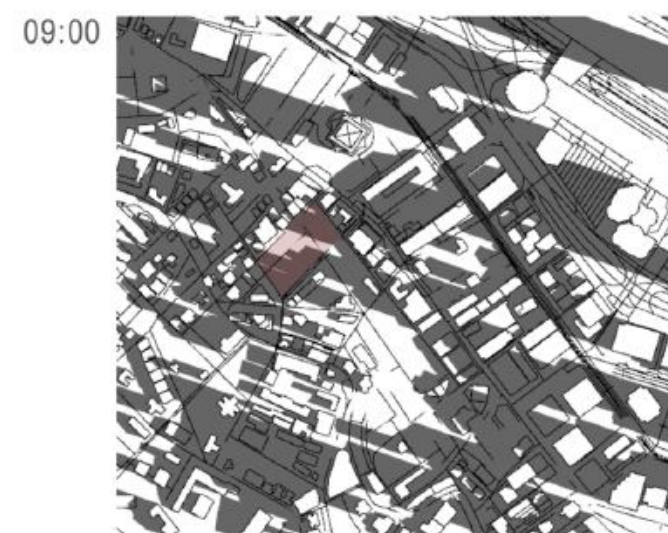
SPRING (21-03)



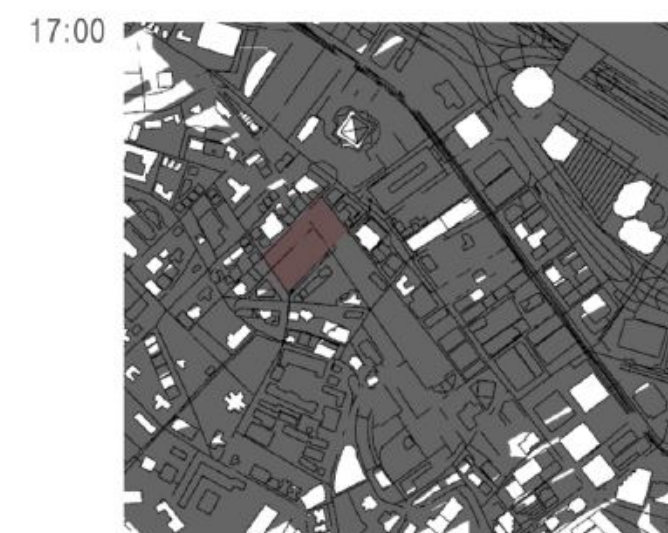
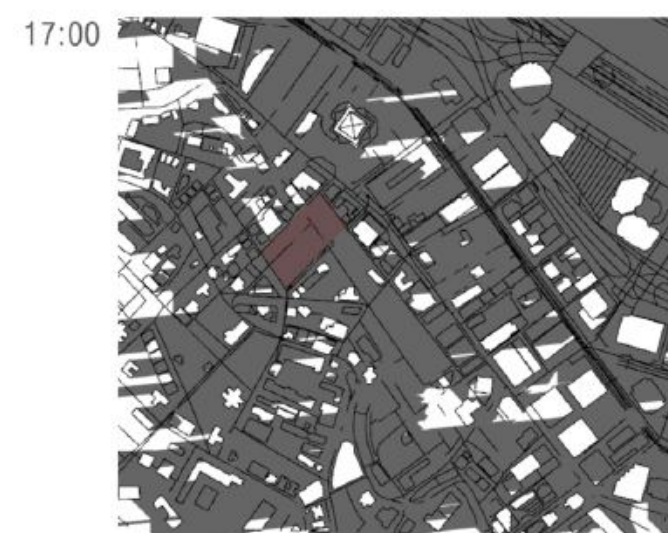
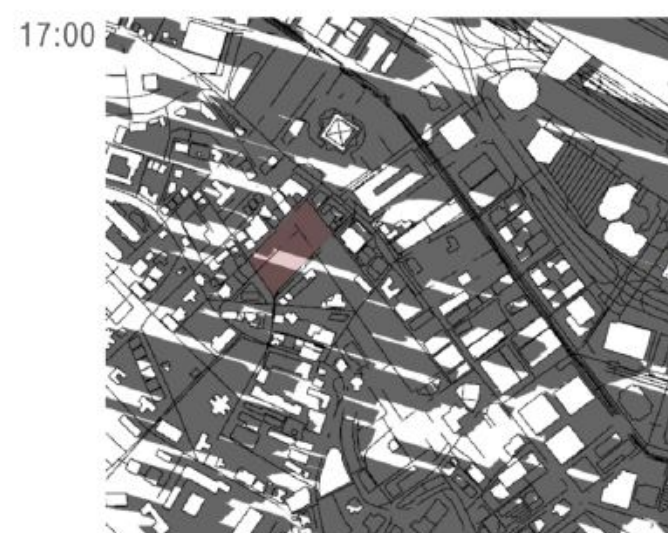
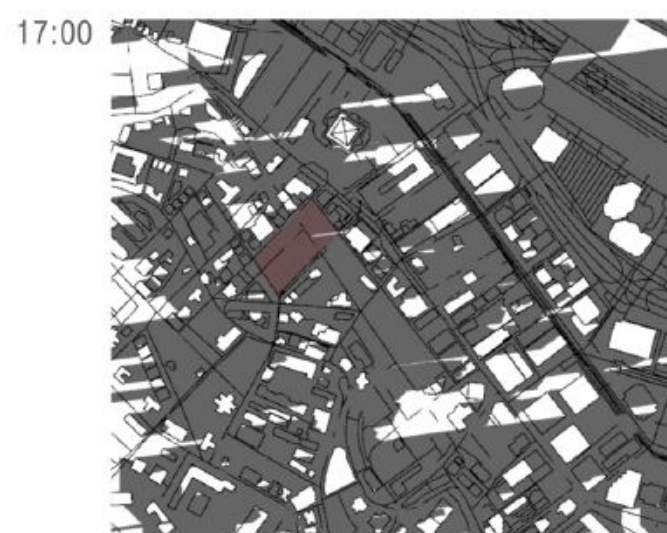
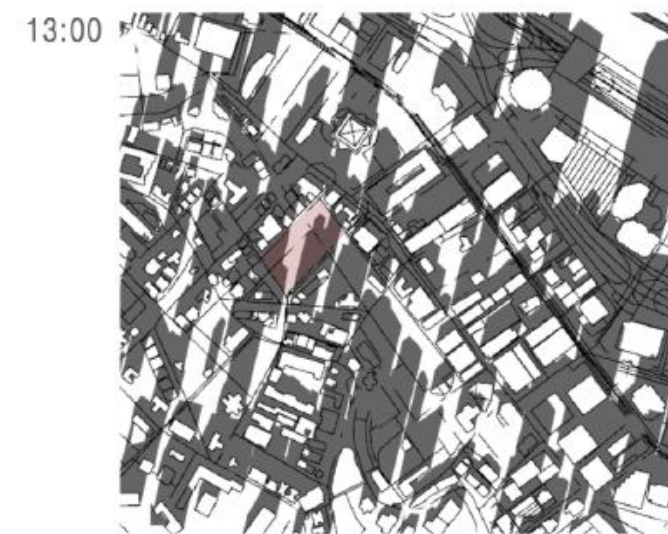
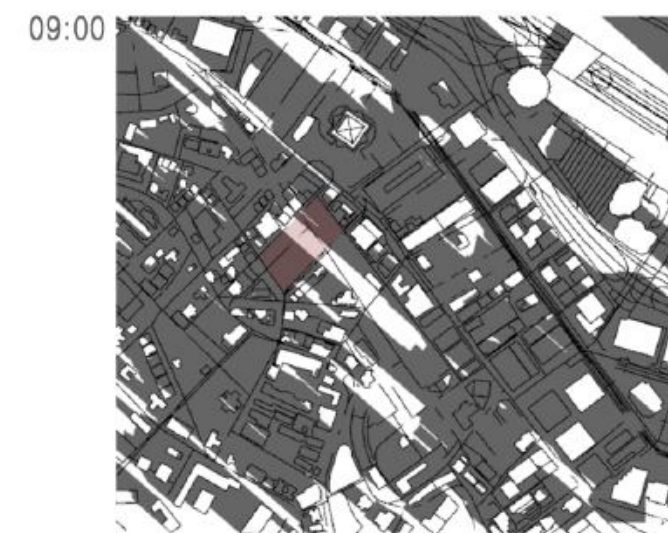
SUMMER (21-06)



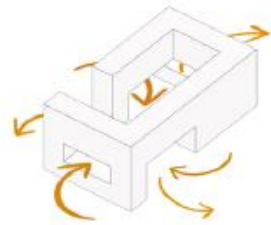
AUTUMN (23-09)



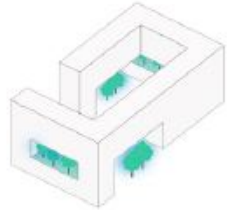
WINTER (21-12)



PREVENTION OF HEAT GAINS IN BUILDING



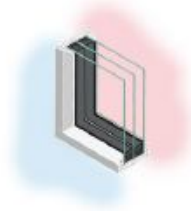
HOLES
Avoid wind flow from being impeded,
mitigating temperature



TREES AND VEGETATION
Help reducing temperature



**NOT OPENABLE WINDOWS
WITH TRICKLE VENTS**
Better control of temperature but
allow small amounts of ventilation



DOUBLE OR TRIPLE GLASS
Stop heat entering in summer and
heat escaping in winter



**ROOF AND WALL
CONTINUOUS INSULATION**
Minimize heat gain

**USE OF MATERIAL WITH A LOW
THERMAL STORAGE CAPACITY AND
SHORT TIME LAG**

LIGHT COLOUR OF WALL SURFACE
Helps reflecting heat

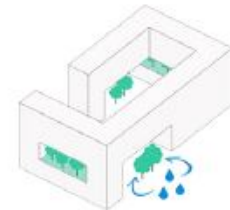


THERMAL CHIMNEY AND HIGH LEVEL CEILING
High level ceiling exhaust ensure complete
emptying of warm air in ceiling spaces.
The exhaust plenum is at slightly negative
pressure, induced by north flues "stack
effect".

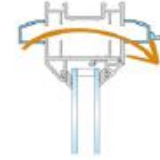
CONTROL HUMIDITY



HOLES
Improve natural ventilation in the
courtyard and in the terraces,
mitigating humidity



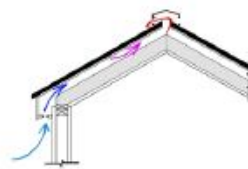
TREES AND VEGETATION
Reduce humidity



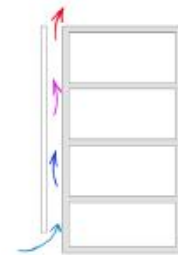
**NOT OPENABLE WINDOWS
WITH TRICKLE VENTS**
Better control of temperature but
allow small amounts of ventilation



**UNDER FLOOR VENTILATION AND
VAPOR BARRIER**
Avoid vapour raising from the ground

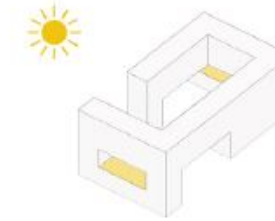


VENTILATED ROOF
Avoid heat transfer into the habitable
spaces in summer

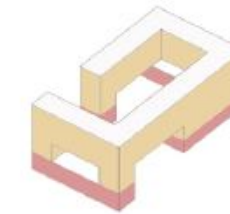


VENTILATED FACADE
Reduce condensation due to humidity

IMPROVE LIGHTING

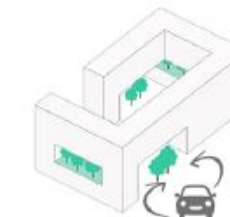


HOLES
Improve lighting



**ZOOING ACCORDING TO
THE LIGHT NEED**
avoid wasting natural light and
energy to illuminate

REDUCE POLLUTION LEVEL

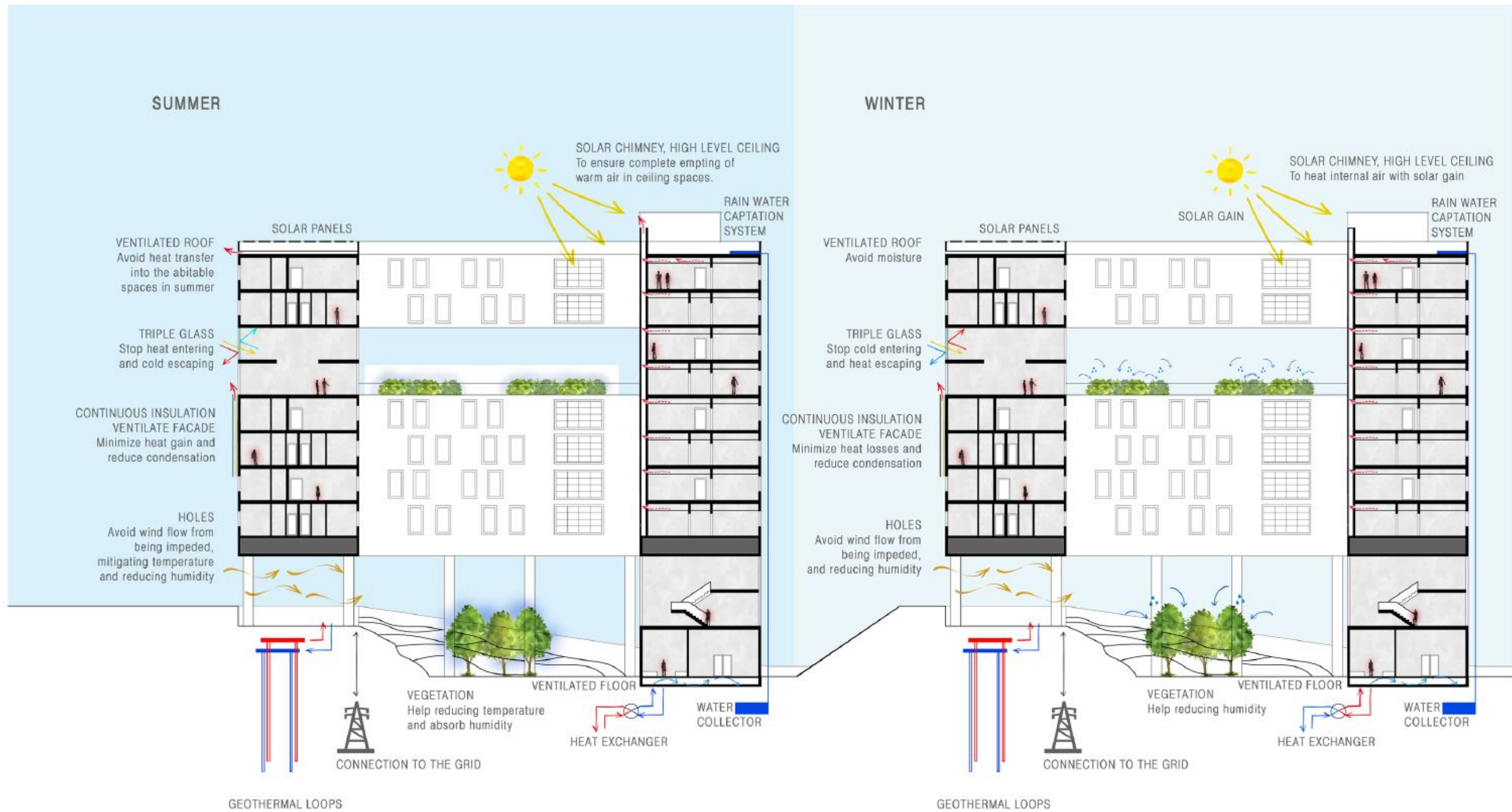


TREES AND VEGETATION
Help in decrease pollution

SAVE WATER



RAINWATER COLLECTORS
Supply the water need with
rain water



LOCATION INFORMATION

Location: Nancy, France
 Year: 2013
 Architect: Bourbon Architects, Zanon
 Surface: 980 m²
 Themes: Architecture, apartments

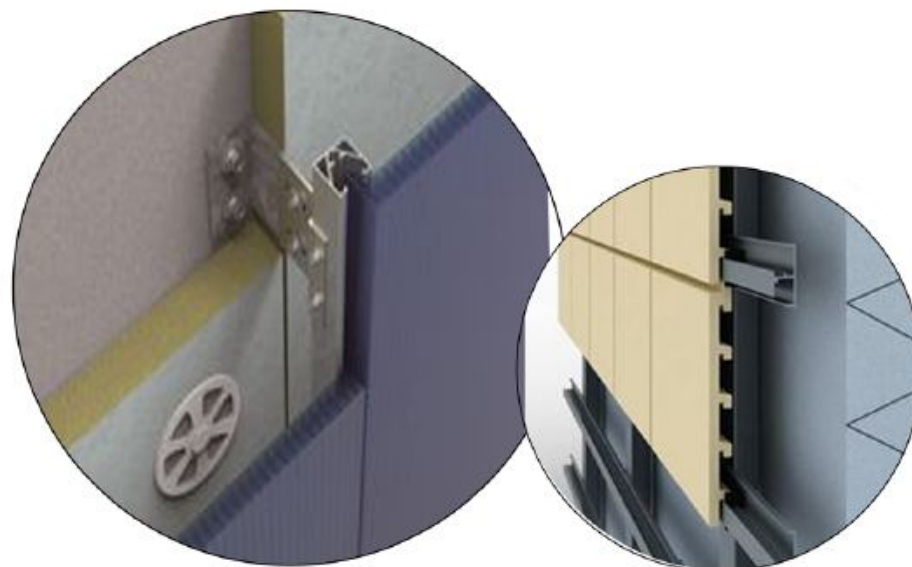
GENERAL INFO

The program of this residence for mental disabled people includes a set of common premises (reception, dining room, office, media lounge) as well as 24 studio flats. This construction consists of two compact main buildings, carved on their five faces.

KEY WORDS

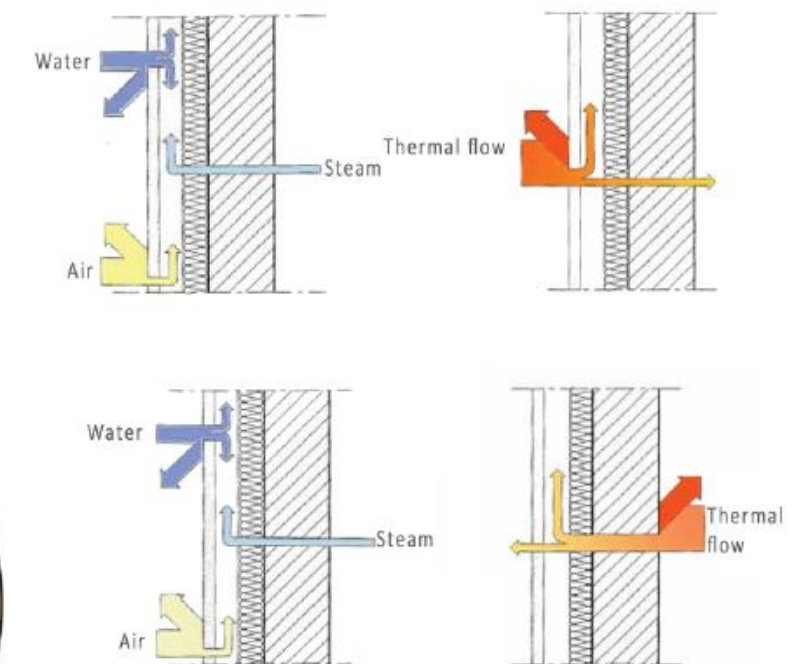
- Ventilated facade
- It is based on the ascending air movement, from the solar radiation that heats the external surface of the wall
- Removal of water vapor from inside
- There is no direct contact between the inner layers and rainwater

SOME DETAILS

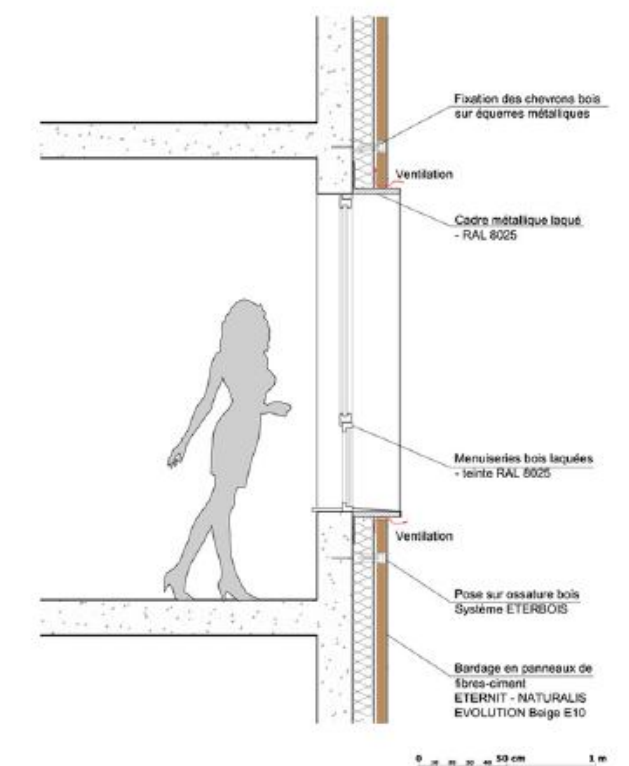


CONCLUSIONS FOR OUR PROJECT - APPLICATIONS

Operating scheme in summer and winter



The thermal insulation layer is placed in the gap with continuity: this eliminates the thermal bridges. The insulating material can be polystyrene, polyurethane or mineral wool (it does not get wet directly due to the presence of the detached coating).



HIGH WATER RETENTION

Depending on the Green Roof design, the immediate water run-off can be reduced by 10-90% greatly reducing the drainage flow rates. This enables the outlets, down pipes, ground drains, sewer pipes to be reduced in capacity there by reducing construction costs.

REDUCE NOISE LEVELS

Green Roofs reduce reflective sound by up to 3 dB and improve sound insulation by up to 8 dB. This is most effective with buildings near airports, or noisy discotheques and machinery.

ADDITIONAL THERMAL INSULATION

It improve the thermal insulation in both summer and winter. Some specialized system are certified as thermal insulation.

REDUCTION OF DUST AND SMOG LEVELS

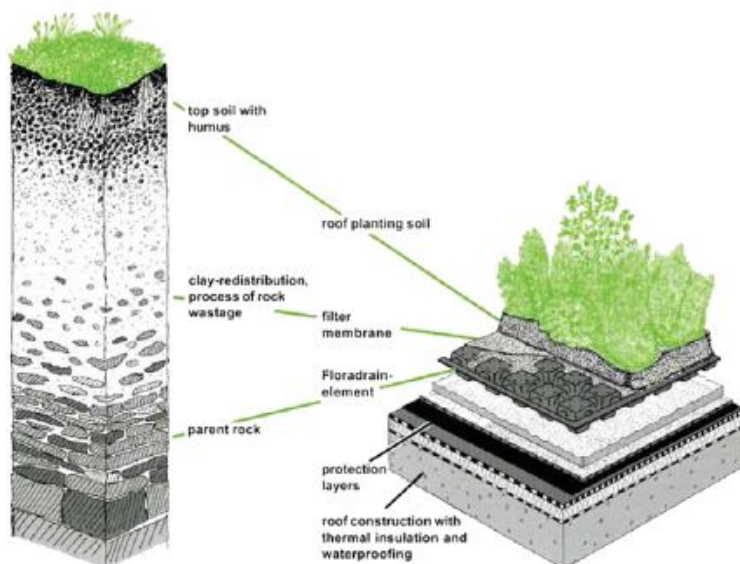
The vegetation helps to filter out dust and smog particulates. Nitrates and other harmful materials are absorbed out of the air and rainfall and bound within the soil.

NATURAL HABITAT FOR ANIMALS AND PLANTS

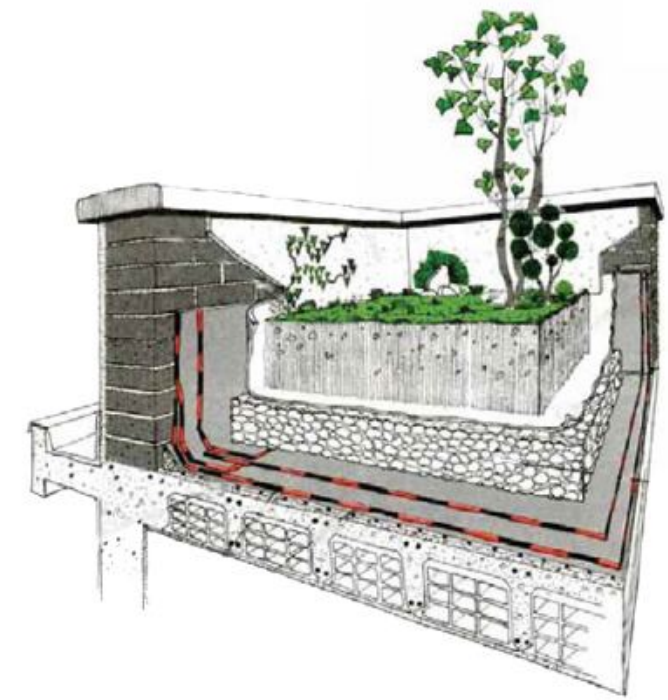
It encourage wildlife to remain within built-up areas.

USE OF SPACE

Converting or designing normally unused roof areas into some social spaces, particularly for recreational or sporting use not only make use of expensive space, but saves on the costs of purchasing additional land.



From right to left, top down:
 Più Arch, Allianz Headquarters, Milano, 2017, 29700 m²
 Jean Nouvel, Musée du Quai Branly, Paris, 1999-2006, 40660 m²
 RPWB, California Academy of Sciences, San Francisco, 2000-2008, 37000 m²
 RPWB, Pinwheel Development study, Beirut, 2009-2013, 78000 m²
 Più Arch, Allianz Headquarters, Milano, 2017, 29700 m²

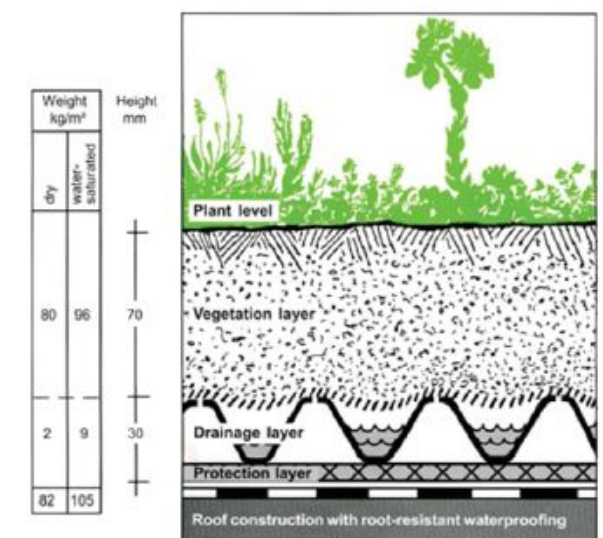


IMPROVES THE CLIMATIC ENVIRONMENT

The green packets also cool and humidity the surrounding air creating a microclimate which has beneficial within the immediate area

INCREASES THE LIFE EXPECTANCY OF THE ROOF

A Green Roof protects the waterproofing from climatic extremes, UV exposure and mechanical damage. This greatly increases the life expectancy of the waterproofing



Build-up height: approx 100mm
 Wet weight, incl. plants: approx. 95 kg/m²
 Retention capacity: approx 23 l/m²

LOCATION INFORMATION

Location: Geuzenveld, Amsterdam
 Year: 2006
 Architect: MVRDV
 Surface: 35000 m²
 Themes: Architecture, Housing

GENERAL INFO

The Parkrand building condenses small housing units into an impressive volume preserving and even enlarging, the park. The program is split into five towers connected with a patio which forms a lifted semi-public area that overlooks and enlarges the surrounding park. The park building is seen to continue the optimistic tradition that characterizes the history of these post war modernist neighbourhoods.

KEY WORDS

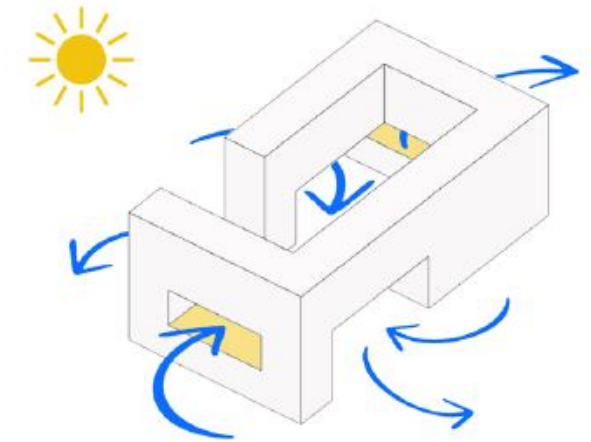
- Communal patio and a series of rooftop penthouses
- An open and airy block
- Different views from all directions
- The garden offers protection from rain and wind, secured access, and more intimate spaces and playgrounds
- A central space for the inhabitants, an outdoor 'living room'
- Lights enter thanks to the holes
- Furniture, decorative walls, ceiling and floor finishes, plants, and 'chandeliers'.

SIMILAR BUILDINGS GAVE US SOME QUICK SUGGESTIONS

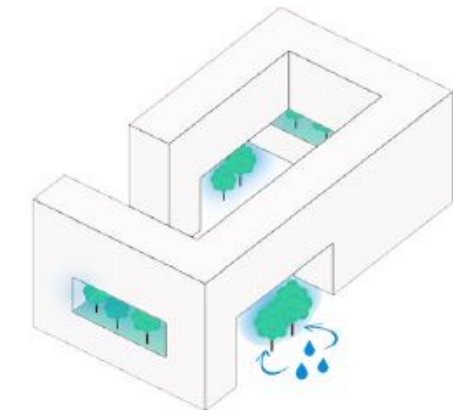


From left to right:
 Mirador, MVRDV, Spain, surface: 18300m²
 Parkroyal, WOHA, surface: 29811 m²
 Simmons Hall, Steven Holl, USA, surface: 18116 m²
 Rutger Business School, TEN Arquitectos, surface: 20000 m²
 Skiville, WOHA, surface: 29392 m²

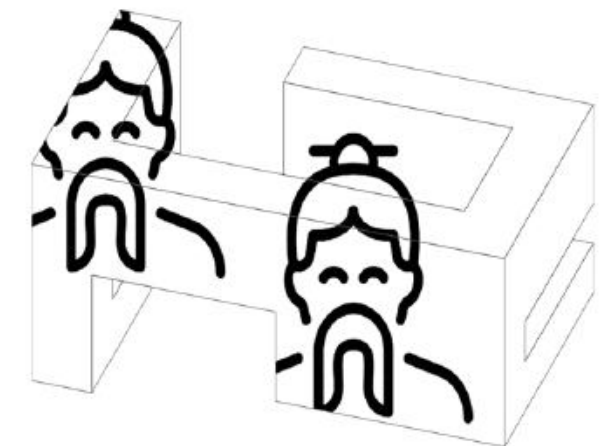
CONCLUSIONS FOR OUR PROJECT - APPLICATIONS



The holes allow the entrance of lights and wind and also creating cultural spaces.



The trees offer protection from humidity and high temperatures.



Respect the surroundings and the chinese history with the typical shape of the courtyard habitation.

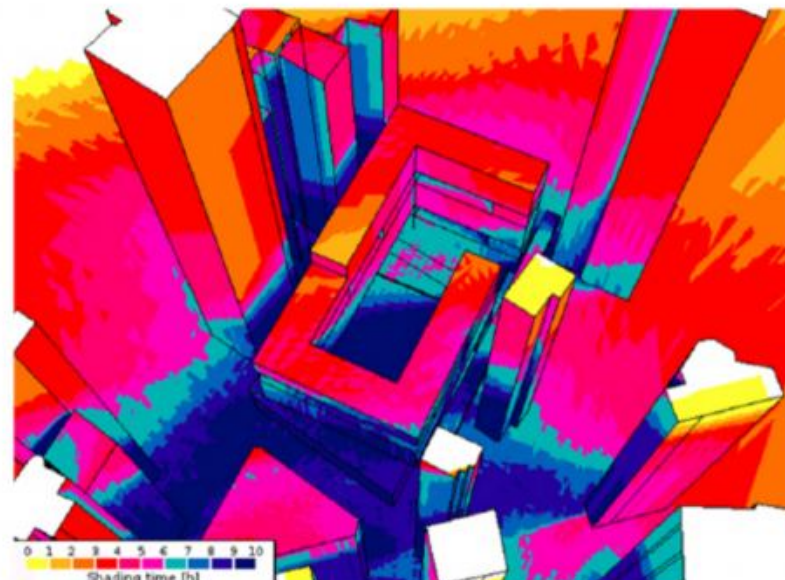
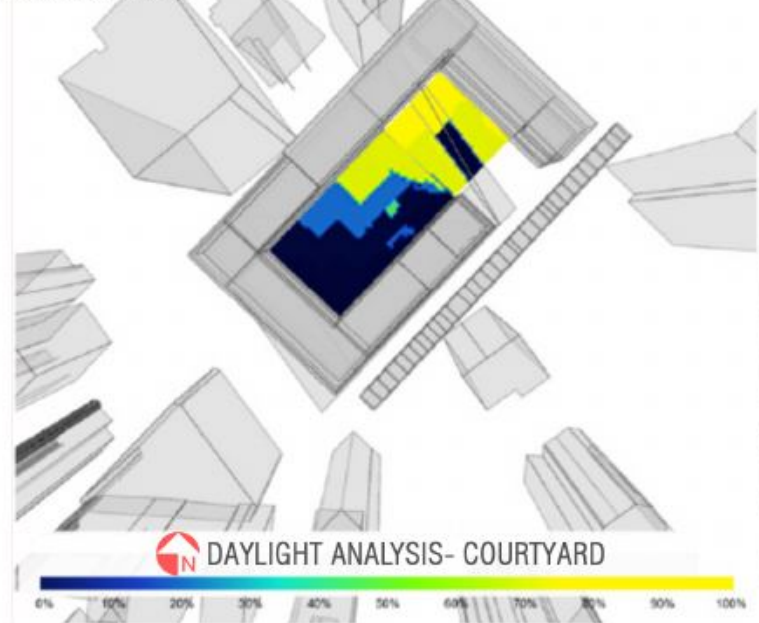
DAYLIGHT TASK - RESIDENTIAL BLOCKS

INTRODUCTION OF STRATEGIES

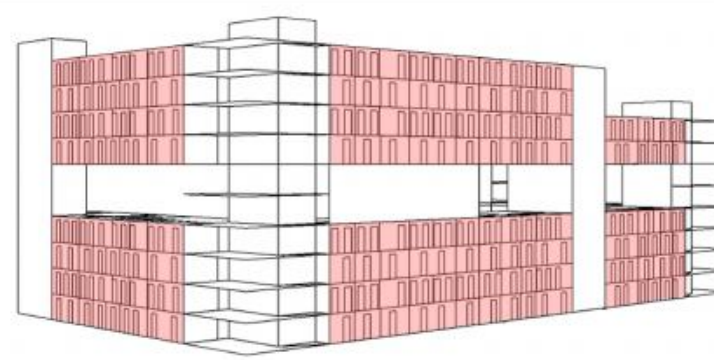
DAYLIGHT ANALYSIS IS DONE FIRSTLY BASED ON FORMER ASSESSMENT ON OUR GENERAL VOLUME AND COURTYARD IN THE CONTEXT. AFTER THAT WE EVALUATED 2 EXTERNAL AND INTERNAL FACADES SEPARATELY AND ROOM BY ROOM OF EVEN FLOORS OF RESIDENTIAL BLOCKS (LEVELS: 2ND, 4TH, 6TH AND 8TH).

IN EXTERNAL FACADE, WE ANALYSED 3 DIFFERENT CASES WITH VARIOUS NUMBERS OF WINDOWS, REGARDING TO ARCHITECTURAL DESIGN IDEAS. AFTER GENERAL ANALYSIS WE TOOK THE ROOMS WITH THE WORST SITUATIONS, IN EACH ORIENTATION, AND WE RAN NEW SIMULATIONS TO ASSESS THE DAYLIGHT BEHAVIOUR OF EACH ROOM.

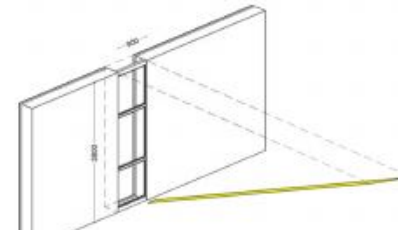
AND FOR INTERNAL ENVELOPE, 3 CASES OF DIFFERENT NUMBERS OF SHADINGS ARE TAKEN INTO ACCOUNT TO OBTAIN THE BEST DAYLIGHT CONDITION IN OUR BUILDING. IN THIS PART 2 COMMON AREAS IN EVEN FLOORS ARE SHOWN AS EXAMPLES FOR FURTHER ASSESSMENT.



STRATEGIES FOR EXTERNAL FACADE

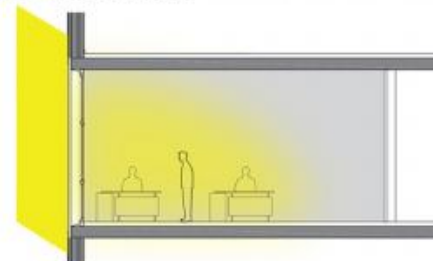


REACHING THE IDEA OF MAXIMIZING AMBIENT SUNLIGHT, WE USED DIFFERENT NUMBERS OF A WINDOW MODULE FOR EXTERNAL FACADE.



DIRECT SUNLIGHT- SLOT WINDOW

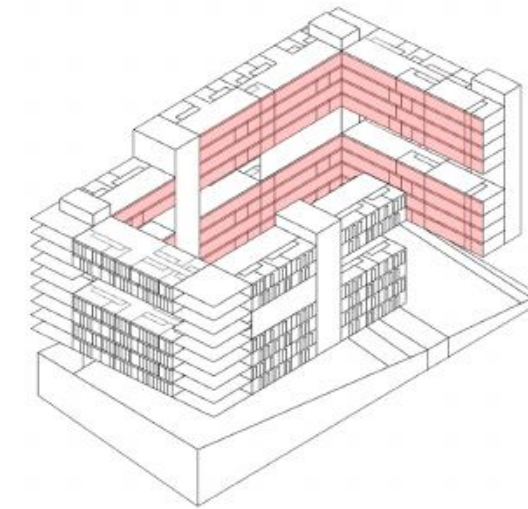
USING SLOT WINDOWS WITH 1.05 m x 3m DIMENSION, FOR SAME GLAZED AREA, WE CAN REDUCE DIRECT SUN PENETRATION, AND SIMULTANEOUSLY LIGHT QUALITY WOULD INCREASE AND COME DEEPER WITHIN THE SPACE.



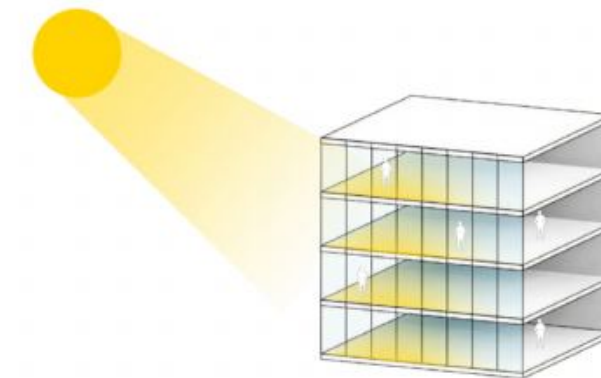
AMBIENT SUNLIGHT- SLOT WINDOW



STRATEGIES FOR INTERNAL FACADE



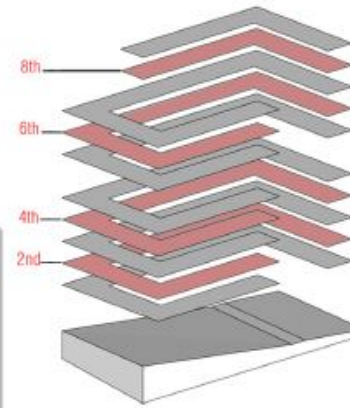
FOR THE INTERNAL FACADE, WITH THE VIEW OF THE COURTYARD, WE DECIDED TO HAVE A LIGHTER FACADE. THEREFORE, IT CAN INDUCE THE SENSE OF WIDER SPACE FROM THE COURTYARD VIEW. TO REACH THIS IDEA OF ILLUMINATION AND LIGHTNESS, CURTAINWALLS ARE PROPOSED FOR EVERY DIFFERENT ORIENTATION OF INTERNAL FACADE.



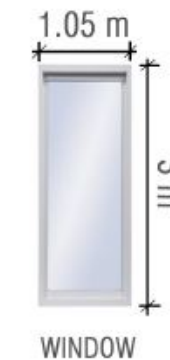
EXTERNAL FACADE ANALYSIS



KEY PLAN



KEY LEVELS



WINDOW

CASE 1 (BASE CASE)

THE BASE CASE OF EXTERIOR FACADE HAS BEEN DONE TAKING INTO ACCOUNT THE ROOMS WITH DIFFERENT RATIO, HAVING DIFFERENT NUMBERS OF SAME WINDOW MODULE. THE 15 sqm ROOM HAS ONE WINDOW AND THE 35 sqm, IS CONSIDERED TO HAVE TWO WINDOWS. EACH MODULE WINDOW IS 1.05m x 3m.

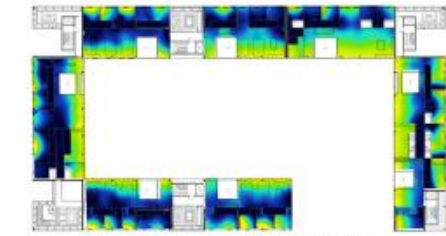
RESULT: WITH THIS DIMENSION OF WINDOWS, sDA VALUES ARE NOT ACCEPTABLE IN MOST THE ROOMS. THE WORST SITUATION IN TERMS OF sDA ARE SHOWN IN TABLES AND PLANS.



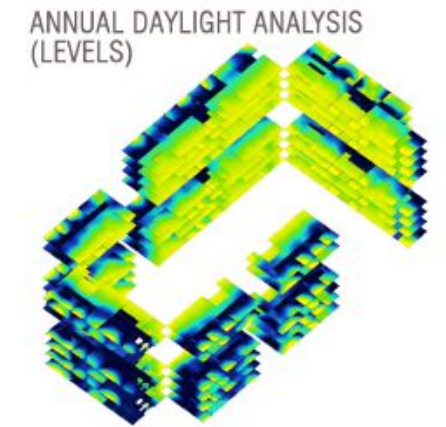
15 msq-ROOM
1 WINDOW
WINDOW SIZE:
1.05m x 3m



35 msq-ROOM
2 WINDOWS
WINDOW SIZE:
1.05m x 3m



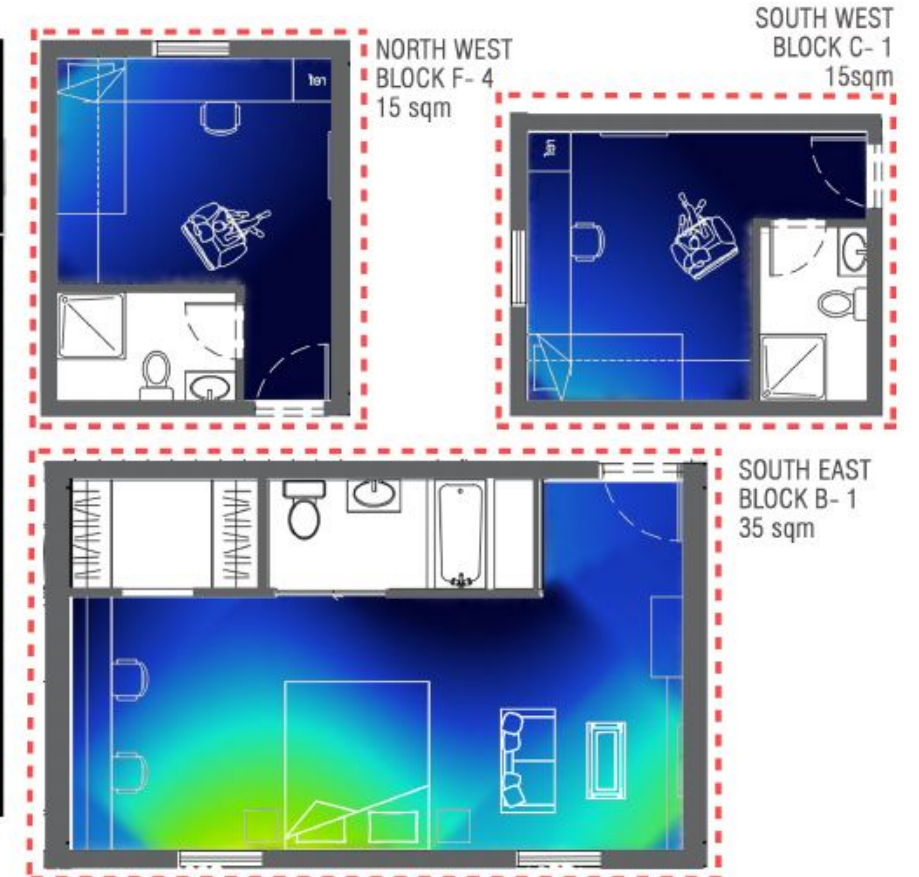
ANNUAL DAYLIGHT ANALYSIS (PLAN)



ANNUAL DAYLIGHT ANALYSIS (LEVELS)

EXTERNAL FACADE ANALYSIS CASE 1 (BASE CASE)

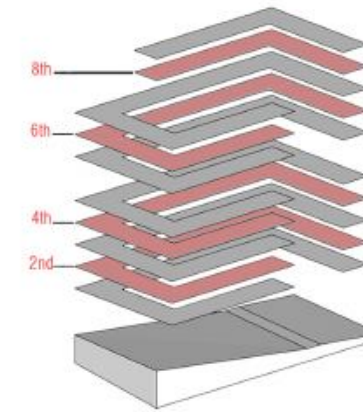
EXTERNAL FACADE ANALYSIS CASE 1 (BASE CASE)		EXTERNAL FAÇADE																												
		SOUTH EAST								SOUTH WEST				NORTH WEST										NORTH EAST						
		BLOCK A				BLOCK B				BLOCK C				BLOCK D				BLOCK E			BLOCK F			BLOCK G				BLOCK H		
		1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	1	2	3	4	5	1	2	3	4	1
DF (%)	FLOOR 2	1.2	1.5	1.3	0.8	0.5	0.8	0.6	1.0	0.3	0.9	0.5	1.0	1.4	1.1	1.1	0.8	0.5	0.3	0.5	0.6	0.4	0.7	0.3	0.6	3.5	1.6	1.8	1.9	2.0
	FLOOR 4	1.2	1.6	1.3	0.8	0.6	0.9	0.7	1.0	0.5	1.1	0.5	1.1	1.4	1.2	1.1	0.9	0.5	0.3	0.5	0.6	0.4	0.8	0.3	0.7	3.5	1.7	1.9	1.7	1.9
	FLOOR 6	1.1	1.5	1.4	0.8	0.6	1.1	0.9	1.1	0.5	1.4	0.7	1.3	1.3	1.0	1.2	1.0	0.5	0.3	0.5	0.7	0.4	0.7	0.5	0.7	3.4	1.6	1.8	1.8	1.9
	FLOOR 8																	0.6	0.3	0.6	0.7	0.5	0.8	0.7	1.1	3.5	1.6	1.9	1.9	1.9
sDA (%)	FLOOR 2	43	33	50	20	10	33	50	33	10	33	33	40	33	50	33	17	20	20	9	33	8	30	7	43	67	50	50	67	67
	FLOOR 4	50	33	50	20	17	33	50	33	10	33	33	40	33	50	33	17	20	20	9	33	8	30	7	50	50	50	50	67	67
	FLOOR 6	50	33	50	20	17	33	50	33	10	33	33	40	33	50	33	50	20	20	9	33	8	30	7	50	50	50	50	67	67
	FLOOR 8																	20	33	9	33	8	30	7	50	67	50	50	67	67
ASE (%)	FLOOR 2	36	33	36	11	3	3	3	33	4	10	4	10	3	3	3	3	2	0	0	0	0	0	0	0	17	0	0	17	0
	FLOOR 4	36	33	36	11	3	3	3	33	4	10	4	10	3	3	3	3	2	0	0	0	0	0	0	0	17	0	0	17	0
	FLOOR 6	41	33	41	11	3	3	3	33	13	17	13	17	3	3	3	3	2	0	0	0	0	0	0	0	17	0	0	17	0
	FLOOR 8																	2	0	0	0	0	0	0	0	17	0	0	17	0



EXTERNAL FACADE ANALYSIS



KEY PLAN



KEY LEVELS

1.05 m

3 m

WINDOW

CASE 2

AFTER MAKING ANALYSIS ON THE BASE CASE, WE DETERMINED THAT THE VALUES OF DF AND sDA SHOULD BE INCREASED. THEREFOR, IN CASE 2, WE CONSIDERED 2 WINDOWS FOR 15msq-ROOMS AND 3 WINDOWS FOR 35-msq-ONES.

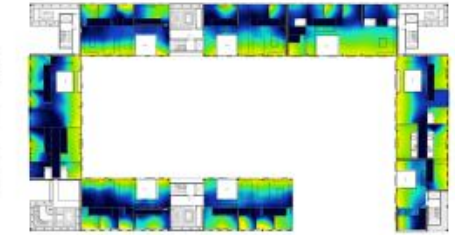
RESULT: ANALYSING THE CASE 2 VALUES, SAME ISSUES IN sDA VALUES IS STILL EXISTED.



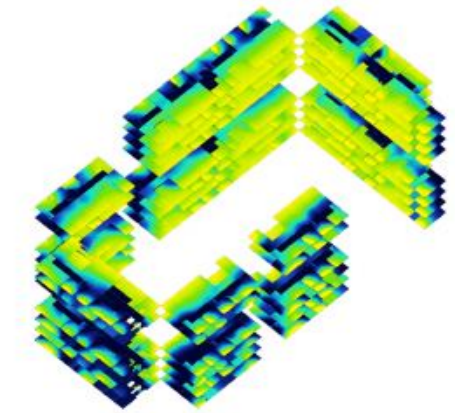
15 msq-ROOM
2 WINDOWS
WINDOW SIZE:
1.05m x 3m



35 msq-ROOM
3 WINDOWS
WINDOW SIZE:
1.05m x 3m



ANNUAL DAYLIGHT ANALYSIS (PLAN)



ANNUAL DAYLIGHT ANALYSIS (LEVELS)

EXTERNAL FACADE ANALYSIS (CASE 2)

		EXTERNAL FAÇADE																											
		SOUTH EAST								SOUTH WEST				NORTH WEST										NORTH EAST					
		BLOCK A				BLOCK B				BLOCK C				BLOCK D				BLOCK E				BLOCK F				BLOCK G			
		1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	5	1	2	3	4	1	2	3
DF (%)	FLOOR 2	1.4	1.5	1.3	1.4	0.8	0.9	0.6	1.8	0.4	1.1	0.7	1.4	1.3	0.8	1.1	1.1	0.6	0.3	0.6	0.7	0.7	0.8	0.4	0.6	4.6	1.6	2.7	3.3
	FLOOR 4	1.5	1.4	1.3	1.4	0.9	0.9	0.7	1.5	0.4	1.3	0.9	1.7	1.5	0.9	1.1	1.2	0.6	0.3	0.7	0.8	0.9	1.0	0.5	0.7	4.6	1.6	2.5	3.4
	FLOOR 6	1.5	1.6	1.4	1.4	1.0	1.2	0.9	1.5	0.6	1.7	1.1	1.9	1.5	0.8	1.2	2.2	0.6	0.3	0.7	0.9	0.9	1.0	0.8	1.0	4.6	1.6	2.6	3.3
	FLOOR 8																	0.9	0.3	0.9	0.9	1.0	1.1	0.9	1.0	4.5	1.6	2.7	3.4
sDA (%)	FLOOR 2	83	83	67	60	17	49	57	67	20	50	43	80	67	50	33	67	30	20	50	37	20	50	20	50	83	50	91	83
	FLOOR 4	93	93	67	80	33	49	57	67	20	50	43	80	67	50	33	67	30	20	50	37	20	50	20	57	83	50	91	83
	FLOOR 6	93	93	67	80	33	49	57	67	33	50	43	100	67	50	33	83	30	20	50	37	33	50	50	57	91	50	91	83
	FLOOR 8																	40	33	50	50	33	50	50	57	91	50	91	83
ASE (%)	FLOOR 2	40	40	20	17	3	3	3	33	5	17	7	11	4	3	3	4	3	0	2	0	0	2	0	0	17	0	3	17
	FLOOR 4	40	40	20	33	3	3	3	33	5	17	7	11	4	3	3	4	3	0	2	0	0	2	0	0	17	0	3	17
	FLOOR 6	43	43	20	33	3	3	3	33	11	33	33	25	4	3	3	4	3	0	2	0	0	2	0	0	17	0	3	17
	FLOOR 8																	3	3	2	2	0	2	0	0	17	0	3	17

0%

50%

65%

100%

sDA

NOT GOOD

ACCEPTABLE

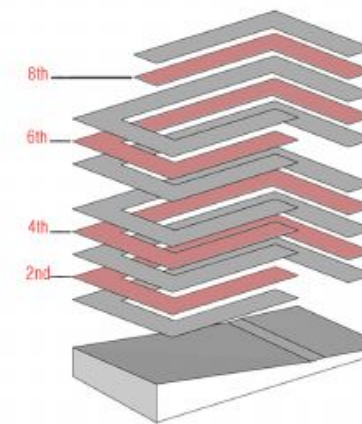
GOOD



EXTERNAL FACADE ANALYSIS



KEY PLAN



KEY LEVELS



CURTAIN WALL

CASE 3

BY MAKING ANALYSIS ON CASE 2, WE STILL HAD PROBLEMS IN TERMS OF sDA IN SOME UNITS (B1, B2, C1, C3, D3, E1, E2, F1, F2, F3).

IN CASE 3, WE CONSIDERED CURTAIN WALLS FOR THESE ROOMS TO MAKE THE sDA VALUE ACCEPTABLE.

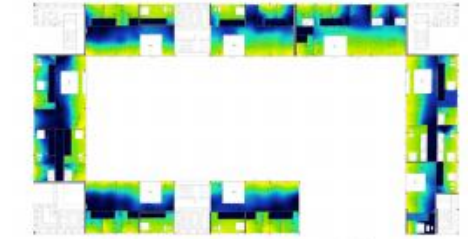
RESULT: FINALLY THE 3 SLECTED WORST SITUATIONS REACHED TO AN ACCEPTABLE AND GOOD VALUES.



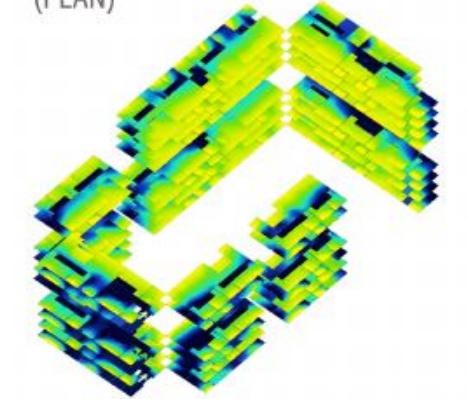
15 msq-ROOM
CURTAIN WALLS



35 msq-ROOM
CURTAIN WALLS



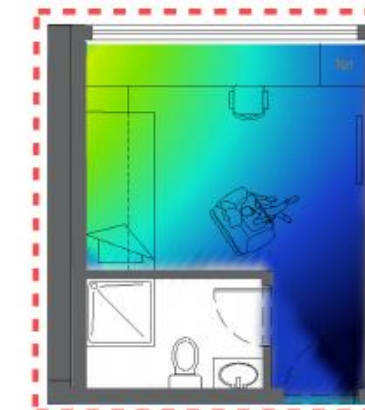
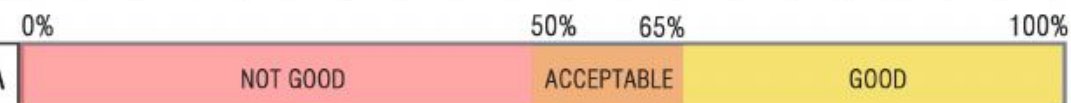
ANNUAL DAYLIGHT ANALYSIS
(PLAN)



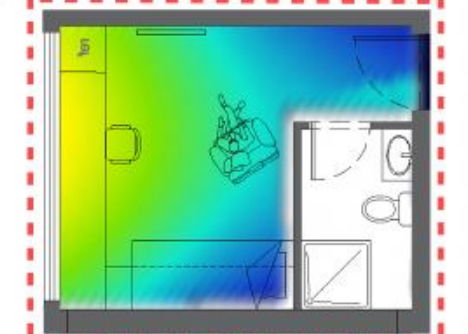
ANNUAL DAYLIGHT ANALYSIS
(LEVELS)

EXTERNAL FACADE ANALYSIS (CASE 3)

EXTERNAL F A C A D E ANALYSIS (CASE 3)		EXTERNAL FAÇADE																													
		SOUTH EAST								SOUTH WEST				NORTH WEST										NORTH EAST							
		BLOCK A				BLOCK B				BLOCK C				BLOCK D				BLOCK E			BLOCK F					BLOCK G				BLOCK H	
		1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	1	2	3	4	5	1	2	3	4	1	
DF (%)	FLOOR 2	1.4	1.5	1.3	1.4	1.8	2.1	0.6	1.8	1.3	1.1	1.4	1.4	1.3	0.8	2.4	1.1	1.8	1.1	0.6	1.7	1.5	0.8	1.6	0.6	4.6	1.6	2.7	3.3	3.7	
	FLOOR 4	1.5	1.5	1.3	1.4	1.8	2.4	0.7	1.5	1.5	1.3	1.4	1.7	1.5	0.9	2.6	1.2	1.8	1.2	0.7	1.7	1.8	1.0	1.3	0.7	4.6	1.6	2.5	3.4	3.6	
	FLOOR 6	1.5	1.5	1.4	1.4	1.9	2.7	0.9	1.5	2.0	1.7	2.0	1.9	1.5	0.8	2.6	2.2	1.9	1.3	0.7	2.0	1.8	1.0	0.9	1.0	4.6	1.6	2.6	3.3	3.9	
	FLOOR 8																	2.2	1.5	0.9	2.1	2.1	1.1	0.9	1.0	4.5	1.6	2.7	3.4	3.9	
sDA (%)	FLOOR 2	83	83	67	60	83	100	57	67	50	50	100	80	67	57	100	67	80	50	50	80	80	50	50	50	83	50	91	83	83	
	FLOOR 4	93	93	67	80	83	100	57	67	50	50	100	80	67	57	100	67	80	67	50	100	100	50	50	57	83	50	91	83	83	
	FLOOR 6	93	93	67	80	83	100	57	67	100	50	100	100	67	57	100	83	100	67	50	100	100	50	67	57	91	50	91	83	83	
	FLOOR 8																	100	67	50	100	100	50	67	57	91	50	91	83	100	
ASE (%)	FLOOR 2	40	40	20	17	3	17	3	33	17	17	17	11	4	3	33	4	3	0	2	0	0	2	0	0	17	0	3	17	17	
	FLOOR 4	40	40	20	33	3	17	3	33	17	17	20	11	4	3	33	4	3	0	2	3	3	2	0	0	17	0	3	17	17	
	FLOOR 6	43	43	20	33	17	17	3	33	33	33	33	25	4	3	33	4	3	0	2	3	3	2	0	0	17	0	3	17	17	
	FLOOR 8																	3	3	2	3	3	2	0	0	17	0	3	17	17	



NORTH WEST
BLOCK F- 4
15 sqm

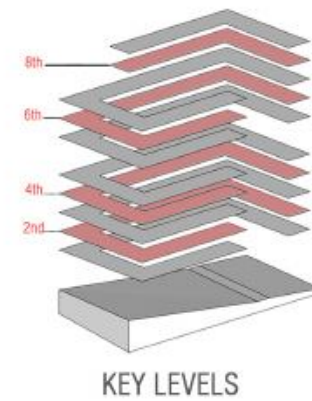
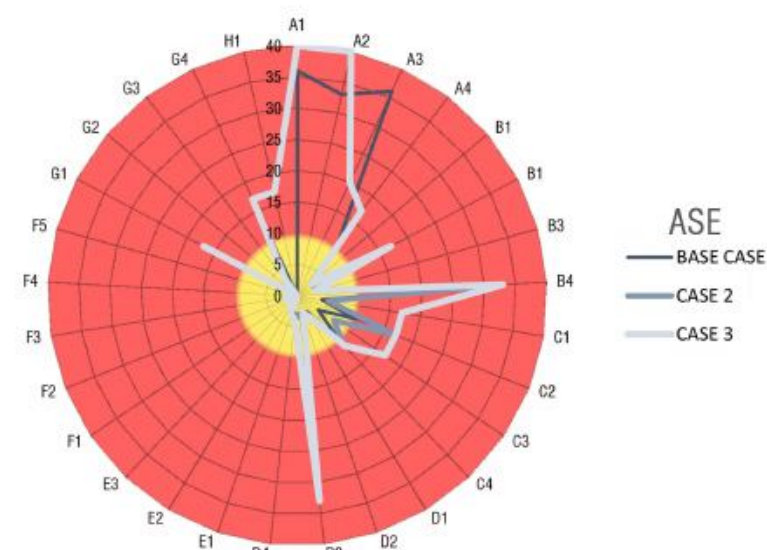
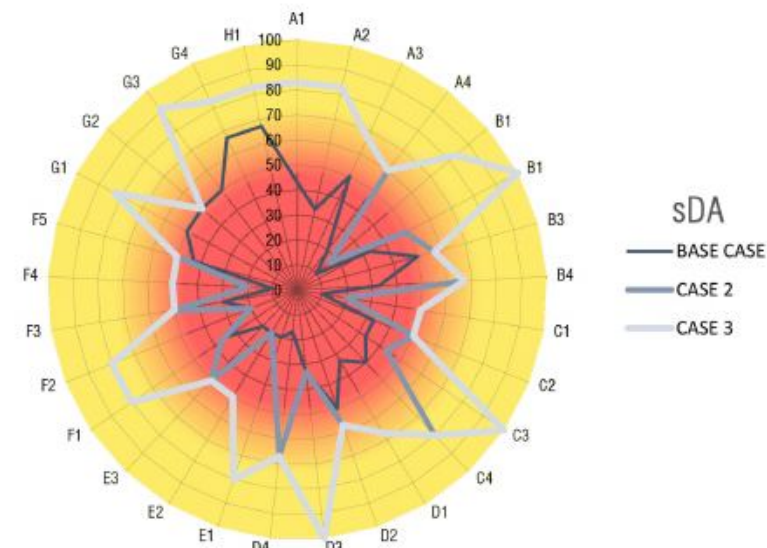
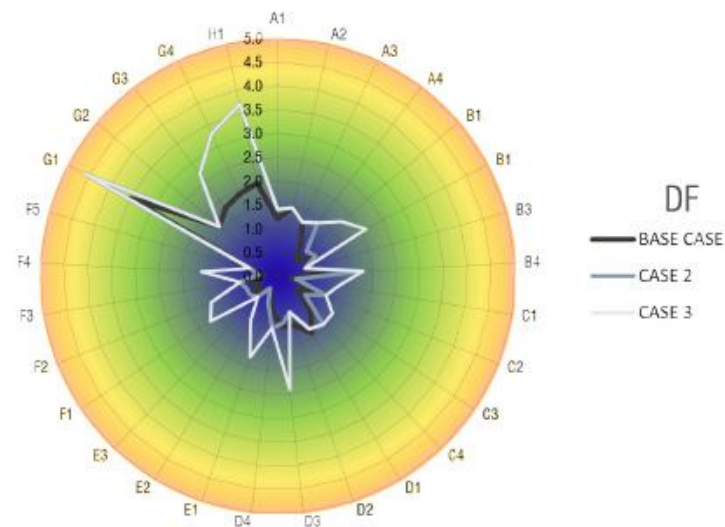


SOUTH WEST
BLOCK C-1
15 sqm



SOUTH EAST
BLOCK B- 1
35 sqm

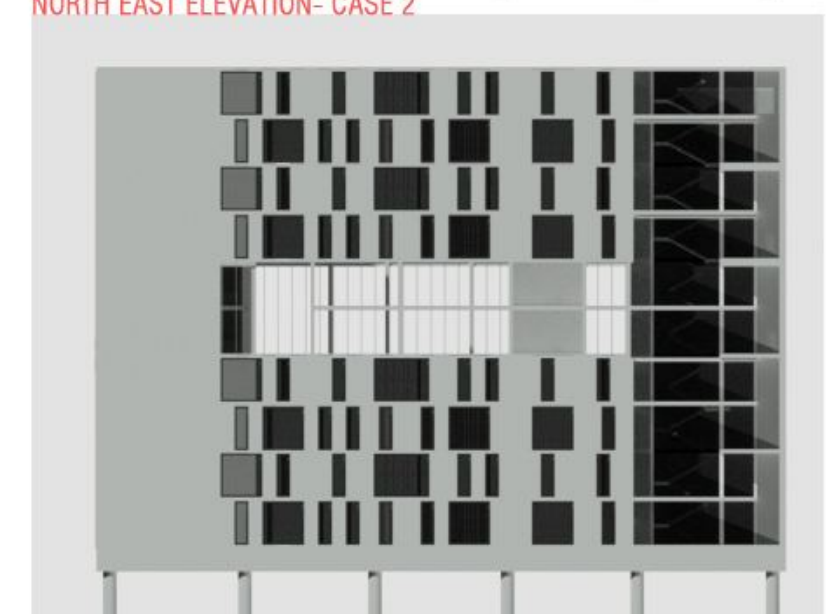
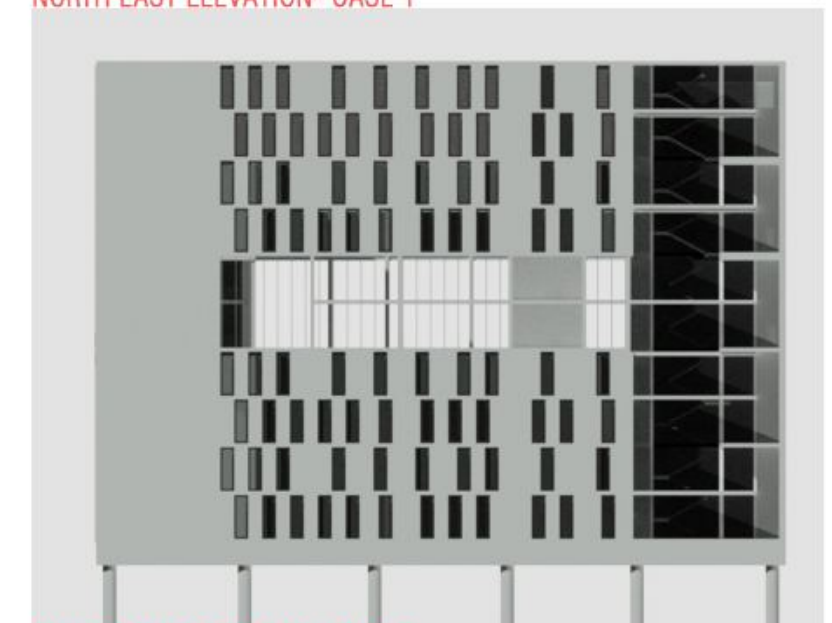
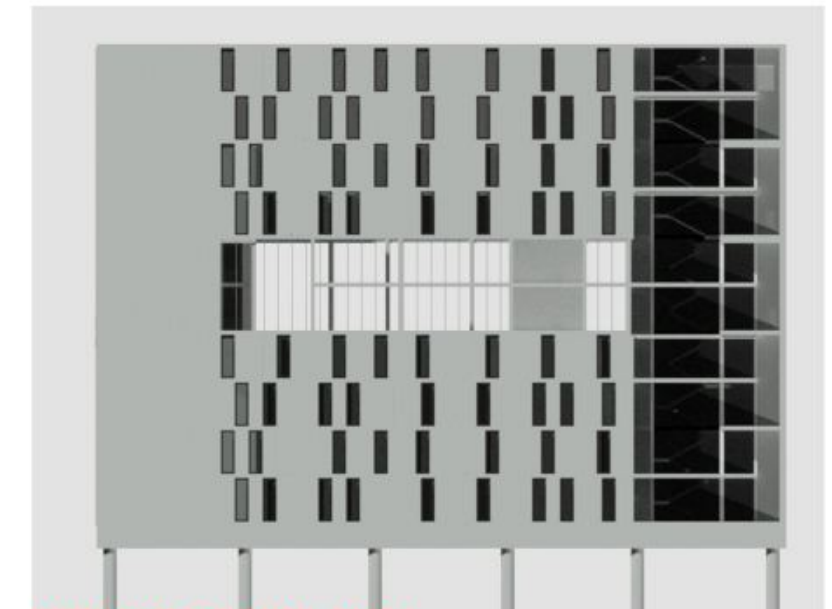
COMPARISON OF 3 CASES



3 DIFFERENT COMPOSITIONS BASED ON THE CHANGES OF 3 CASES (EXTERIOR WINDOWS NUMBERS AND DISTRIBUTION) ARE SHOWN IN NORTH EAST FACADE.

AFTER MAKING ANALYSIS ON THE BASE CASE OF EXTERNAL FACADE AND COMPARING THE sDA AND ASE CHARTS OF 3 CASES, WE DETERMINED THAT THE VALUES OF sDA ARE QUITE LOW, BUT ASE AMOUNTS ARE IN AN ACCEPTABLE RANGE IN MOST OF THE ROOMS BUT IN SOME ROOMS WITH ASE PROBLEMS, IT CAN BE SOLVED BY USING INTERNAL CURTAINS. BESIDE THAT IT IS CLEAR THAT THE DIFFERENCE OF HEIGHT DOES NOT AFFECT SIGNIFICANTLY sDA AND ASE VALUES IN EXTERIOR FACADE, SO, THESE VALUES DOES NOT CHANGE CONSIDERABLY. IMPLEMENTING THE THIRD CASE, WE REACHED A CONSIDERABLE INCREASE IN sDA VALUES, WHILE THE INCREASES IN AMOUNT OF ASE WAS NEGLIGIBLE IN DIFFERENT FLOORS AND BLOCKS.

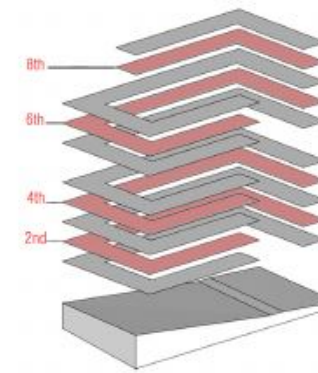
RESULT: ALTHOUGH CASE 3 IS THE BEST CHOICE IN TERMS OF ACCEPTABLE AMOUNT OF sDA, CASE 2 WAS CHOSEN REGARDING THE ARCHITECTURAL DESIGN DECISIONS FOR THE EXTERNAL FACADE.



INTERNAL FACADE ANALYSIS



KEY PLAN



KEY LEVELS



CURTAIN WALL

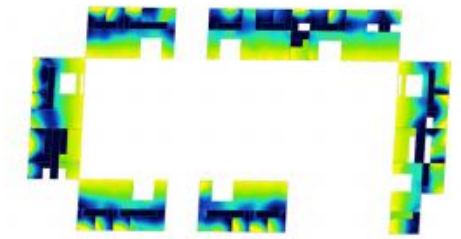
BASE CASE (INTERIOR FACADE) NO SHADING

THE BASE CASE OF INTERIOR FACADE IS CONSIDERED TO HAVE CURTAIN WALL ALL ALONG THE FACADE, TO MAKE IT LIGHTER FROM THE COURTYARD VIEW. IN THIS CASE WE DO NOT HAVE SHADINGS IN INTERIOR FACADE.

AFTER A GENERAL ANALYSIS OF THE BASE CASE OF INTERIOR FACADE, WE FOUND OUT THAT, IN CONTRADICTION WITH EXTERIOR FACADE, DIFFERENCE IN HEIGHT CAN AFFECT sDA AND ASE VALUES APPROXIMATELY. THIS INCREASE IN HIGHER LEVELS MADE US TO USE MORE SHADING PANELS THAN IN LOWER LEVELS. IN OTHER WORDS, THE HIGHER LEVELS, THE MORE SHADINGS ARE NEEDED.

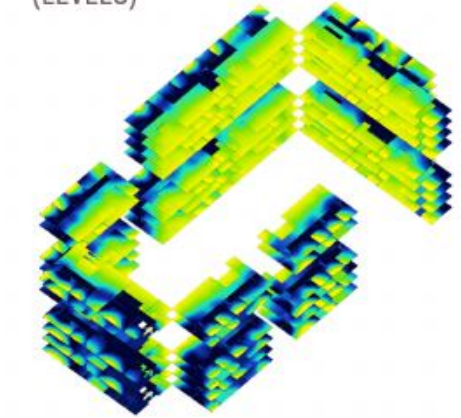
IT SHOULD BE MENTIONED THAT ACCORDING TO THE PREVIOUS ANALYSIS, THE AMOUNT OF sDA AND ASE VALUES IN NORTHERN BLOCKS (NORTH WEST AND NORTH EAST), IN AVERAGE ARE HIGHER THAN THE SOUTHERN ONES.

NEXT STEP: ACCORDING TO ASE VALUES, THE WORST SITUATIONS ARE IN BLOCK E AND G. THEREFORE, WE CHOSE COMMON SPACES IN THESE BLOCKS FOR FURTHER ASSESSMENT.



ANNUAL DAYLIGHT ANALYSIS
(PLAN)

ANNUAL DAYLIGHT ANALYSIS
(LEVELS)

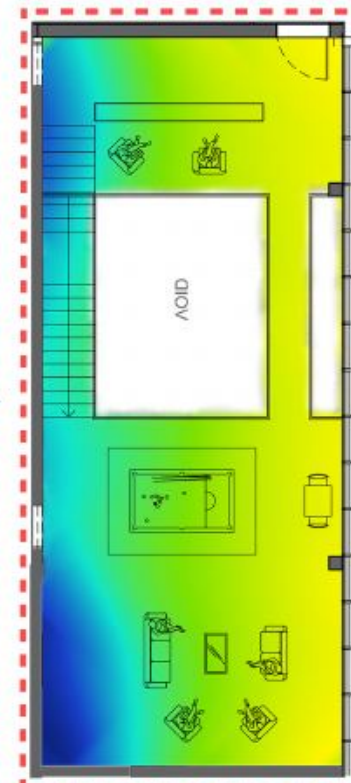


INTERIOR FACADE ANALYSIS (BASE CASE)

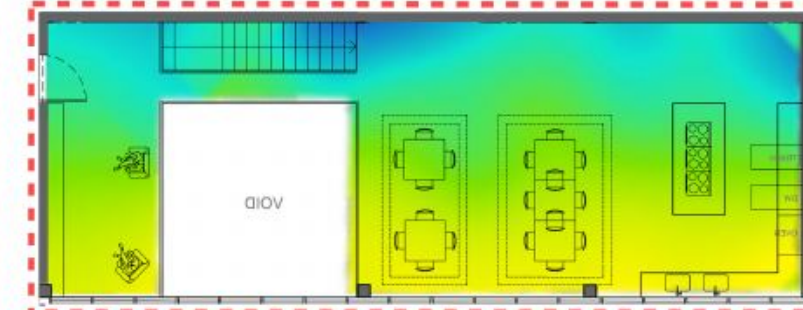
INTERIOR FACADE ANALYSIS (BASE CASE)		INTERIOR FAÇADE													
		SOUTH EAST		SOUTH WEST			NORTH WEST				NORTH EAST				
		A	B	BLOCK C			D	E	BLOCK F		BLOCK G		BLOCK H		
		C	C	C	1	2	C	C	C	1	C	1	C	1	
DF	FLOOR 2	1.4	1.4	1.9	2.7	3.1	1.8	2.2	2.2	2.4	2.2	3.9	1.9	1.4	
	FLOOR 4	1.6	1.6	2.1	2.9	3.1	2.0	2.5	2.3	2.9	2.5	3.9	2.2	1.6	
	FLOOR 6	2.3	2.5	3.1	3.9	3.0	3.0	3.1	2.6	3.3	3.1	3.9	2.7	1.6	
	FLOOR 8							3.2	3.3	3.4	3.2	3.9	2.8	2.3	
sDA	FLOOR 2	55	50	50	100	100	55	52	60	100	53	100	55	55	
	FLOOR 4	55	50	50	100	100	55	55	66	100	57	100	65	55	
	FLOOR 6	69	68	84	100	100	68	83	83	100	63	100	82	60	
	FLOOR 8							90	91	100	77	100	91	100	
ASE	FLOOR 2	15	0	6	11	6	17	31	29	33	29	21	18	0	
	FLOOR 4	15	0	6	11	6	29	31	29	33	29	21	36	11	
	FLOOR 6	19	10	6	11	11	34	34	31	33	31	27	36	11	
	FLOOR 8							34	31	33	31	27	36	11	
		010100													
ASE		ACCEPTABLENOT ACCEPTABLE													

BY USING CURTAINWALL IN INTERNAL FACADE WE DO NOT HAVE ANY SIGNIFICANT ISSUE IN TERMS OF sDA.

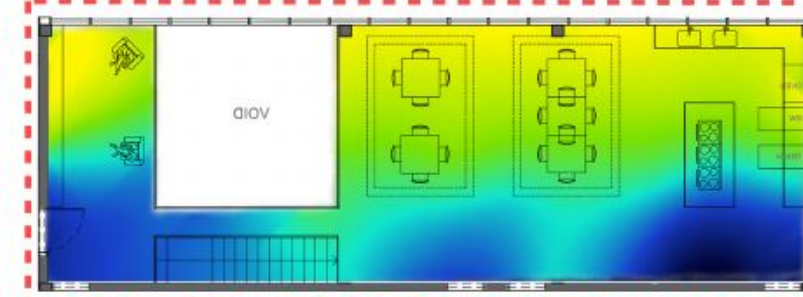
SOUTH WEST
BLOCK C- COMMON SPACE



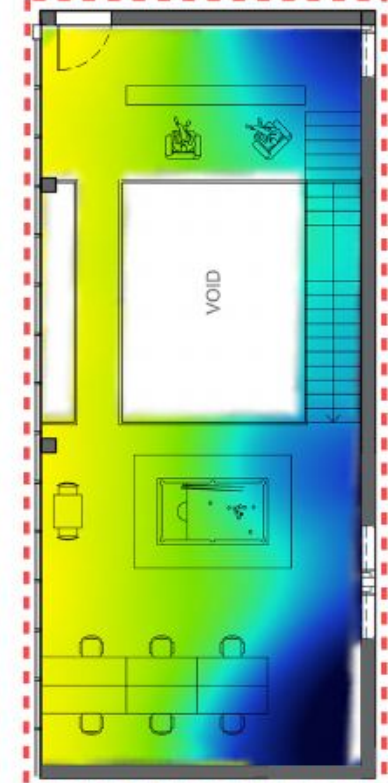
NORTH WEST
BLOCK E- COMMON SPACE



SOUTH EAST
BLOCK A- COMMON SPACE



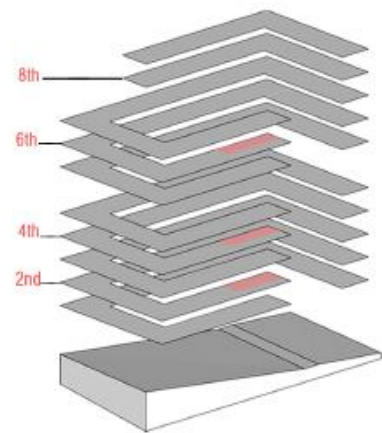
NORTH EAST
BLOCK G- COMMON SPACE



INTERNAL FACADE ANALYSIS



KEY PLAN



KEY LEVELS

BAMBOO SHADINGS

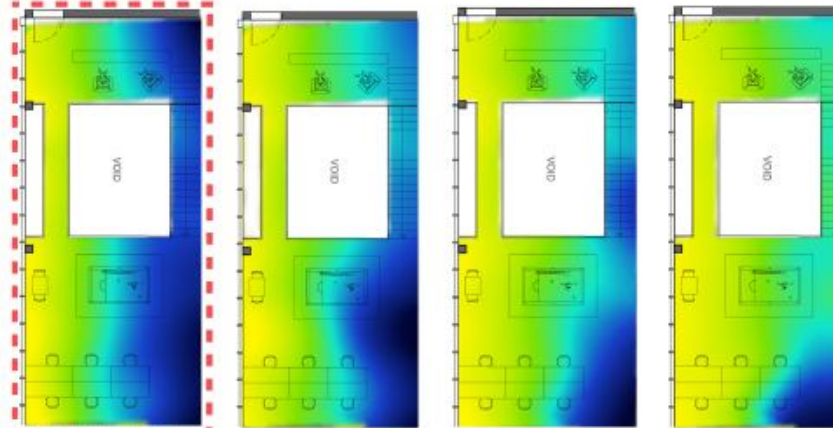


NORTH EAST ELEVATION

BASE CASE (INTERIOR FACADE)

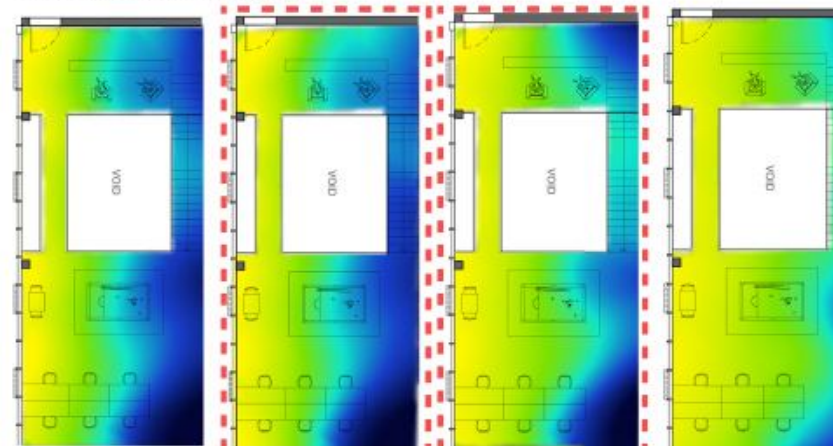
CASE 1 (NO SHADING)

WE CONSIDERED THE BASE CASE WITHOUT SHADING, JUST WITH CURTAIN WALLS.



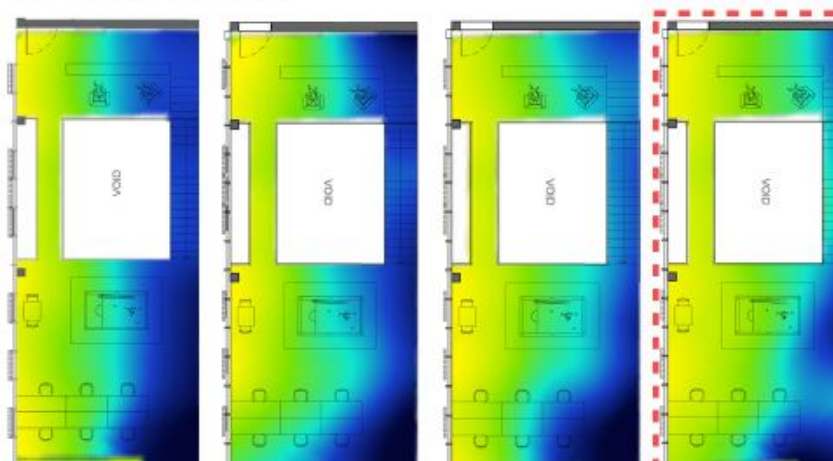
NORTH EAST - LEVEL 2- 4- 6- 8
BLOCK G- COMMON SPACE

CASE 2 (20% SHADING)



NORTH EAST - LEVEL 2- 4- 6- 8
BLOCK G- COMMON SPACE

CASE 3 (40% SHADING)



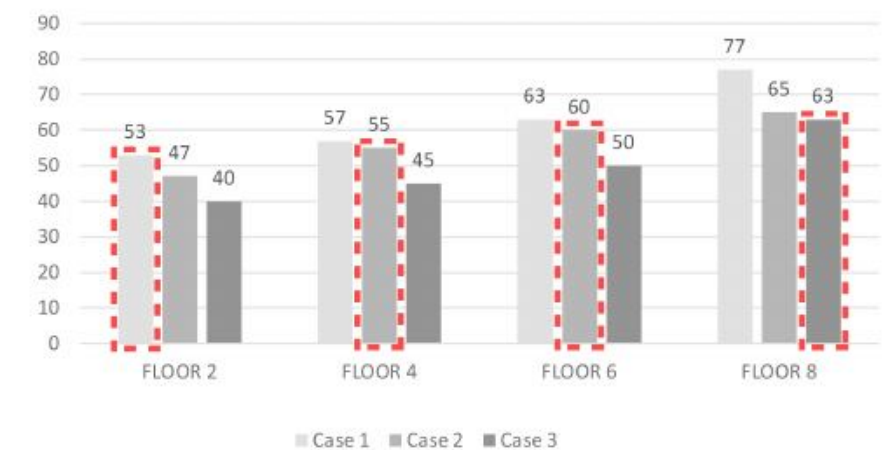
NORTH EAST - LEVEL 2- 4- 6- 8
BLOCK G- COMMON SPACE

ACCORDING TO PREVIOUS ANALYSIS, SHADING PANELS ARE PROPOSED TO DECREASE THE ASE VALUES. AS IT WAS MENTIONED BEFORE, HIGHER LEVELS NEED MORE SHADING PANELS. THEREFORE, WE SELECTED BEST CASE IN TERMS OF LOWER ASE AMOUNT WITH THE ACCEPTABLE RANGE OF SDA VALUE.

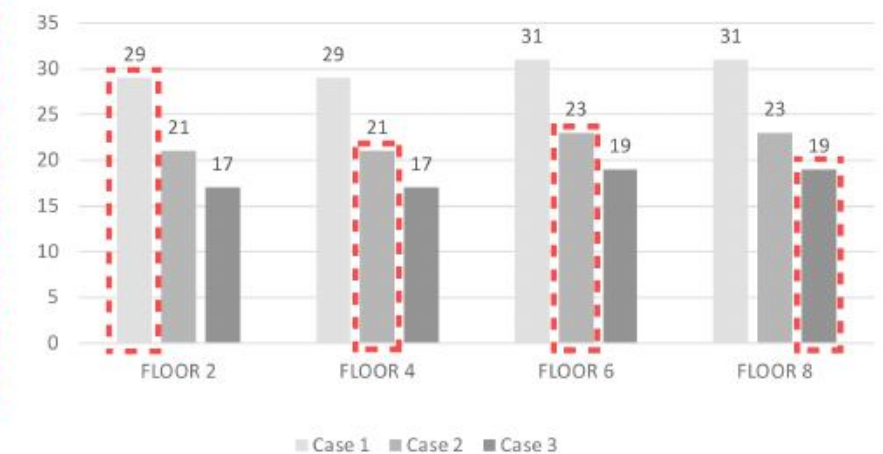
RESULT FOR NORTH EAST FACADE- BLOCK G- COMMON SPACE:

	SELECTED CASE
FLOOR 2	CASE 1
FLOOR 4	CASE 2
FLOOR 6	CASE 2
FLOOR 8	CASE 3

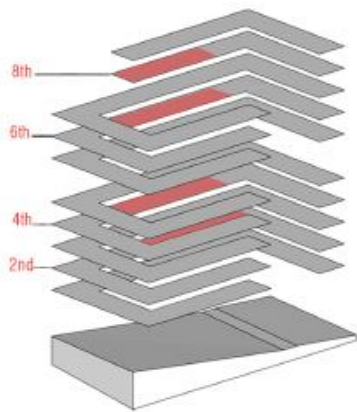
spatial DAYLIGHT AUTONOMY (sDA)



ANUAL SUNLIGHT EXPOSURE (ASE)

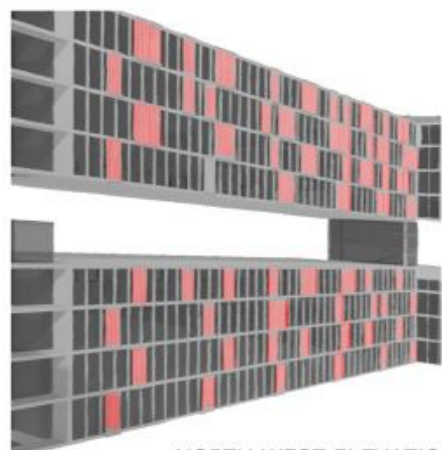


INTERNAL FACADE ANALYSIS



KEY LEVELS

NORTH WEST WING (BLOCK E)		Case 1	Case 2	Case 3
DF	FLOOR 2	2.2	2.1	1.9
	FLOOR 4	2.5	2.2	1.9
	FLOOR 6	3.1	2.6	2.1
	FLOOR 8	3.2	2.8	2.5
sDA	FLOOR 2	52	49	40
	FLOOR 4	55	52	45
	FLOOR 6	83	79	55
	FLOOR 8	90	82	65
ASE	FLOOR 2	31	17	9
	FLOOR 4	31	17	9
	FLOOR 6	34	21	11
	FLOOR 8	34	21	11



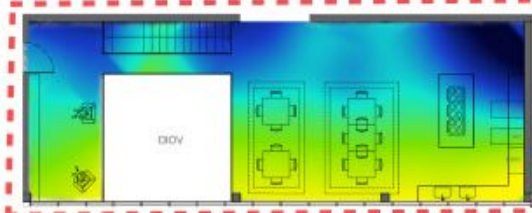
NORTH WEST ELEVATION

RESULT FOR NORTH EAST FACADE- BLOCK G- COMMON SPACE:

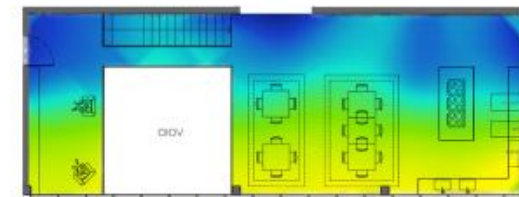
	SELECTED CASE
FLOOR 2	CASE 1
FLOOR 4	CASE 2
FLOOR 6	CASE 2
FLOOR 8	CASE 3

BASE CASE (INTERIOR FACADE) CASE 1 (NO SHADING)

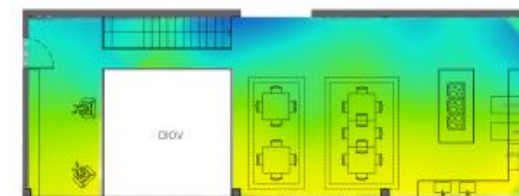
WE CONSIDERED THE BASE CASE WITHOUT SHADING, JUST WITH CURTAIN WALLS.



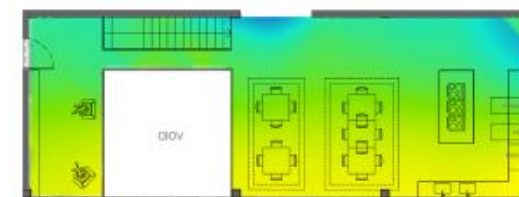
NORTH WEST - LEVEL 2- NO SHADING
BLOCK E- COMMON SPACE



NORTH WEST - LEVEL 4- NO SHADING
BLOCK E- COMMON SPACE

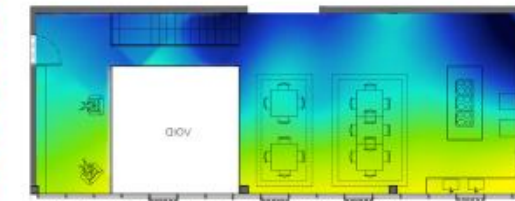


NORTH WEST - LEVEL 6- NO SHADING
BLOCK E- COMMON SPACE

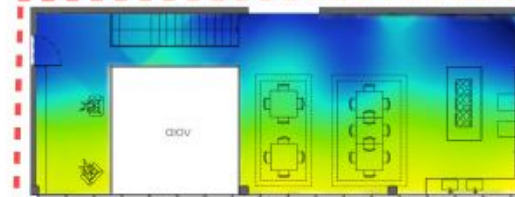


NORTH WEST - LEVEL 8- NO SHADING
BLOCK E- COMMON SPACE

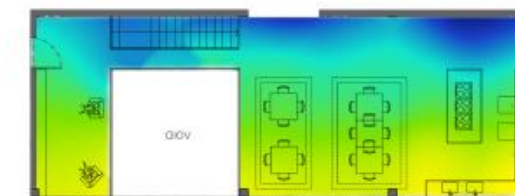
CASE 2 (20% SHADING)



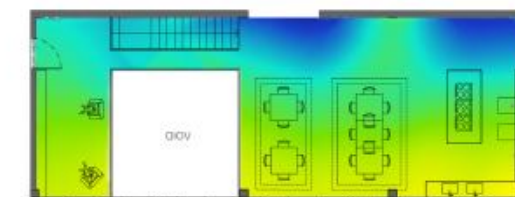
NORTH WEST - LEVEL 2- 4 SHADINGS
BLOCK E- COMMON SPACE



NORTH WEST - LEVEL 4- 4 SHADINGS
BLOCK E- COMMON SPACE

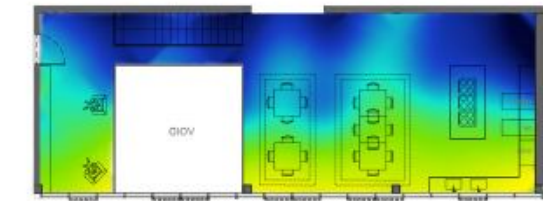


NORTH WEST - LEVEL 6- 4 SHADINGS
BLOCK E- COMMON SPACE

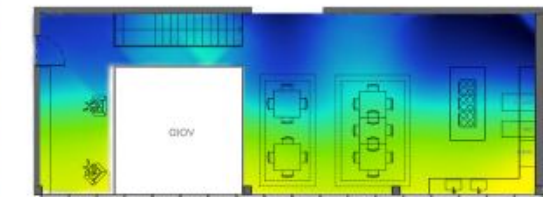


NORTH WEST - LEVEL 8- 4 SHADINGS
BLOCK E- COMMON SPACE

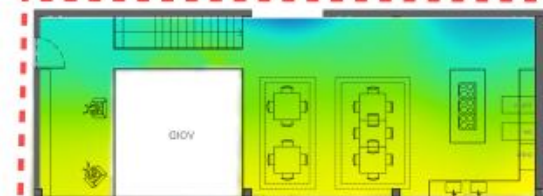
CASE 3 (40% SHADING)



NORTH WEST - LEVEL 2- 8 SHADINGS
BLOCK E- COMMON SPACE



NORTH WEST - LEVEL 4- 8 SHADINGS
BLOCK E- COMMON SPACE

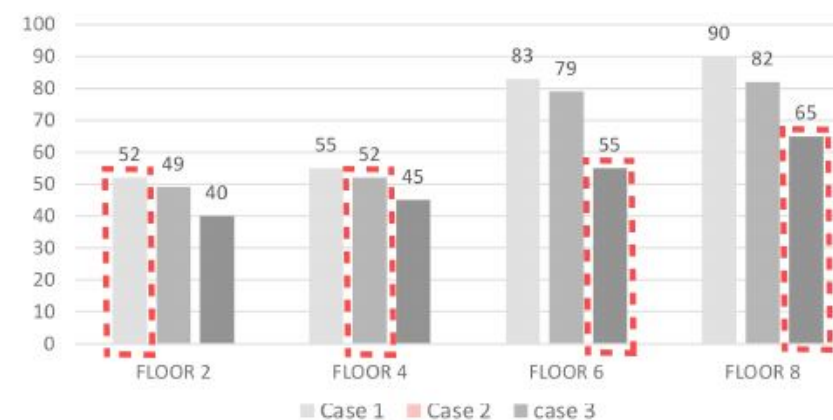


NORTH WEST - LEVEL 6- 8 SHADINGS
BLOCK E- COMMON SPACE

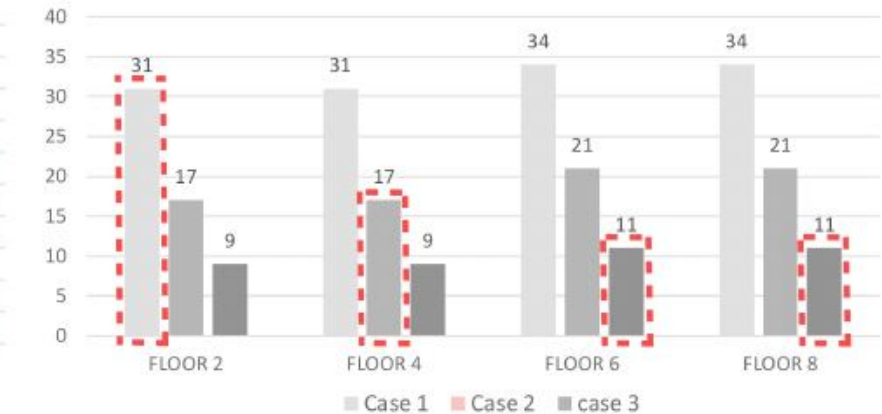


NORTH WEST - LEVEL 8- 8 SHADINGS
BLOCK E- COMMON SPACE

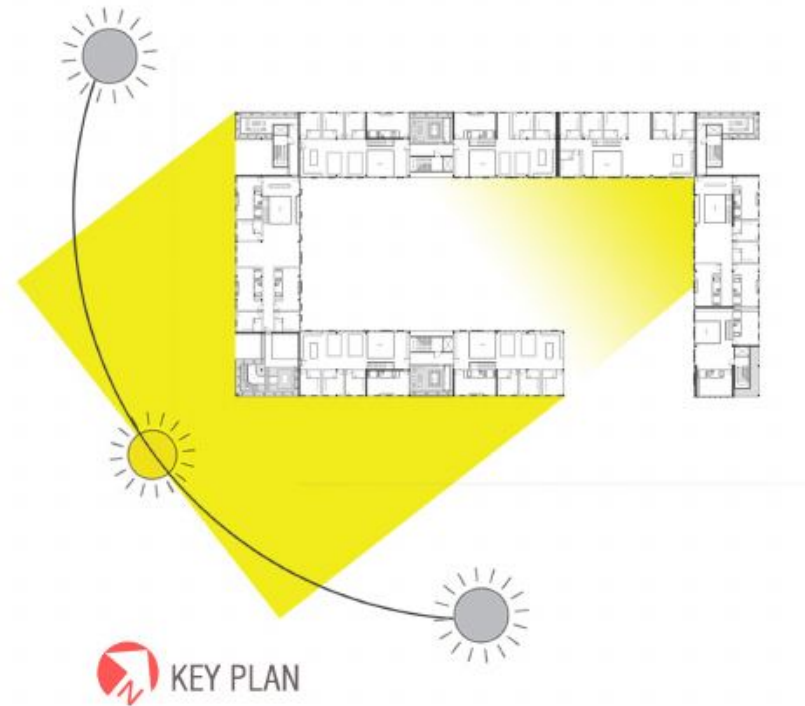
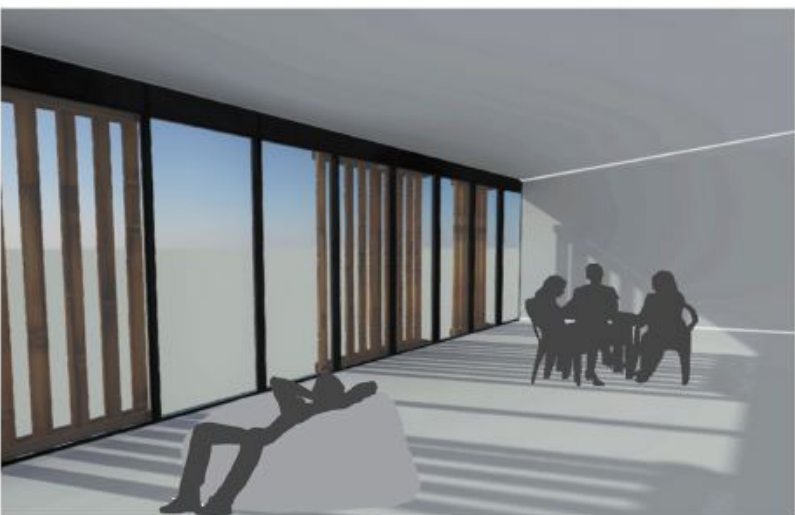
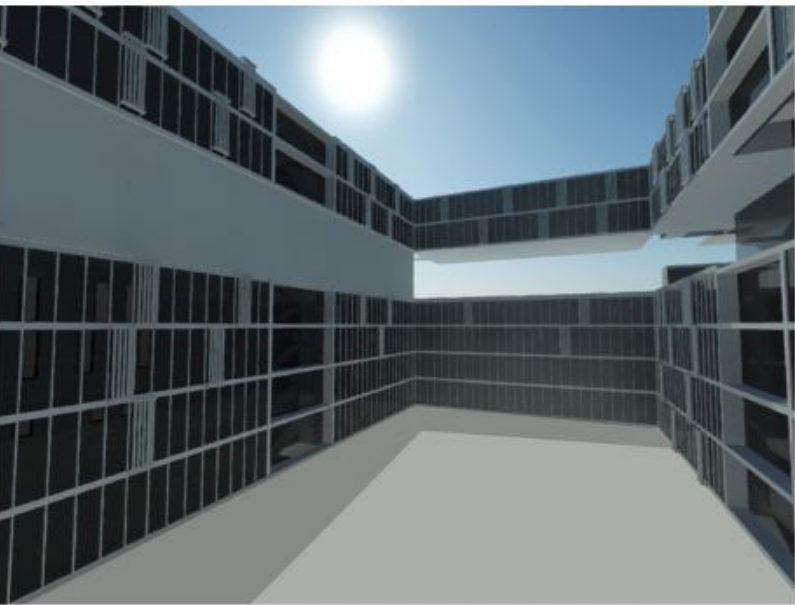
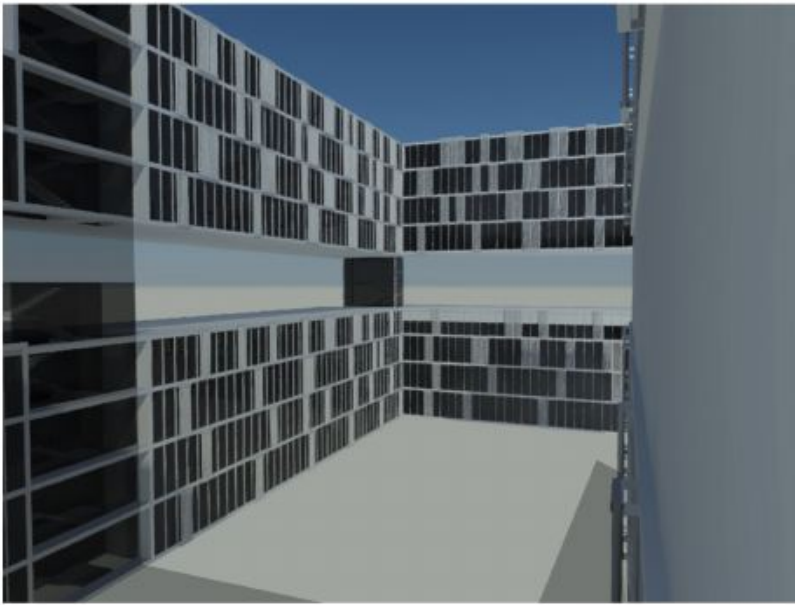
spatial DAYLIGHT AUTONOMY (sDA)



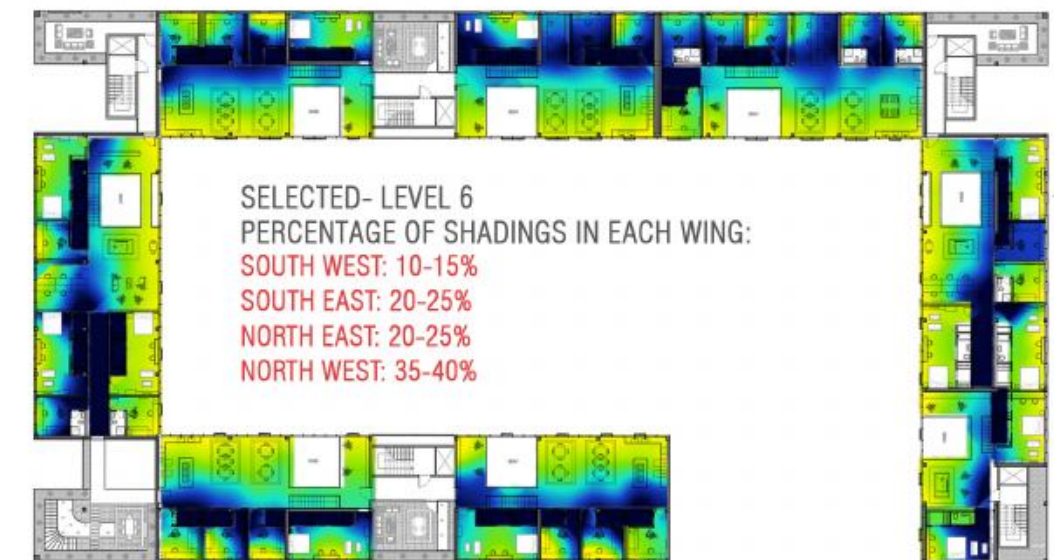
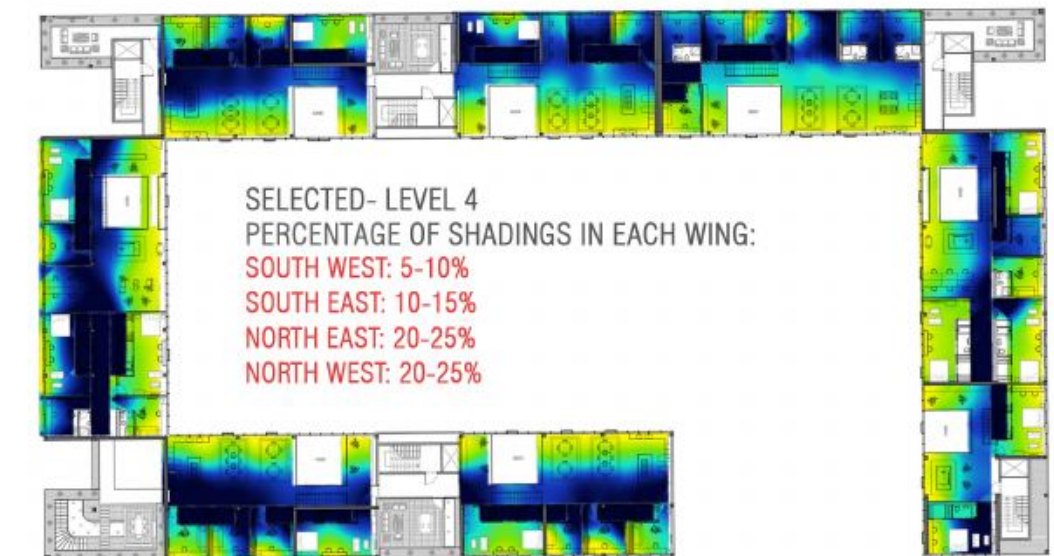
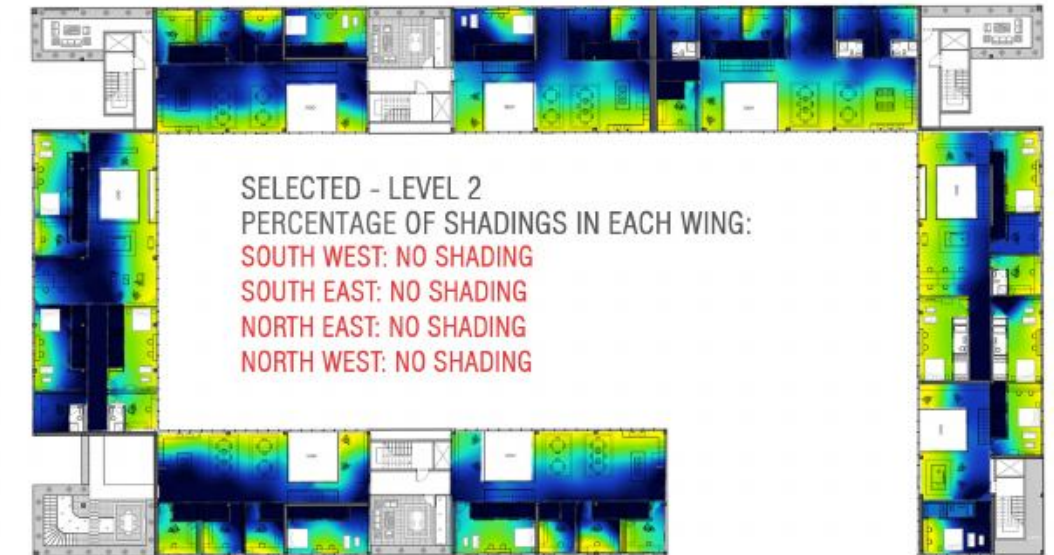
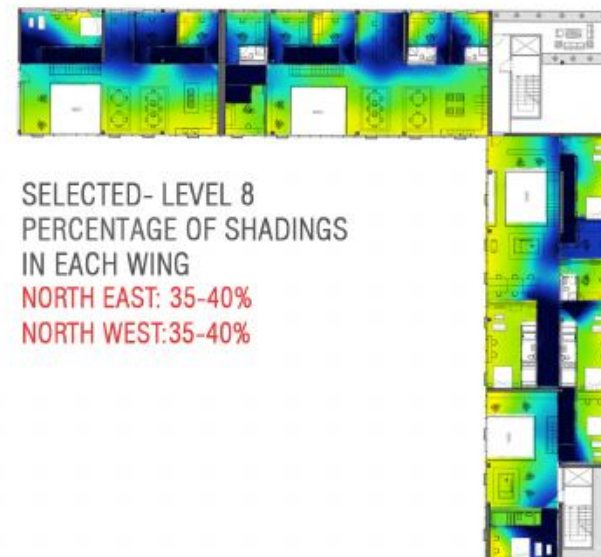
ANUAL SUNLIGHT EXPOSURE (ASE)



SELECTED SITUATION ANALYSIS

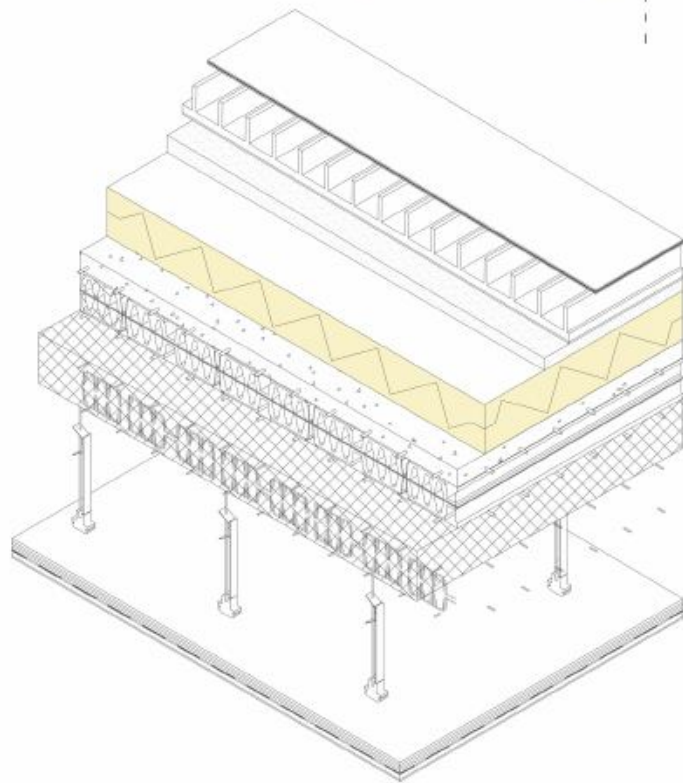
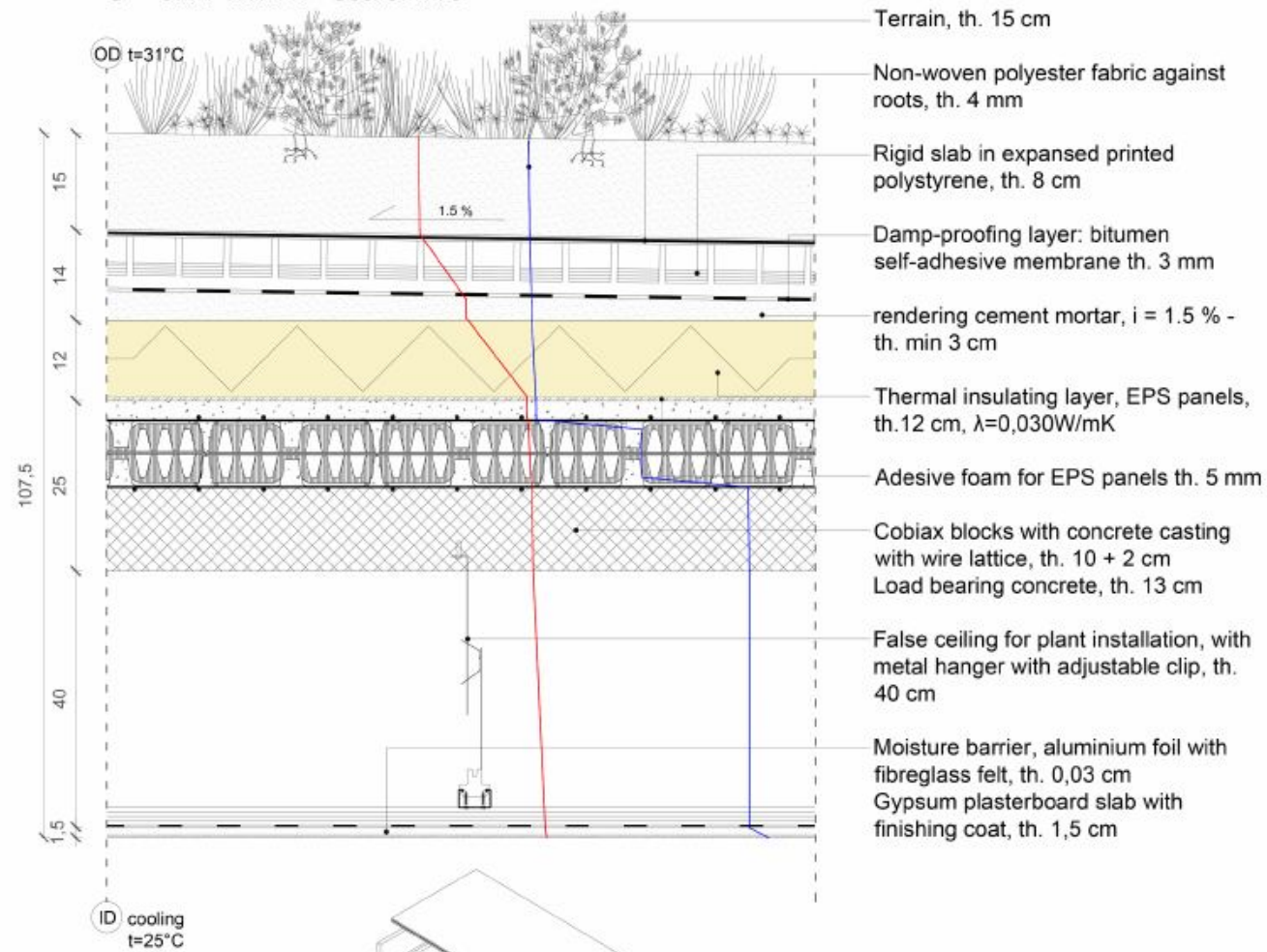


FOR INTRNAL FACADE, BY ANALYSING 2 COMMON SPACES FACING THE INTERNAL COURTYARD IN 2 DIFFERENT ORIENTATIONS, WE REACHED TO THE DIFFERENT VARIATIONS OF SHADINGS IN EACH LEVELS AND ORIENTATIONS. RESULT: REGARDING THE DAYLIGHT FACTORS, NORTHERN BLOCKS NEED MORE SHADING PANELS THAN SOUTHERN ONES. FURTHERMORE, AMONG THE NORTHERN FACADES, NORTH WEST HAS THE HIGHEST AMOUNT OF ASE, THEN IT NEEDS A HIGHER PERCENTAGE OF SHADINGS.



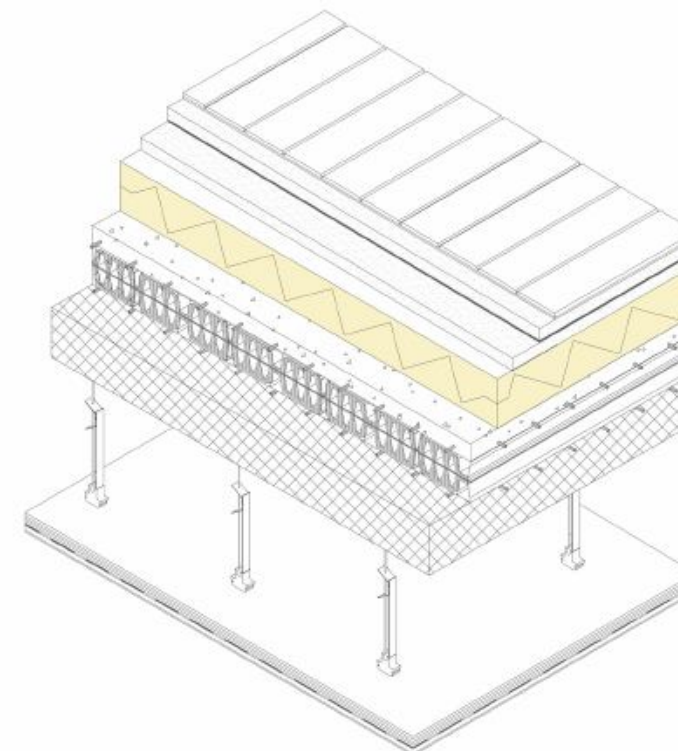
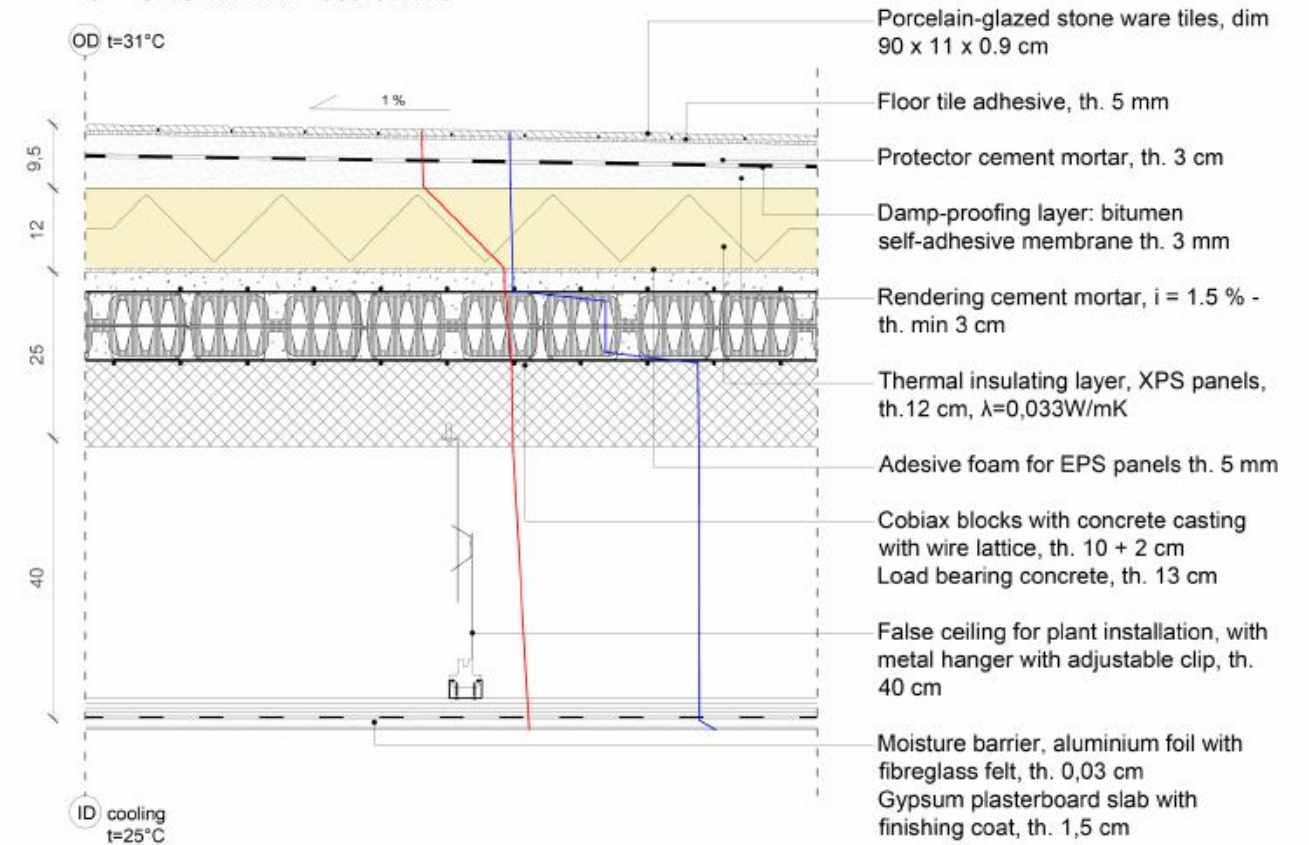
H.C.100 - GREEN ROOF

$U = 0.14 \text{ W/m}^2\text{k}$ - scale:1:10



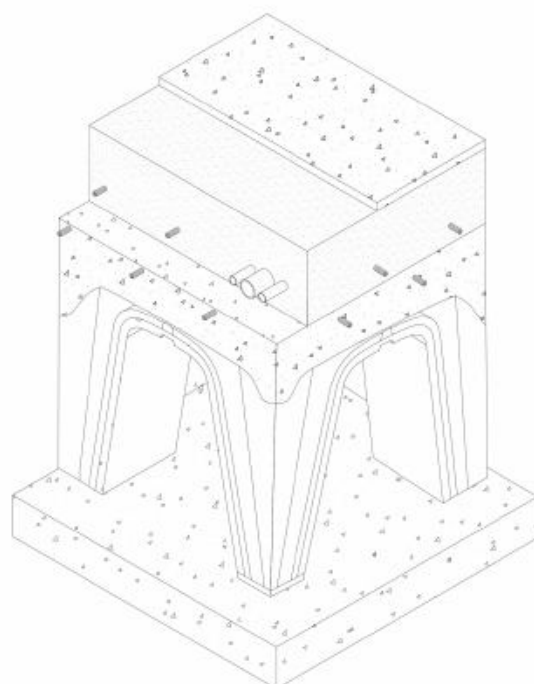
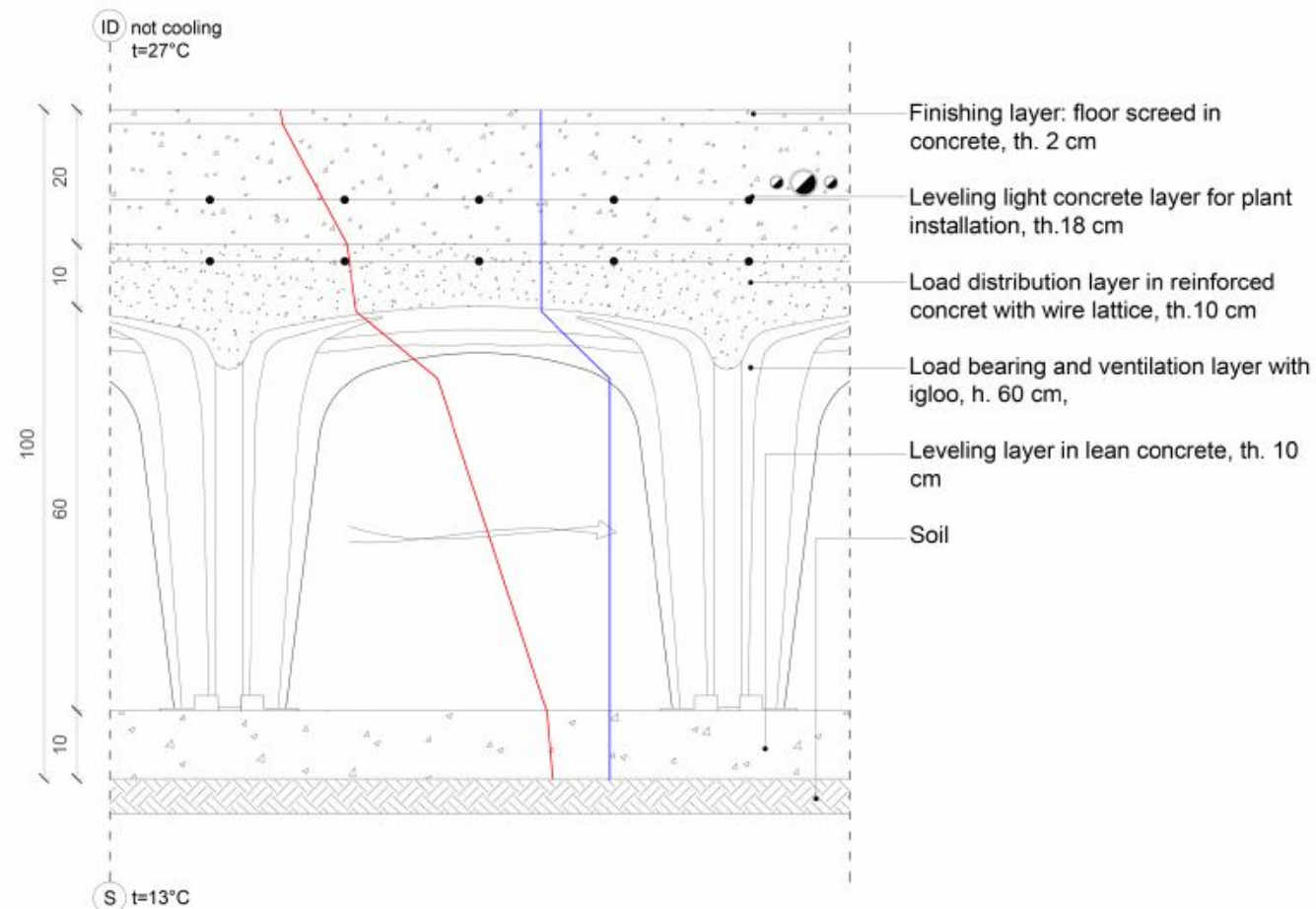
H.C. 101 - ACCESSIBLE ROOF

$U = 0.19 \text{ W/m}^2\text{k}$ - scale:1:10



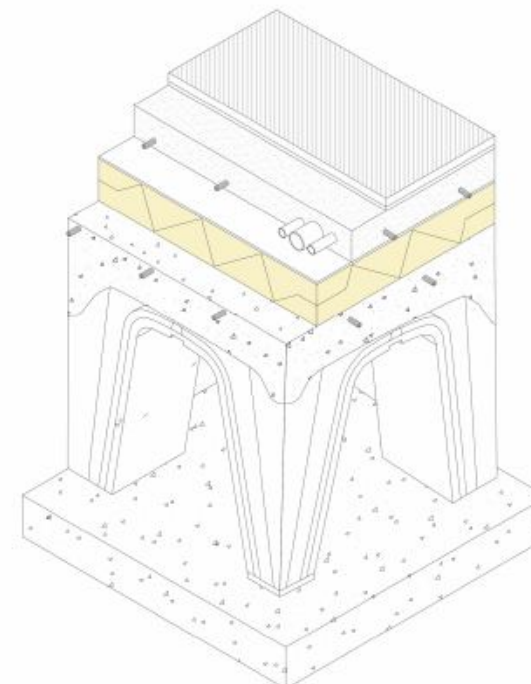
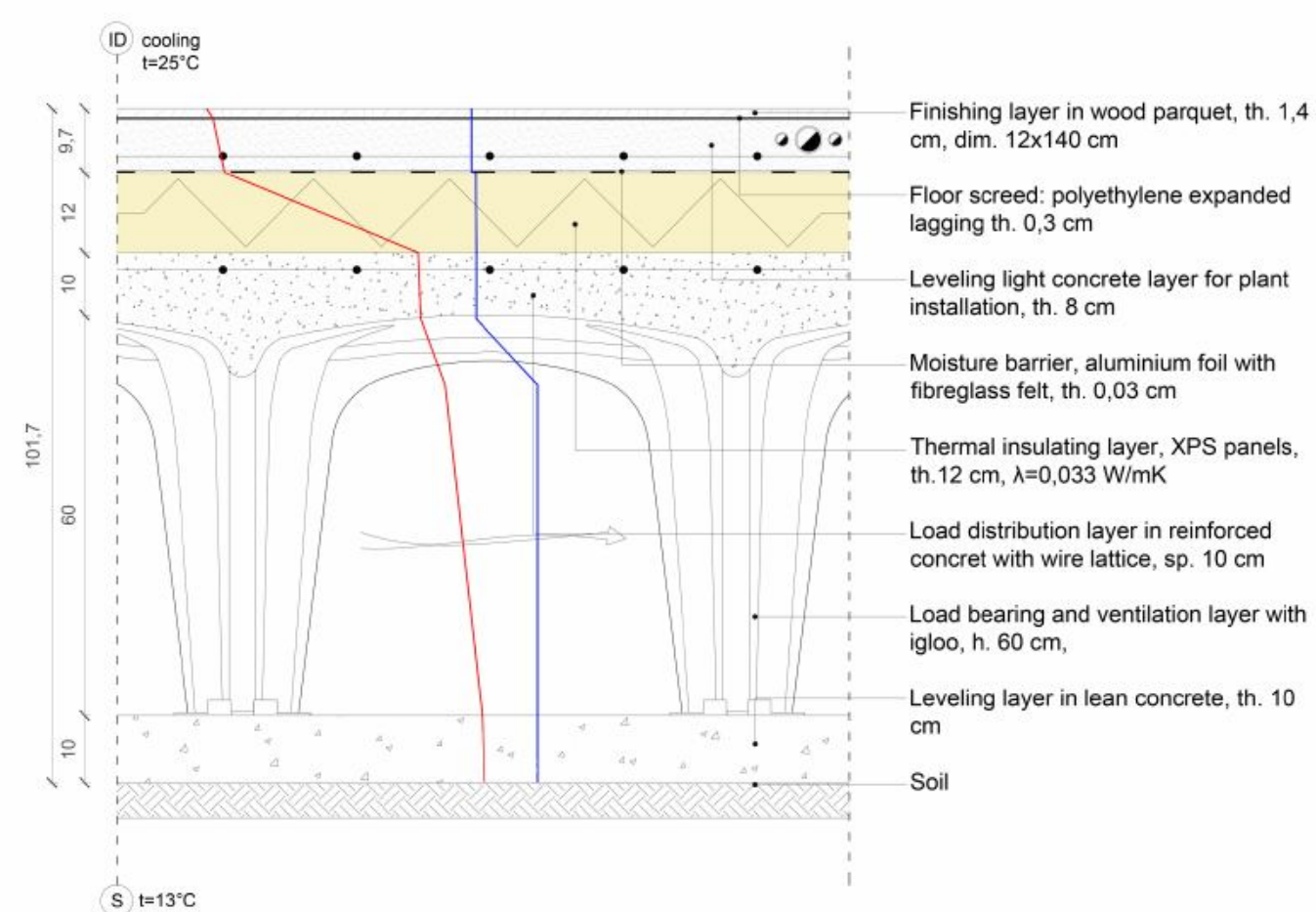
H.C. 102 - NOT INSULATED SLAB IN CONTACT WITH THE GROUND

$U = 1.4 \text{ W/m}^2\text{k}$ - scale:1:10



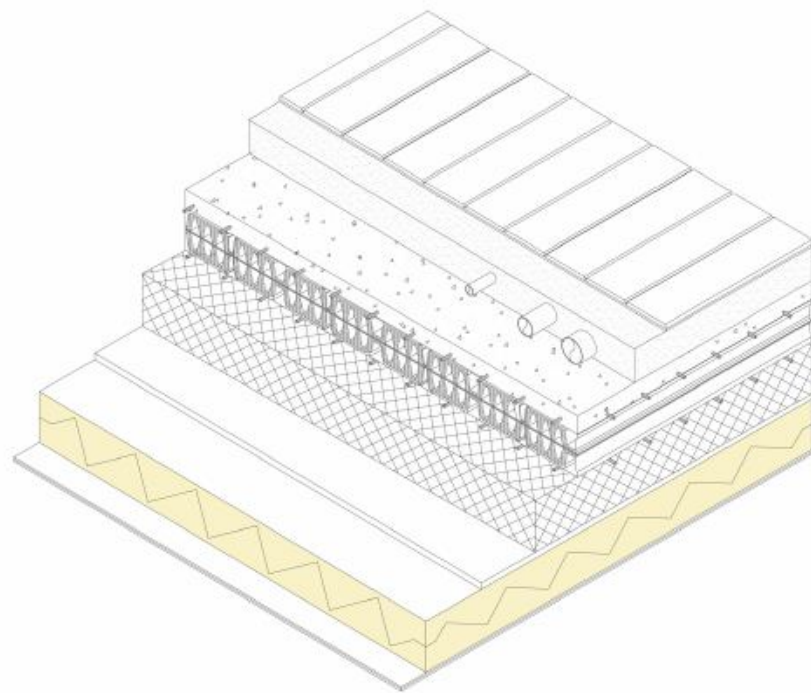
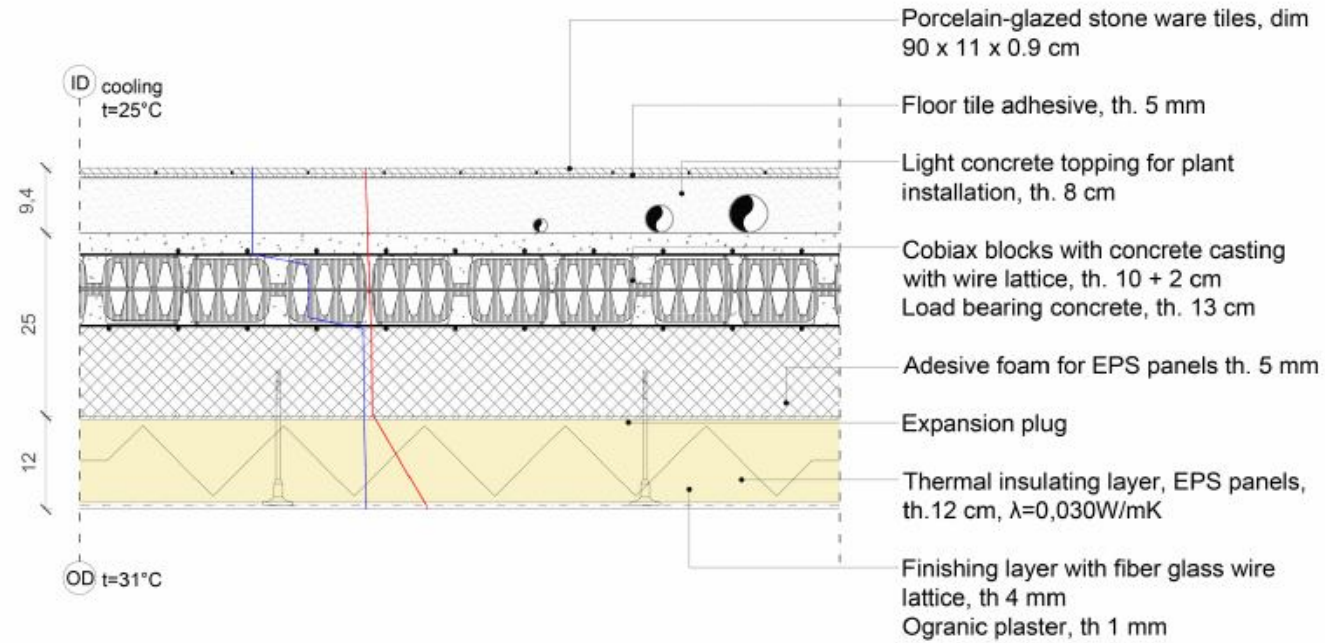
H.C. 103 - INSULATED SLAB IN CONTACT WITH THE GROUND

$U=0.25 \text{ W/m}^2\text{k}$ - scale:1:10



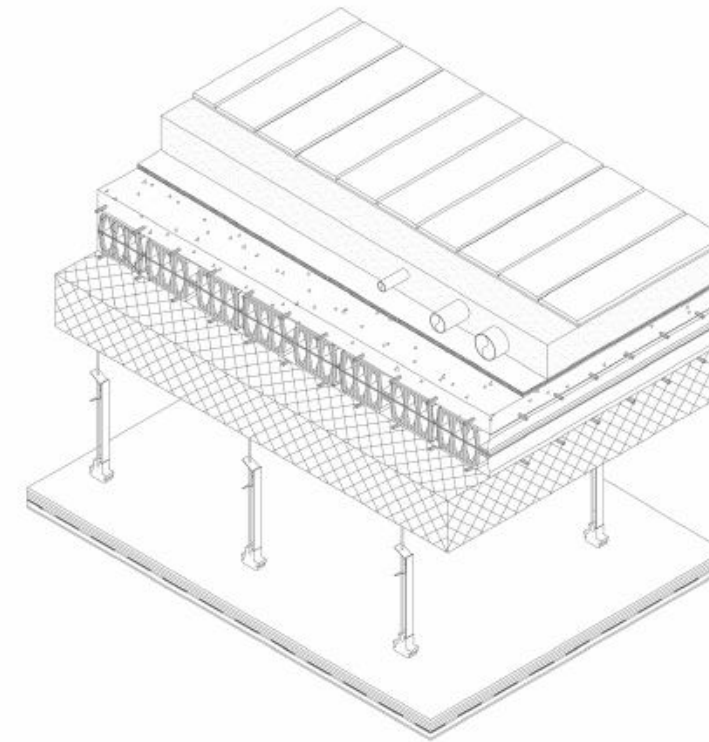
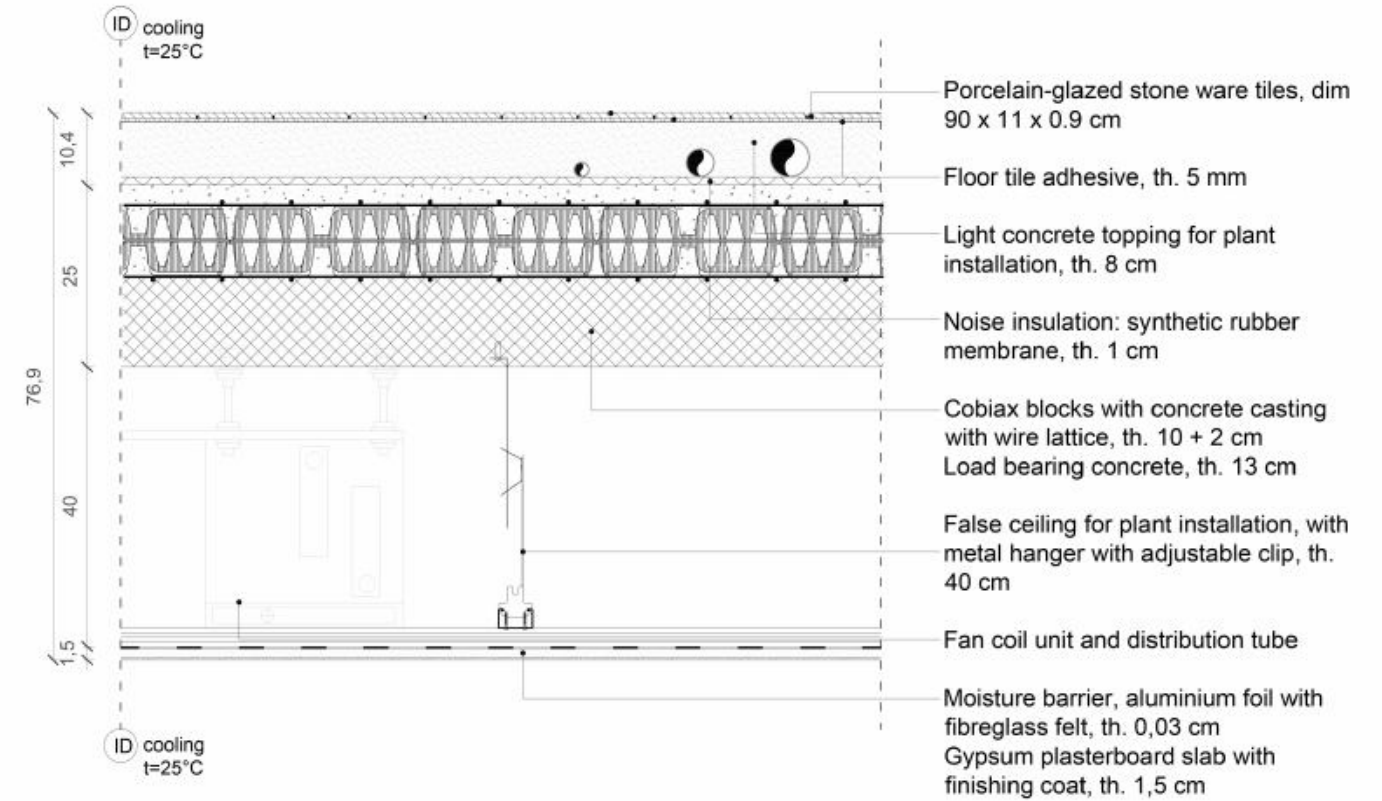
H.C. 104 - SLAB ABOVE OUTDOOR SPACES

$U = 0.2 \text{ W/m}^2\text{k}$ - scale:1:10



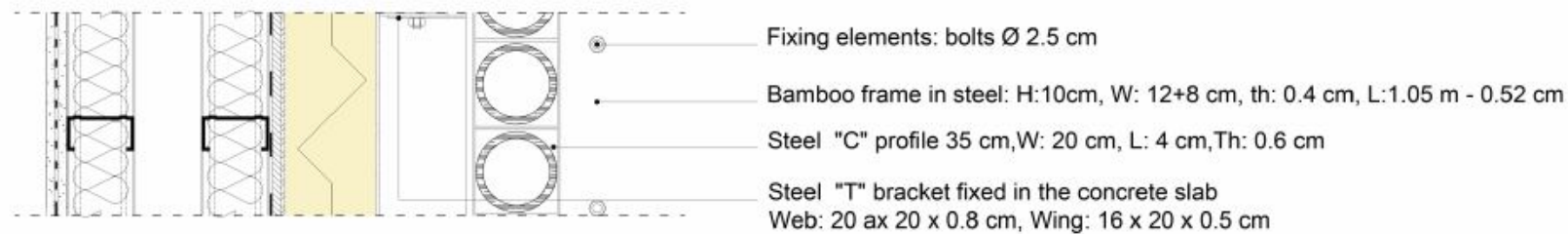
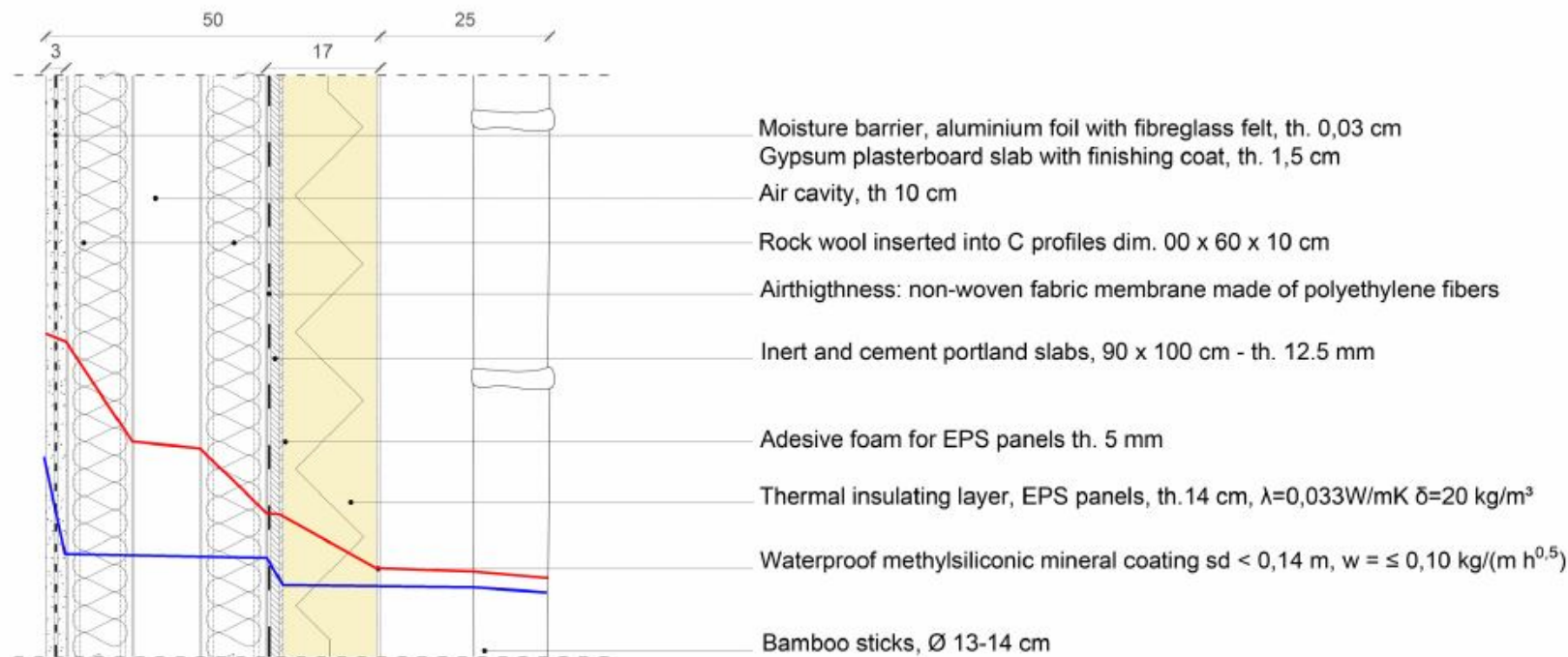
H.C.105 - INTERMEDIATE CEILING

$U = - \text{W/m}^2\text{k}$ - scale:1:10



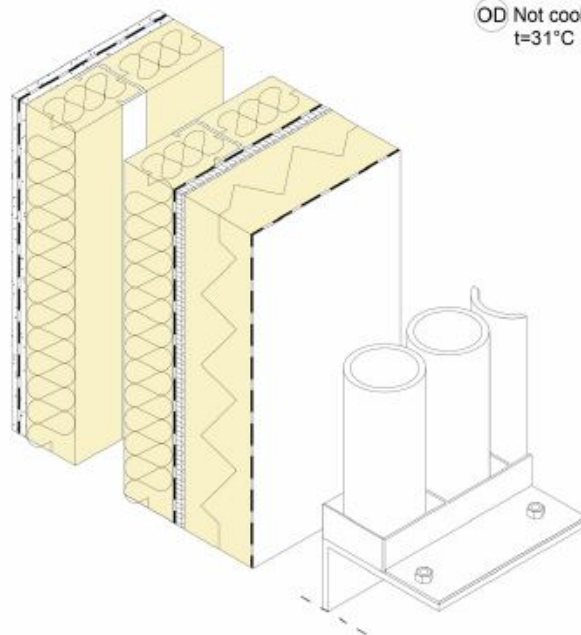
V.C. 101 - INSULATED EXTERNAL WALL

$U = 0.08 \text{ W/m}^2\text{k}$ - scale:1:10



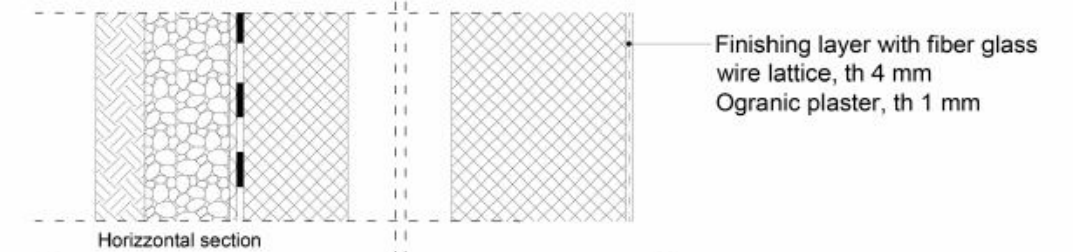
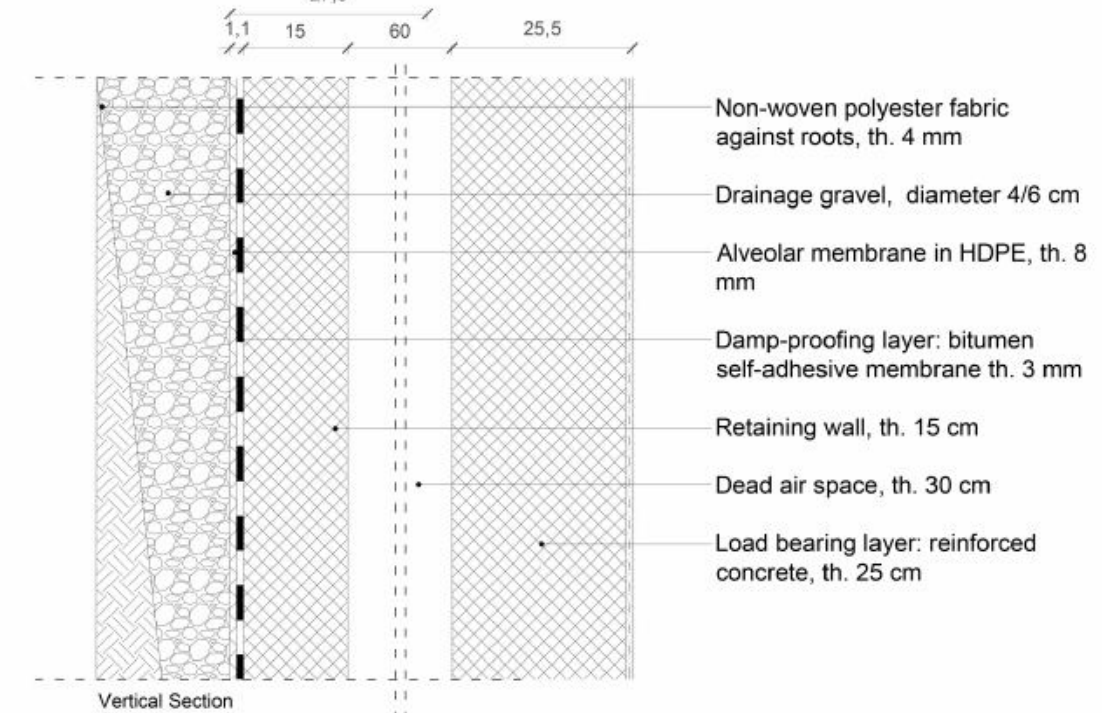
ID cooling
 $t=25^\circ\text{C}$

OD Not cooling
 $t=31^\circ\text{C}$



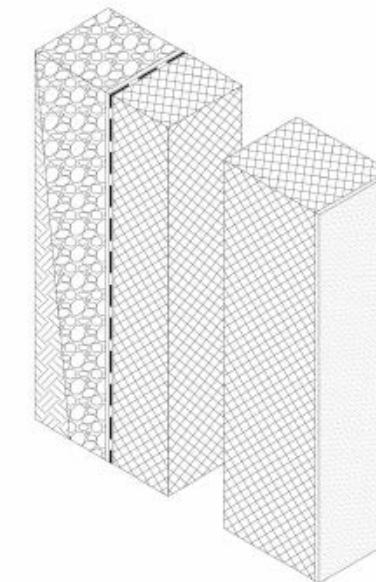
V.C. 102 - UNINSULATED RETAINING WALL

$U = - \text{W/m}^2\text{k}$ - scale:1:10

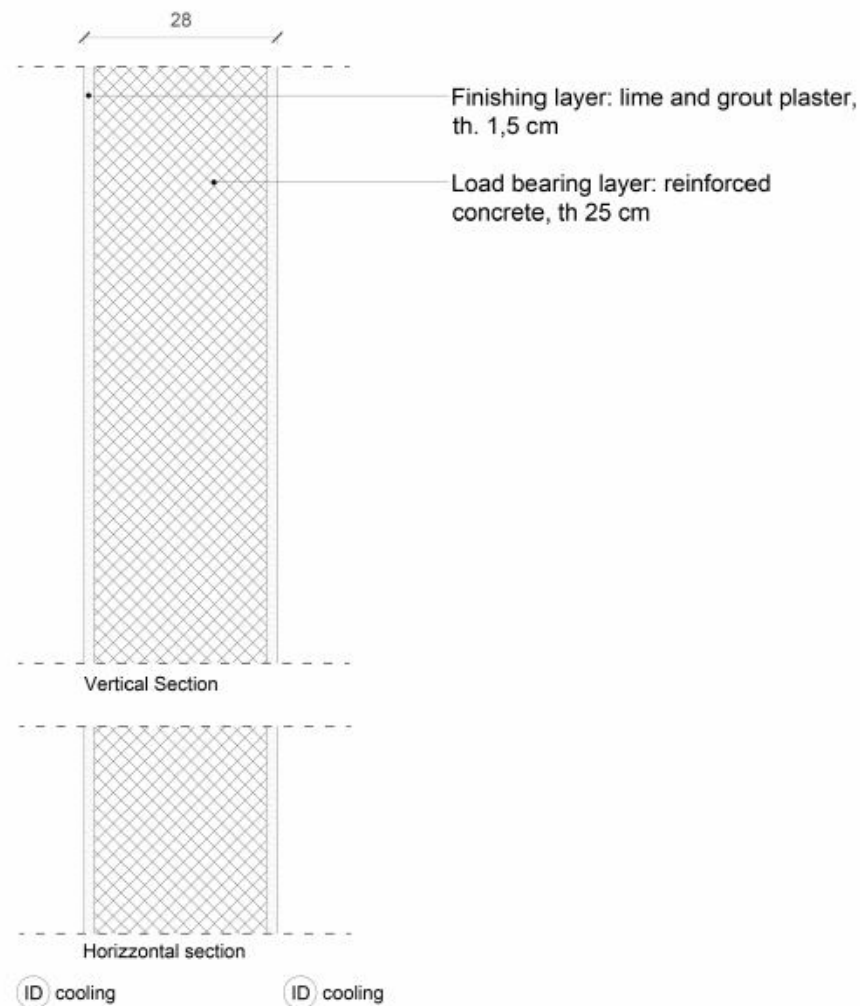


S $t=13^\circ\text{C}$

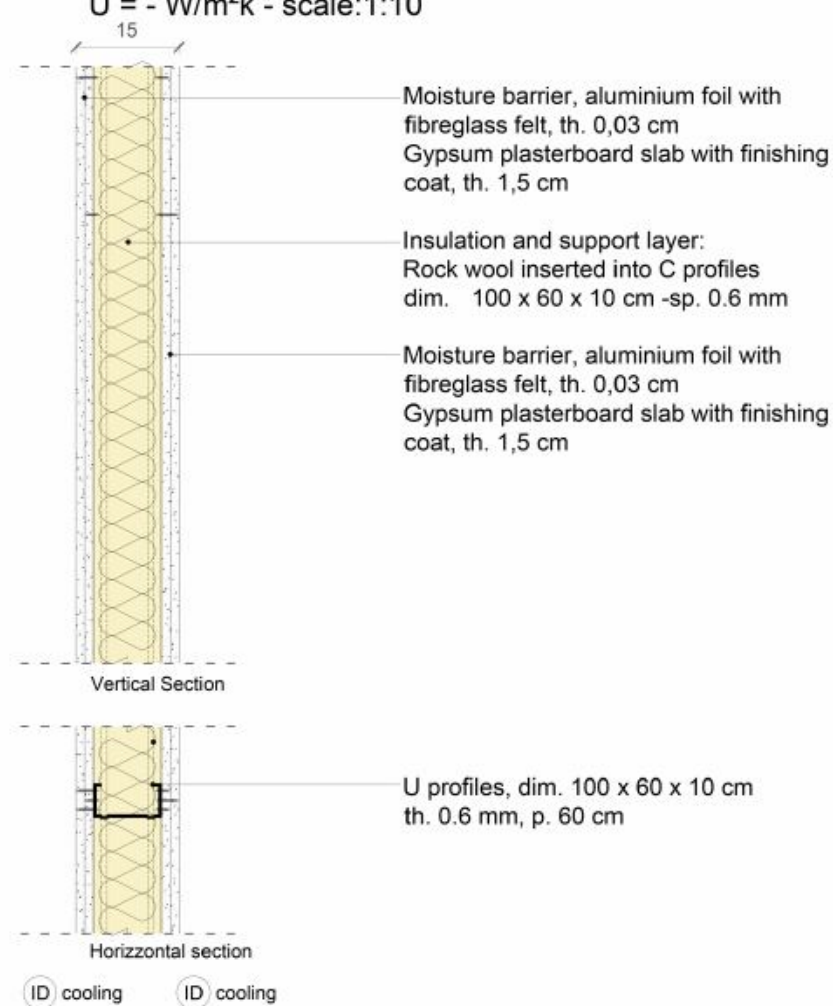
ID Not cooling
 $t=27^\circ\text{C}$



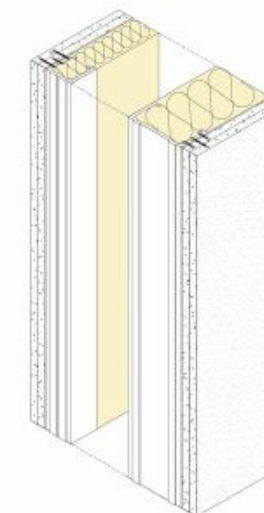
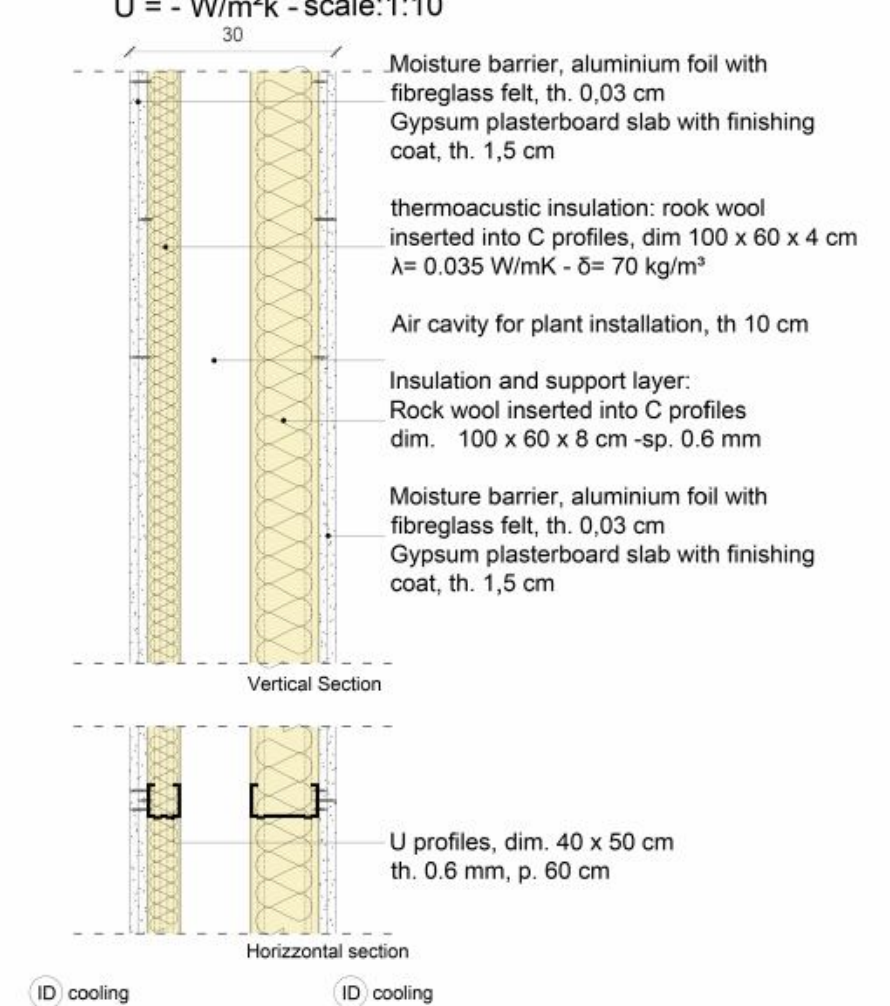
V.C. 103 - STAIRWELL
 $U = - W/m^2k$ - scale:1:10



V.C. 104 - INSULATED INNER WALL
 $U = - W/m^2k$ - scale:1:10



V.C. 105 - INSULATED INNER WALL WITH CAVITY FOR PLANT INSTALLATION
 $U = - W/m^2k$ - scale:1:10



BU01

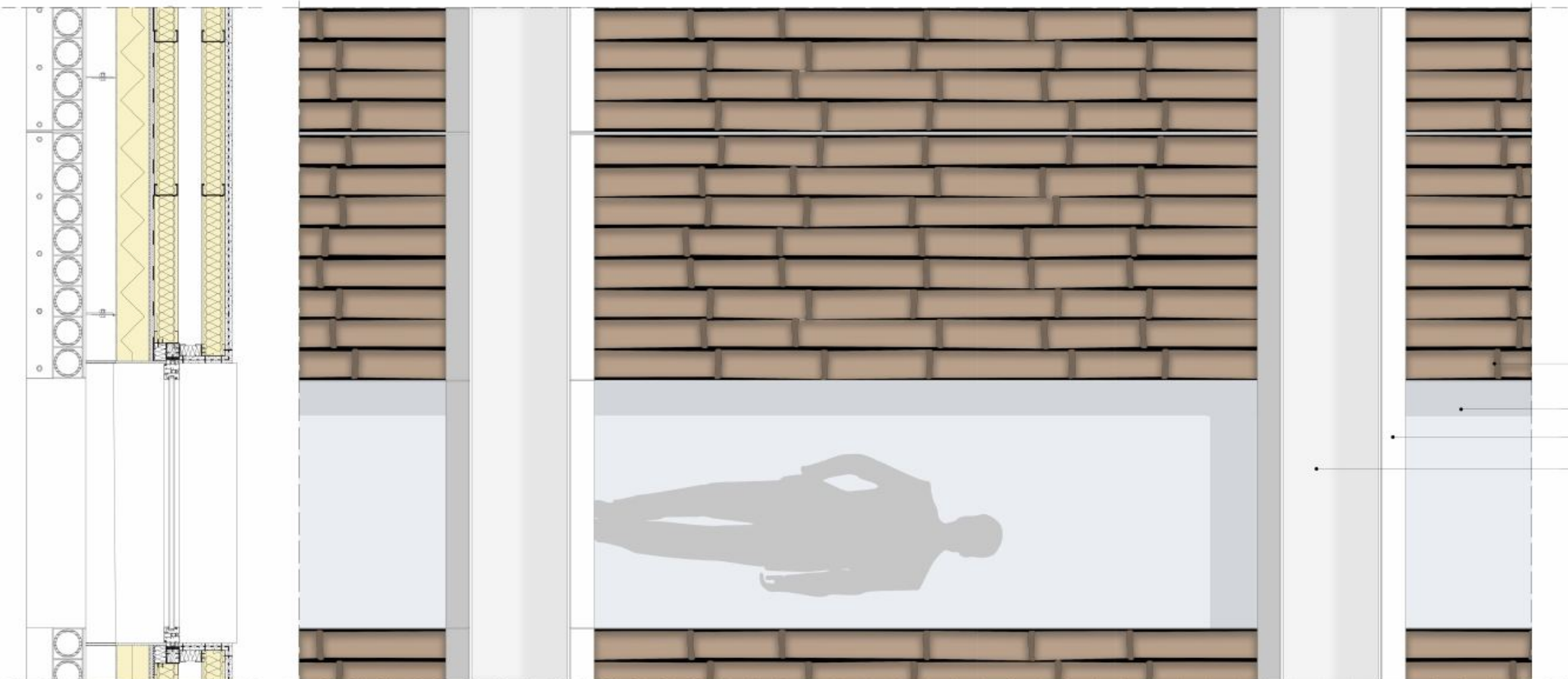
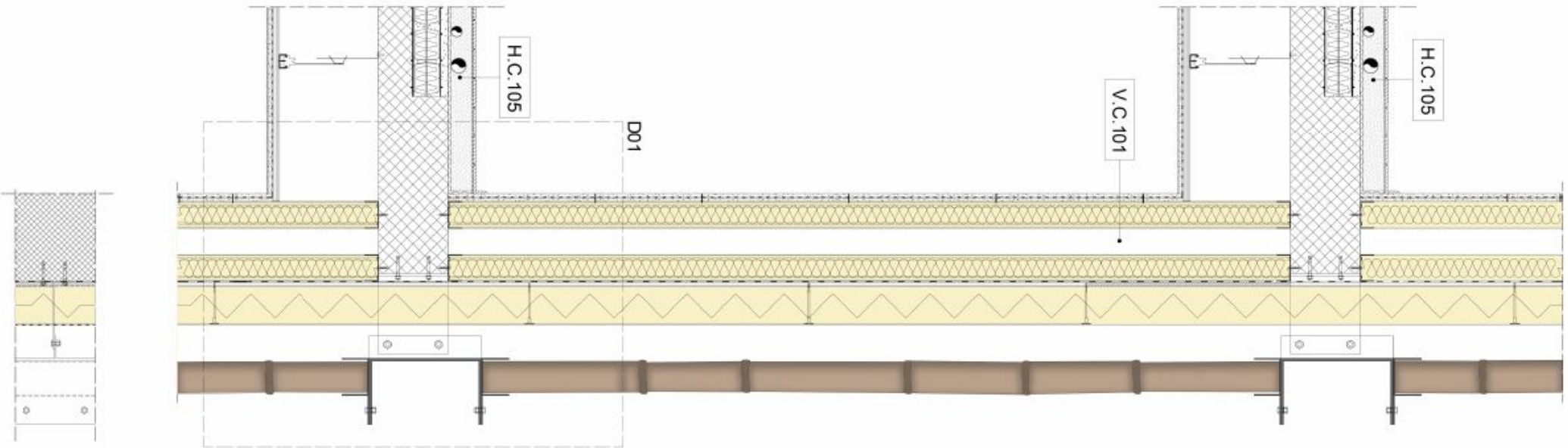
Intermediate floor

Steel "C" profile H:35 cm, W: 20 cm, L: 4 cm, Th: 0.6 cm

Bamboo frame in steel: H:10cm, W: 12+8 cm, th: 0.4 cm, L:1.05 m - 0.52 cm

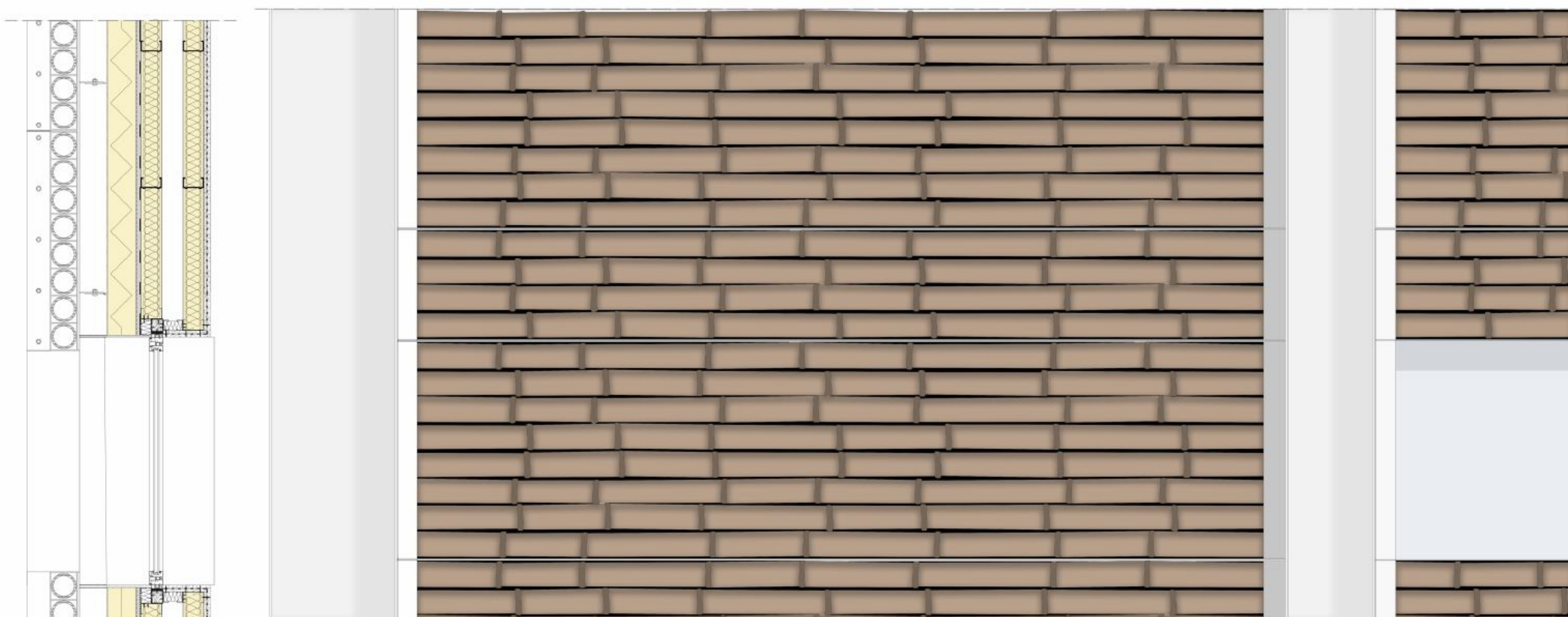
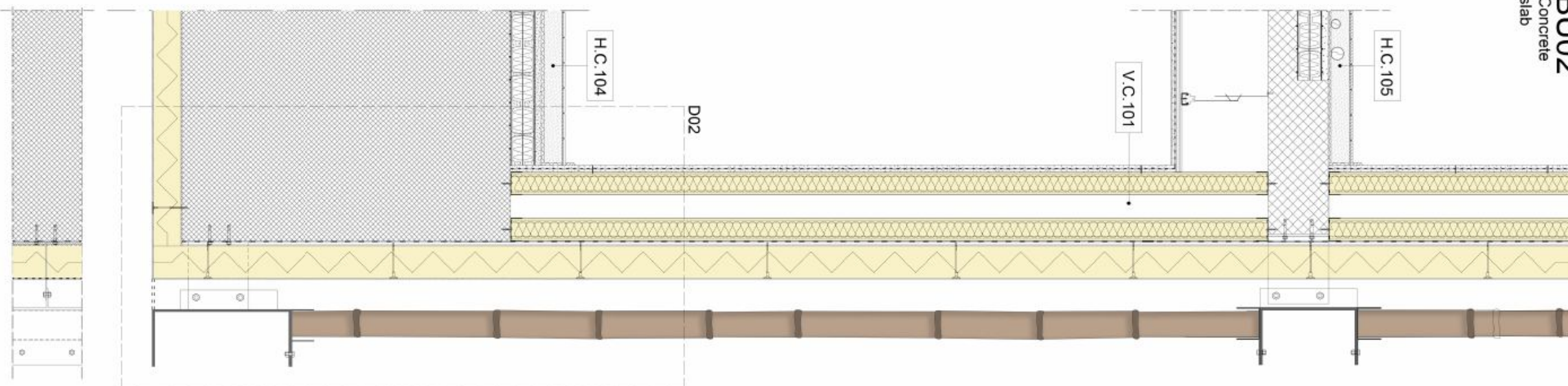
Double glass thermally toughened

Bamboo sticks, Ø 13-14 cm



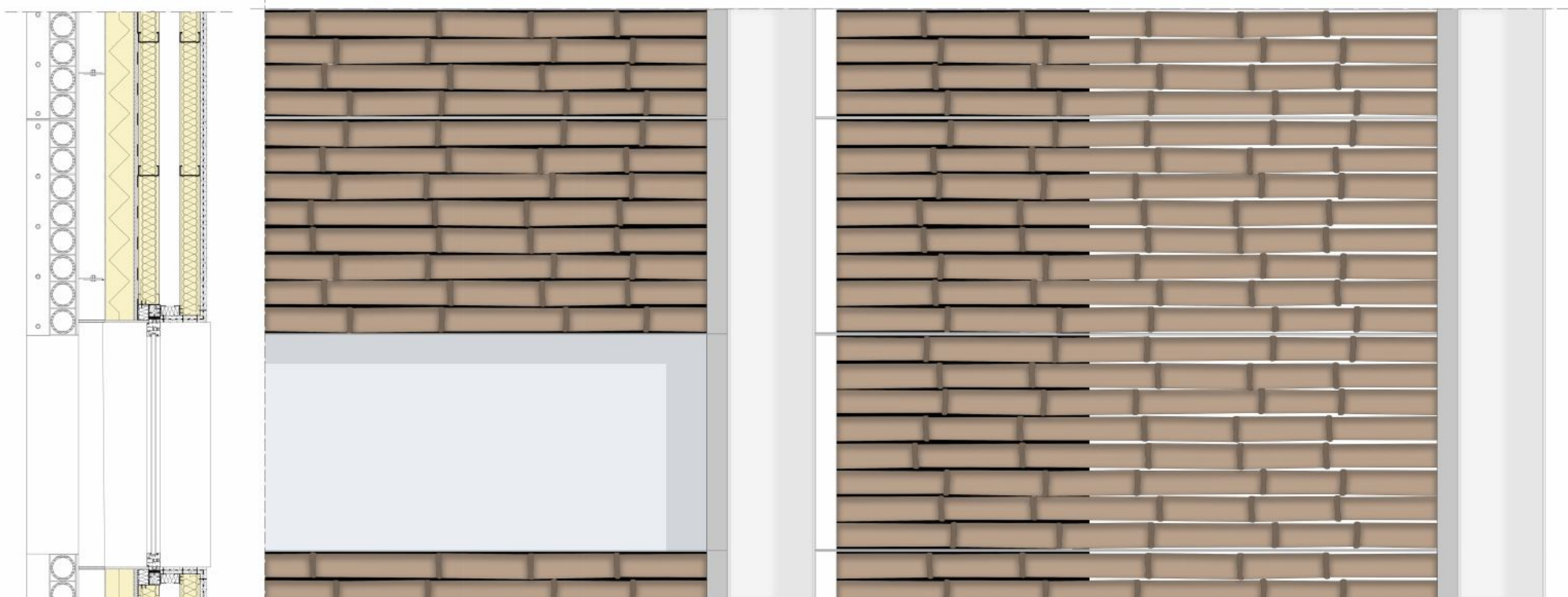
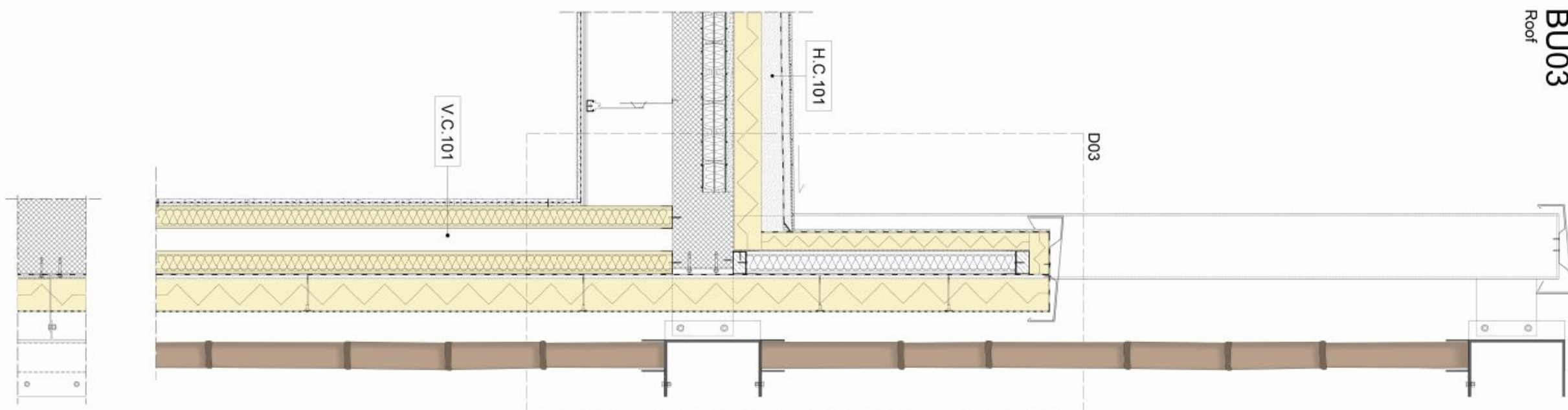
Scale 1 : 20

BU02 Concrete slab



Scale 1 : 20

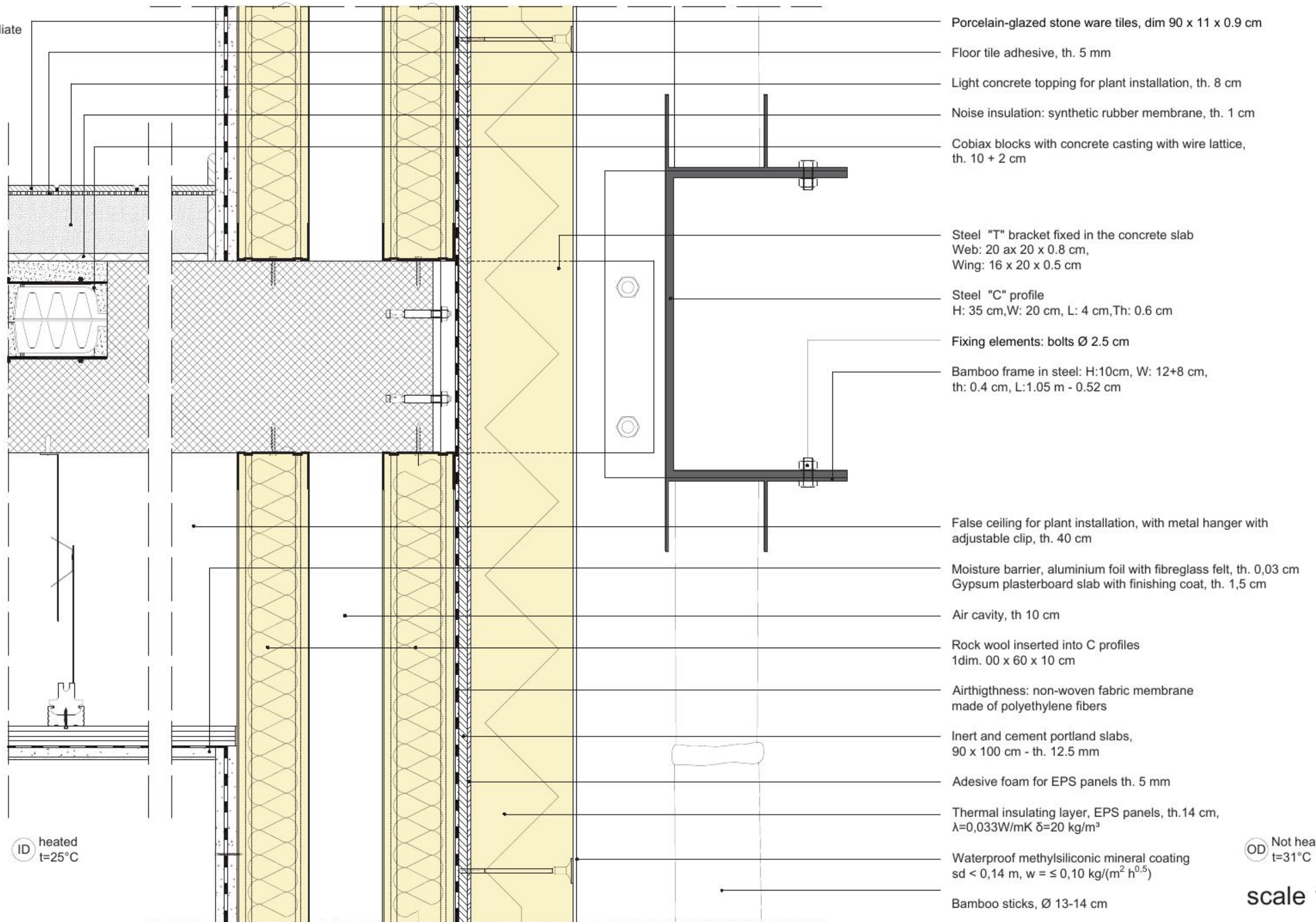
BU03
Roof



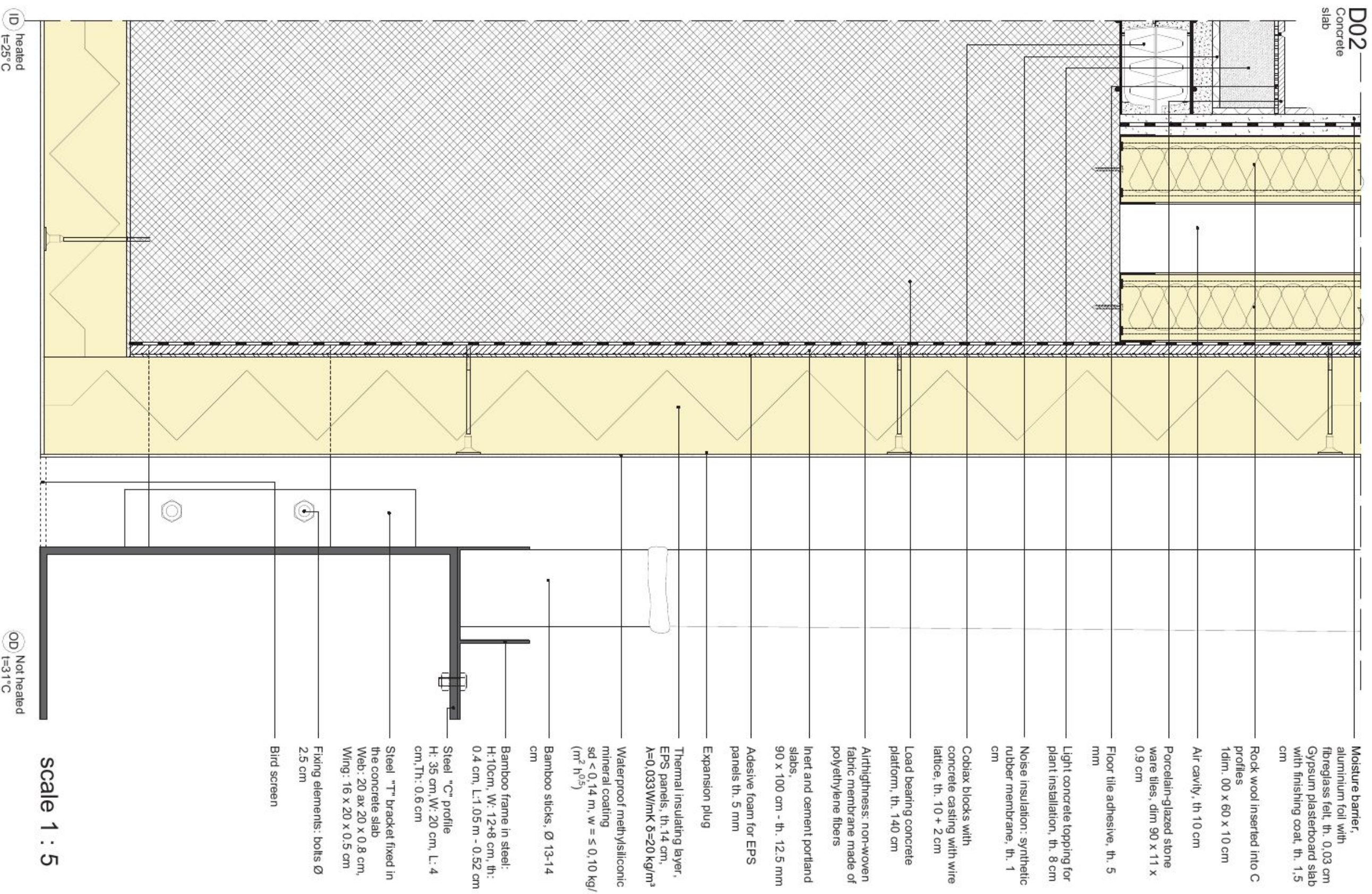
Scale 1 : 20

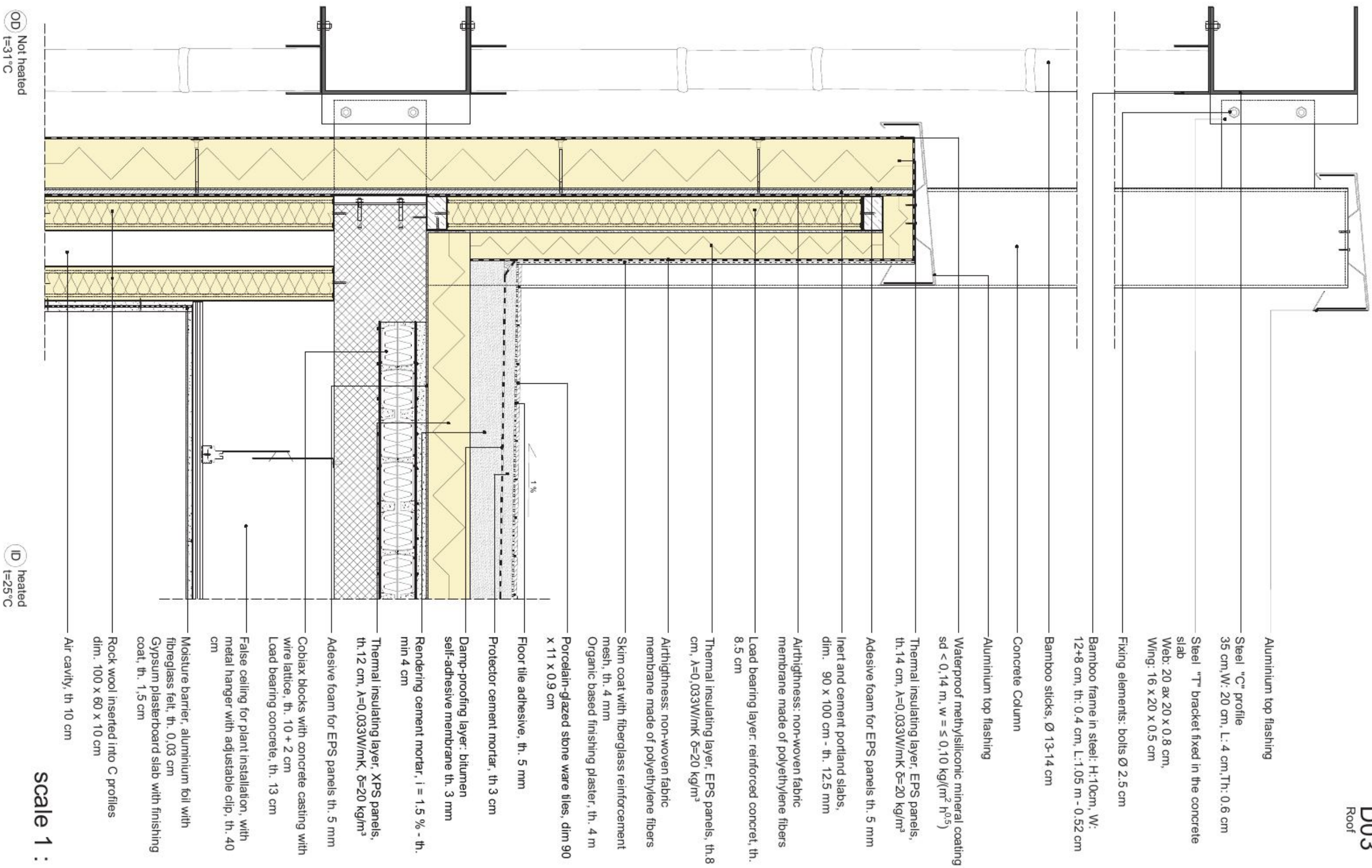
D01

Intermediate floor



scale 1 : 5





BAMBOO PANELS GENERATION

- 1** Welding of steel frame
h: 340 cm, l: 105 cm - 52,5 cm
th: 0,4 cm



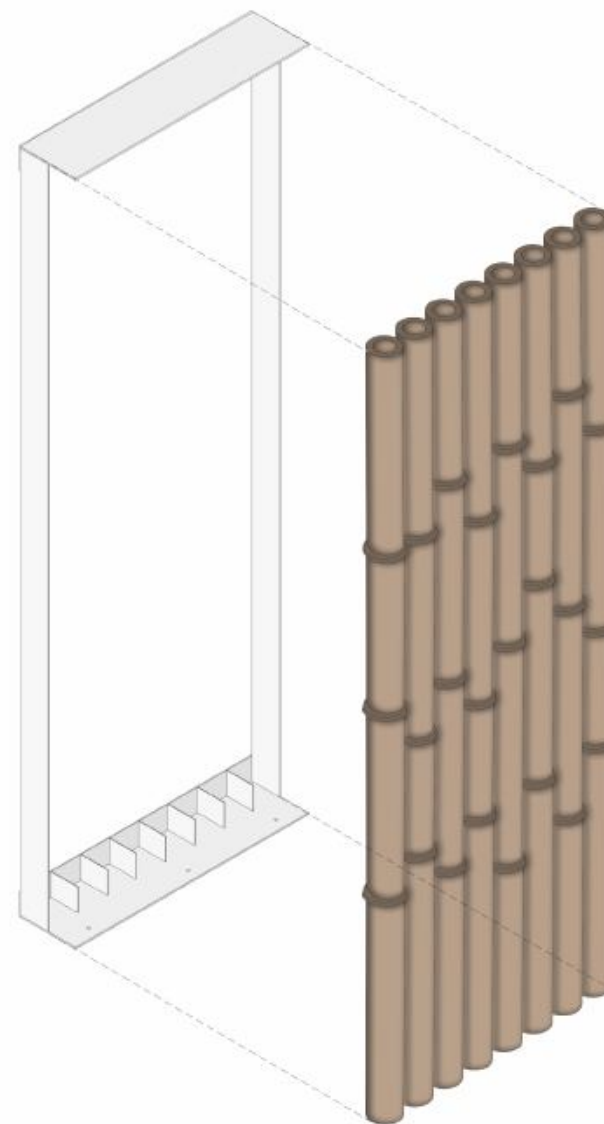
detail 1 in the
following page

- 2** Welding of steel elements
to divide and sustain bamboo
sticks: (th. 1.5 mm)

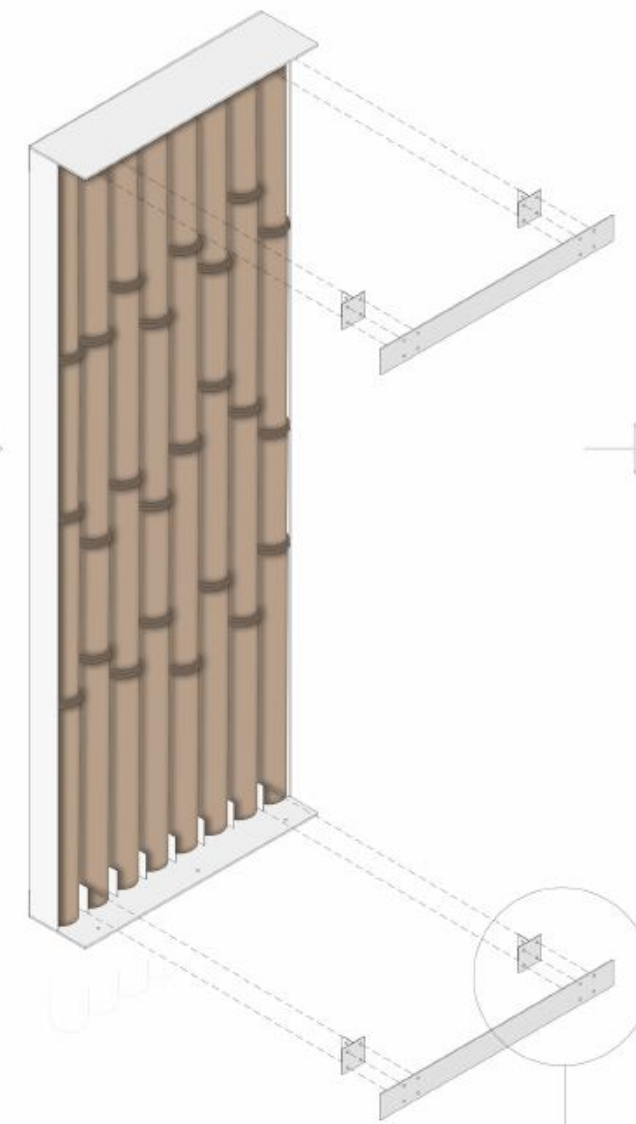


detail 2 in the
following page

- 3** Insertion of bamboo sticks
h: 340 cm, $\varnothing$ 12 - 13 cm,
weight: 2.5 - 3 kg



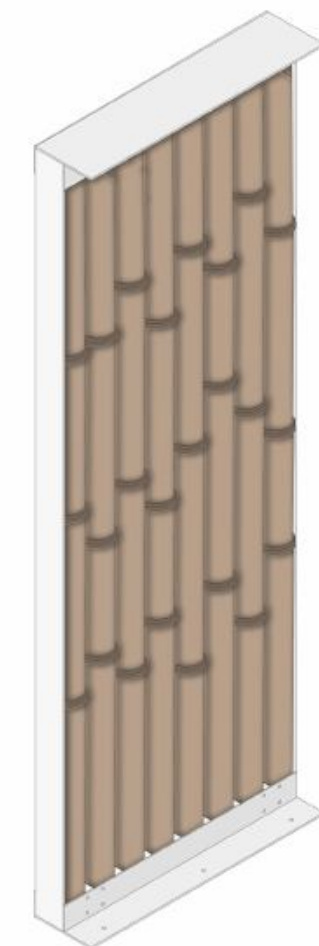
- 4** Bolting of steel bracket and
closing steel panel,
th: 3 mm



detail 5 in the
following page

- 5** Final panels:
dim: 340 x 105 cm,
weight: 152 kg

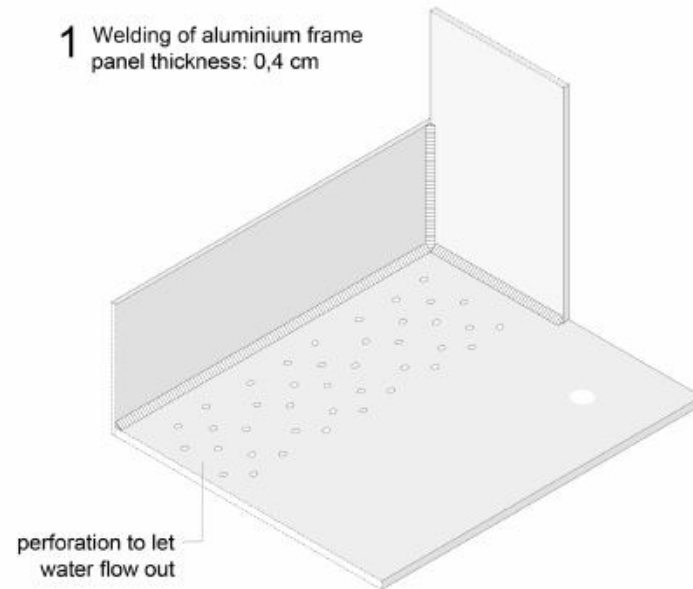
dim: 340 x 52.5 cm,
weight: 128 kg



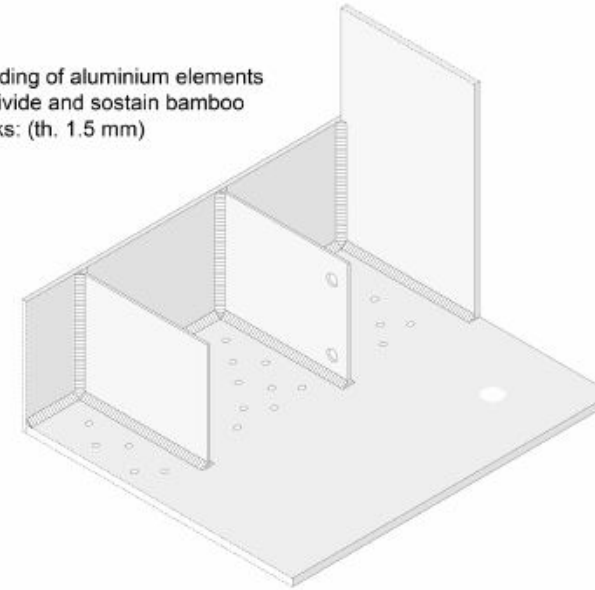
1 : 20

DETAILS

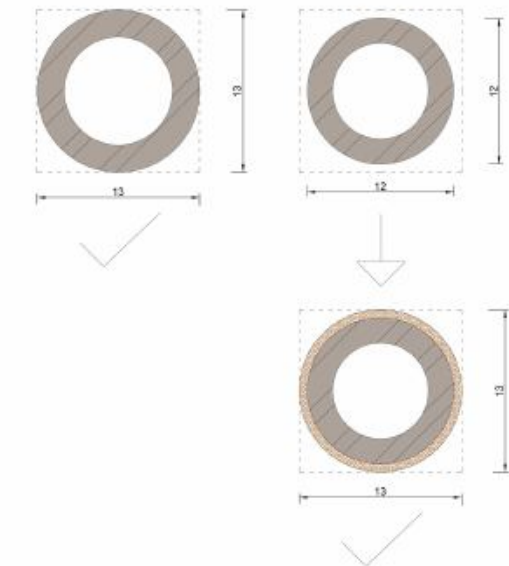
- 1 Welding of aluminium frame
panel thickness: 0,4 cm



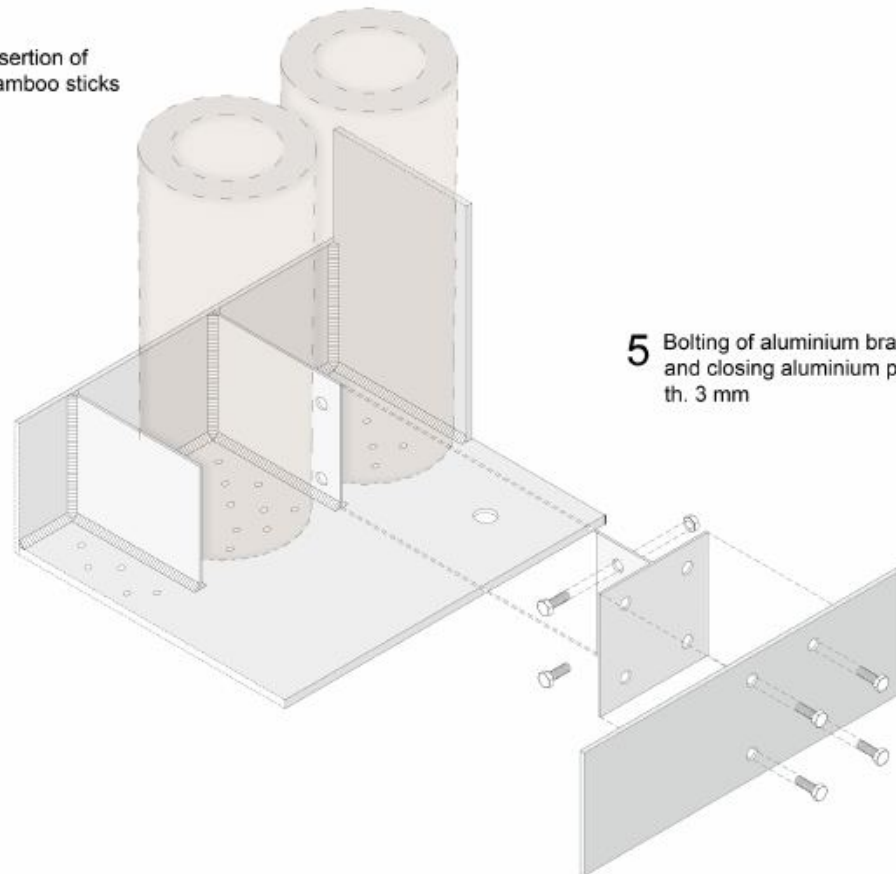
- 2 Welding of aluminium elements
to divide and sustain bamboo
sticks: (th. 1.5 mm)



- 3 Bamboo dimensions check
and addition of polyurethane foam to allow the
smaller bamboo sticks to fit into the frame

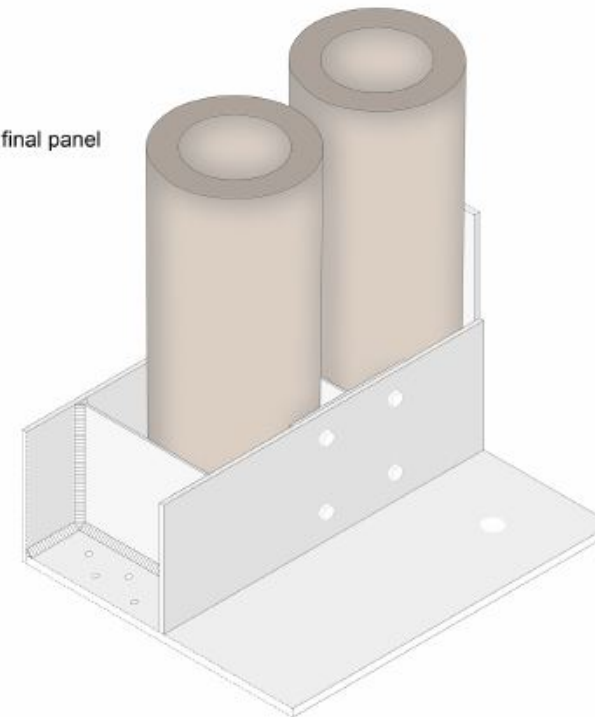


- 4 Insertion of
bamboo sticks

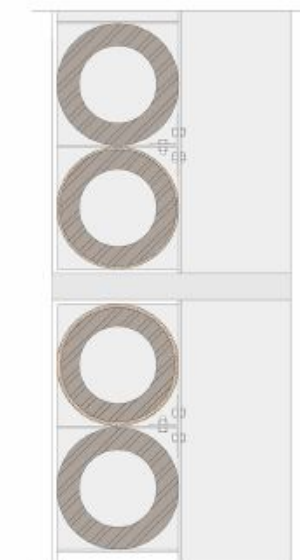


- 5 Bolting of aluminium bracket
and closing aluminium panel,
th. 3 mm

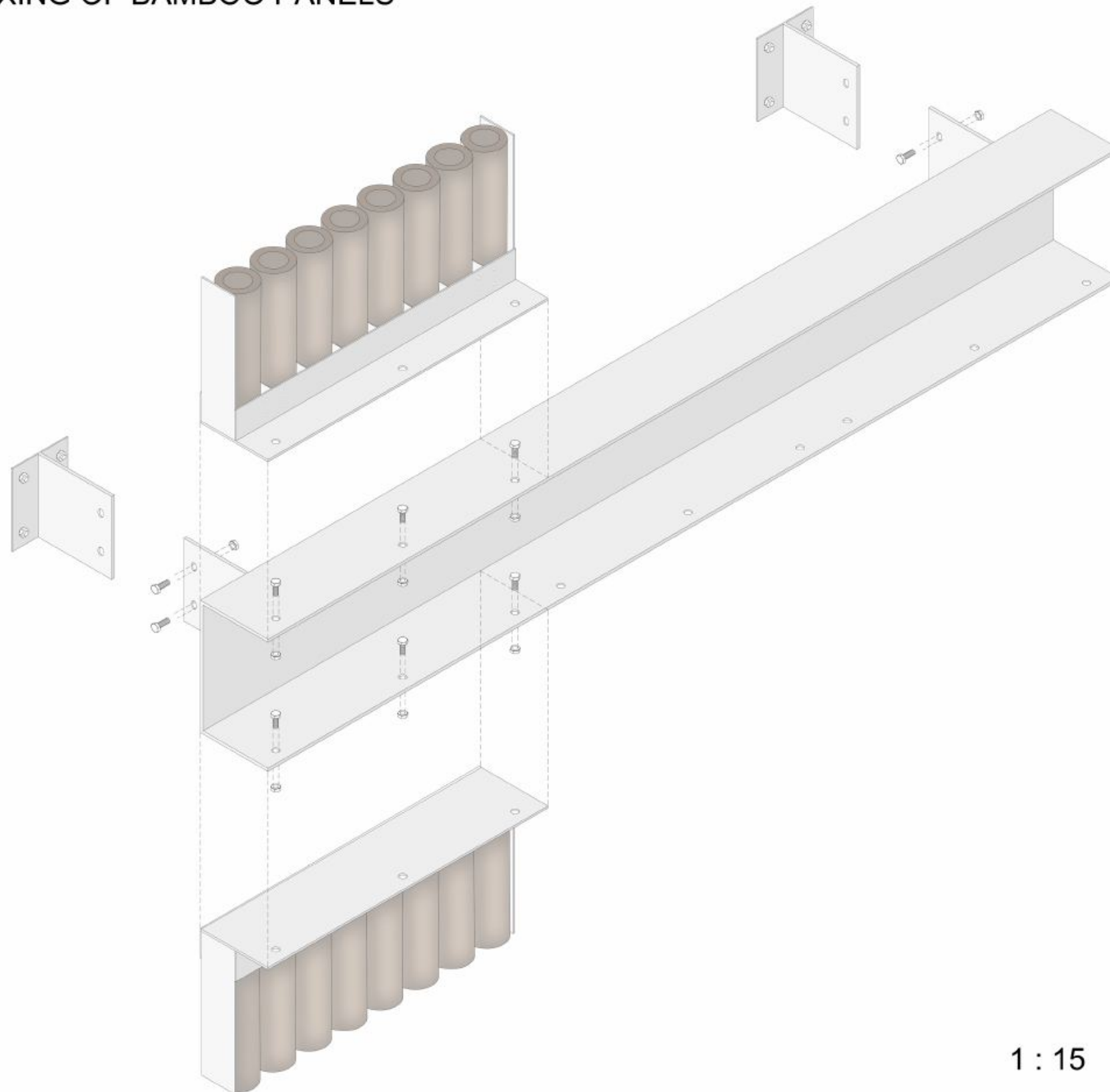
- 6 final panel



1 : 5



FIXING OF BAMBOO PANELS



PLUG HSA M 10x90

High-performance metallic beat anchor for daily static loads on non-cracked concrete

Material composition: Carbon steel, galvanized

Head configuration: Externally threaded



T BRACKET

Dimensions: h:25 cm, l: 25cm
th: 0.5 cm

Material composition: galvanized steel

Finishing: rastproof varnish

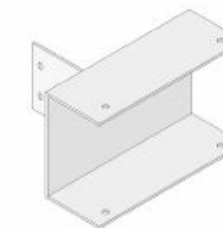


U PROFILE

Dimensions: h:40 cm, l 25 cm
th. 1 cm

Material composition: galvanized steel

Finishing: rastproof white varnish for steel

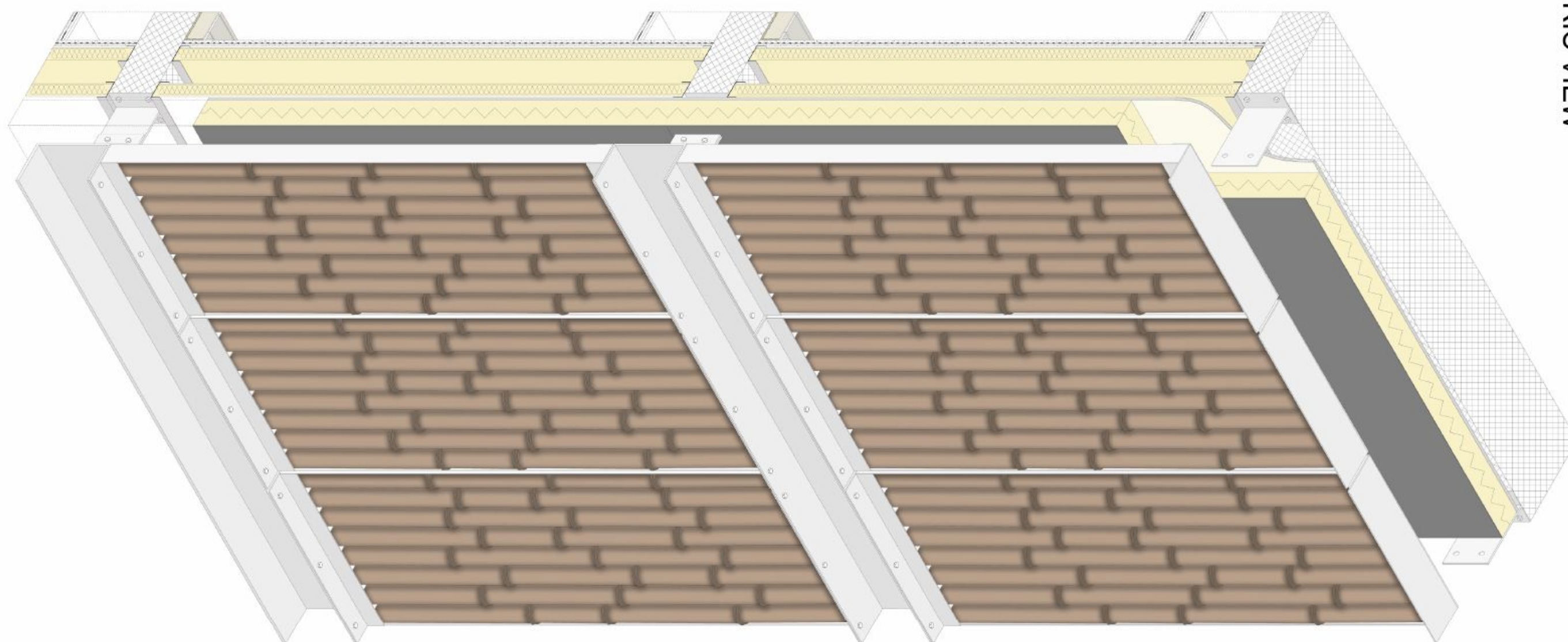


BOLT M12

Head diameter: 19 mm
Thread diameter: 12 mm

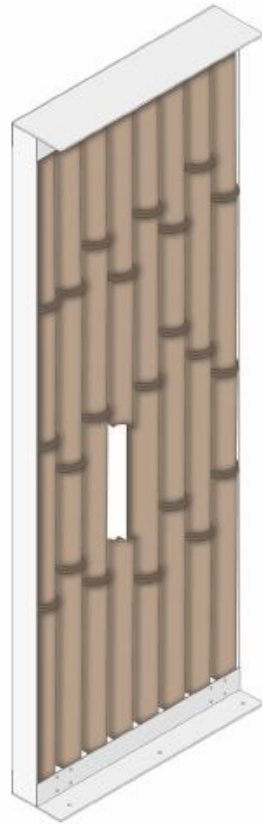
bolts put in vertical should be also welded to avoid unscrewing



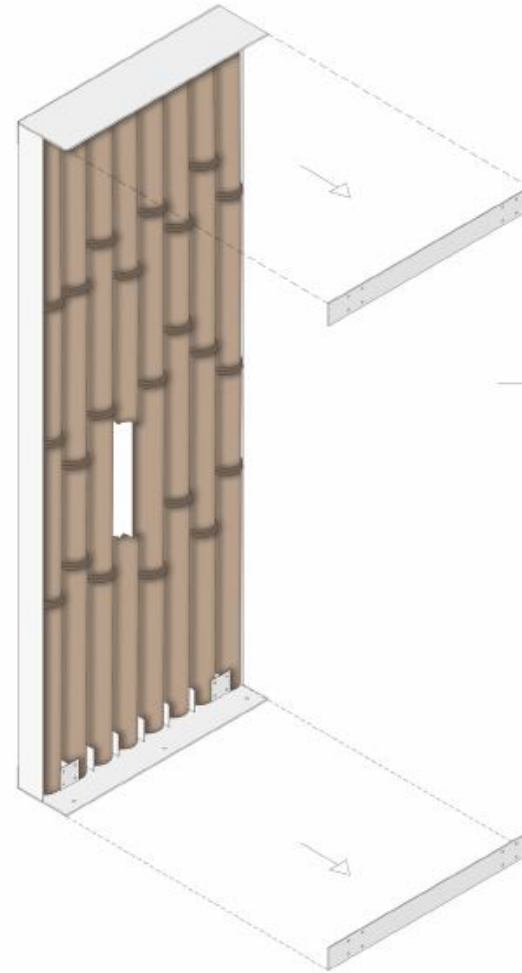


MAINTENANCE

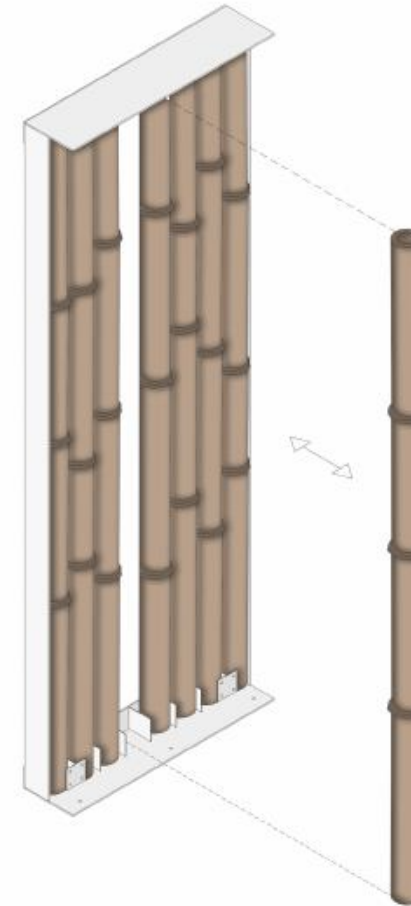
1 Damaged or broken bamboo



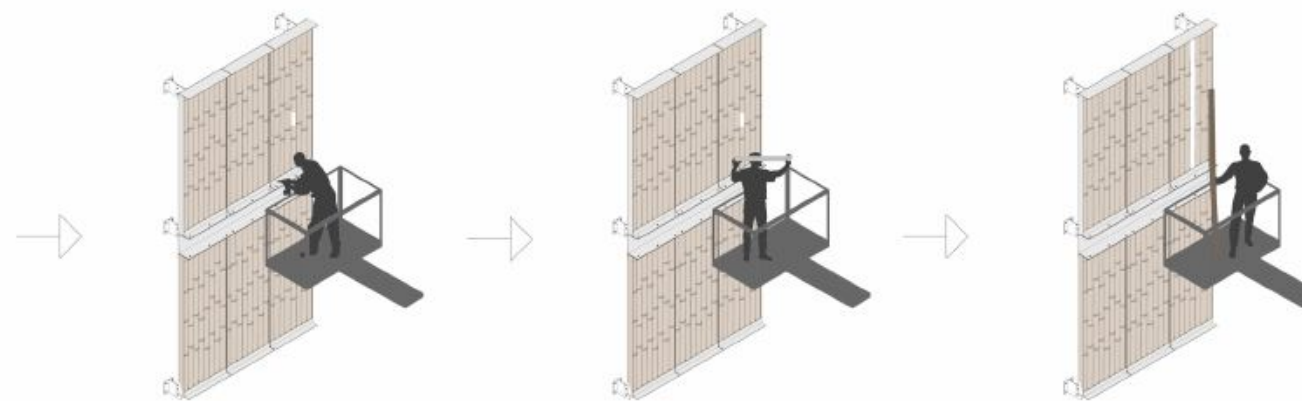
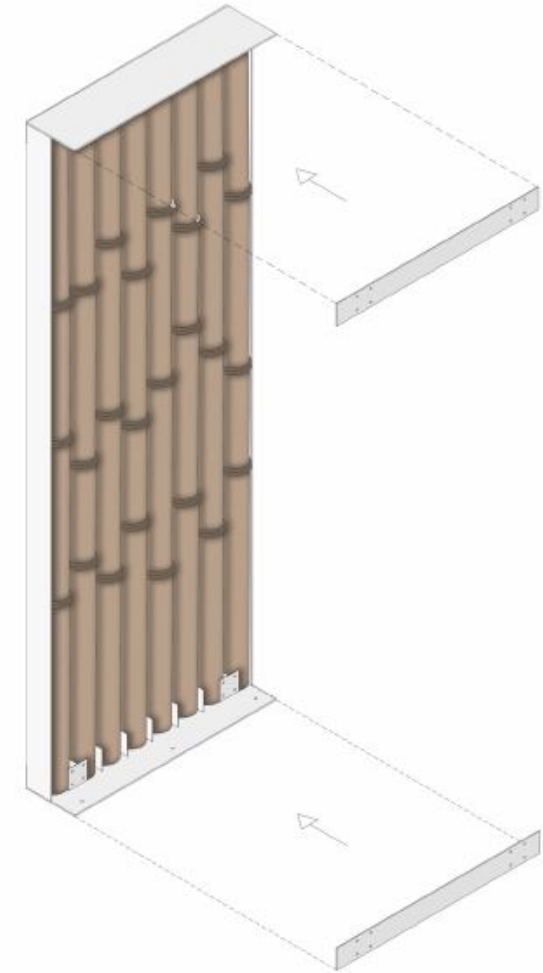
2 Removal of the closing panel

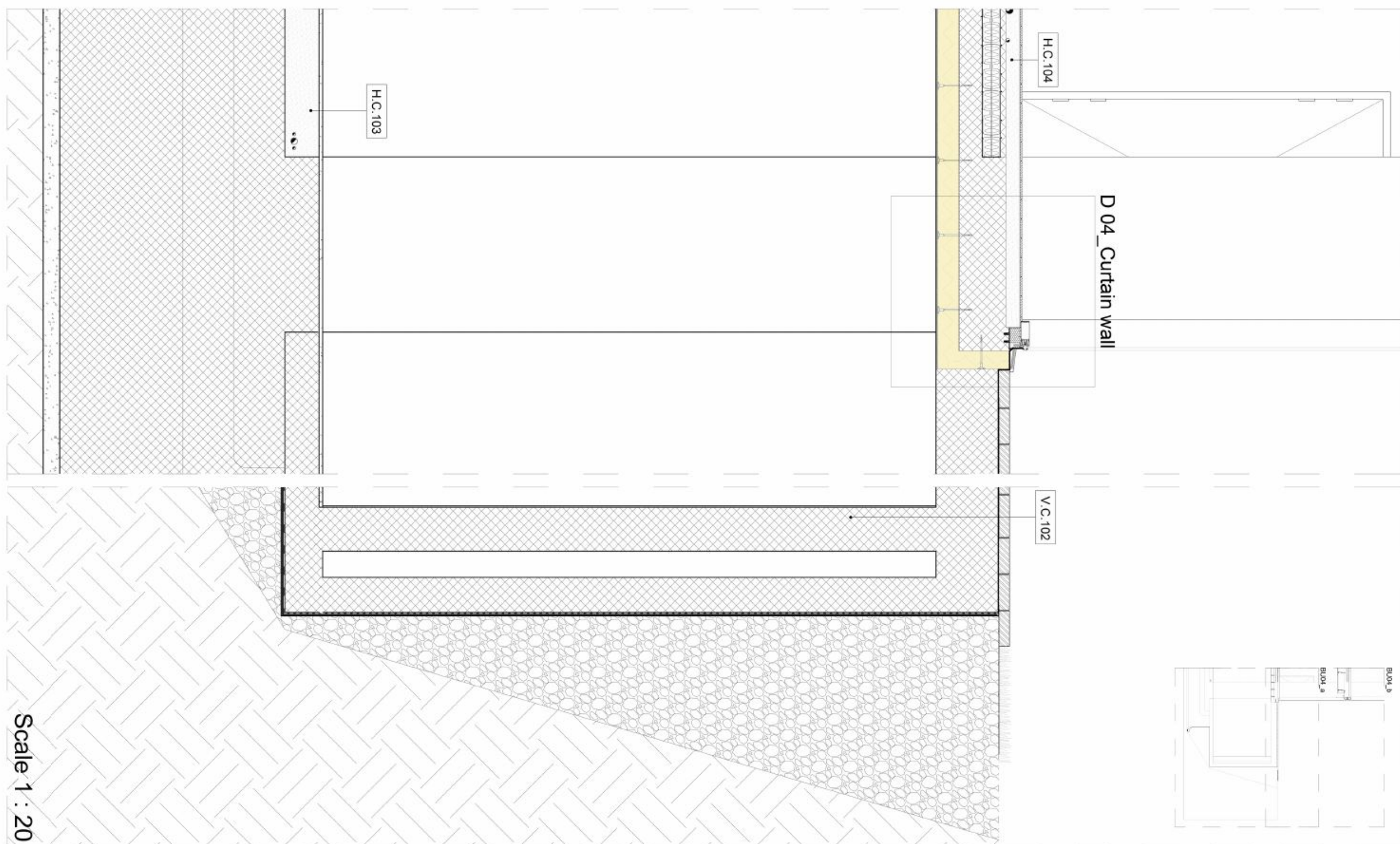


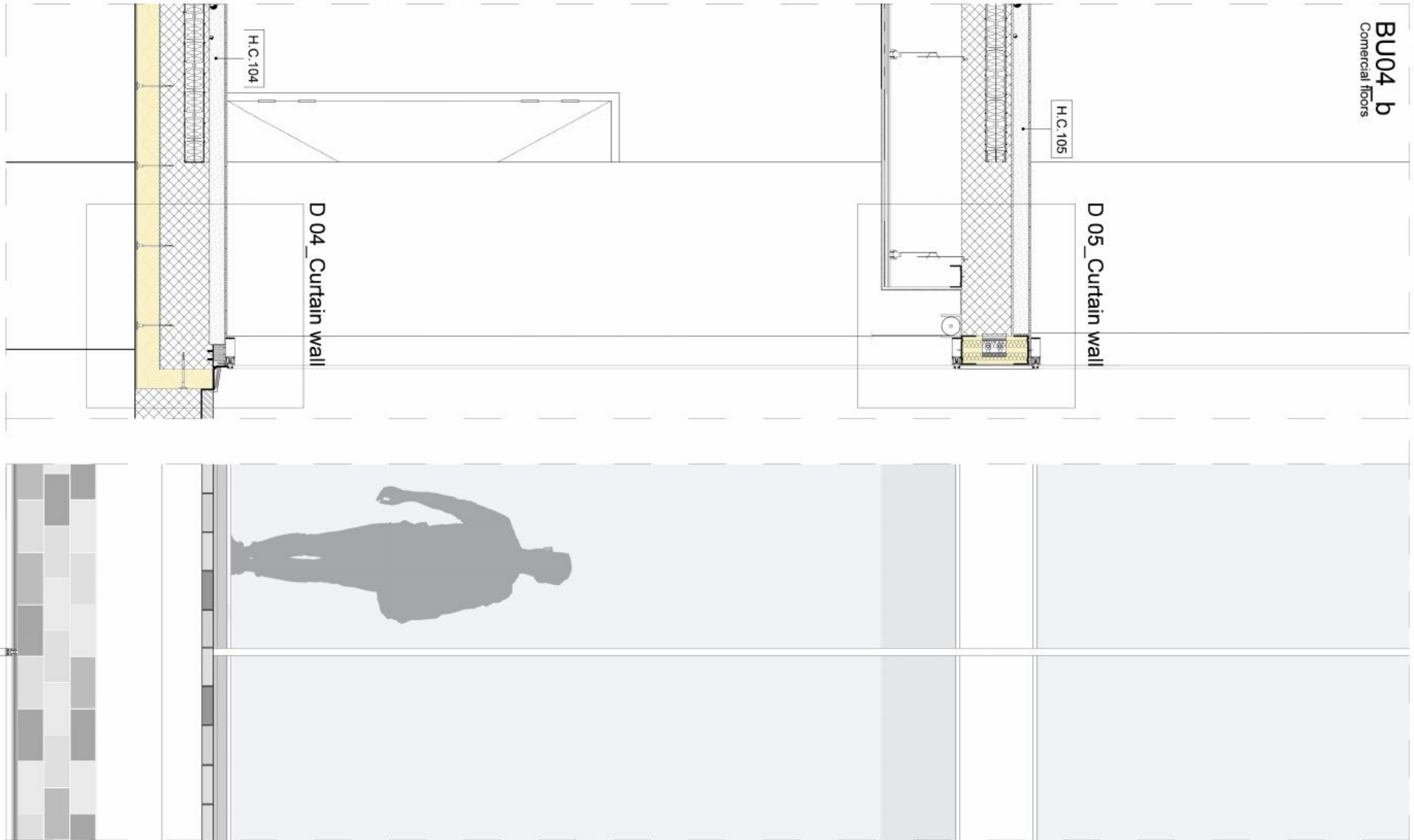
3 substitution of broken bamboo



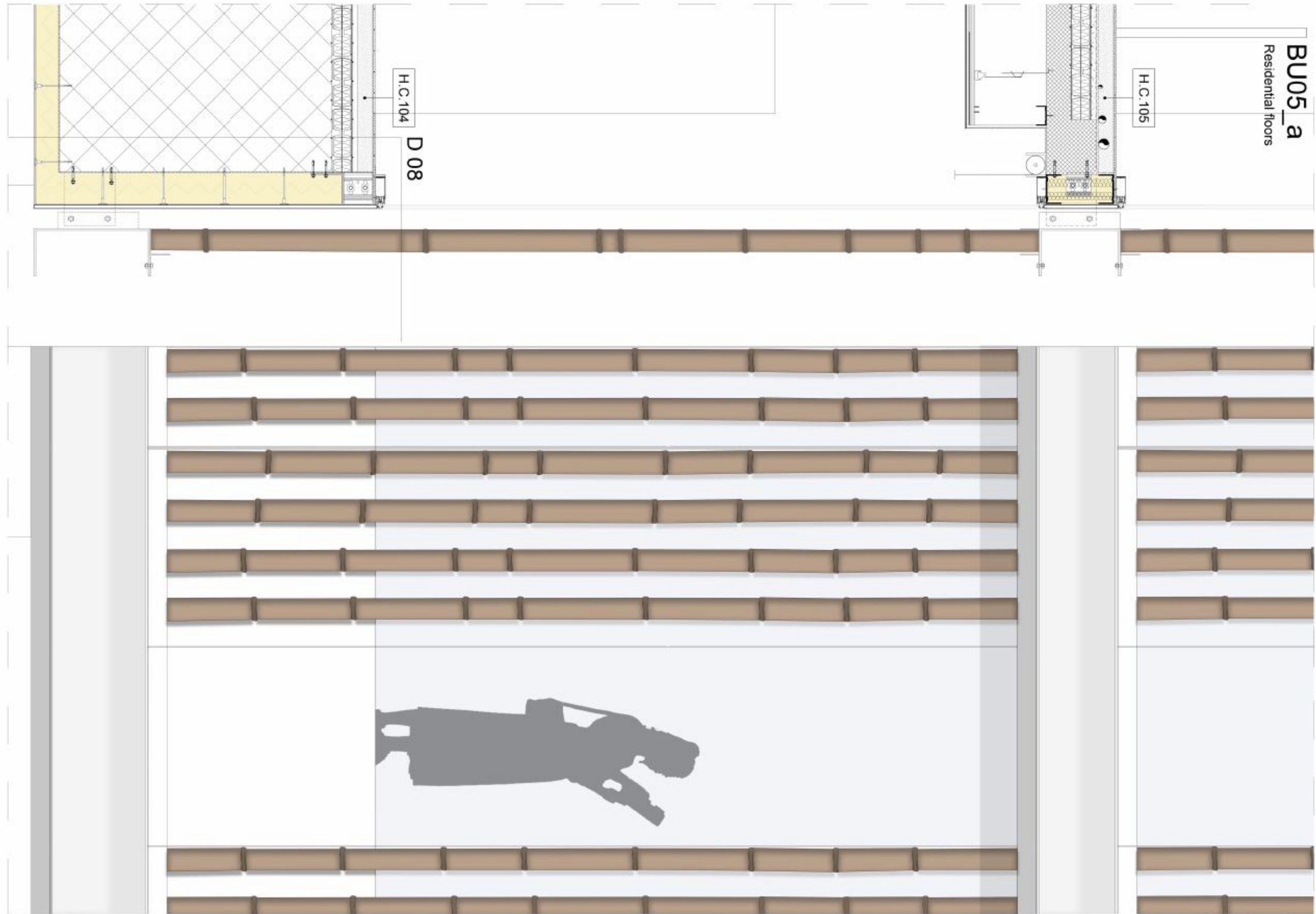
4 bolting of closing panel



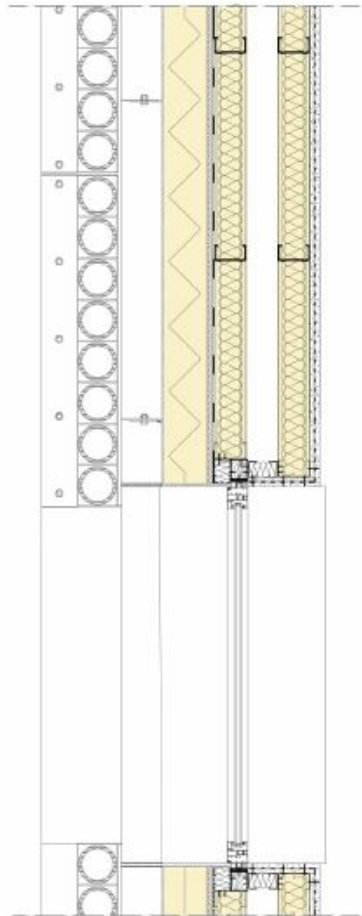


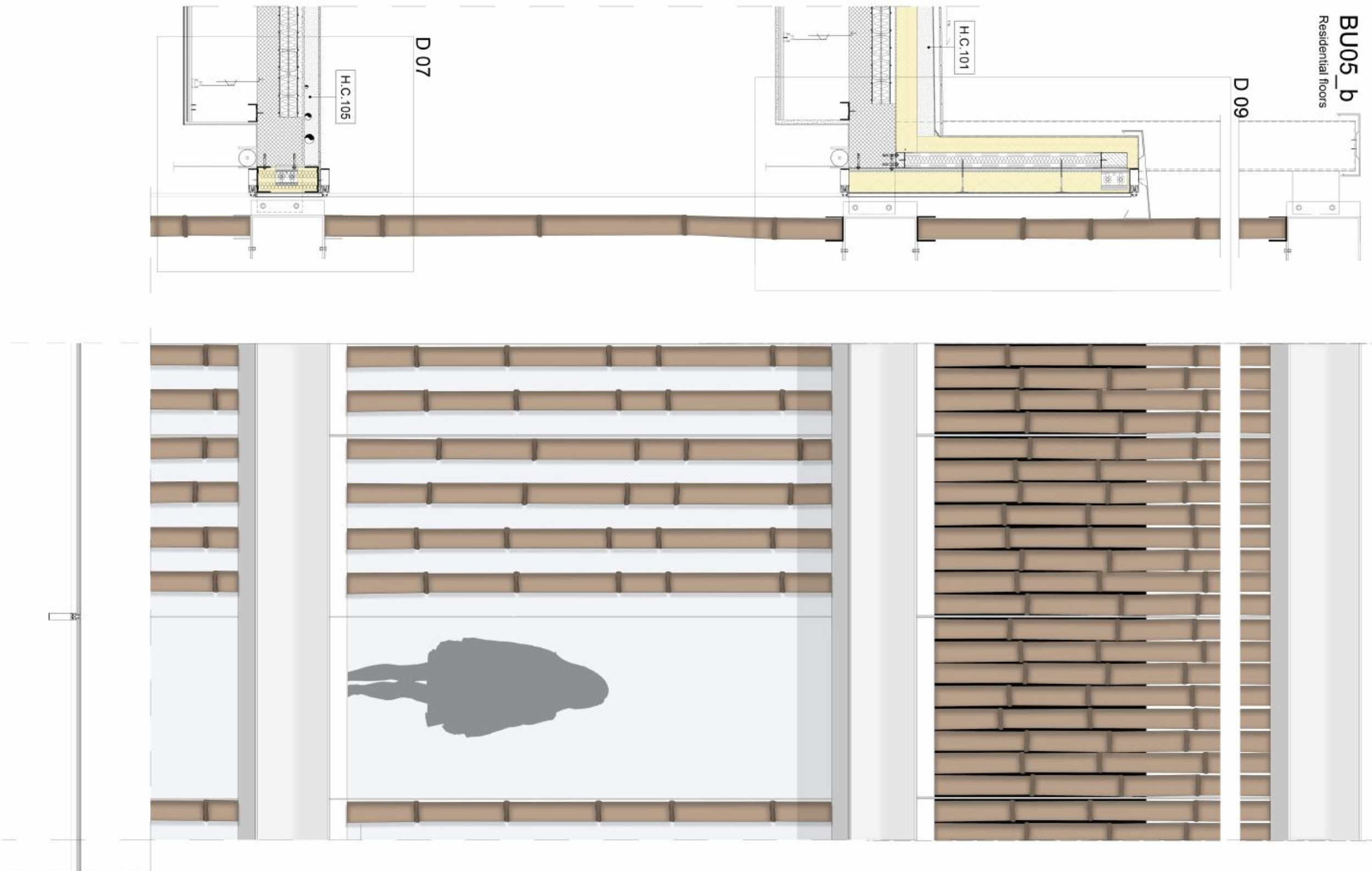


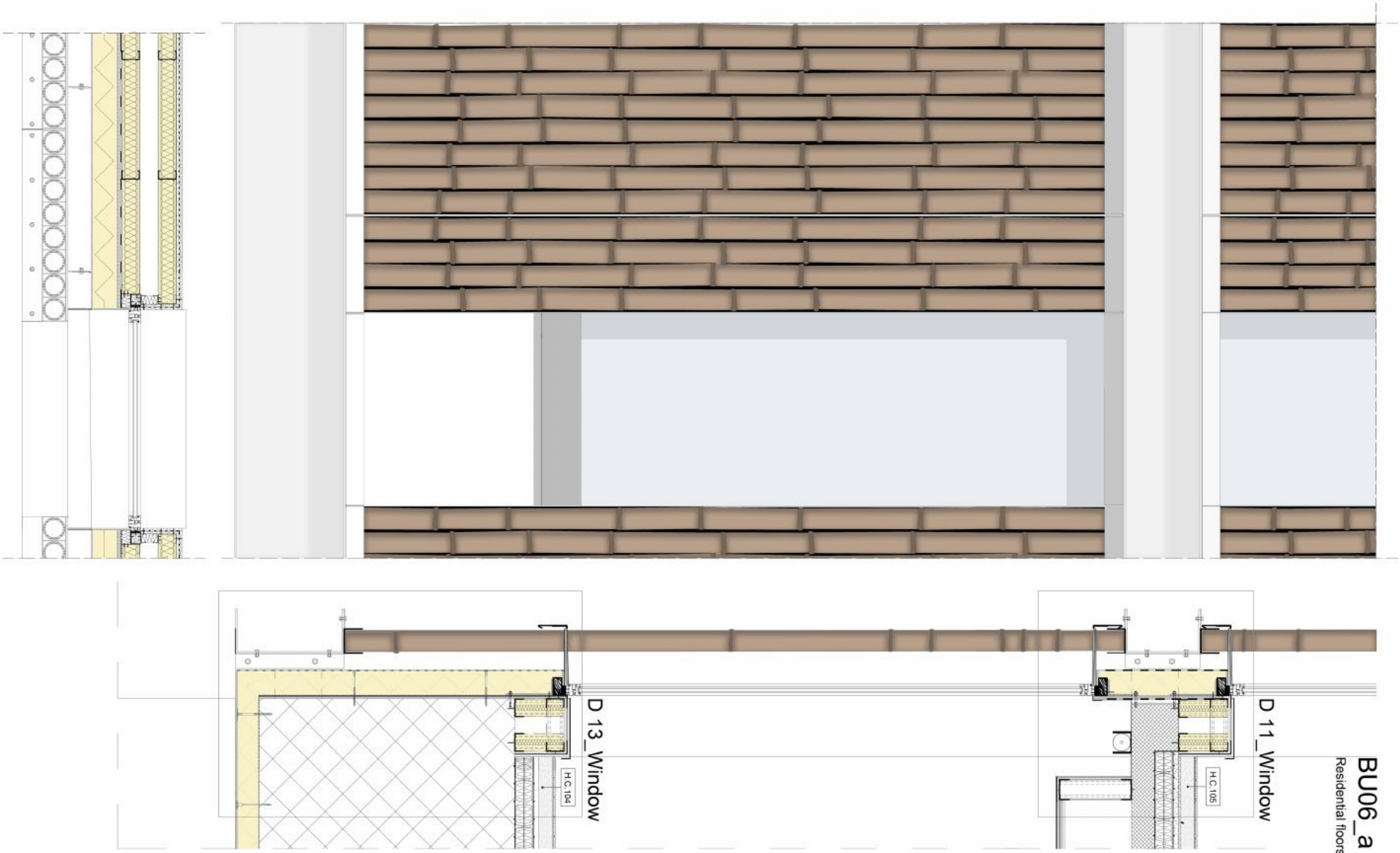
BU05_a
Residential floors

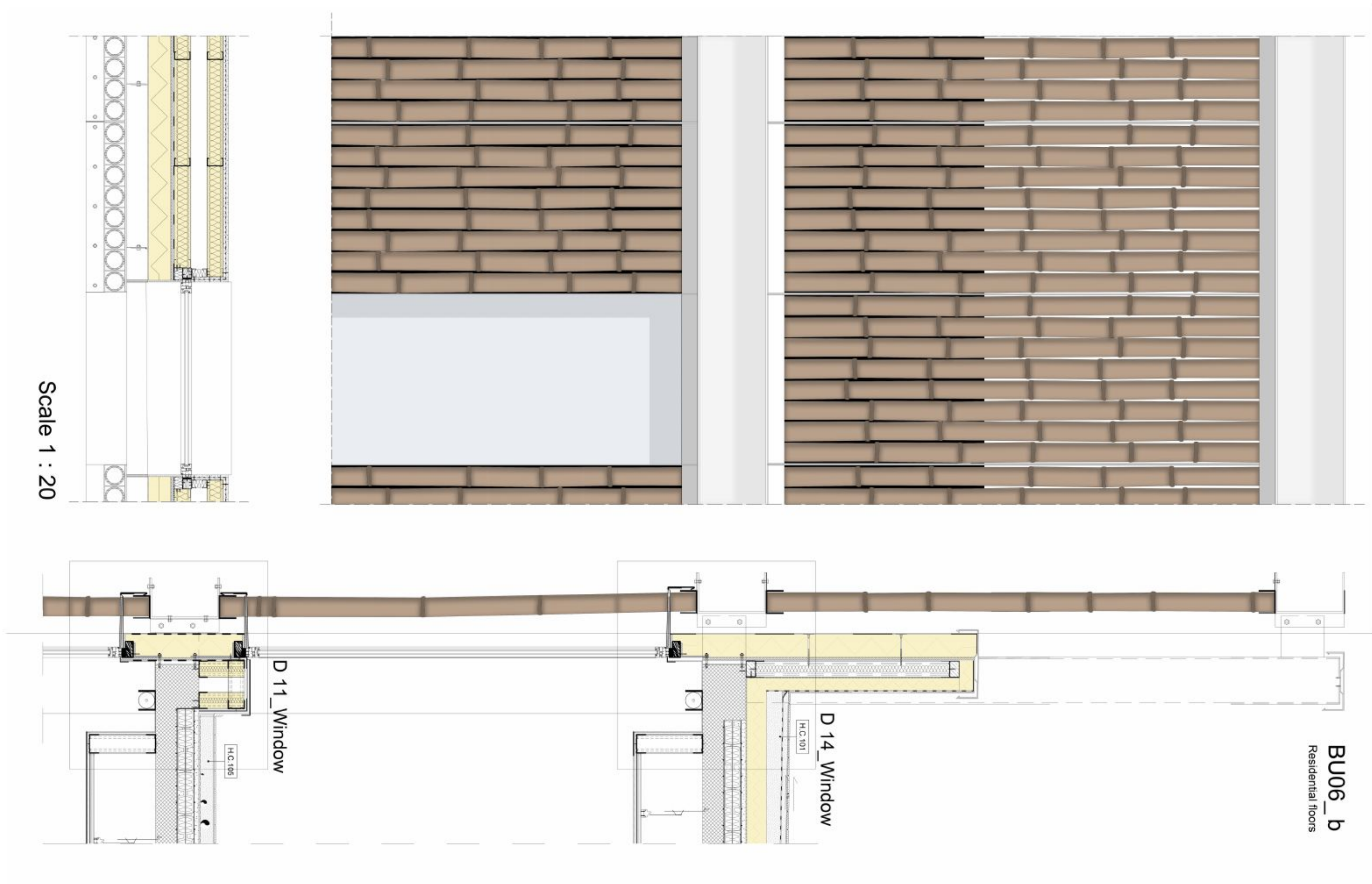


Scale 1 : 20









D 04_Curtain wall

Ground floor

Scale 1:5

EPDM gasket
Curtain wall mullion
Spacer
EPDM gasket
Transom

Support element in cellular glass

Covering element

Porcelain-glazed stone ware tiles,
dim 90 x 11 x 0.9 cm

Floor tile adhesive, th. 5 mm

Light concrete topping for plant installation,
th. 8 cm

Load bearing concrete beam,
dim. 100 cm x 26 cm

Adesive foam for EPS panels th. 5 mm

Thermal insulating layer, EPS panels,
th. 12 cm, $\lambda=0,030\text{W/mK}$

Finishing layer, fiber glass wire lattice, th 4 mm
Organic plaster, th 1 mm

Sealed glazing unit

Double glass unit with cavity

Thermal insulating layer, EPS panels,
th. 12 cm, $\lambda=0,030\text{W/mK}$

Steel chantlate

Impermeable anti-root membrane, th. 3mm, POLIMAT

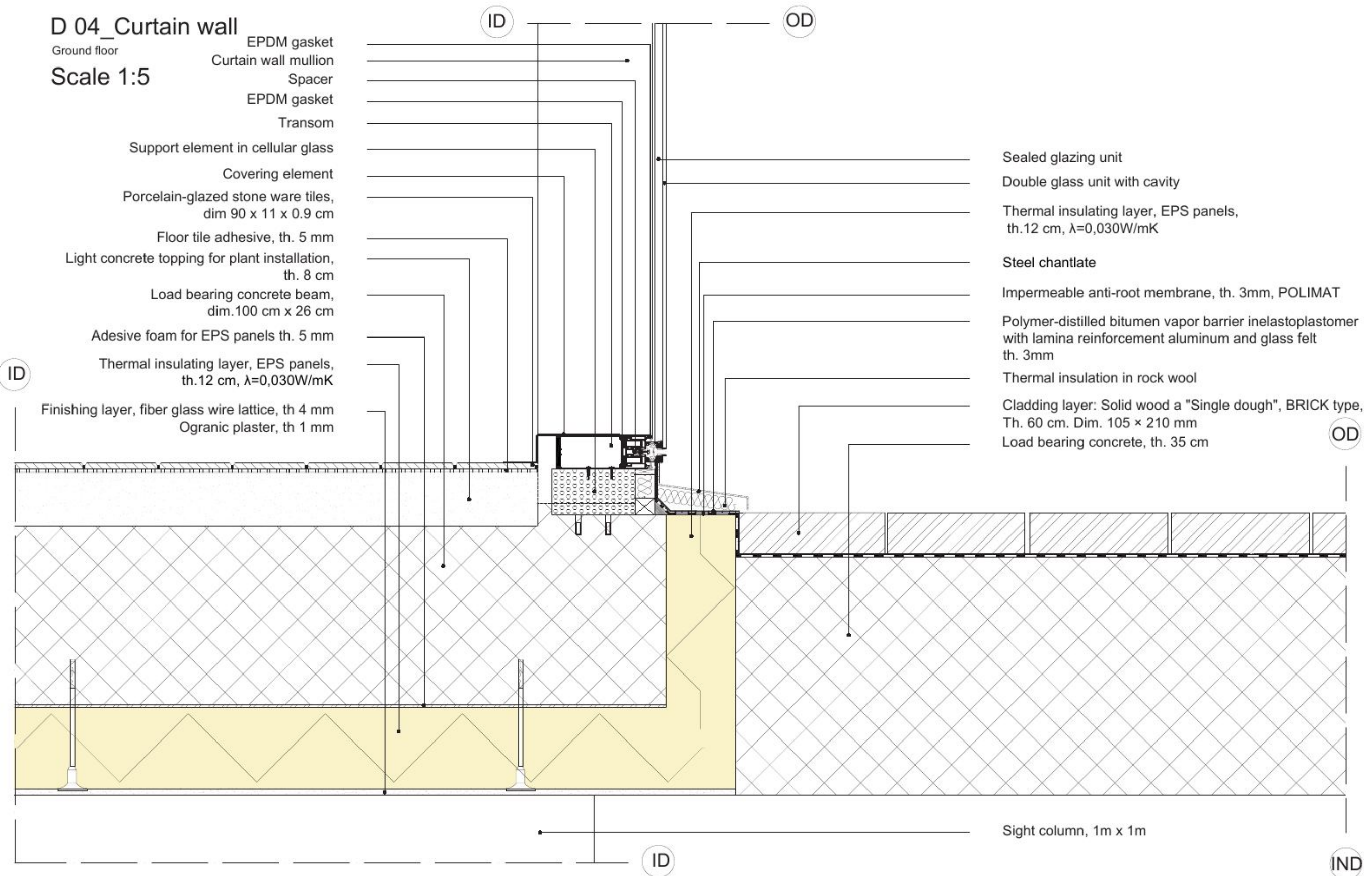
Polymer-distilled bitumen vapor barrier inelastoplastomer
with lamina reinforcement aluminum and glass felt
th. 3mm

Thermal insulation in rock wool

Cladding layer: Solid wood a "Single dough", BRICK type,
Th. 60 cm. Dim. 105 x 210 mm

Load bearing concrete, th. 35 cm

Sight column, 1m x 1m



D 05_Curtain wall

Intermediate floor - public zone

Scale 1:5

Curtain wall mullion

Covering element

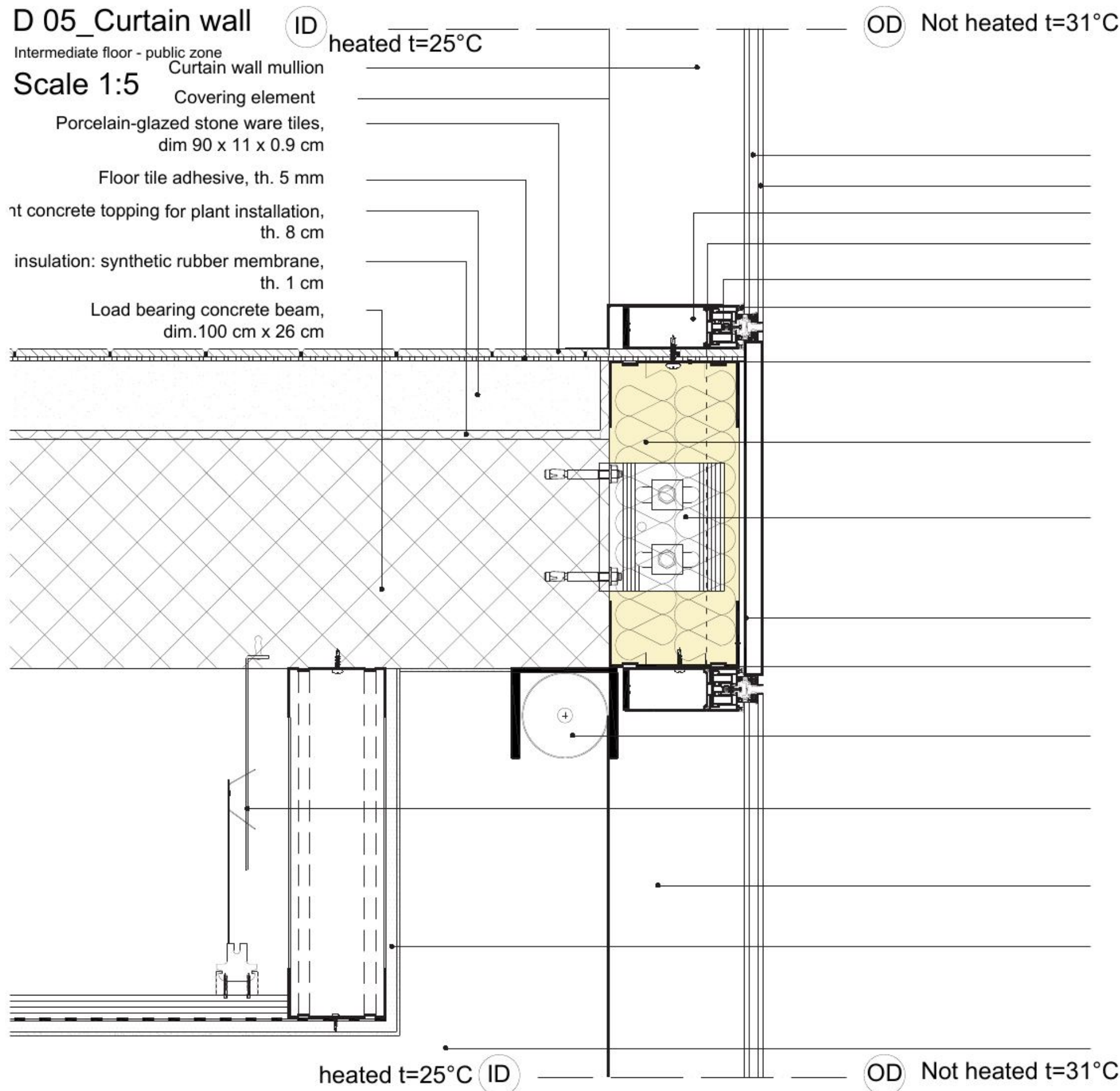
Porcelain-glazed stone ware tiles,
dim 90 x 11 x 0.9 cm

Floor tile adhesive, th. 5 mm

at concrete topping for plant installation,
th. 8 cm

insulation: synthetic rubber membrane,
th. 1 cm

Load bearing concrete beam,
dim. 100 cm x 26 cm



Sealed glazing unit

Double glass unit with cavity

Transom

EPDM gasket

Spacer

EPDM gasket

C-shaped in galvanized steel type "KNAUF profile C 50x100
dim. 50x100 mm - th. 0.6 mm with 40 cm pitch

Thermal insulation layer, in rock wool, th. 10 cm, dim. 60x12
 $\lambda = 0.034 \text{ W / mK}$, type "ISOVER - XPSMF"

Continuous facade fixing through T-shaped steel plate fixed
curtain wall and to concrete layer,
type HALFEN

SPANDREL" element in steel, steel th.: 1.5 mm; cavity th. 17

C-shaped in galvanized steel type "KNAUF profile C 50x100
dim. 50x100 mm - th. 0.6 mm with 40 cm pitch

Electronically controllable roller blind

False ceiling for plant installation,
with metal hanger with adjustable clip,
th. 40 cm

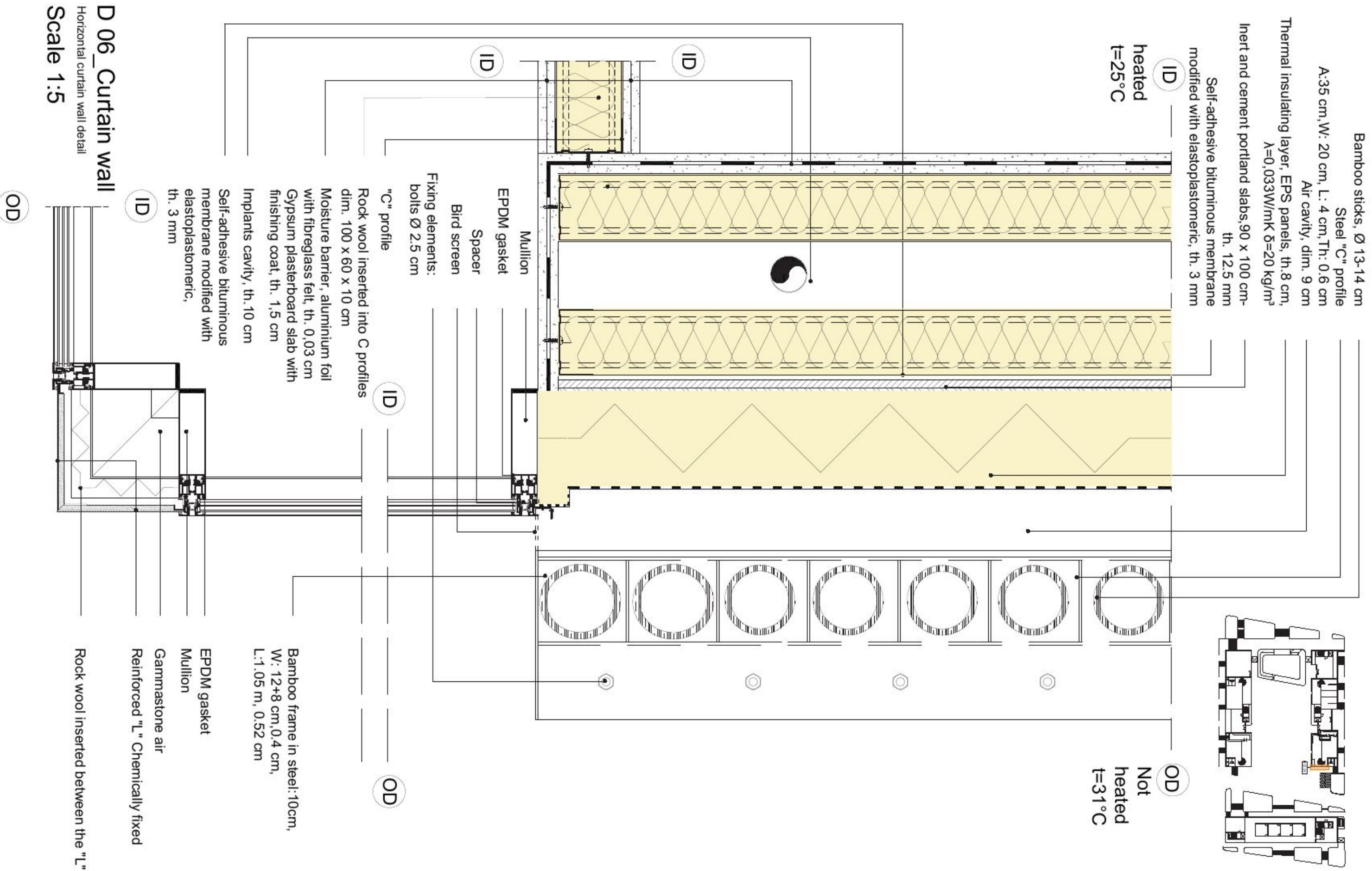
Mullion

Moisture barrier, aluminium foil with fibreglass felt, th. 0,03 c
Gypsum plasterboard slab with finishing coat, th. 1,5 cm

Sight column, 1m x 1m

heated t=25°C ID

OD Not heated t=31°C



heated $t=25^{\circ}\text{C}$ ID D 07__Curtain wall

Intermediate floor - residential zone

Scale 1:5

Spacer

EPDM gasket

Transom

Covering element

Porcelain-glazed stone ware tiles,
dim 90 x 11 x 0.9 cm

Floor tile adhesive, th. 5 mm

Light concrete topping for plant installation,
th. 8 cm

Noise insulation: synthetic rubber membrane,
th. 1 cm

Load bearing concrete beam,
dim.30 cm x 26 cm

OD Not heated $t=31^{\circ}\text{C}$

ID

ID

ID

ID

OD

EPDM gasket

Sealed glazing unit

Double glass unit with cavity

Bamboo sticks, $\varnothing$ 13-14 cm

Bamboo frame in Steel:

H: 10cm, W: 12+8 cm, th: 0.4 cm, L: 1.05 m,
0.52 cm

Fixing elements: bolts $\varnothing$ 2.5 cm

"SPANDREL" element in steel, steel th.:
1.5 mm; cavity th. 17mm

C-shaped in galvanized steel type
"KNAUF profile C 50x100x50",
dim. 50x100 mm - th. 0.6 mm with 40 cm pitch

Steel "T" bracket fixed in the concrete slab
Web: 20 ax 20 x 0.8 cm, Wing: 16 x 20 x 0.5 cm

Fixing elements: bolts $\varnothing$ 2.5 cm

Thermal insulation layer, in rock wool, th. 10 cm,
dim. 60x125 cm, $\lambda = 0.034 \text{ W / mK}$,
type "ISOVER - XPSMF"

Continuous facade fixing through T-shaped
steel plate fixed to the curtain wall and to
concrete layer, type HALFEN

Steel "C" profile

H: 35 cm, W: 20 cm, L: 4 cm, Th: 0.6 cm

Fixing element: plugs

Cobix blocks with concrete casting with
wire lattice, th. 10 + 2 cm

Load bearing concrete, th. 13 cm

False ceiling for plant installation,
with metal hanger with adjustable clip,
th. 40 cm

Mullion

Moisture barrier,
aluminium foil with fibreglass felt, th. 0,03 cm
Gypsum plasterboard slab with finishing coat,
th. 1,5 cm

heated $t=25^{\circ}\text{C}$ ID

ID

OD Not heated $t=31^{\circ}\text{C}$

Sealed glazing unit

Double glass unit with cavity

EPDM gasket

Tansom

Porcelain-glazed stone ware tiles, dim $90 \times 11 \times 0.9 \text{ cm}$

Continuous facade fixing through T-shaped steel plate fixed to the curtain wall and to concrete layer, type HALFEN

Floor tile adhesive, th. 5 mm

Light concrete topping for plant installation, th. 8 cm

Anchoring "L" element in steel supporting the mullion

Cobias blocks with concrete casting with wire lattice, th. $10 + 2 \text{ cm}$

Load bearing concrete, th. 13 cm

Fixing elements: plugs

Load bearing concrete platform, th. 140 cm

Adhesive foam for EPS panels th. 5 mm

Thermal insulating layer, EPS panels, th. 12 cm, $\lambda=0.030\text{W/mK}$

Finishing layer, fiber glass wire lattice, th 4 mm
Organic plaster, th 1 mm

Expansion plug

"SPANDREL" element in steel, steel th.: 1.5 mm; cavity th. 17mm

Bamboo sticks, $\varnothing 13\text{-}14 \text{ cm}$

Bamboo frame in Steel:
H: 10cm, W: 12+8 cm,
th: 0.4 cm, L: 1.05 m-0.52 cm

Fixing elements:
bolts $\varnothing 2.5 \text{ cm}$

Continuous facade fixing through T-shaped steel plate fixed to the curtain wall and to concrete layer, type HALFEN

Steel "T" bracket fixed in the concrete slab
Web: 20 ax 20 x 0.8 cm,
Wing: 16 x 20 x 0.5 cm

Fixing elements:
bolts $\varnothing 2.5 \text{ cm}$

Steel "C" profile
H: 35 cm, W: 20 cm,
L: 6 cm, Th: 0.6 cm

Covering element

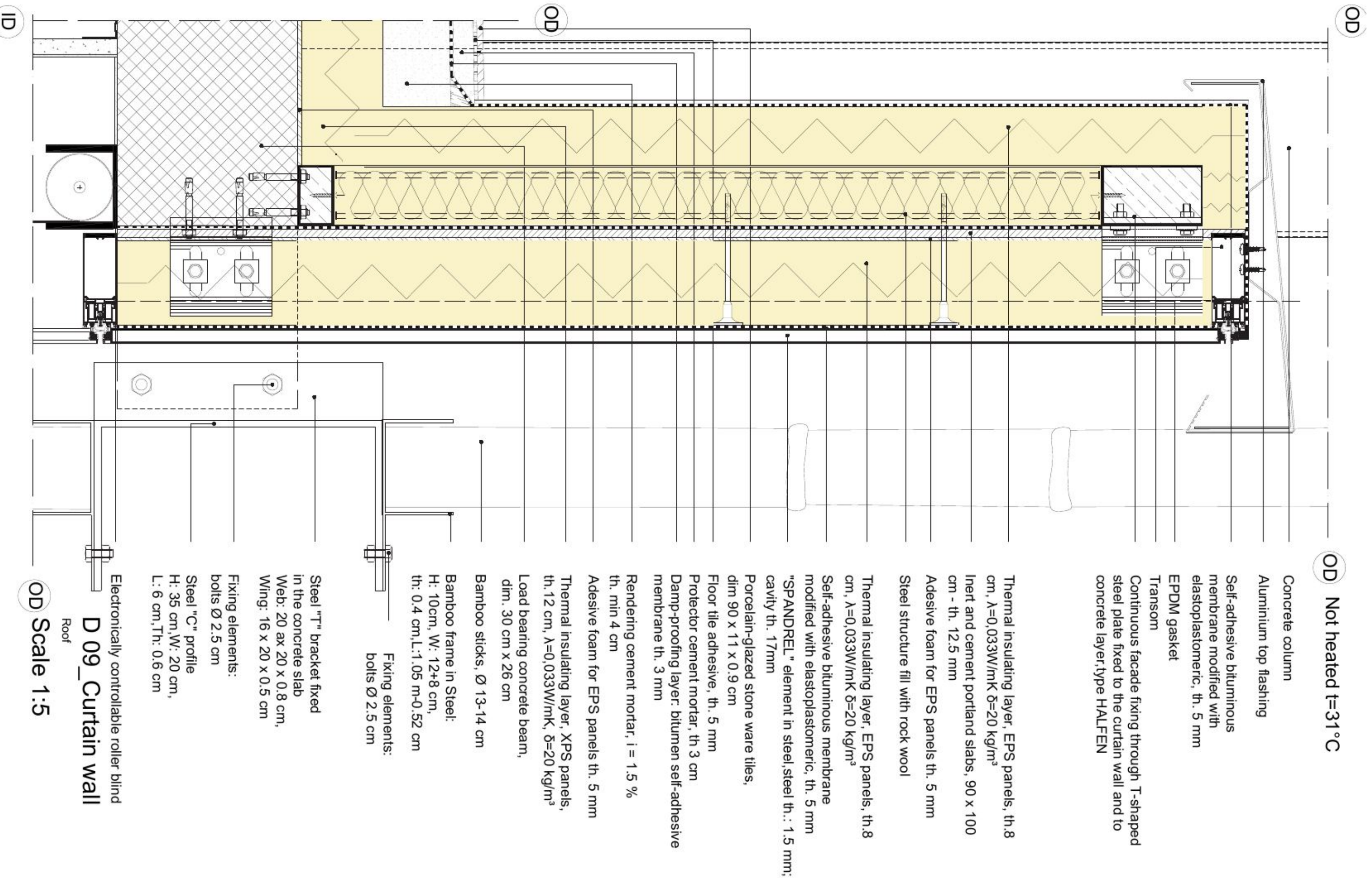
Bird screen

D 08_Curtain wall

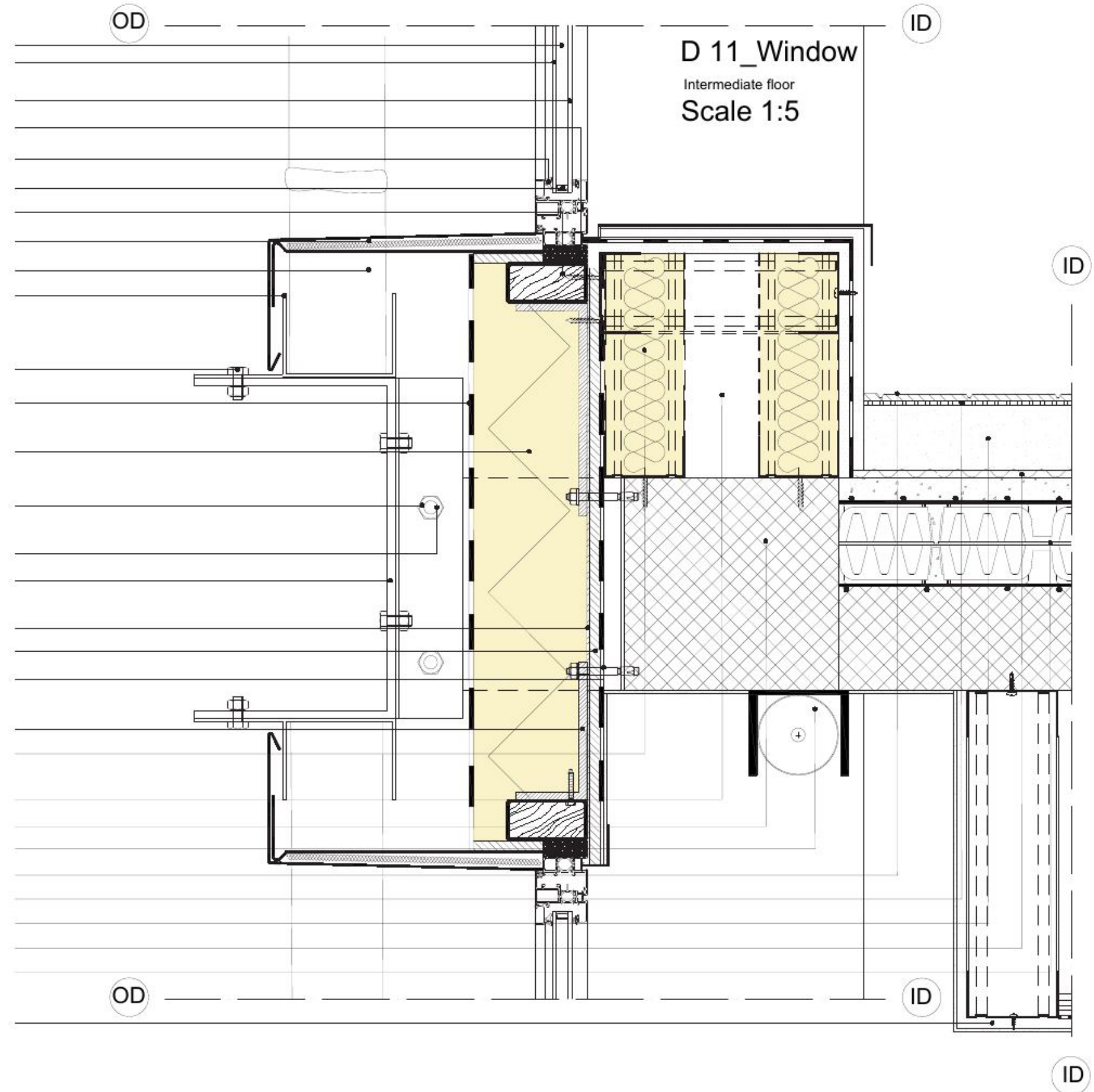
Concrete slab

Scale 1:5

OD



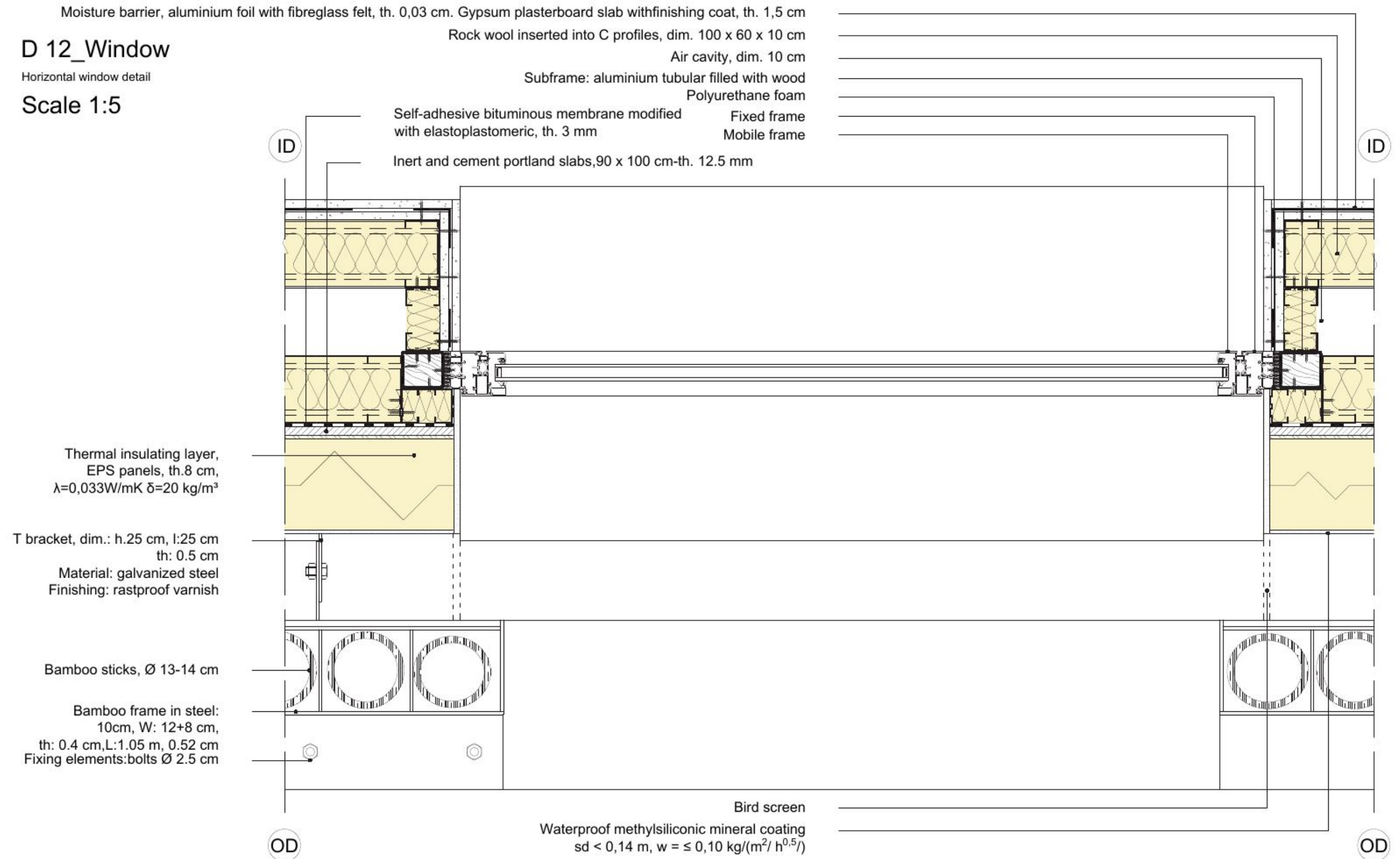
Argon 90% - 15 mm
 Planible clearite - 4 mm, thermally thoghened with stopsol coating on the outside
 Planible clearite - 4 mm thermally thoghened
 Polyurethane foam
 Over lapping gasket EPDM providing wind sealing protection
 Thermal break strip in polymerica material, 34 mm
 Subframe: aluminium tubular filled with wood
 Aluminium external windowsill
 Bamboo sticks, Ø 13-14 cm
 Bamboo frame in steel:
 H: 10cm, W: 12+8 cm,th: 0.4 cm,L:1.05 m,
 0.52 cm
 Fixing elements: bolts Ø 2.5 cm
 Self-adhesive bituminous membrane modified with elastoplastomeric, th. 5 mm
 Thermal insulating layer, EPS panels, th.14 cm, $\lambda=0,033W/mK$ $\delta=20$ kg/m³
 Steel "T" bracket fixed in the concrete slab
 Web: 20 ax 20 x 0.8 cm, Wing: 16 x 20 x 0.5 cm
 Fixing elements: bolts Ø 2.5 cm
 Steel "C" profile
 H: 35 cm,W: 20 cm, L: 4 cm,Th: 0.6 cm
 Adesive foam for EPS panels th. 5 mm
 Inert and cement portland slabs,90 x 100 cm - th. 12.5 mm
 Self-adhesive bituminous membrane modified with elastoplastomeric, th. 3 mm
 Supporting steel "L" element for the windows, 7 cm x 15 cm
 Rock wool inserted into C profiles
 dim. 100 x 60 x 10 cm
 Air cavity, th 10 cm
 Load bearing concrete beam, dim.30 cm x 26 cm
 Electronically controllable roller blind
 Porcelain-glazed stone ware tiles,dim 90 x 11 x 0.9 cm
 Floor tile adhesive, th. 5 mm
 Light concrete topping for plant installation, th. 8 cm
 Noise insulation: synthetic rubber membrane, th. 1 cm
 Cobiax blocks with concrete casting with wire lattice, th. 10 + 2 cm
 Load bearing concrete, th. 13 cm
 Moisture barrier,aluminium foil with fibreglass felt, th. 0,03 cm
 Gypsum plasterboard slab with finishing coat, th. 1,5 cm

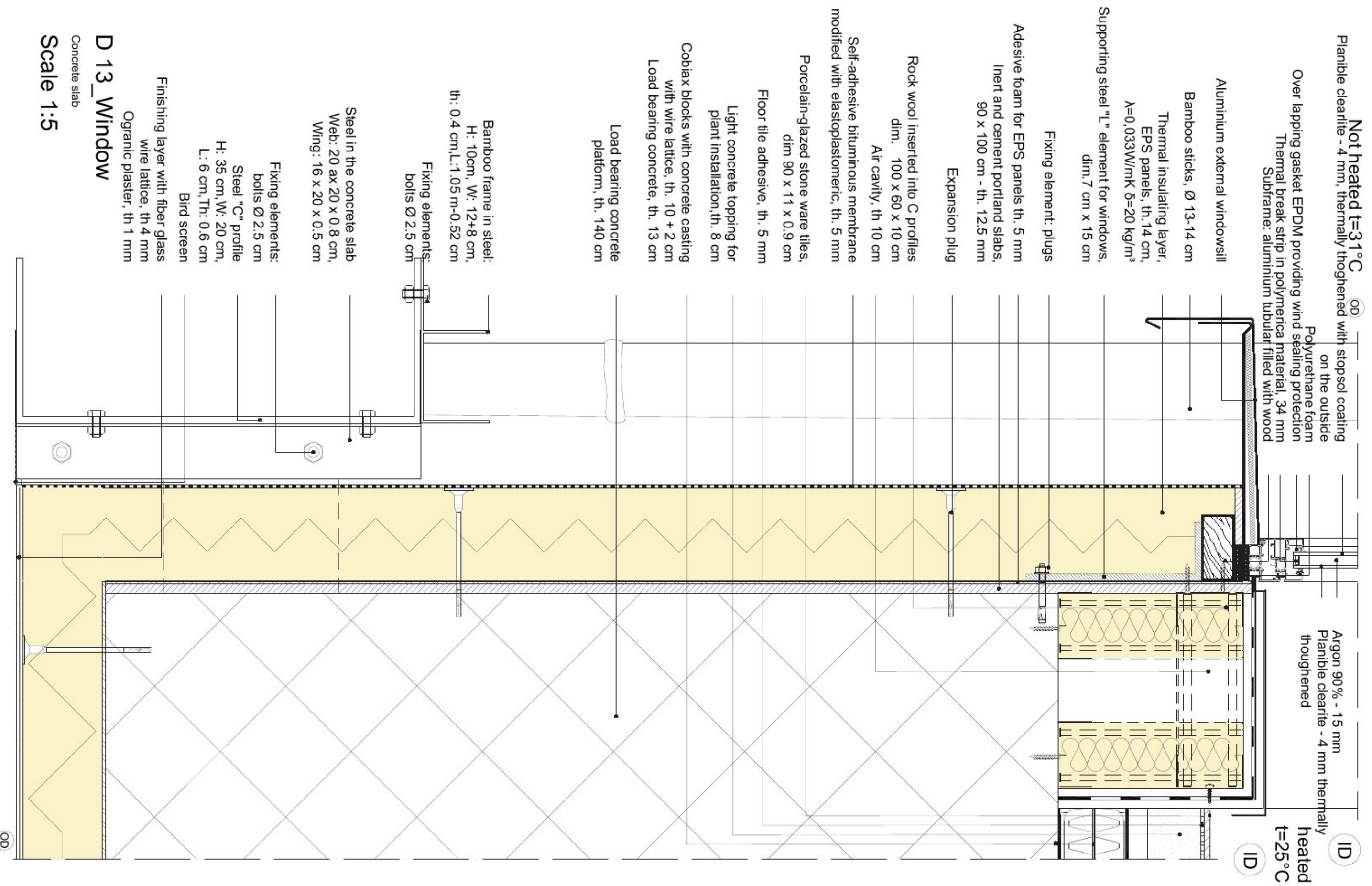


D 12_Window

Horizontal window detail

Scale 1:5





Not heated OD Concrete column
 $t=31^{\circ}\text{C}$ Aluminium top flashing
D 14_Window Self-adhesive bituminous
 Roof membrane modified with
 elastoplastic, th. 5 mm
 Scale 1:5

Bamboo sticks, $\varnothing$ 13-14 cm
 Skim coat with fiberglass reinforcement
 mesh, th. 4 mm
 Organic based finishing plaster, th. 4 mm
 Waterproof methylsilicon mineral coating
 $sd < 0,14 \text{ m}$, $w \leq 0,10 \text{ kg}/(\text{m}^2 \text{ h}^{0,5})$
 Thermal insulating layer, EPS panels, th. 8
 cm, $\lambda=0,033\text{W}/\text{mK}$ $\delta=20 \text{ kg}/\text{m}^3$
 Inert and cement portland slabs, 90 x 100
 cm - th. 12.5 mm

Adesive foam for EPS panels th. 5 mm
 Thermal insulating layer, EPS panels, th. 8
 cm, $\lambda=0,033\text{W}/\text{mK}$ $\delta=20 \text{ kg}/\text{m}^3$
 Self-adhesive bituminous membrane
 modified with elastoplastic, th. 5 mm

Porcelain-glazed stone ware tiles,
 dim 90 x 11 x 0.9 cm
 Floor tile adhesive, th. 5 mm
 Protector cement mortar, th 3 cm
 Damp-proofing layer: bitumen self-adhesive
 membrane th. 3 mm
 Rendering cement mortar, $i = 1.5 \%$
 th. min 4 cm

Thermal insulating layer, XPS panels,
 th. 12 cm, $\lambda=0,033\text{W}/\text{mK}$, $\delta=20 \text{ kg}/\text{m}^3$
 Adesive foam for EPS panels th. 5 mm

Load bearing concrete beam,
 dim. 30 cm x 26 cm

Bamboo frame in steel:
 H: 10cm, W: 12+8 cm,
 th: 0.4 cm, L: 1.05 m-0.52 cm

Fixing elements:
 bolts $\varnothing$ 2.5 cm

Steel "T" bracket fixed
 in the concrete slab
 Web: 20 ax 20 x 0.8 cm,
 Wing: 16 x 20 x 0.5 cm

Fixing elements:
 bolts $\varnothing$ 2.5 cm

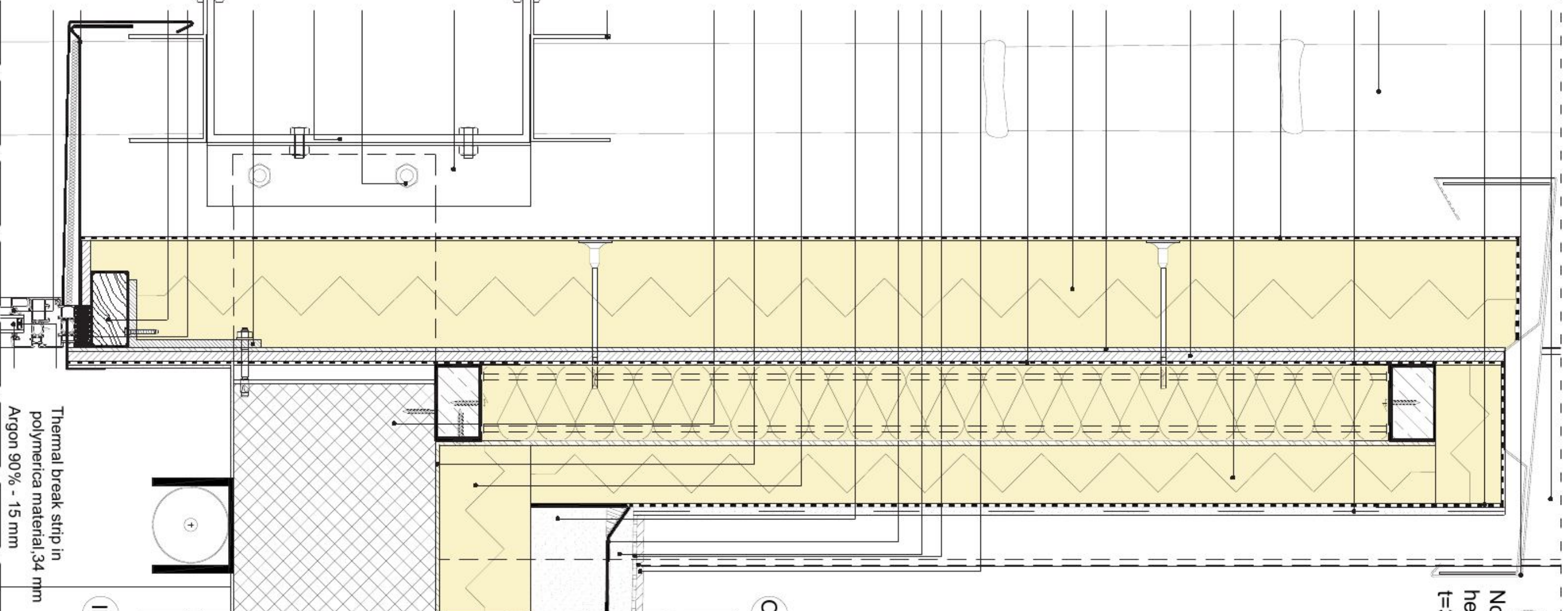
Steel "C" profile
 H: 35 cm, W: 20 cm,
 L: 6 cm, Th: 0.6 cm

Supporting steel "L" element for the windows,
 7 cm x 15 cm

Polyurethane foam
 Subframe: aluminium tubular filled with wood

Aluminium external window sill
 Over lapping gasket EPDM providing
 wind sealing protection

OD



OD Not
 heated
 $t=31^{\circ}\text{C}$

ID

heated $t=25^{\circ}\text{C}$ ID

D 10_Curtain wall

Detail with parapet

Scale 1:5

Spacer
EPDM gasket
Transom
Covering element
Glass parapet

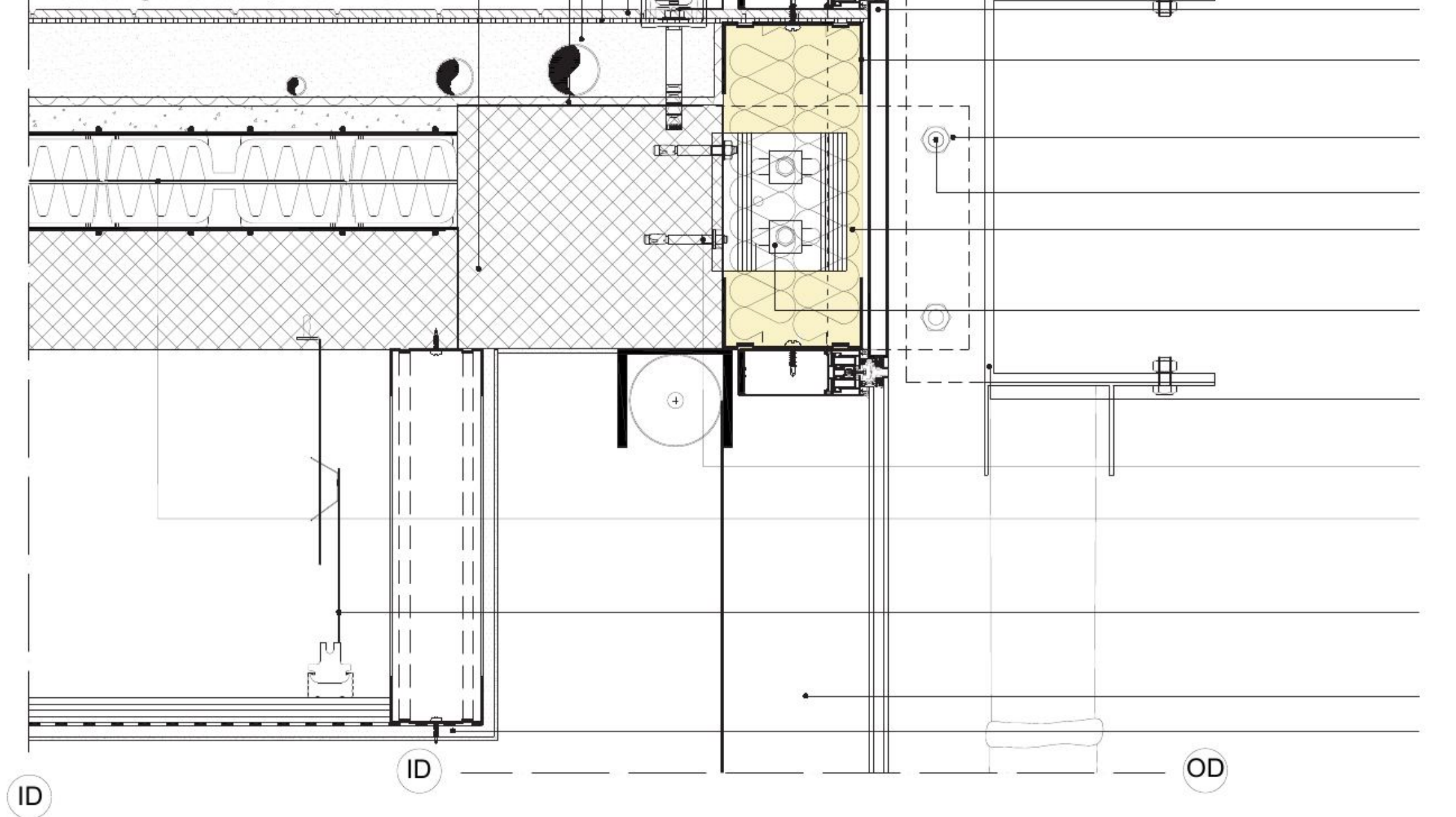
Porcelain-glazed stone ware tiles,
dim 90 x 11 x 0.9 cm

Floor tile adhesive, th. 5 mm

ID Light concrete topping for plant installation,
th. 8 cm

Noise insulation: synthetic rubber membrane,
th. 1 cm

Load bearing concrete beam, dim. 30 cm x 26 cm



EPDM gasket
Sealed glazing unit
Double glass unit with cavity
Bamboo sticks, $\varnothing$ 13-14 cm

Bamboo frame in Steel:
H: 10cm, W: 12+8 cm, th: 0.4 cm, L: 1.05 m,
0.52 cm

Fixing elements: bolts $\varnothing$ 2.5 cm
"SPANDREL" element in steel, steel th.:
1.5 mm; cavity th. 17mm
C-shaped in galvanized steel type
"KNAUF profile C 50x100x50",
dim. 50x100 mm - th. 0.6 mm with 40 cm pitch
Steel "T" bracket fixed in the concrete slab
Web: 20 ax 20 x 0.8 cm, Wing: 16 x 20 x 0.5 cm

Fixing elements: bolts $\varnothing$ 2.5 cm
Thermal insulation layer, in rock wool, th. 10 cm,
dim. 60x125 cm, $\lambda = 0.034 \text{ W / mK}$,
type "ISOVER - XPSMF"

Continuous facade fixing through T-shaped
steel plate fixed to the curtain wall and to
concrete layer, type HALFEN

Steel "C" profile
H: 35 cm, W: 20 cm, L: 4 cm, Th: 0.6 cm

Fixing element: plugs

Cobix blocks with concrete casting with
wire lattice, th. 10 + 2 cm
Load bearing concrete, th. 13 cm

False ceiling for plant installation,
with metal hanger with adjustable clip,
th. 40 cm

Mullion

Moisture barrier,
aluminium foil with fibreglass felt, th. 0.03 cm
Gypsum plasterboard slab with finishing coat,
th. 1,5 cm

GLAZING RESPONSE CURVES

THE FOLLOWING ARE THE RESPONSE CURVES FOR U-VALUE AND SOLAR HEAT GAIN COEFFICIENT OF GLAZINGS RESPECTING

THE ENERGY USE INTENSITY, ANNUAL ELECTRICITY DEMAND AND COOLING EQUIPMENT DESIGN CAPACITY.

REGARDING THE CLIMATE AND POSITION OF OUR BUILDING IT SEEMS THAT A HIGHER U-VALUE WOULD CAUSE THE HEAT TO BE TRAPPED INSIDE OF OUR BUILDING, THAT IS MUCH BETTER EXHIBITED LOOKING AT THE SOUTH EASTERN FACADE

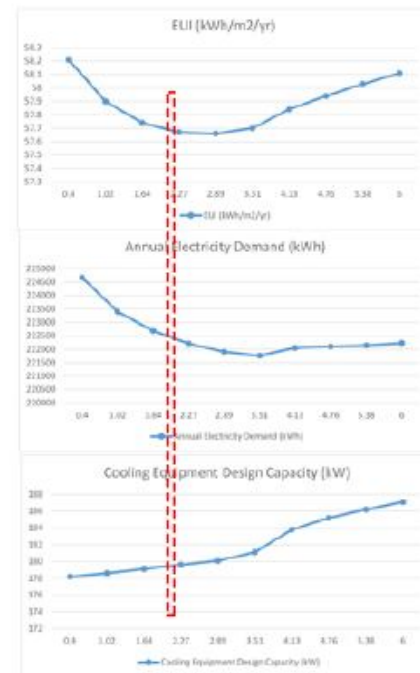
RESPONSES IN CASE OF U-VALUES WHICH SHOWS THAT THE SIDE THAT IS SUBJECTED TO MORE DIRECT SURFACE HEATING IS REQUIRED TO HAVE A HIGHER U-VALUE TO RESPONSE A BETTER PERFORMANCE FOR THE BUILDING.

HENCE, THE VALUES CHOSEN FOR EACH SIDE OF THE FACADE TO PROVIDE THE OPTIMUM PERFORMANCE IS SHOWN HERE.

MOVING FORWARD DUE TO SIMILARITY BETWEEN THE VALUES ONLY 4 DIFFERENT TECHNOLOGIES FOR THE GLAZING CONFIGURATIONS ARE CHOSEN, TWO FOR THE SE FACADES (ONE WINDOW CONFIGURATION AND ONE

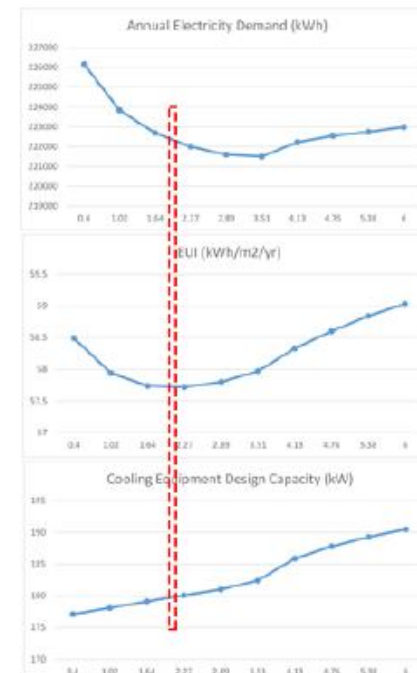
CURTAINWALL CONFIGURATION) AND TWO FOR THE REST OF THE FACES.

NORTH EAST



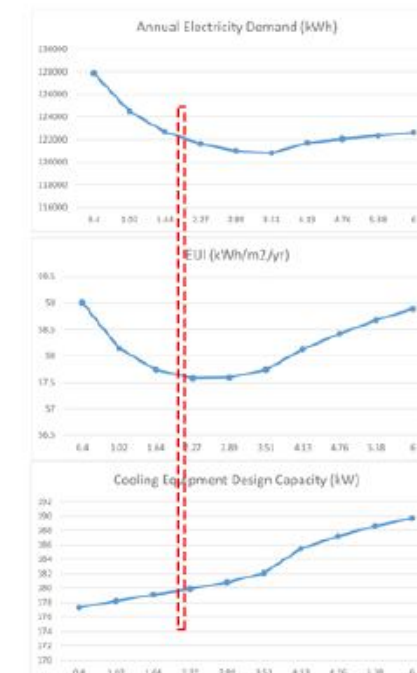
CHOSEN VALUE 2.25

NORTH WEST



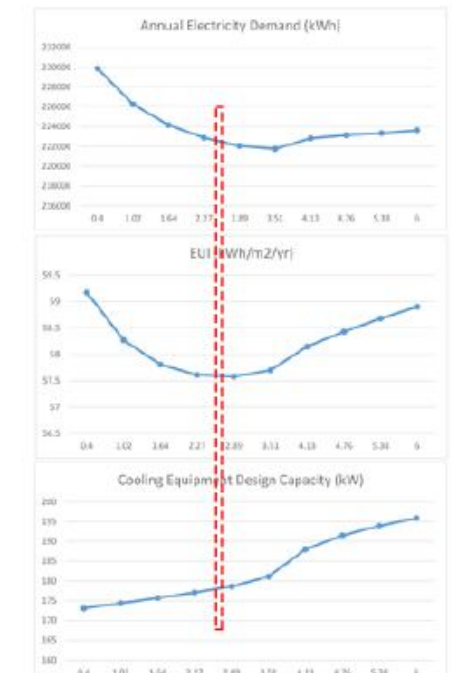
CHOSEN VALUE 2.25

SOUTH WEST

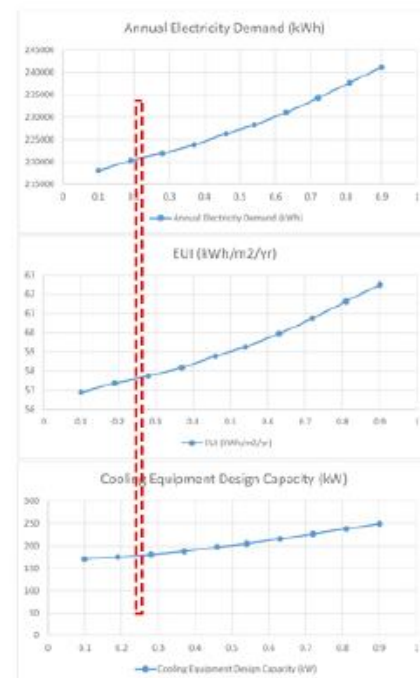


CHOSEN VALUE 2.25

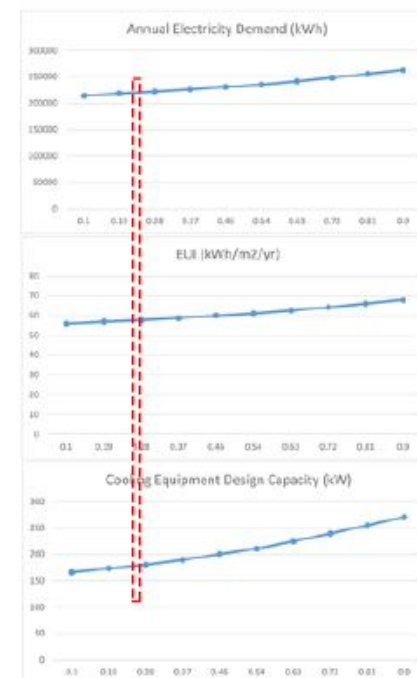
SOUTH EAST



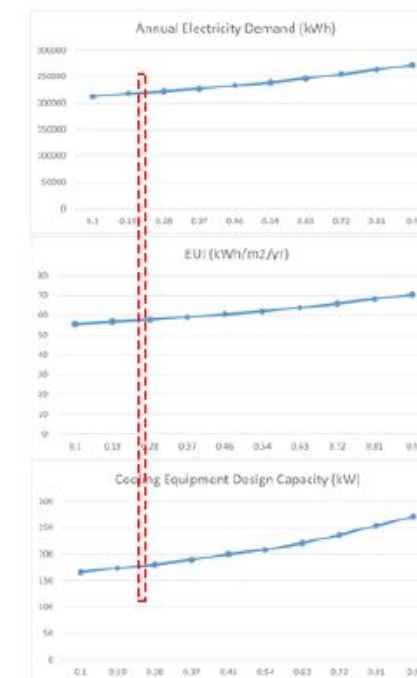
CHOSEN VALUE 2.8



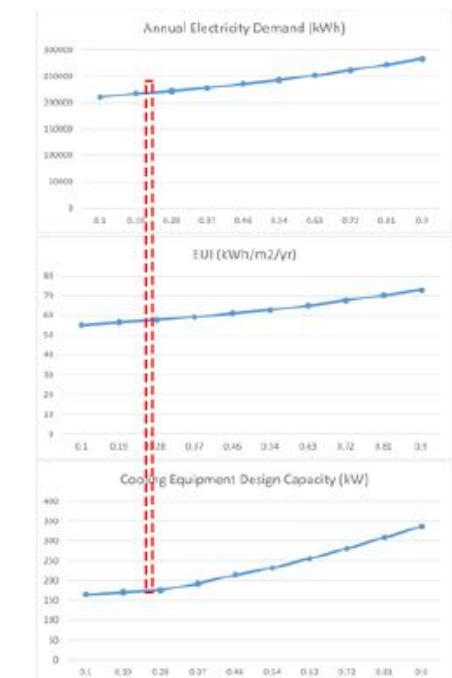
CHOSEN VALUE 0.25



CHOSEN VALUE 0.25



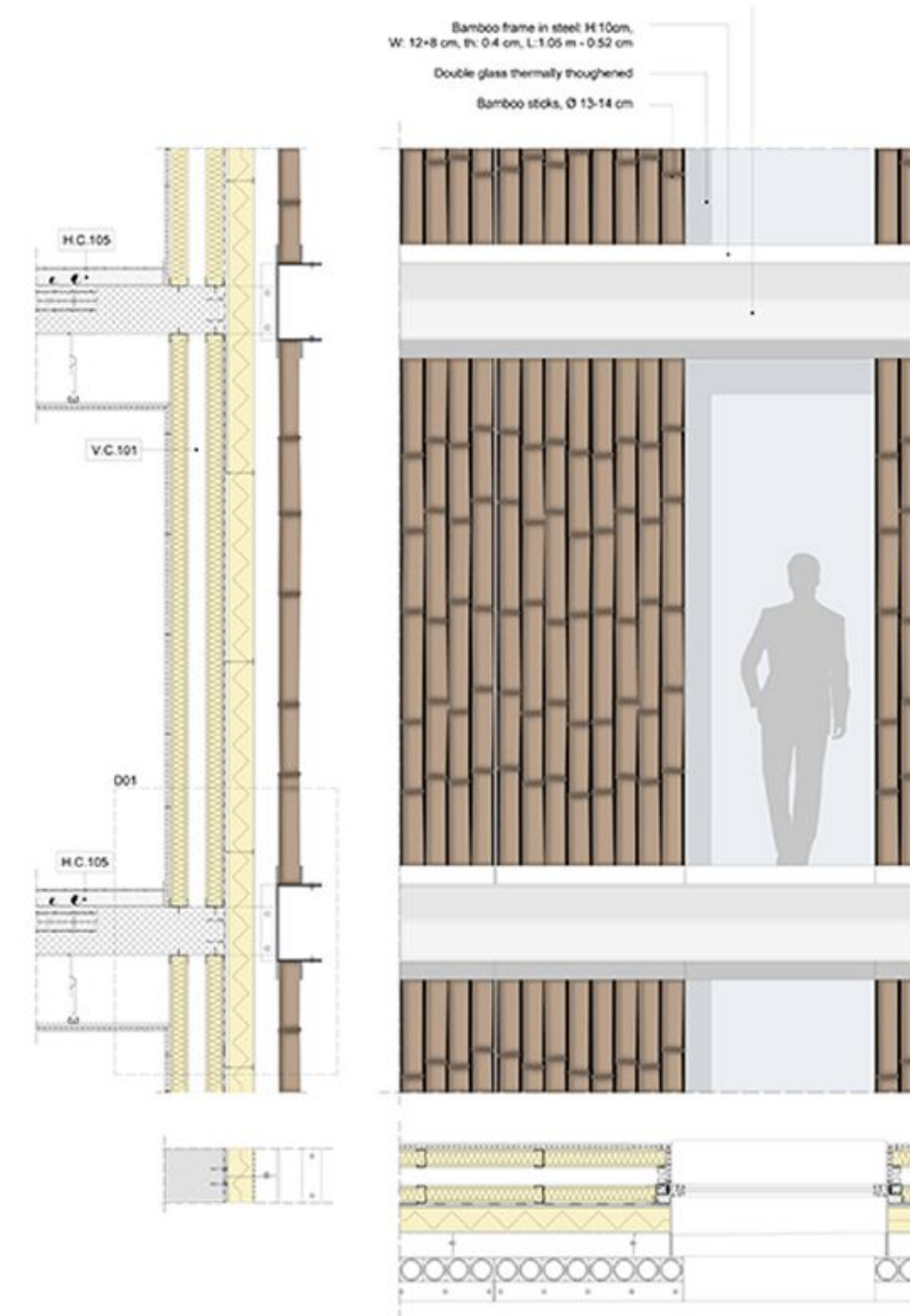
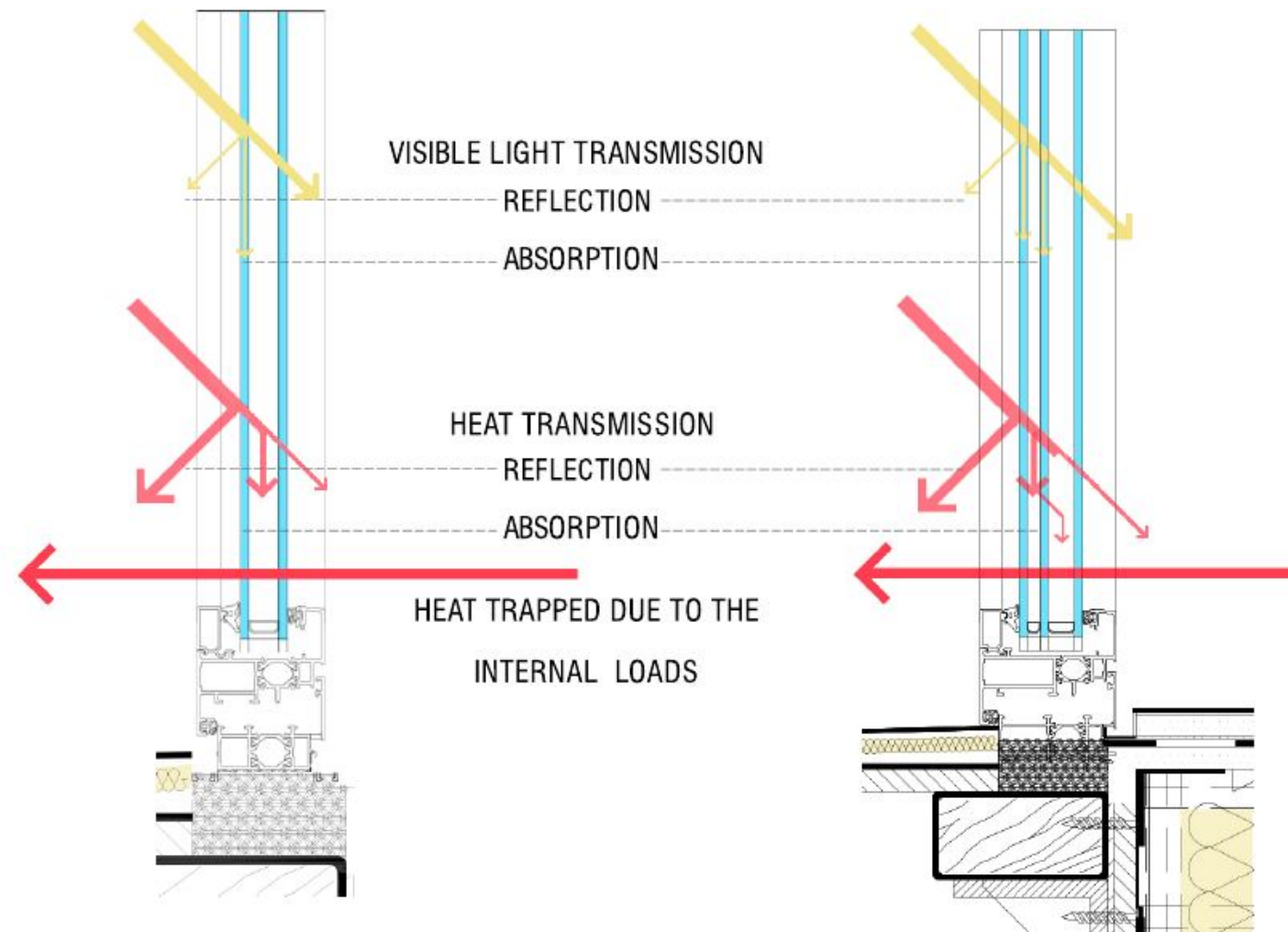
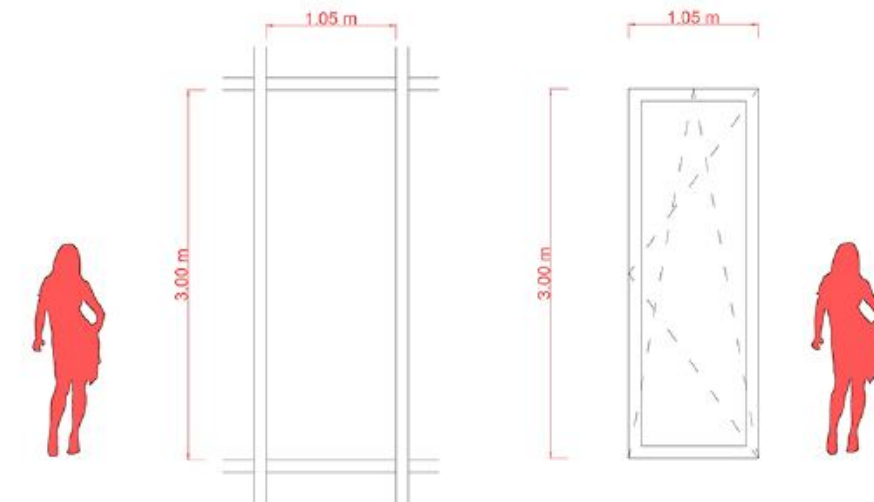
CHOSEN VALUE 0.25



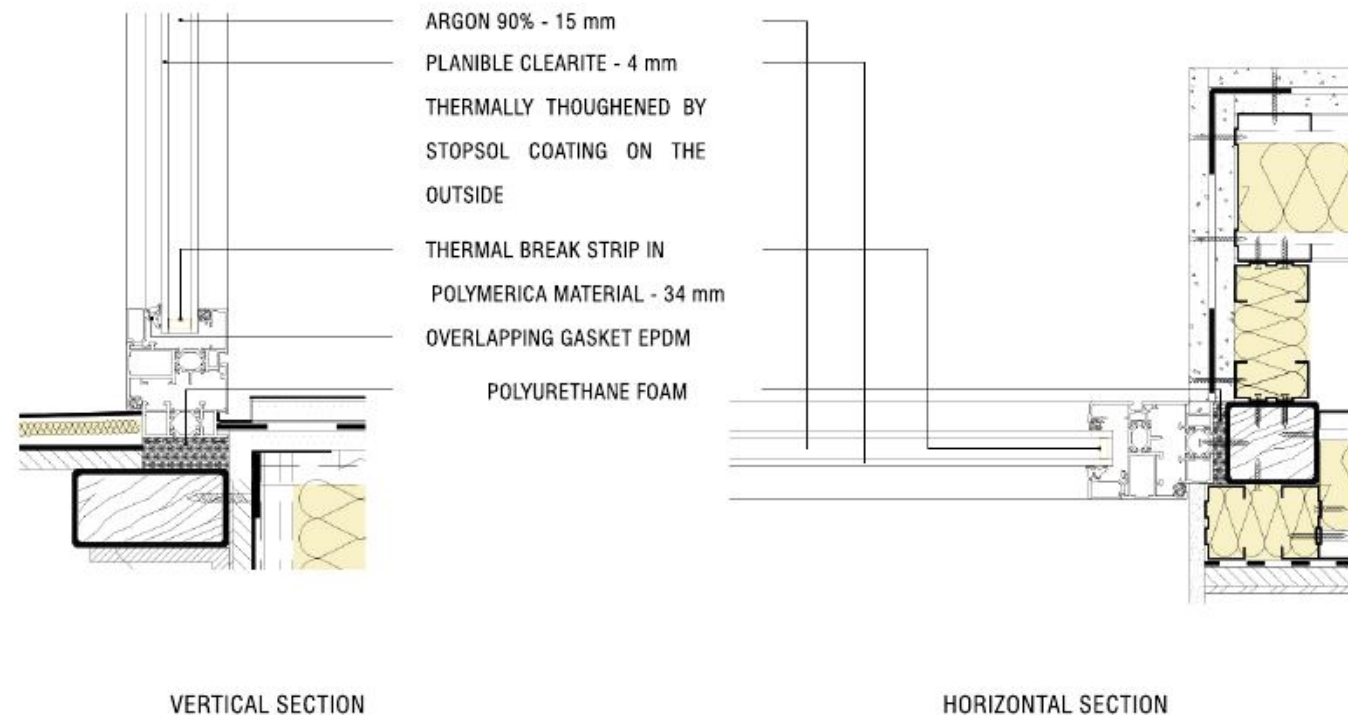
CHOSEN VALUE 0.25

GLASS PROPERTIES

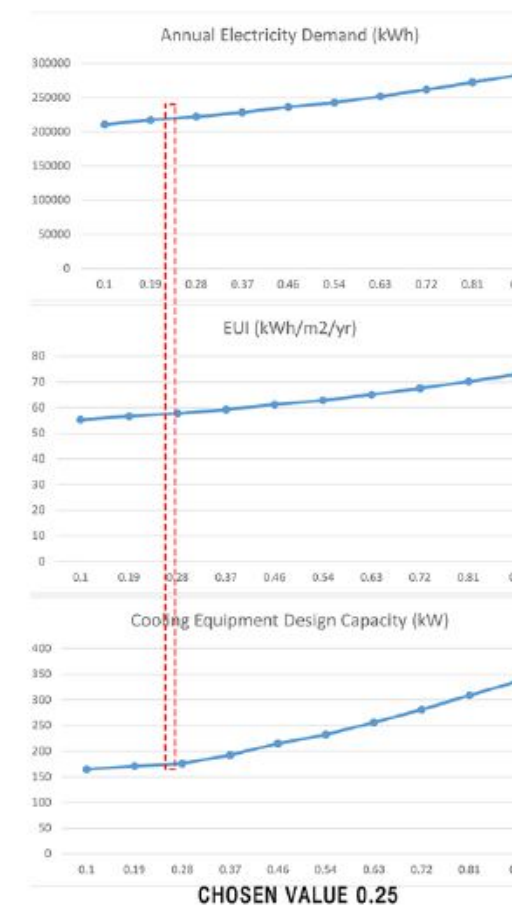
Frame properties			Window properties			
Code	Product Name	Material	U _f (W/m ² K)	U _w (W/m ² K)	No. Panes	SHGC
1	T8000 - Acoustical Tandem Casement Windows	Aluminum	1,8	2,2	3	25%
2	T6000 - Acoustical Tandem Casement Windows	Aluminum	2,5	2,6	2	25%
3	7550 WALL™ CURTAIN WALL	Aluminum	1,9	2,2	3	25%
4	7950 WALL™ CURTAIN WALL	Aluminum	2,5	2,6	2	25%



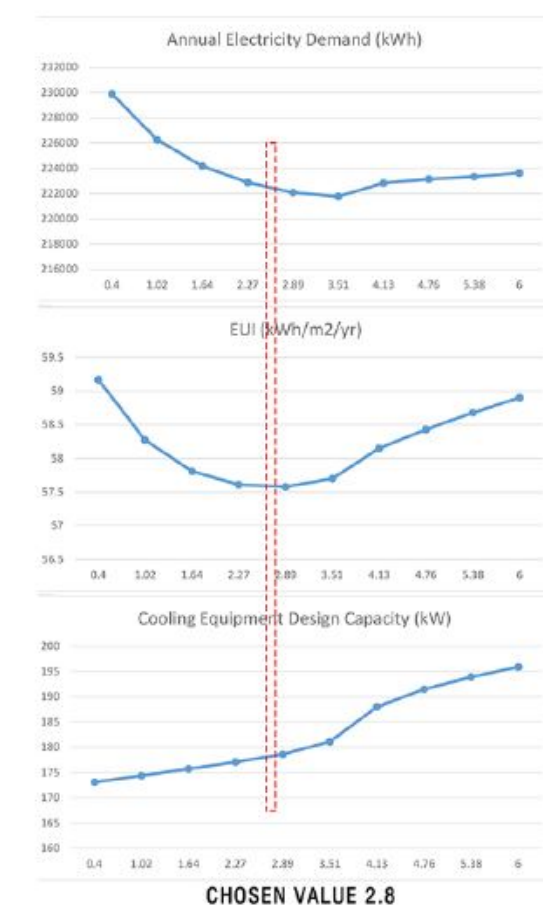
SOUTH EAST FACADE



SHCG



U-Value



Glass performance data simulation

Light properties - EN 410

Light transmittance : τ_v [%]	35
External light reflection : ρ_v [%]	35
Internal light reflection : ρ_{vi} [%]	30
Colour rendering index : R_a [%]	91

Energy properties - EN 410

Solar factor : g [%]	25
External energy reflection : ρ_e [%]	31
Internal energy reflection : ρ_{ei} [%]	24
Direct energy transmission : τ_e [%]	41
Energy absorption glass 1 : α_{e1} [%]	25
Energy absorption glass 2 : α_{e2} [%]	3
Total energy absorption : α_e [%]	28
Shading coefficient : SC	0.53
UV transmission : τ_{uv} [%]	15
Selectivity	0.76

Thermal properties - EN 673

Thermal transmittance (vertical) : U_g [W/(m ² .K)]	2.6
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Acoustic properties

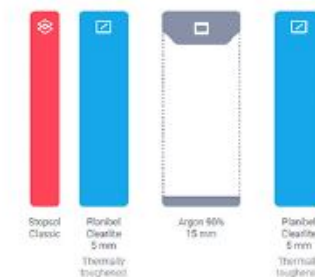
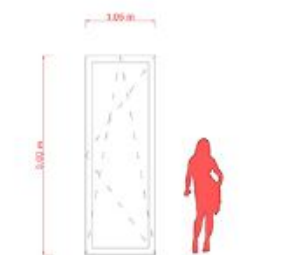
Direct airborne sound insulation - ESTIMATED : R_w (C;Ctr) [dB]	31 (-1;-3)
---	------------

Safety properties

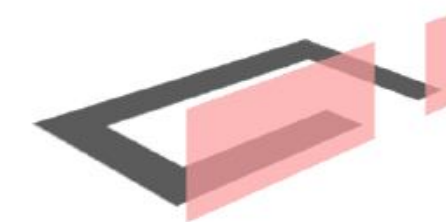
Resistance to fire - EN 13501-2	NPD
Reaction to fire - EN 13501-1	NPD
Bullet resistance - EN 1063	NPD
Burglar resistance - EN 356	NPD
Pendulum body impact resistance - EN 12600	1C3 / 1C3
Explosion resistance - EN 13541	NPD

Thickness and weight

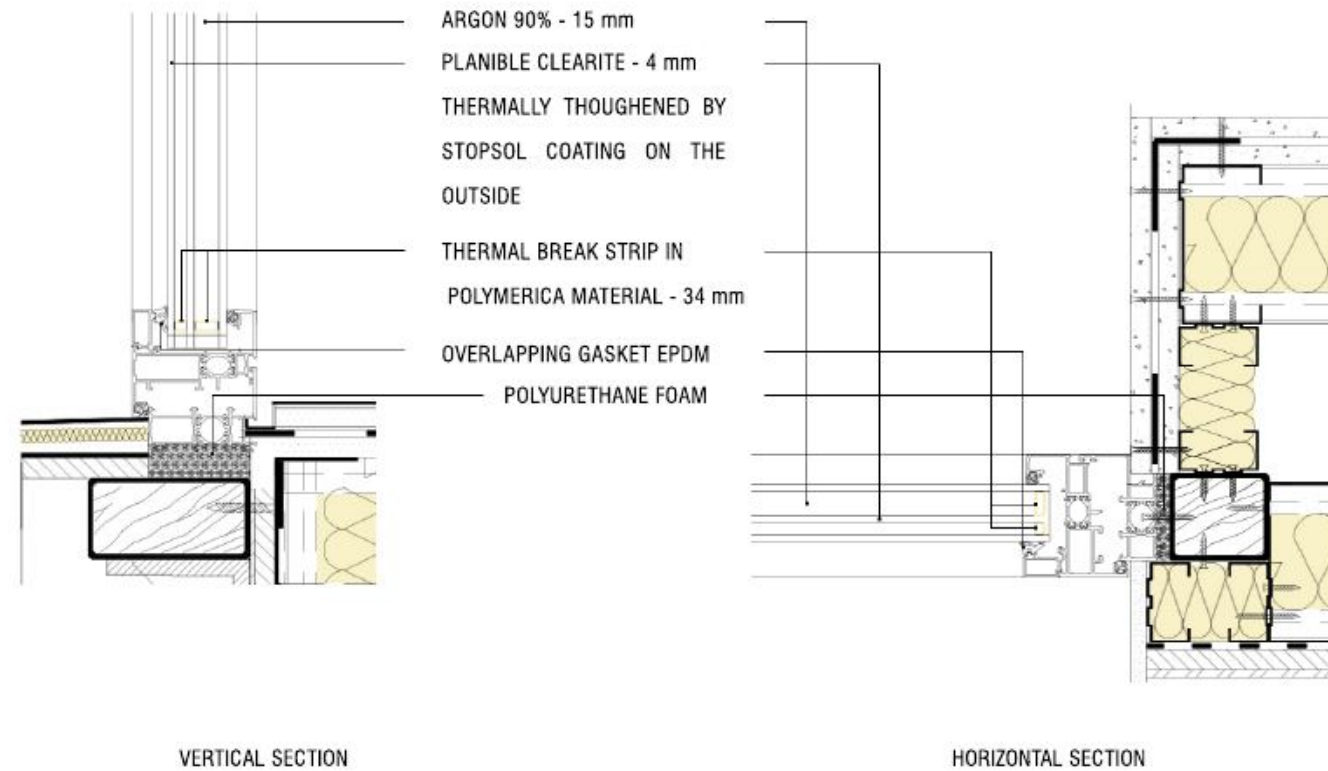
Nominal thickness : [mm]	25.0
Weight : [kg/m ²]	25



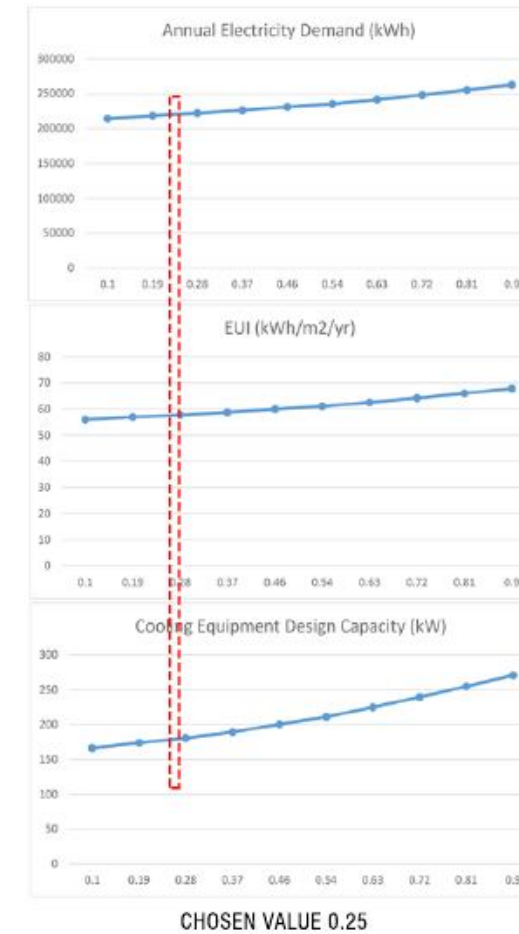
CONSIDERING THE OPTIMAL RESPONSE OF GLAZING PROPERTIES FOR EACH FACADE OF THE BUILDING WE CHOOSE DIFFERENT SYSTEMS OF GLAZING IN TWO TYPES OF CONVENTIONAL OPERABLE WINDOWS (FOR THE FACADE FACING THE CITY) AND CURTAINWALL SYSTEM (FACADE FACING THE COURTYARD).



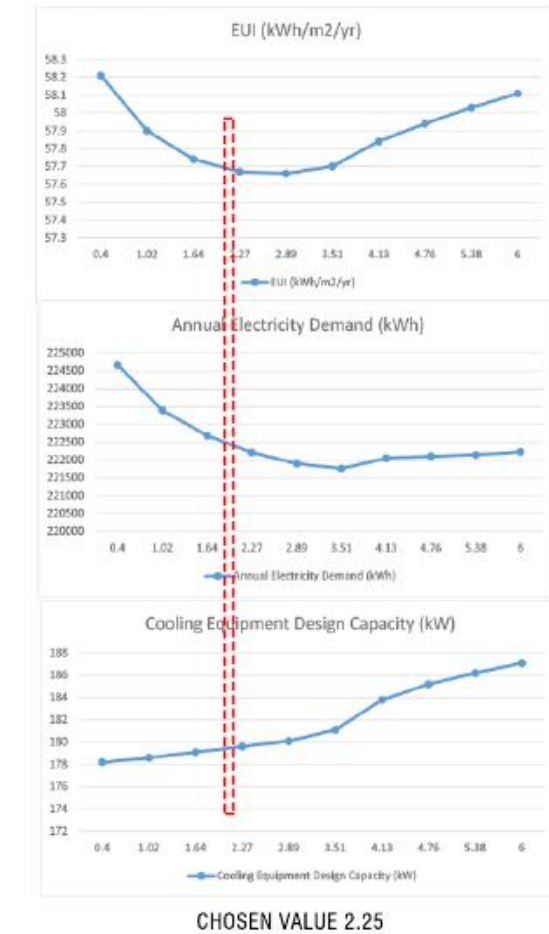
NORTH EAST, NORTH WEST, SOUTH WEST FACADE



SHCG



U-Value



Glass performance data simulation

Light properties - EN 410

Light transmittance : τ_v [%]	32
External light reflection : ρ_v [%]	36
Internal light reflection : ρ_{vi} [%]	33
Colour rendering index : R_a [%]	92

Energy properties - EN 410

Solar factor : g [%]	25
External energy reflection : ρ_e [%]	32
Internal energy reflection : ρ_{ei} [%]	26
Direct energy transmission : τ_e [%]	36
Energy absorption glass 1 : α_{e1} [%]	26
Energy absorption glass 2 : α_{e2} [%]	3
Energy absorption glass 3 : α_{e3} [%]	3
Total energy absorption : α_e [%]	32
Shading coefficient : SC	0.48
UV transmission : τ_{uv} [%]	12
Selectivity	0.78

Thermal properties - EN 673

Thermal transmittance (vertical) : U_g [W/(m ² .K)]	2.2
--	-----

Acoustic properties

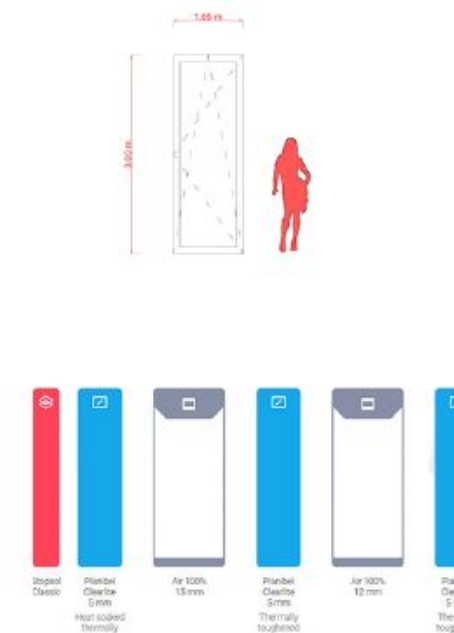
Direct airborne sound insulation - ESTIMATED : R_w (C;Ctr) [dB]	34 (-2;-6)
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Safety properties

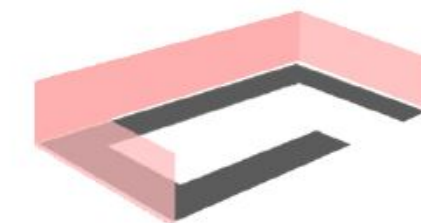
Resistance to fire - EN 13501-2	NPD
Reaction to fire - EN 13501-1	NPD
Bullet resistance - EN 1063	NPD
Burglar resistance - EN 356	NPD
Pendulum body impact resistance - EN 12600	1C3 / 1C3 / 1C3
Explosion resistance - EN 13541	NPD

Thickness and weight

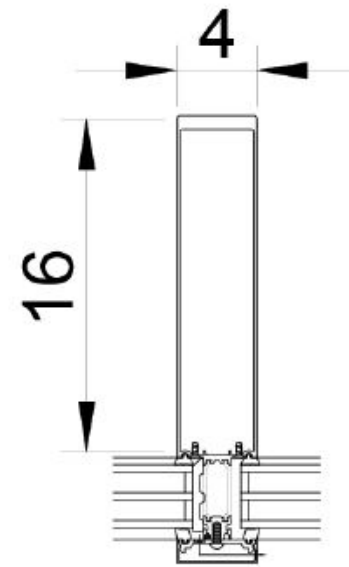
Nominal thickness : [mm]	42.0
Weight : [kg/m ²]	38



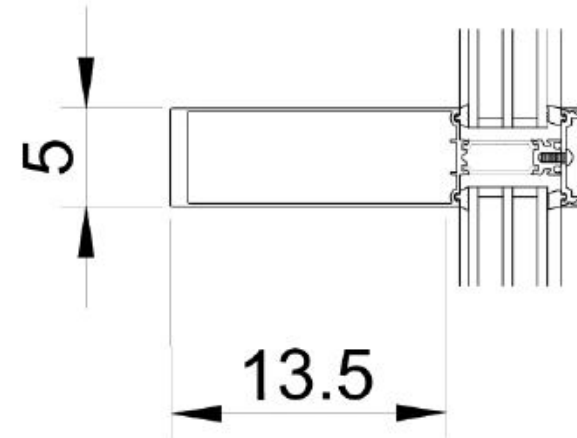
CONSIDERING THE OPTIMAL RESPONSE OF GLAZING PROPERTIES FOR EACH FACADE OF THE BUILDING WE CHOOSE DIFFERENT SYSTEMS OF GLAZING IN TWO TYPES OF CONVENTIONAL OPERABLE WINDOWS (FOR THE FACADE FACING THE CITY) AND CURTAINWALL SYSTEM (FACADE FACING THE COURTYARD).



NORTH EAST, NORTH WEST, SOUTH WEST FACADE



MULLION



TRANSOM

Glass performance data simulation

Light properties - EN 410

Light transmittance : τ_v [%]	32
External light reflection : ρ_v [%]	36
Internal light reflection : ρ_{vi} [%]	33
Colour rendering index : Ra [%]	92

Energy properties - EN 410

Solar factor : g [%]	25
External energy reflection : ρ_e [%]	32
Internal energy reflection : ρ_{ei} [%]	26
Direct energy transmission : τ_e [%]	36
Energy absorption glass 1 : α_{e1} [%]	26
Energy absorption glass 2 : α_{e2} [%]	3
Energy absorption glass 3 : α_{e3} [%]	3
Total energy absorption : α_e [%]	32
Shading coefficient : SC	0.48
UV transmission : τ_{uv} [%]	12
Selectivity	0.78

Thermal properties - EN 673

Thermal transmittance (vertical) : U_g [W/(m ² .K)]	2.2
--	-----

Acoustic properties

Direct airborne sound insulation - ESTIMATED : R_w (C;Ctr) [dB]	34 (-2;-6)
---	------------

Safety properties

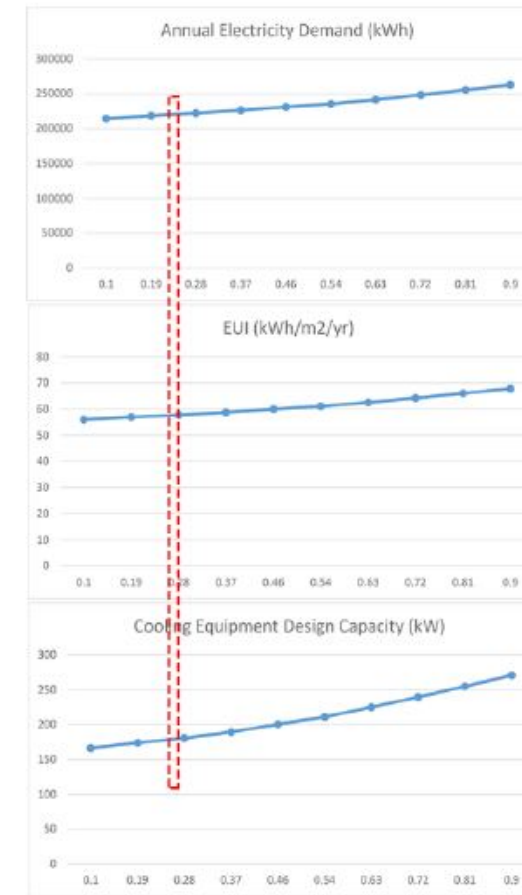
Resistance to fire - EN 13501-2	NPD
Reaction to fire - EN 13501-1	NPD
Bullet resistance - EN 1063	NPD
Burglar resistance - EN 356	NPD
Pendulum body impact resistance - EN 12600	1C3 / 1C3 / 1C3
Explosion resistance - EN 13541	NPD

Thickness and weight

Nominal thickness : [mm]	42.0
Weight : [kg/m ²]	38

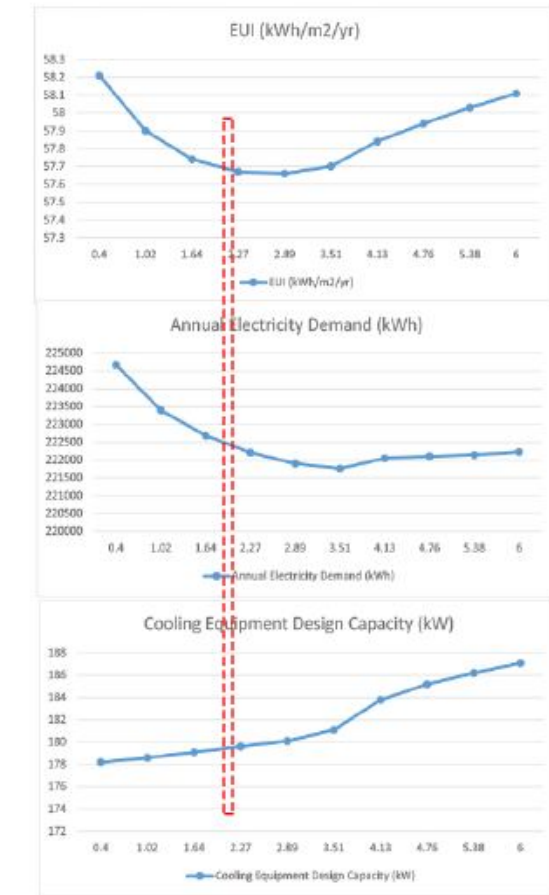
RESPONSE CURVES

SHCG

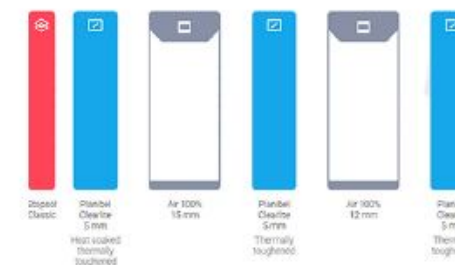
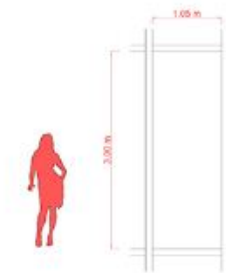


CHOSEN VALUE 0.25

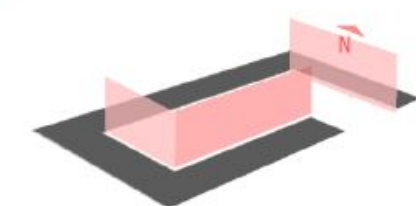
U-Value



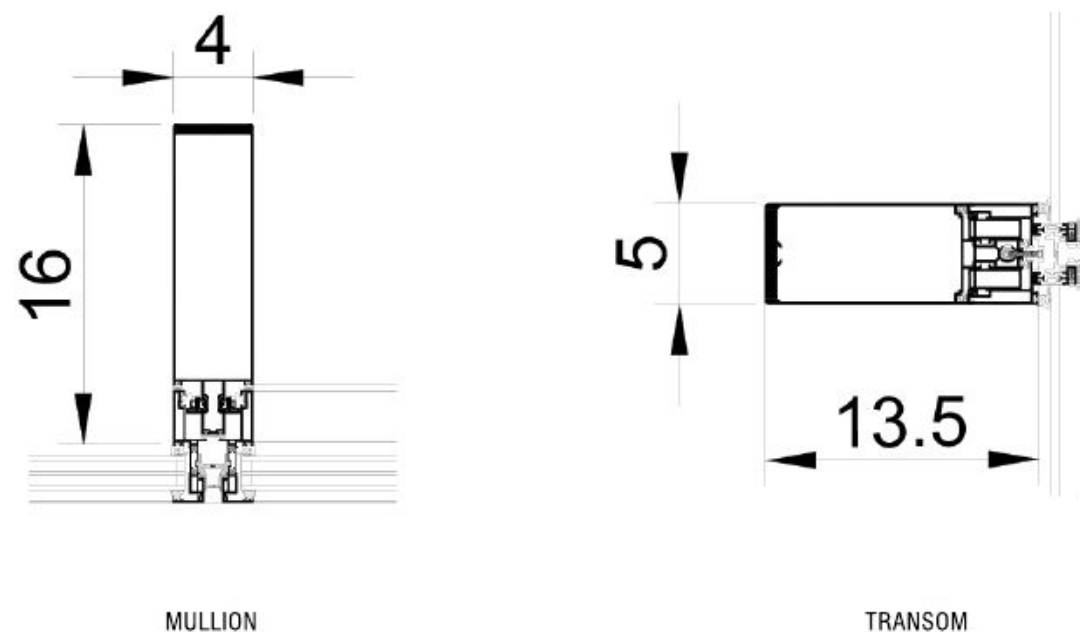
CHOSEN VALUE 2.25



CONSIDERING THE OPTIMAL RESPONSE OF GLAZING PROPERTIES FOR EACH FACADE OF THE BUILDING WE CHOOSE DIFFERENT SYSTEMS OF GLAZING IN TWO TYPES OF CONVENTIONAL OPERABLE WINDOWS (FOR THE FACADE FACING THE CITY) AND CURTAINWALL SYSTEM (FACADE FACING THE COURTYARD).



SOUTH EAST FACADE



Glass performance data simulation

Light properties - EN 410

Light transmittance : τ_v [%]	35
External light reflection : ρ_v [%]	35
Internal light reflection : ρ_{vi} [%]	30
Colour rendering index : R_a [%]	91

Energy properties - EN 410

Solar factor : g [%]	25
External energy reflection : ρ_e [%]	31
Internal energy reflection : ρ_{ei} [%]	24
Direct energy transmission : τ_e [%]	41
Energy absorption glass 1 : α_{e1} [%]	25
Energy absorption glass 2 : α_{e2} [%]	3
Total energy absorption : α_e [%]	28
Shading coefficient : SC	0.53
UV transmission : τ_{uv} [%]	15
Selectivity	0.76

Thermal properties - EN 673

Thermal transmittance (vertical) : U_g [W/(m ² .K)]	2.6
--	-----

Acoustic properties

Direct airborne sound insulation - ESTIMATED : R_w (C;Ctr) [dB]	31 (-1;-3)
---	------------

Safety properties

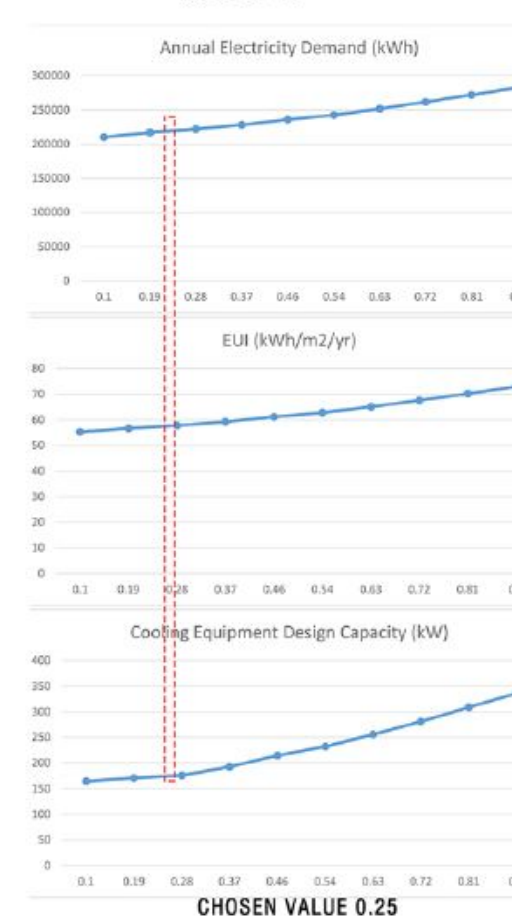
Resistance to fire - EN 13501-2	NPD
Reaction to fire - EN 13501-1	NPD
Bullet resistance - EN 1063	NPD
Burglar resistance - EN 356	NPD
Pendulum body impact resistance - EN 12600	1C3 / 1C3
Explosion resistance - EN 13541	NPD

Thickness and weight

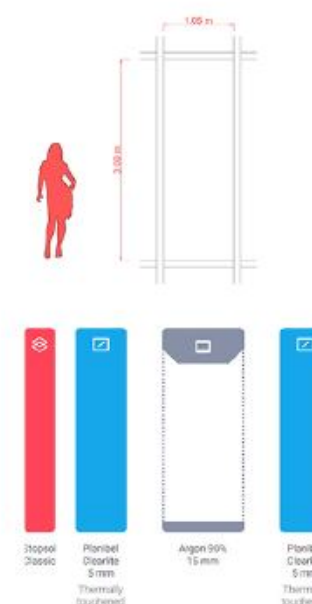
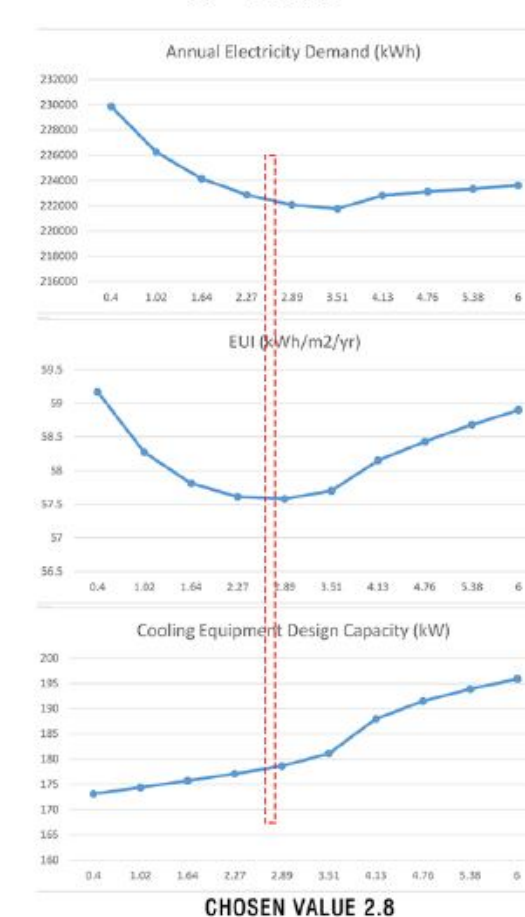
Nominal thickness : [mm]	25.0
Weight : [kg/m ²]	25

RESPONSE CURVES

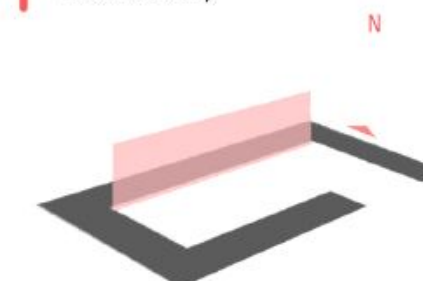
SHCG



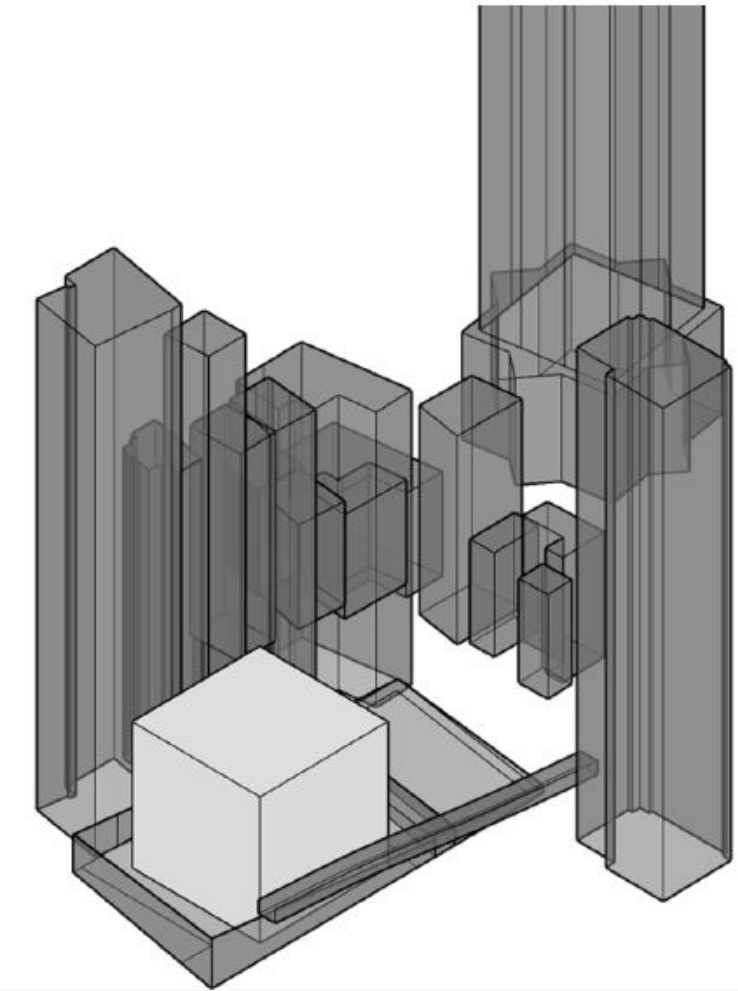
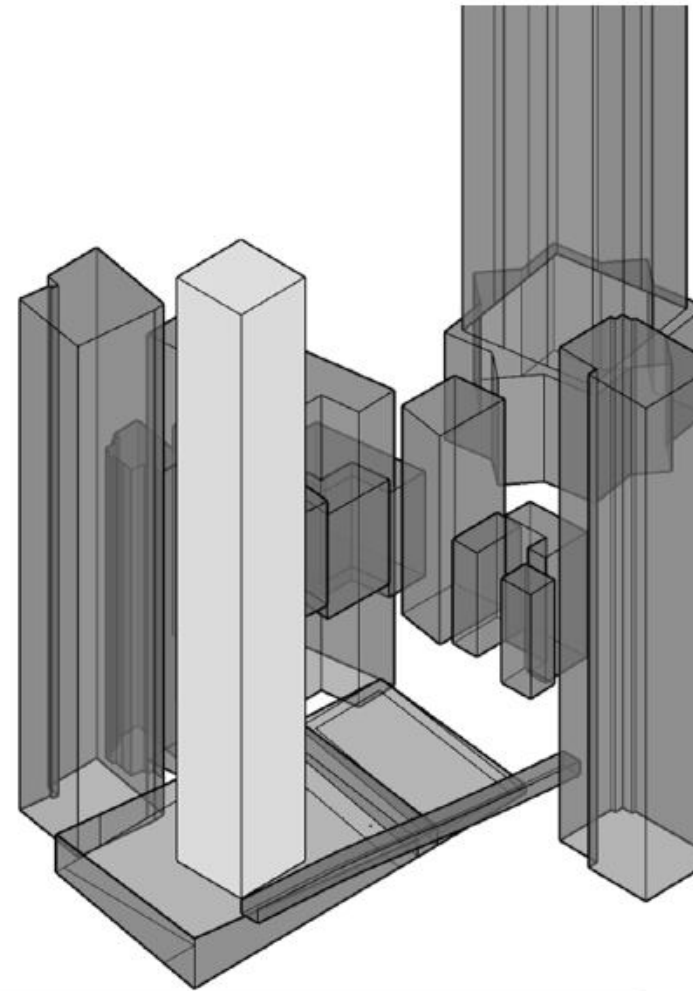
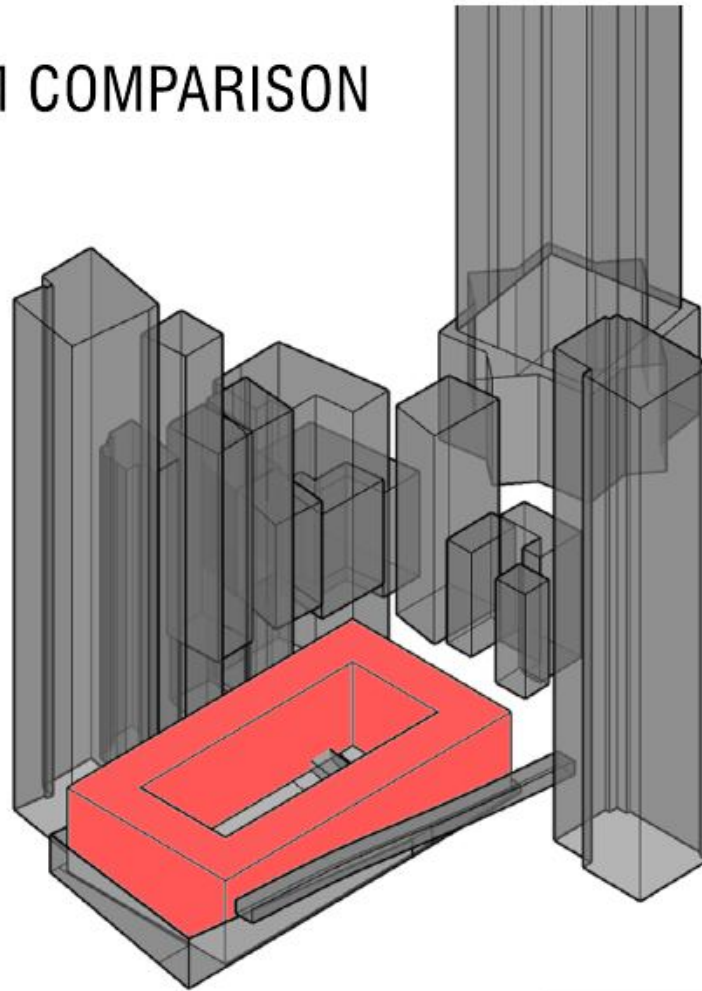
U-Value



CONSIDERING THE OPTIMAL RESPONSE OF GLAZING PROPERTIES FOR EACH FACADE OF THE BUILDING WE CHOOSE DIFFERENT SYSTEMS OF GLAZING IN TWO TYPES OF CONVENTIONAL OPERABLE WINDOWS (FOR THE FACADE FACING THE CITY) AND CURTAINWALL SYSTEM (FACADE FACING THE COURTYARD).



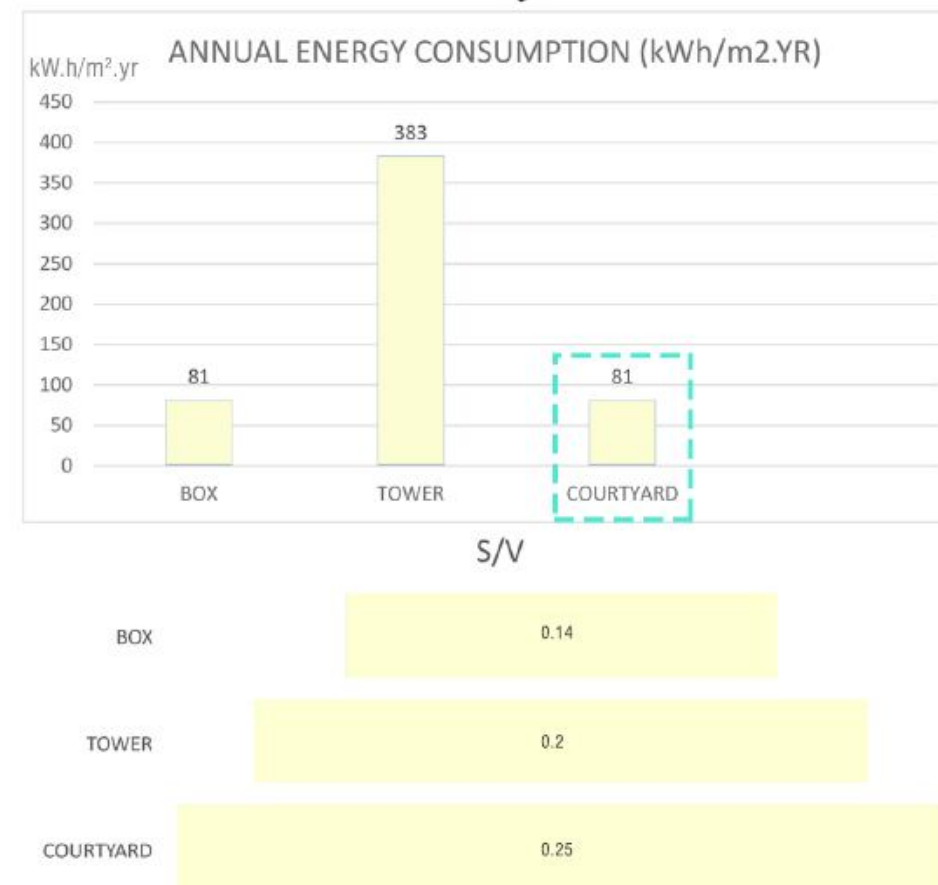
BASIC FORM COMPARISON



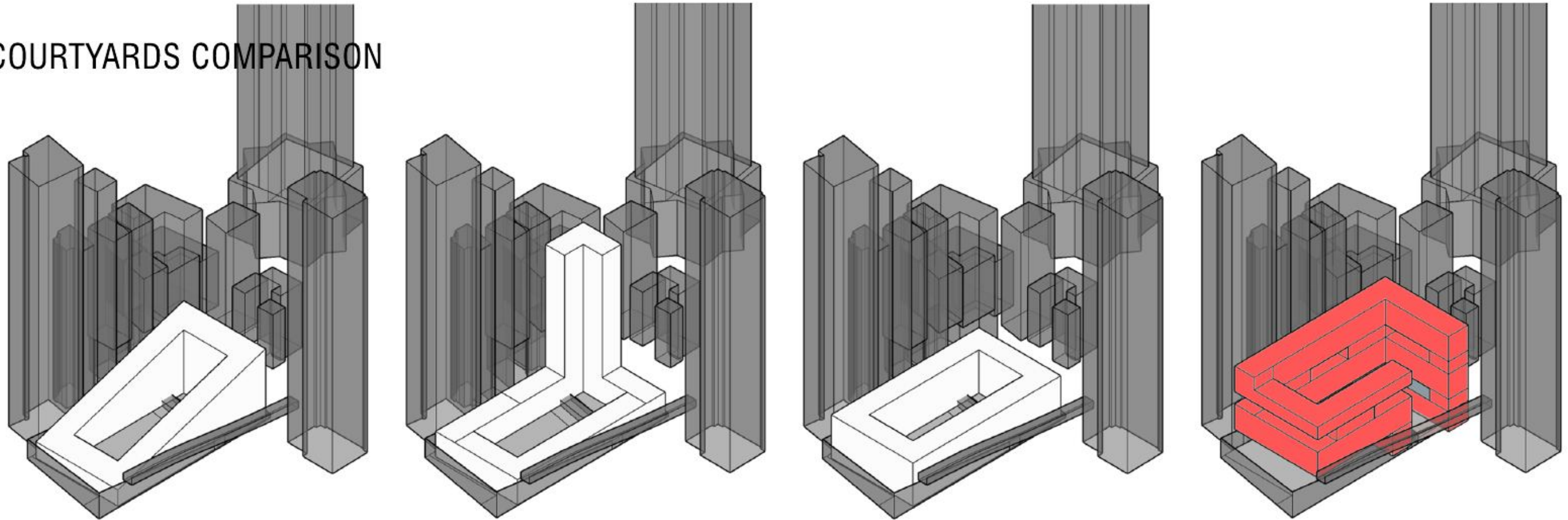
BASELINE:

BASED ON SEFAIRA PLUGIN DEFAULT FOR RESIDENTIALS & ASHRAE 90.1 2013 - CLIMATE ZONE 2A

- FACADE GLAZING ASSEMBLY U-VALUE: 2.27 W/m²K
- FACADE GLAZING SHGC: 0.25
- WALL TYPE: CONCRETE BLOCK
- WALLS ASSEMBLY U-VALUE: 0.7 W/m²K
- FLOOR FINISH: CARPET
- GROUND FLOOR U-VALUE: 0.49 W/m²K
- DESIGN INFILTRATION RATE 7.2 m³/m²h
- ROOF TYPE: METAL DECK
- ROOF U-VALUE: 0.22 W/m²K
- OCCUPANT DENSITY: 50 m³/person
- EQUIPMENT POWER DENSITY: 5 W/m²
- LIGHTING POWER DENSITY: 10 W/m²
- VENTILATION RATE: 10 L/s.person
- SETPOINT TEMPERATURE FOR HEATING: 20°C
- SETPOINT TEMPERATURE FOR COOLING: 25°C
- SETBACK TEMPERATURE HEATING: 18°C
- SETBACK TEMPERATURE COOLING: 28°C
- OPERATING HOURS: 6am TO 10pm



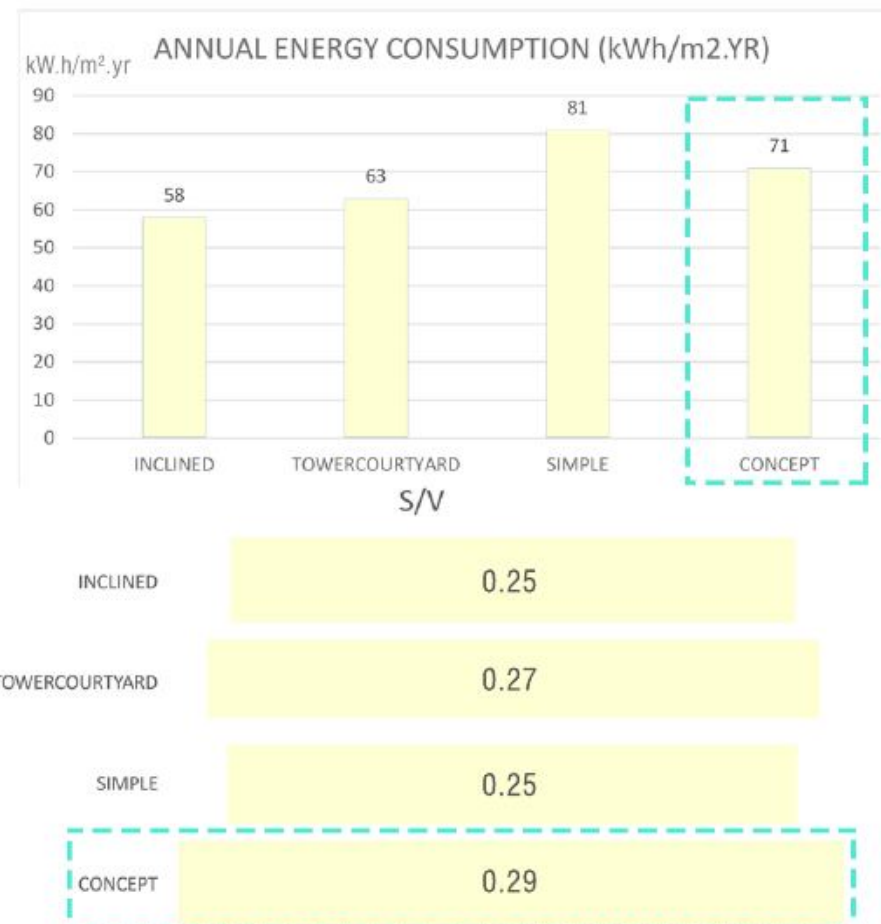
COURTYARDS COMPARISON



BASELINE:

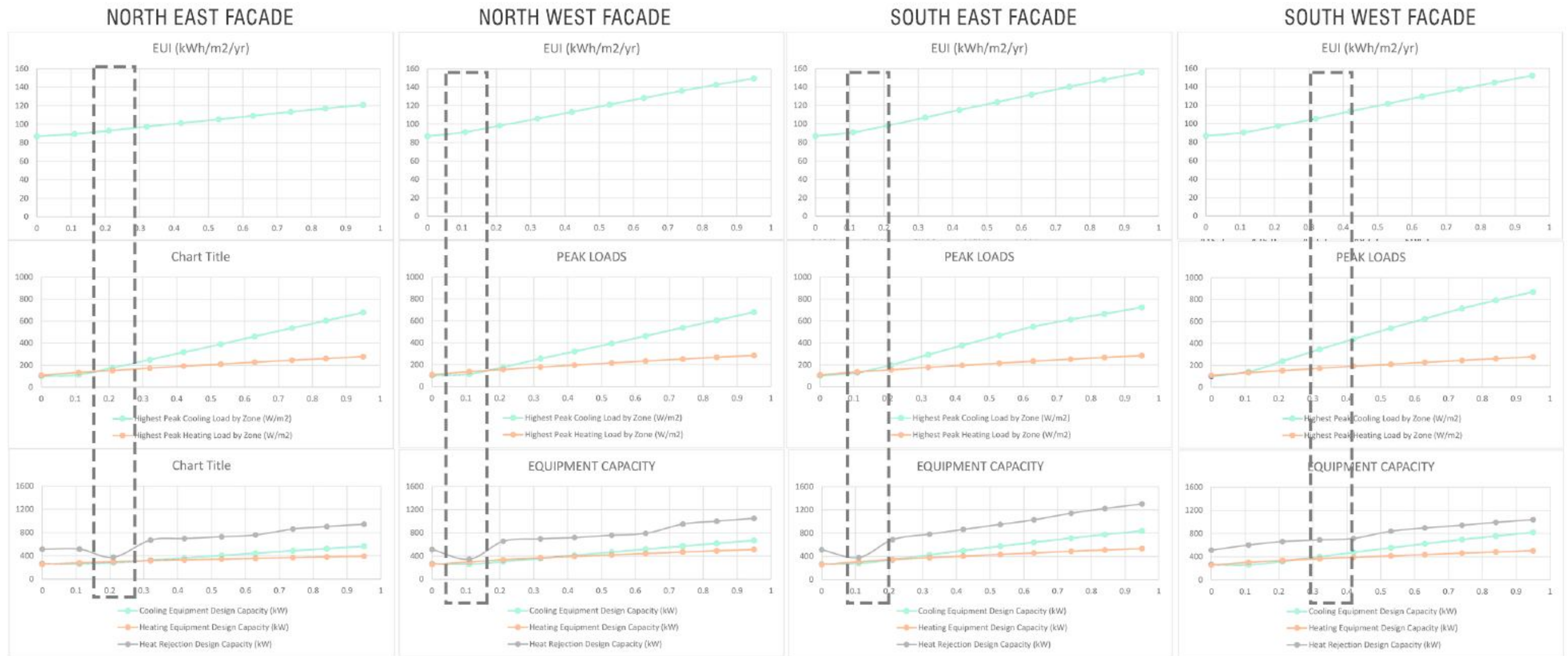
BASED ON SEFAIRA PLUGIN DEFAULT FOR RESIDENTIALS & ASHRAE 90.1 2013 - CLIMATE ZONE 2A

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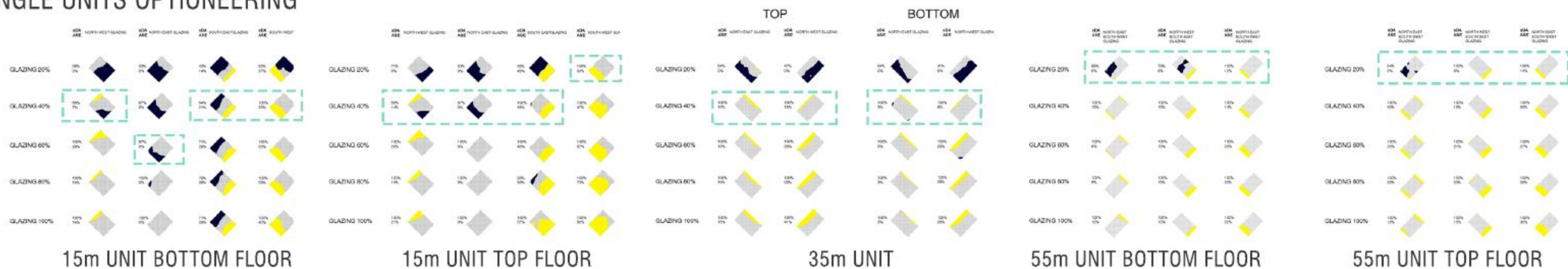


GLAZING BALLPARK

WALL-GLAZING RATIO RESPONSIVE CURVES

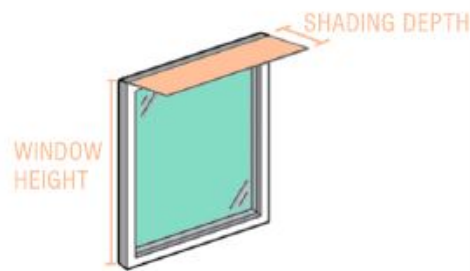


SINGLE UNITS OPTIONEERING



SHADING BALLPARK

RESPONSIVE CURVES COMPARING THE EFFECT OF DIFFERENT HORIZONTAL SHADING DEPTH RATIO TO A FIXED WINDOW HEIGHT.

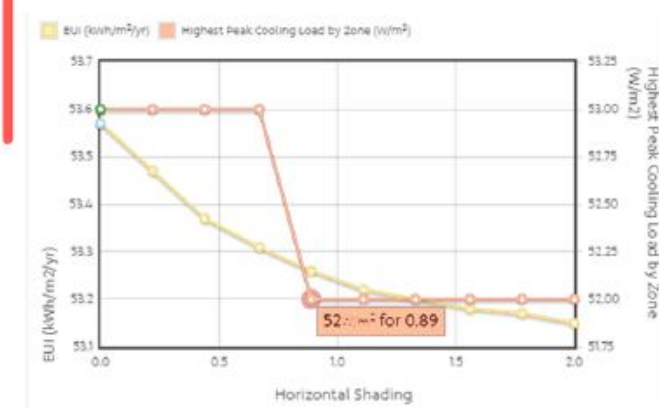
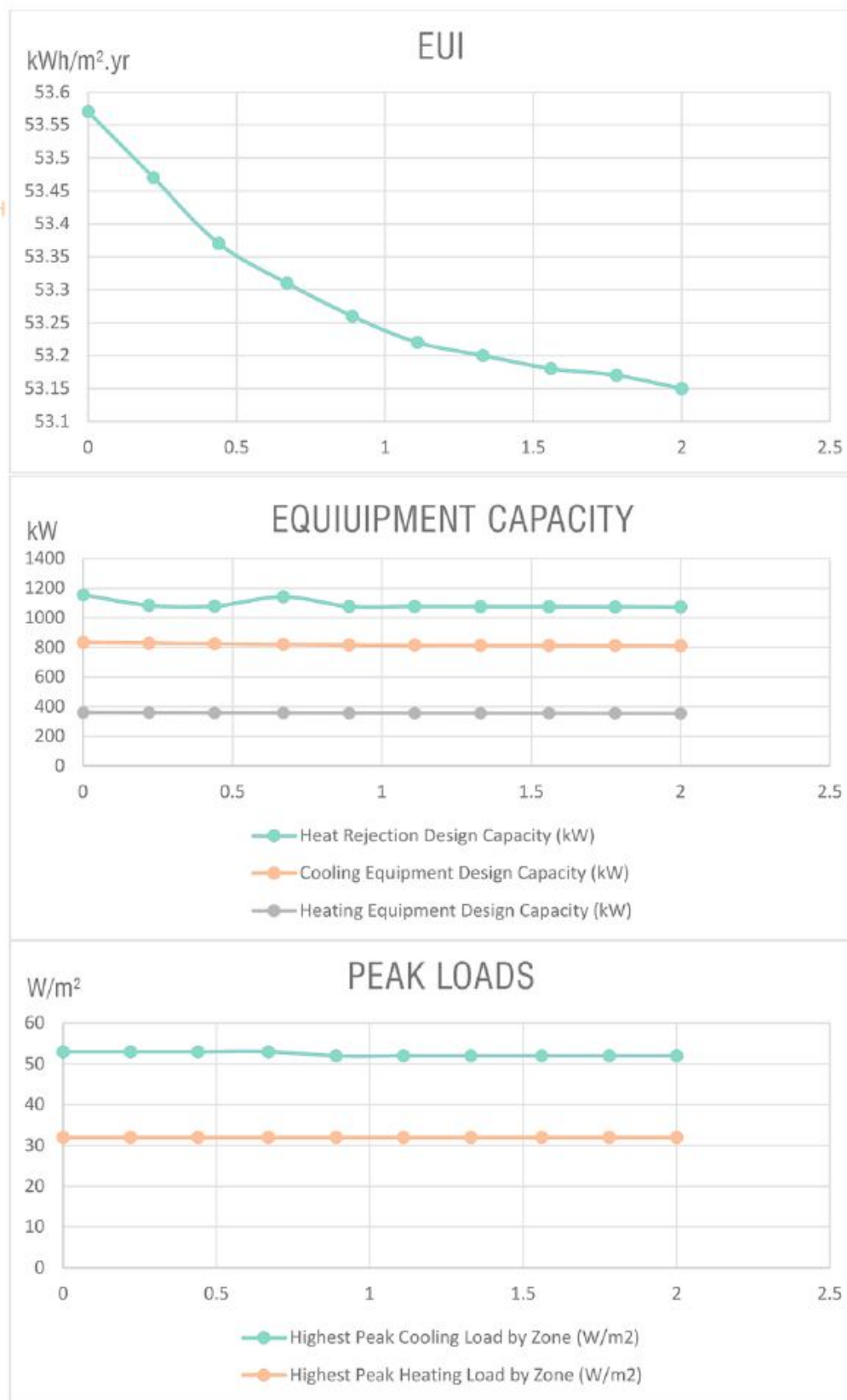


FROM THE FIRST CHART IT CAN BE EXTRACTED THAT AFTER A ROUGHLY ONE TO ONE RATIO BETWEEN THE SHADING AND WINDOW HEIGHT THE EFFECT ON ENERGY USE INTENSITY BECOMES PRETTY MUCH LINEAR.

IN THE CASE OF THE SECOND GRAPH IT CAN BE SEEN THAT OTHER THAN A BUMP ON 0.73 OF THE RATIO IN HEAT REJECTION DESIGN CAPACITY THE EFFECT OF THE SHADING DEPTH IS SOMEHOW NONEXISTENT IN THE CASE OF OUR PROJECT.

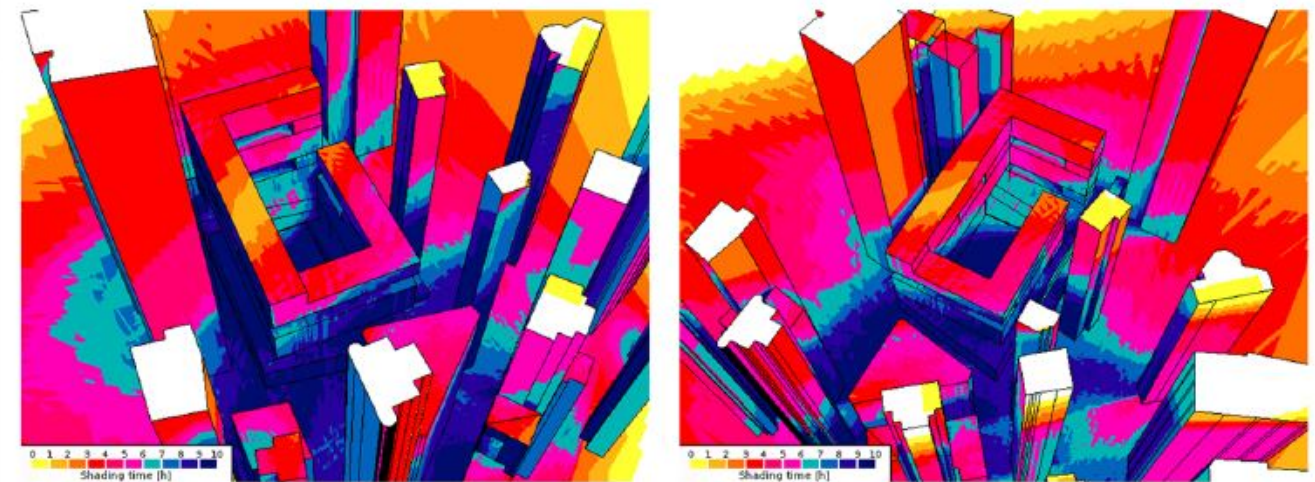
THE SAME CAN BE SEEN IN THE CASE OF PEAK LOADS. EASILY PERCEIVED BY THE GRAPHS COMPARING EACH RATIO FROM 0 SHADING TO TWICE THE HEIGHT OF THE WINDOW IN DEPTH OF SHADING IN ALL ORIENTATIONS OF THE DESIGN.

TO SUM UP, IT CAN BE PREDICTED THAT THE SHADING ELEMENT ONLY EFFECTS DIRECTLY OUR PASSIVE GAINS AND LOSSES AND ALL IN ALL DOES NOT REALLY EFFECT THE DESIGN OF OUR EQUIPMENT AND PEAK LOADS WOULD STILL BE THE SAME.

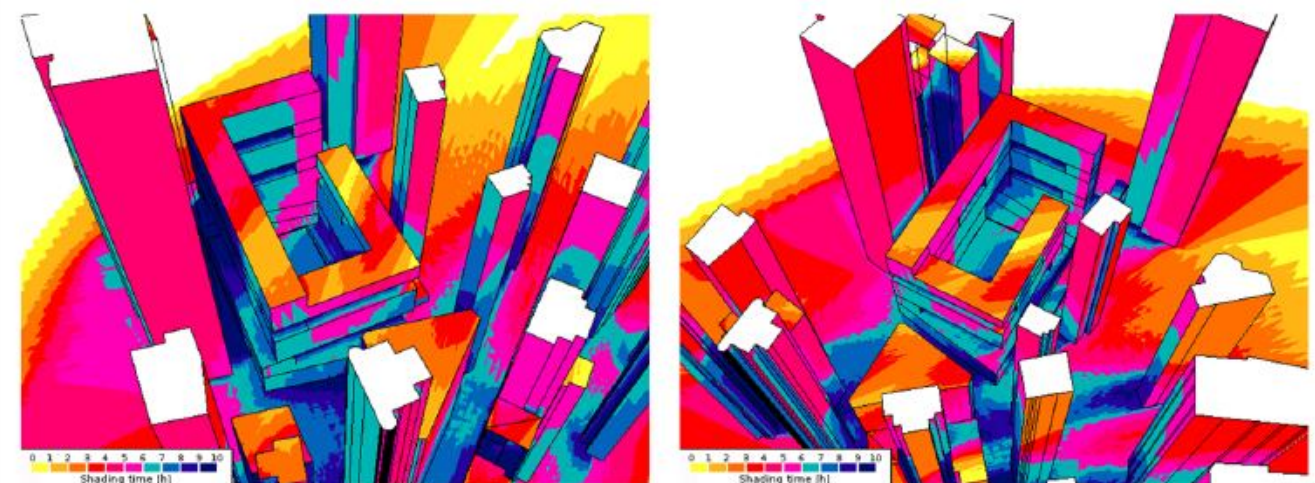


ALTHOUGH KNOWINGLY THE SHADING DEPTH DOES NOT VERY MUCH EFFECT OUR DESIGN WE CHOSE TO TAKE INTO ACCOUNT THE LITTLE AMOUNT OF OPTIMIZATION AS A START TO OUR SHADING OPTIONEERING. AN OVERLAP BETWEEN ENERGY USE INTENSITY GRAPH AND HIGHEST PEAK COOLING LOAD OF THE BUILDING IT GIVES US A CLEAR START POINT AS 0.89 AS RATION BETWEEN WINDOW HEIGHT AND HORIZONTAL SHADING DEPTH. MOVING FORWARD WE WOULD ONLY GO FOR MORE DEPTH THAT IS AS IF IT WOULD PROVIDE US WITH THE OPTIMAL LIGHTING QUALITY INSIDE THE BUILDING UNITS.

SPRING EQUINOX



SUMMER SOLSTICE



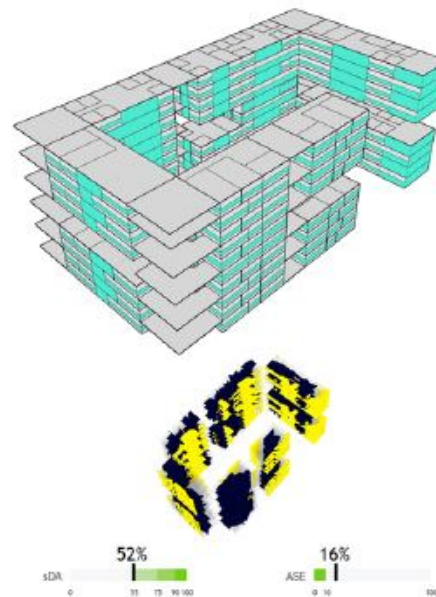
A FAST REVIEW OF THE EFFECT OF CONTEXT ON THE SHADED PARTS OF EACH ORIENTATION RELATED TO OUR BUILDING GIVES US A BALLPARK IDEA WHERE SHADINGS ARE NEEDED MOST AND WHERE NOT SO MUCH.

OPTIONEERING STEP 1

1ST OUTCOME

OPTION ONE IS MAINLY BASED ON BALL PARK NUMBERS AND THE SENSIBLE AREAS WHICH WOULD LACK PROPER LIGHTING.

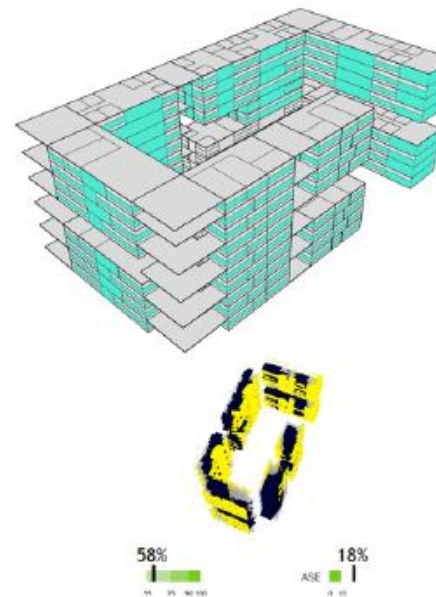
AS A RESULT IT IS VISIBLE THAT NOT ONLY 30% AVERAGE GLAZING TO WALL RATIO IS NOT ENOUGH, CONSIDERING ONLY 52% OF THE SPACE ON AVERAGE WILL RECEIVE AT LEAST 300LUX LIGHTING HALF OF THE YEAR, BUT ALSO WITHOUT PROPER SHADING WE WILL FACE THE ISSUE OF GLARE ON THE SIDES NEARBY WINDOWS WHICH ON AVERAGE 16% OF OUR AREA RECEIVES MORE THAN 1000LUX FOR AT LEAST 250 HOURS IN A YEAR.



2ND OUTCOME

DURING OPTIMIZATION UNTIL THIS STAGE THE EFFORT WAS MAINLY PUT INTO GAINING MINIMUM ACCEPTABLE sDA PERCENTAGE AS TO REACH AT LEAST 55% sDA FOR EACH FLOOR IN THE BUILDING.

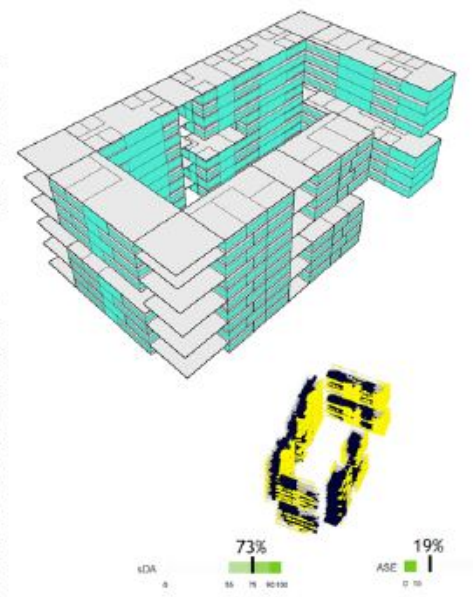
ALTHOUGH WE GAINED A 1.7 PERCENT INCREASE IN THE ENERGY USE INTENSITY, WHICH WAS MAINLY DUE TO THE COOLING LOAD INCREASE, BUT WE COULD REACH AT LEAST 55% sDA FOR EACH FLOOR. WITH THE EXPENSE OF 12.5% REACH IN ASE WHICH WILL BE FURTHER CONTROLLED BY SHADING STRATEGIES.



3RD OUTCOME

CONTINUEING THE SAME LINE OF THOUGHT FROM THE SECOND STAGE IN THIS STAGE THE MAIN EFFORT WAS TO IMPROVE THE DAYLIGHT QUALITY IN THE CASE sDA IN EACH INDIVIDUAL SPACE INSIDE THE BUILDING.

SOMELOWER FLOORS PRONE TO SOURROUNDING BUILDING SHADOWS NEEDED MUCH MORE OPPENING THAT 40% WHICH CAUSED A 3.9% GROWTH IN EUI AND 5.5% INCREASE IN ASE. AGAIN THE EXCESS IN EUI WAS DUE TO COOLING LOAD INCREASE. BUT IN THE END THE IMPORTANT FOR US IN THIS STAGE WAS REACHED WHICH WAS ATLEAST 55% sDA FOR EACH INDIVIDUAL SPACE IN THE BUILDING.



BASELINE:

BASED ON SEFAIRA PLUGIN DEFAULT FOR RESIDENTIALS & ASHRAE 90.1 2013 - CLIMATE ZONE 2A

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- WALLS ASSEMBLY U-VALUE: 0.7 W/m²K
- FLOOR FINISH: CARPET
- GROUND FLOOR U-VALUE: 0.49 W/m²K
- DESIGN INFILTRATION RATE 7.2 m³/m²h
- ROOF TYPE: METAL DECK
- ROOF U-VALUE: 0.22 W/m²K
- OCCUPANT DENSITY: 50 m³/person
- EQUIPMENT POWER DENSITY: 5 W/m²
- LIGHTING POWER DENSITY: 10 W/m²
- VENTILATION RATE: 10 L/s.person
- SETPOINT TEMPERATURE FOR HEATING: 20°C
- SETPOINT TEMPERATURE FOR COOLING: 25°C
- SETBACK TEMPERATURE HEATING: 18°C
- SETBACK TEMPERATURE COOLING: 28°C
- OPERATING HOURS: 6am TO 10pm

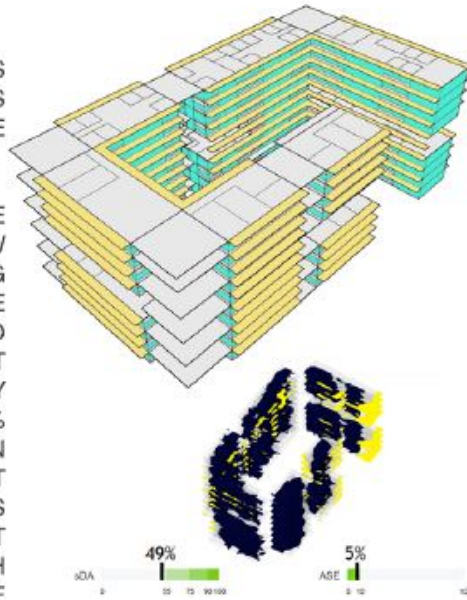


OPTIONEERING STEP 2

4TH OUTCOME

FIRST STEP TO INCLUDE SHADING IS JUST BASED ON BALLPARK IDEAS PROVIDED BY THE RESPONSE CURVES AND SHADOW ANALYSIS.

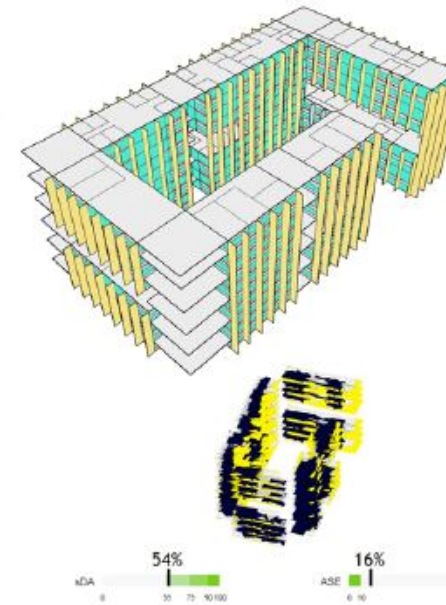
FIRST ELEMENT TO BE TRIED IS THE 0.89 DEPTH COMPARED TO WINDOW HEIGHT HORIZONTAL SHADING OVERHANGING THE WINDOWS. THE RESULT WAS THAT IT DECREASED THE EUI VALUE BY 1.2% AND MOST IMPORTANTLY THE ASE AVERAGE BY 74% BUT AT THE EXPENSE OF 33% LOSS OF sDA WHICH WAS AGAIN PROBLEMATIC FOR DAYLIGHT QUALITY AND ALSO EVEN THIS AMOUNT OF SHADING DID NOT SOLVE THE ISSUE OF ASE FOR EACH INDIVIDUAL SPACE INSIDE THE BUILDING.



5TH OUTCOME

IN THIS STEP THE AIM WAS TO CATCH THE EFFECT OF VERTICAL SHADINGS AND SEE IF THEY WOULD PROPOSE A BETTER BALANCE BETWEEN sDA AND ASE.

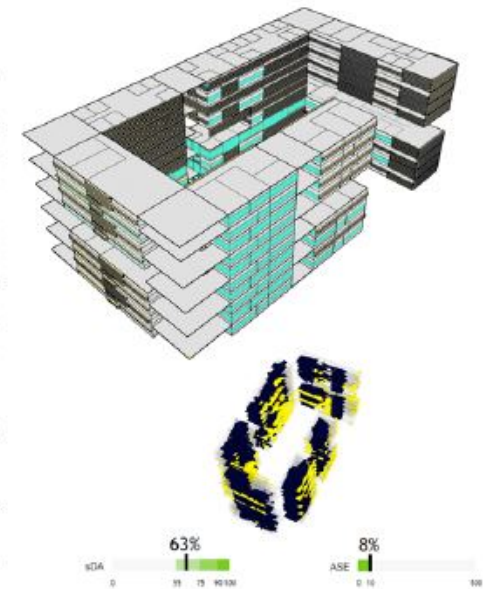
ALTHOUGH IN SOME INDIVIDUAL SPACES THIS TYPE WOULD WORK BETTER THAN THE FIRST OPTION THE OVERAL OUTCOME WAS NOT SATISFACTORY. BUT PROPOSING SEVERAL SHADINGS FOR ONE WINDOW WAS A SOLUTION THAT WAS GAINED BY THIS OPTION.



6TH OUTCOME

REACHING THIS STAGE THE MAIN AIM WAS TO FIND THE PERFECT BALANCE BETWEEN ASE AND sDA VALUES WHILE HAVING IN MIND THE OVERALL ENERGY PERFORMANCE OF THE BUILDING ALTHOUGH ACCORDING THE RESPONSE CURVES THE SIZE AND TYPE OF THE SHADINGS WOULD NOT EFFECT OUR PERFORMANCE MUCH BUT THE SHEAR EXISTENCE OF THEM WOULD DECREASE THE EUI BY ATLEAST 1%.

IN THE END THE RESULT WAS THAT THE PERFECT PERFORMING SHADINGS WERE HORIZONTAL SHADINGS WITH 0.5m DEPTH SPREAD OVER THE WINDOWS TO A 1:1 RATIO TO WINDOW HEIGHT.

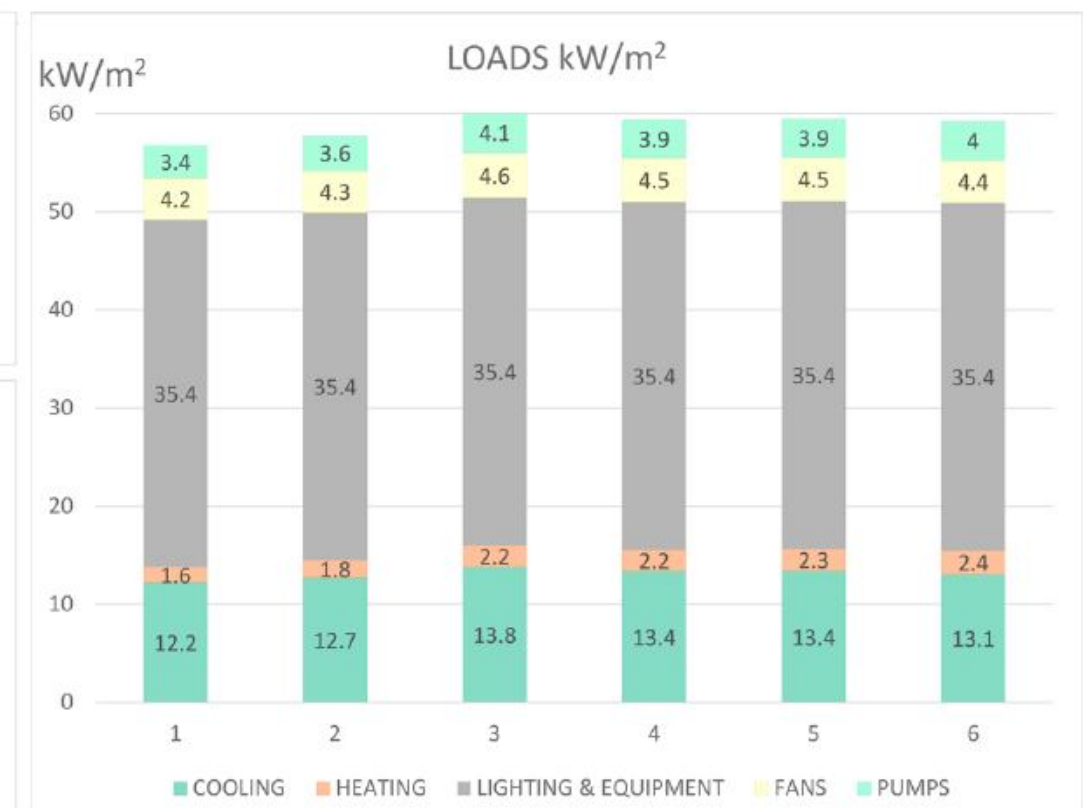


THIS RESULTED NOT ONLY TO THE BEST PERFORMANCE OF THE BUILDING IN THE CASE OF EUI BUT ALSO A BUILDING WITH EACH INDIVIDUAL SPACE HAVING sDA OVER 55% AND ASE UNDER 12%

BASELINE:

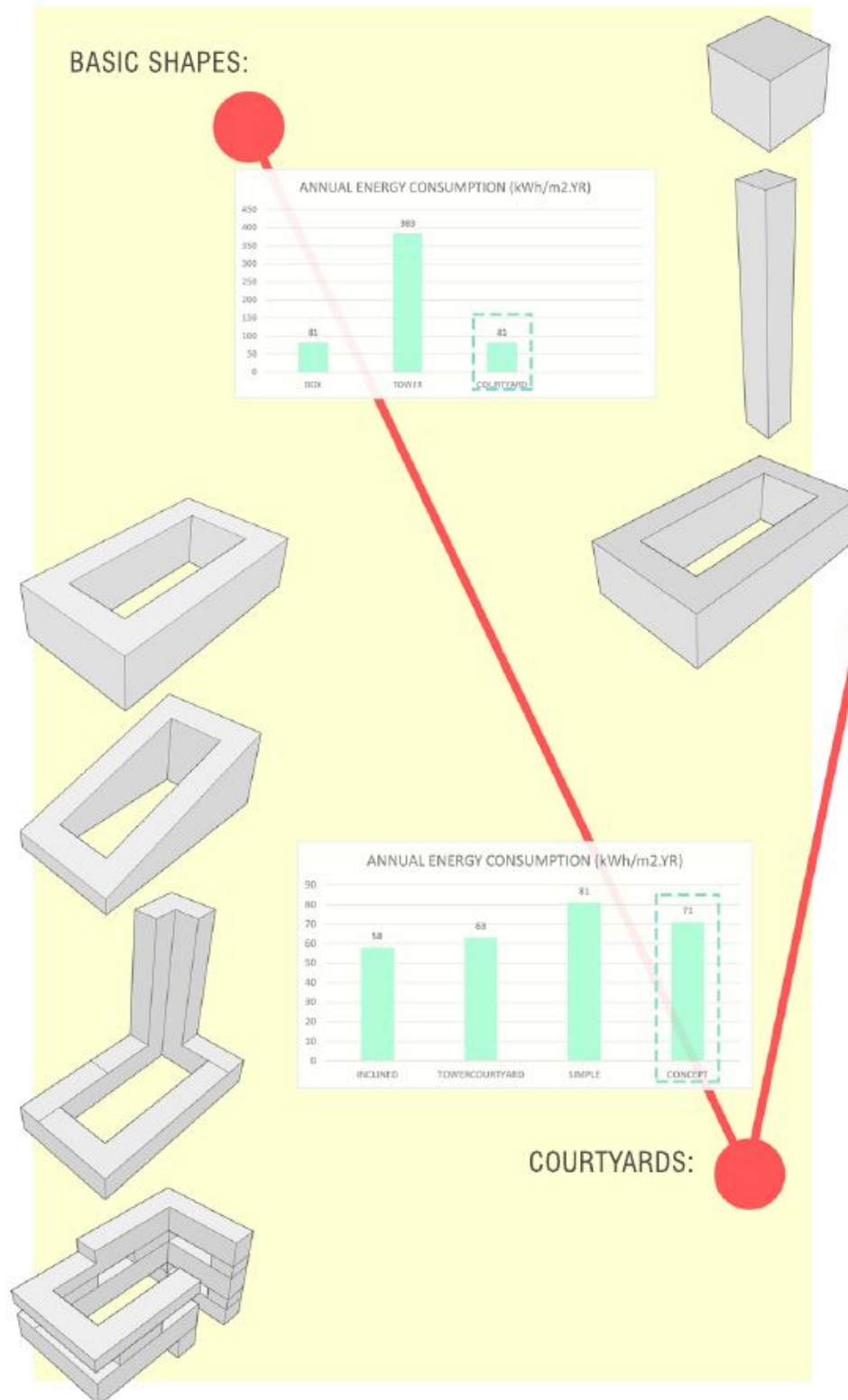
BASED ON SEFAIRA PLUGIN DEFAULT FOR RESIDENTIALS & ASHRAE 90.1 2013 - CLIMATE ZONE 2A

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- WALLS ASSEMBLY U-VALUE: 0.7 W/m²K
- FLOOR FINISH: CARPET
- GROUND FLOOR U-VALUE: 0.49 W/m²K
- DESIGN INFILTRATION RATE 7.2 m³/m²h
- ROOF TYPE: METAL DECK
- ROOF U-VALUE: 0.22 W/m²K
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- OPERATING HOURS: 6am TO 10pm

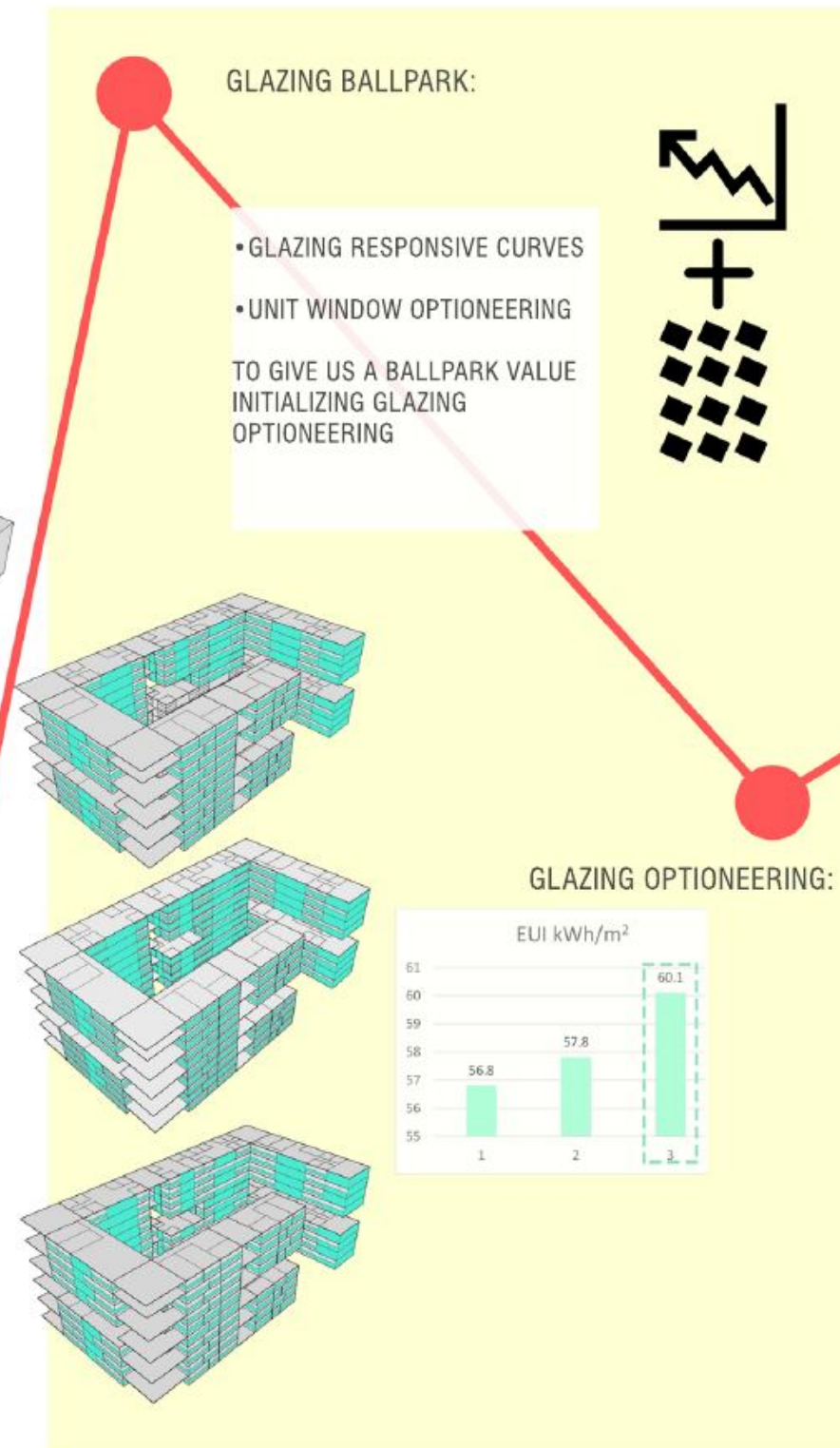


FLOWCHART

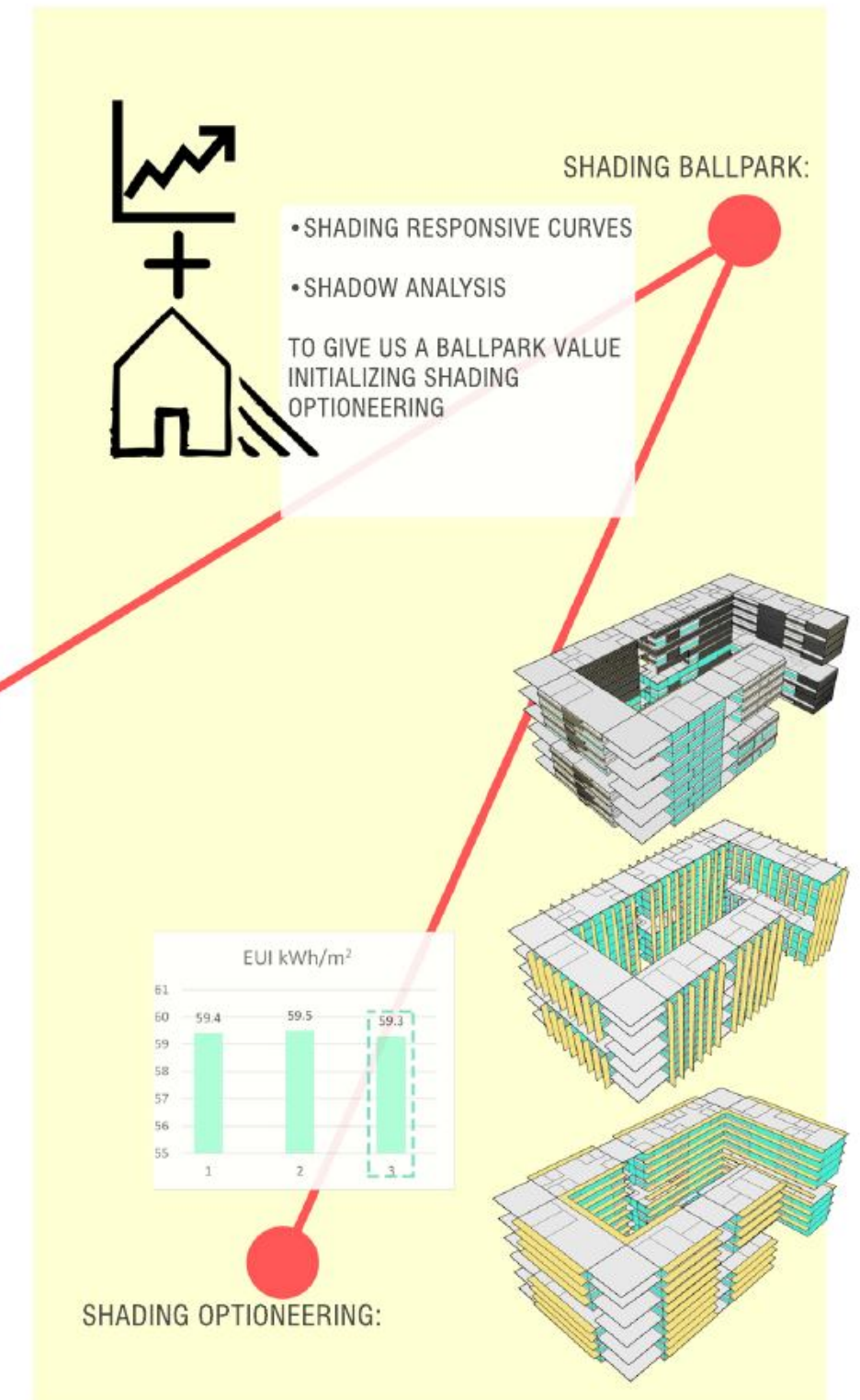
MASSING OPTIONEERING



GLAZING OPTIONEERING



SHADING OPTIONEERING

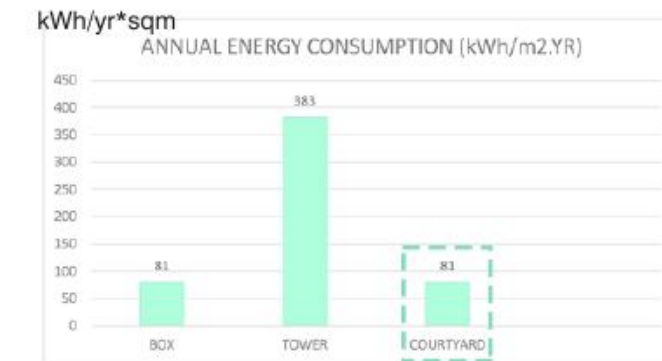


OPTIONEERING

The result table and chart of the massing, glazing, shading optioneering according to energy consumption was carried out to understand better the relation between architectural choices and energy consumption context.

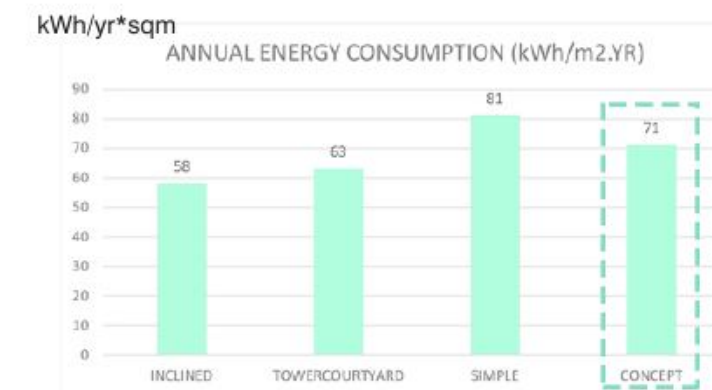
MASSING

MASSING	EUI	EUI CHANGE	COOLING LOAD	HEATING LOAD	TOTAL LOAD
LOW RISE	81		32.5	23.7	56.2
TOWER	383	472%	40	77.2	117.2
COURT YARD	81	-472%	53.8	37.2	91



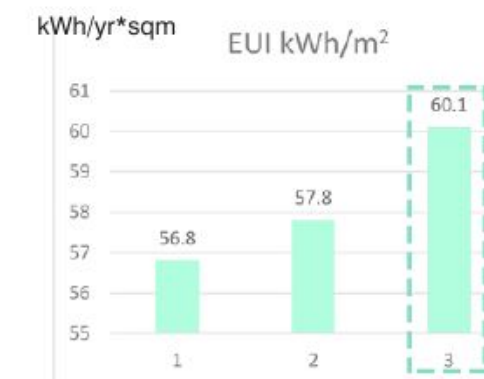
COURT YARD MASSING

MASSING P2	EUI	EUI CHANGE	COOLING LOAD	HEATING LOAD	TOTAL LOAD
OPTION 1	58		34.3	77.8	112.1
OPTION 2	63	1.70%	40.1	16.6	56.7
OPTION 3	81	3.90%	53.8	37.2	91
OPTION 4	71	-13%	54.2	34.3	88.5



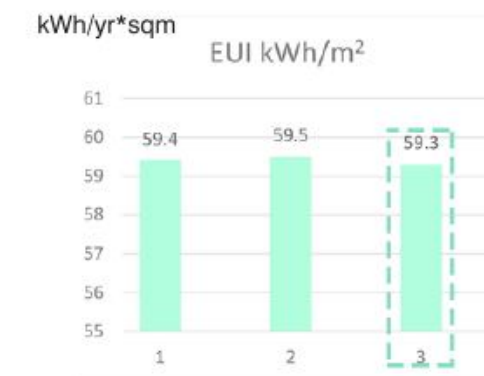
GLAZING OPTIONEERING

GLAZING	EUI	EUI CHANGE	COOLING LOAD	HEATING LOAD	TOTAL LOAD
OPTION 1	56.8		12.2	13.8	26
OPTION 2	57.8	1.70%	12.7	14.5	27.2
OPTION 3	60.1	3.90%	13.8	16	29.8



SHADING OPTIONEERING

SHADING	EUI	EUI CHANGE	COOLING LOAD	HEATING LOAD	TOTAL LOAD
OPTION 1	59.4		12.2	13.8	26
OPTION 2	59.5	0.00%	12.7	14.5	27.2
OPTION 3	59.3	0.00%	13.8	16	29.8



BASE LINE

These baselines are the analytic results of the energy analyses carried out with all the implementations regarding the envelope (glazing, shading, improved U values and infiltration rates). They are the base for the following energy analyses that will integrate the variations on HVAC systems, as ramp up time, efficiency, space use standards and others variables

ENERGY RESULTS - MONTHLY USE BREAKDOWN

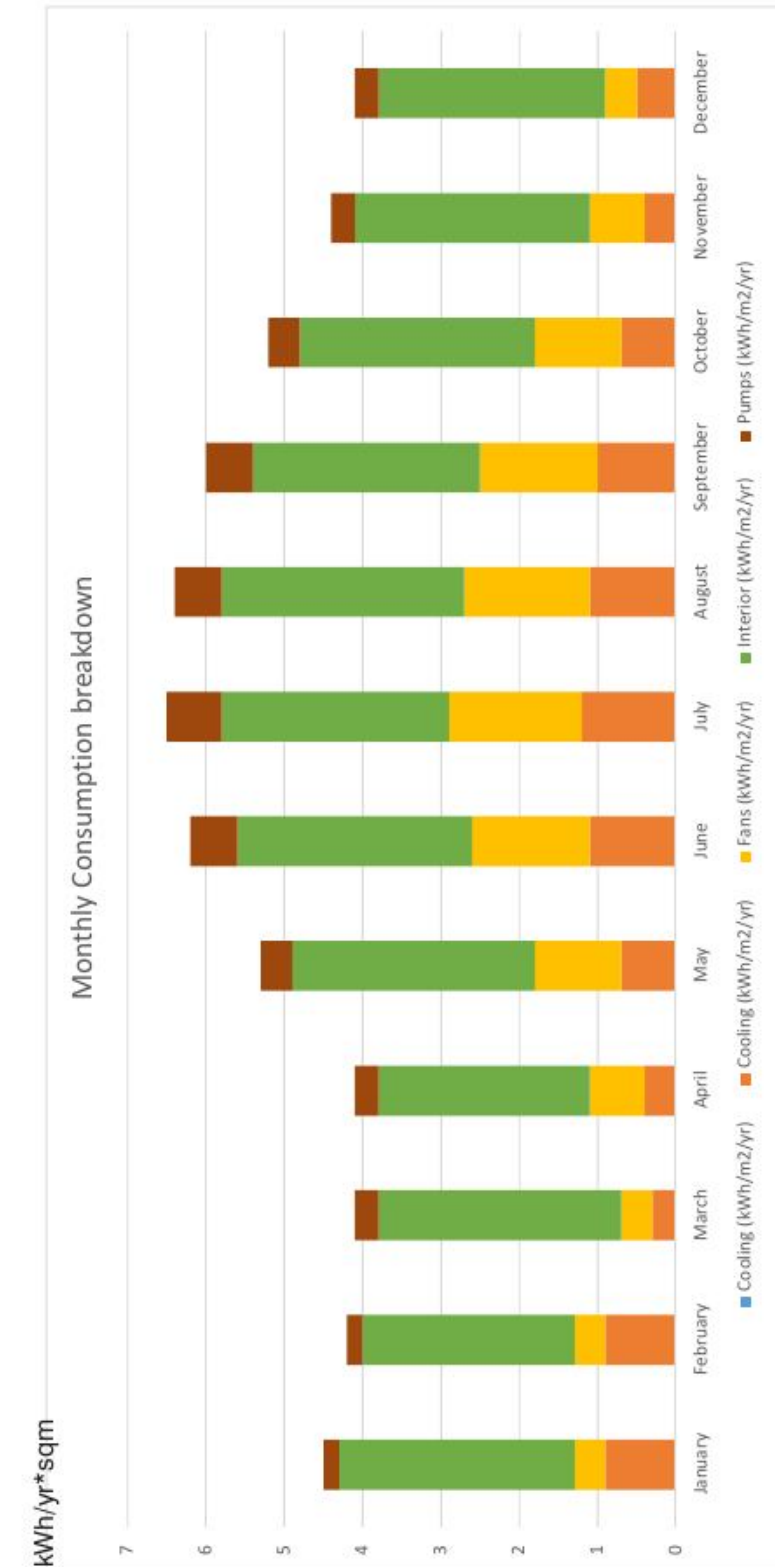
Month	Heating (kWh/m2/yr)	Cooling (kWh/m2/yr)	Fans (kWh/m2/yr)	Interior (kWh/m2/yr)	Pumps (kWh/m2/yr)	Total (kWh/m2/yr)
January	0.9	0.4	3	0.2	0	4.5
February	0.9	0.4	2.7	0.2	0	4.2
March	0.3	0.4	3.1	0.3	0	4.1
April	0.4	0.7	2.7	0.3	0	4.1
May	0.7	1.1	3.1	0.4	0	5.3
June	1.1	1.5	3	0.6	0	6.2
July	1.2	1.7	2.9	0.7	0	6.5
August	1.1	1.6	3.1	0.6	0	6.4
September	1	1.5	2.9	0.6	0	6
October	0.7	1.1	3	0.4	0	5.2
November	0.4	0.7	3	0.3	0	4.4
December	0.5	0.4	2.9	0.3	0	4.1
Annual Total	9.2	11.5	35.4	4.9	0	61

COST RESULTS - MONTHLY USE BREAKDOWN

	Heating (\$/m2)			Cooling (\$/m2)			Fans (\$/m2)		Interior (\$/m2)			Pumps (\$/m2)		Other (\$/i Total (\$/m2)	
Month	AHU	Humidific Zones		AHU	Heat Reje Zones		AHU	Zones	Lighting	Equipment					
January		0	0	0.1	0	0	0	0	0	0.3	0.1	0	0	0.5	
February		0	0	0.1	0	0	0	0	0	0.3	0.1	0	0	0.5	
March		0	0	0	0	0	0	0	0	0.3	0.1	0	0	0.4	
April		0	0	0	0	0	0.1	0	0	0.3	0.1	0	0	0.5	
May		0	0	0	0.1	0	0.1	0	0	0.3	0.1	0.1	0	0.7	
June		0	0	0	0.1	0	0.1	0	0	0.3	0.1	0.1	0	0.7	
July		0	0	0	0.1	0	0.2	0	0	0.3	0.1	0.1	0	0.8	
August		0	0	0	0.1	0	0.2	0	0	0.3	0.1	0.1	0	0.8	
September		0	0	0	0.1	0	0.1	0	0	0.3	0.1	0.1	0	0.7	
October		0	0	0	0.1	0	0.1	0	0	0.3	0.1	0.1	0	0.7	
November		0	0	0	0	0	0.1	0	0	0.3	0.1	0	0	0.5	
December		0	0	0	0	0	0	0	0	0.3	0.1	0	0	0.4	
Annual Tc		0	0	0.2	0.6	0	1	0	0	3.6	1.2	0.6	0	7.2	

CO2e RESULTS - MONTHLY USE BREAKDOWN

Heating (kgCO2e/m2)				Cooling (kgCO2e/m2)			Fans (kgCO2e/m2)		Interior (kgCO2e/m2)		Pumps (kgCO2e/m2)		Other (kg Total (kgCO2e/m2)	
Month	AHU	Humidific Zones		AHU	Heat Reje Zones		AHU	Zones	Lighting	Equipment				
January		0	0	0.2	0	0	0	0.1	0	1	0.5	0.1	0	1.9
February		0	0	0.2	0	0	0	0.1	0	0.9	0.5	0.1	0	1.8
March		0	0	0	0.1	0	0.1	0.1	0	1	0.5	0.1	0	1.9
April		0	0	0	0.1	0	0.2	0.1	0	0.9	0.5	0.1	0	1.9
May		0	0	0	0.3	0.1	0.4	0.1	0.1	1	0.5	0.2	0	2.7
June		0	0	0	0.4	0.1	0.5	0.1	0.1	1	0.5	0.3	0	3
July		0	0	0	0.4	0.2	0.6	0.1	0.2	1	0.5	0.3	0	3.3
August		0	0	0	0.4	0.1	0.6	0.1	0.1	1	0.5	0.3	0	3.1
Septembe		0	0	0	0.4	0.1	0.5	0.1	0.1	1	0.5	0.3	0	3
October		0	0	0	0.3	0.1	0.4	0.1	0.1	1	0.5	0.2	0	2.7
Novembe		0	0	0	0.1	0	0.2	0.1	0	1	0.5	0.2	0	2.1
Decembe		0	0	0.1	0	0	0.1	0.1	0	1	0.5	0.1	0	1.9
Annual Tc		0	0	0.5	2.5	0.7	3.6	1.2	0.7	11.8	6	2.3	0	29.3



HVAC SYSTEMS OPTIONEERING



Recommended HVACS

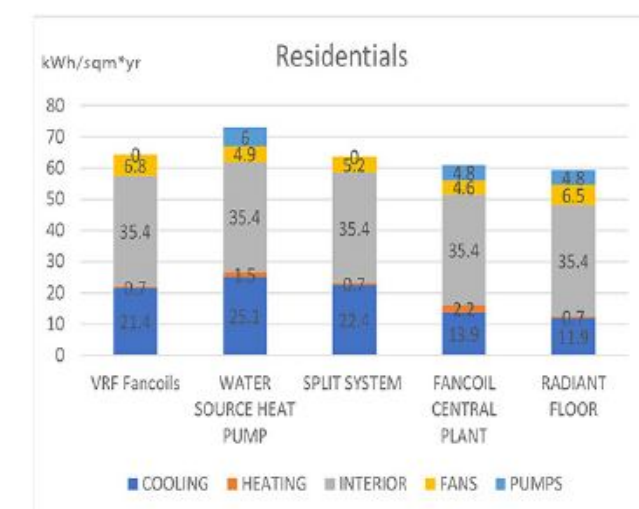
VRF Fancoils
VAV RETURN AIR
SPLIT SYSTEM COP
FANCOIL CENTRAL PLANT
CAV
WATER SOURCE HEAT PUMP
PASSIVE CHILLED BEAM
RADIANT FLOOR
VRV (VARIABLE REFRIGERANT VALUE)

	Residential	Commercial
VRF Fancoils	x	x
VAV RETURN AIR		
SPLIT SYSTEM COP	x	x
FANCOIL CENTRAL PLANT	x	x
CAV		x
WATER SOURCE HEAT PUMP	x	
PASSIVE CHILLED BEAM		
RADIANT FLOOR	x	
VRV (VARIABLE REFRIGERANT VALUE)		x

RESIDENTIALS

WE TRIED FIVE DIFFERENT HVAC SYSTEMS FOR THE RESIDENTIALS AND ALTHOUGH THE RADIANT FLOOR SYSTEMS TO BE A BETTER CHOICE IN CASE OF THE ENERGY USE INTENSITY AND EVEN MORE COMFORTABLE DIFFUSION SYSTEM INSIDE THE UNITS BUT DUE TO THE REQUIRED MECHANICAL VENTILATION WE CHOSE TO GO WITH THE FANCOIL SYSTEM.

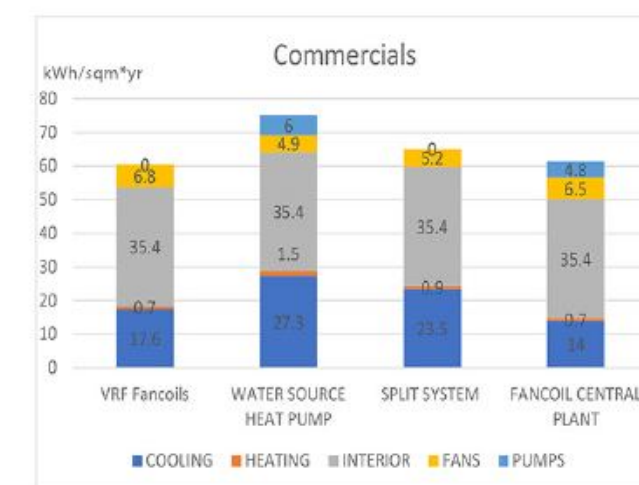
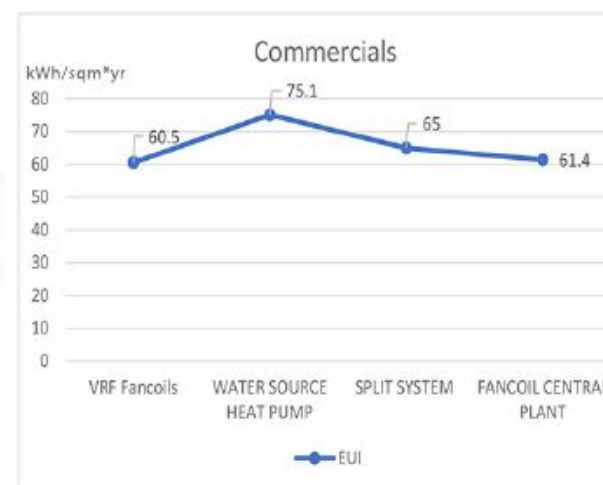
	EUI	COOLING	HEATING	INTERIOR	FANS	PUMPS	%
VRF Fancoils	64.3	21.4	0.7	35.4	6.8	0	6%
WATER SOURCE HEAT PUMP	72.9	25.1	1.5	35.4	4.9	6	20%
SPLIT SYSTEM	63.7	22.4	0.7	35.4	5.2	0	5%
FANCOIL CENTRAL PLANT	60.9	13.9	2.2	35.4	4.6	4.8	
RADIANT FLOOR	59.3	11.9	0.7	35.4	6.5	4.8	-3%
CHOSEN BASELINE							
FANCOIL CENTRAL PLANT	60.9	13.9	2.2	35.4	4.6	4.8	



COMMERCIALS

ALTHOUGH THE VRF FANCOIL SEEMS TO BE A SLIGHTLY BETTER CHOICE TO GO WITH IN CASE OF ENERGY USE INTENSITY BUT WE CHOSE TO GO WITH THE CENTRAL PLANT FANCOIL SYSTEM SO WE CAN HAVE A UNITIZED SYSTEM WHOLE THROUGH THE BUILDING HENCE, A MORE EFFICIENT SYSTEM CAN BE DESIGNED.

	EUI	COOLING	HEATING	INTERIOR	FANS	PUMPS	%
VRF Fancoils	60.5	17.6	0.7	35.4	6.8	0	-1%
CAV	75.1	27.3	1.5	35.4	4.9	6	22%
SPLIT SYSTEM	65	23.5	0.9	35.4	5.2	0	6%
FANCOIL CENTRAL PLANT	61.4	14	0.7	35.4	6.5	4.8	
CHOSEN BASELINE							
FANCOIL CENTRAL PLANT	61.4	14	0.7	35.4	6.5	4.8	



CHOSEN HVAC OPTIONEERING



AFTER CHOOSING THE PROPER HVAC SYSTEM FOR THE BUILDING WE CHOSE TO GO WITH A SYSTEM WITH UNITIZED PLANTS FOR BOTH COMMERCIAL AND RESIDENTIAL PARTS OF THE BUILDING.

MOVING FORWARD WE TRIED TO FURTHER OPTIMIZE THE CHOSEN SYSTEM IN THE CASE OF COOLING WHICH SEEMS TO BE THE MOST IMPORTANT ASPECT OF THE DESIGN HAVING THE HIGHEST IMPACT ON THE FINAL OUTCOME IN BOTH CASE OF COMFORT AND ENERGY USE INTENSITY.

COP	EUI (KWh/m2/yr)		% COOLING	HEATING
4	64		16.6	1.6
4.35	63.1	1%	15.7	1.6
4.5	61.9	2%	14.5	1.6
4.75	60.9	2%	13.5	1.6

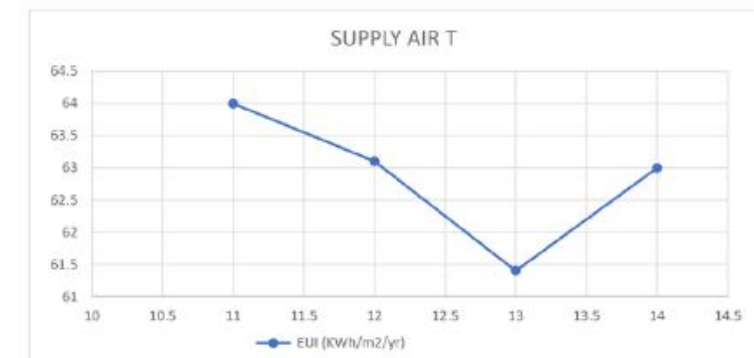
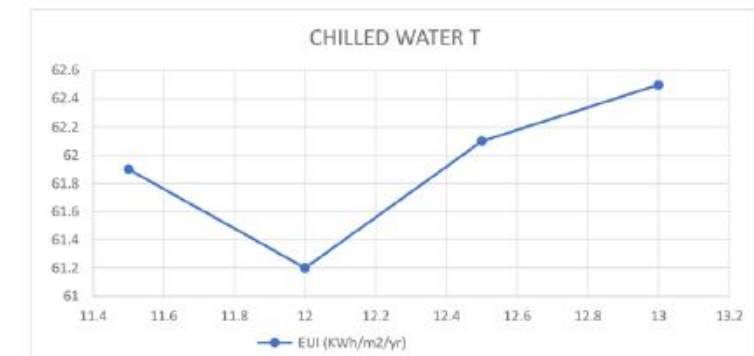
CHILLED WATER T	EUI (KWh/m2/yr)		% COOLING	HEATING
13	62.5		14	1.6
12.5	62.1	1%	13.6	1.6
12	61.2	1%	13.8	1.6
11.5	61.9	-1%	14.5	1.6

SUPPLY AIR T	EUI (KWh/m2/yr)		% COOLING	HEATING
11	64		16.6	1.6
12	63.1	1%	15.7	1.6
13	61.4	3%	14	1.6
14	63	-3%	15.6	1.6

DEFAULT	61.4		14	1.6
OPT SUPPLY AIR T	61.4		14	1.6
OPT CHILLED WATER T	61.2		13.8	1.6
OPT COP OF CHILLER	60.9		13.5	1.6

		EUI (KWh/ %	COOLING	HEATING	
SUMMARY	DEFAULT BASELINE	61.4	0.00%	14	1.6
	OPT SUPPLY AIR T	61.4	0.00%	14	1.6
	OPT CHILLED WATER T	61.2	-0.33%	13.8	1.6
	OPT COP OF CHILLER	60.9	-0.49%	13.5	1.6

SUMMARY



SPECIFICATIONS OF THE FINALIZED HVAC SYSTEM

AIR SIDE				
SUPPLY AIR T	SUPPLY AIR DEWPOINT T	COOLING DESIGN AIR T	HEATING DESIGN AIR T	
13	13	13	35	
COOLING COIL SOURCE	HEATING COIL SOURCE	HEAT RECOVERY SENSIBLE EFFIC.	PEAK SPECIFIC FAN POWER (W/L.s)	
CHW LOOP	HHW LOOP	85%	3.49	
WATER SIDE				
WATER COOLED CHILLER	CHILLER COP	PEAK DISTRIBUTION EFFICIENCY	CHILLED WATER T	
	4.75	90%	12	
GAS FIRED BOILER	BOILER EFF.	PEAK DISTRIBUTION EFFICIENCY	HOT WATER T	
	90%	85%	80	

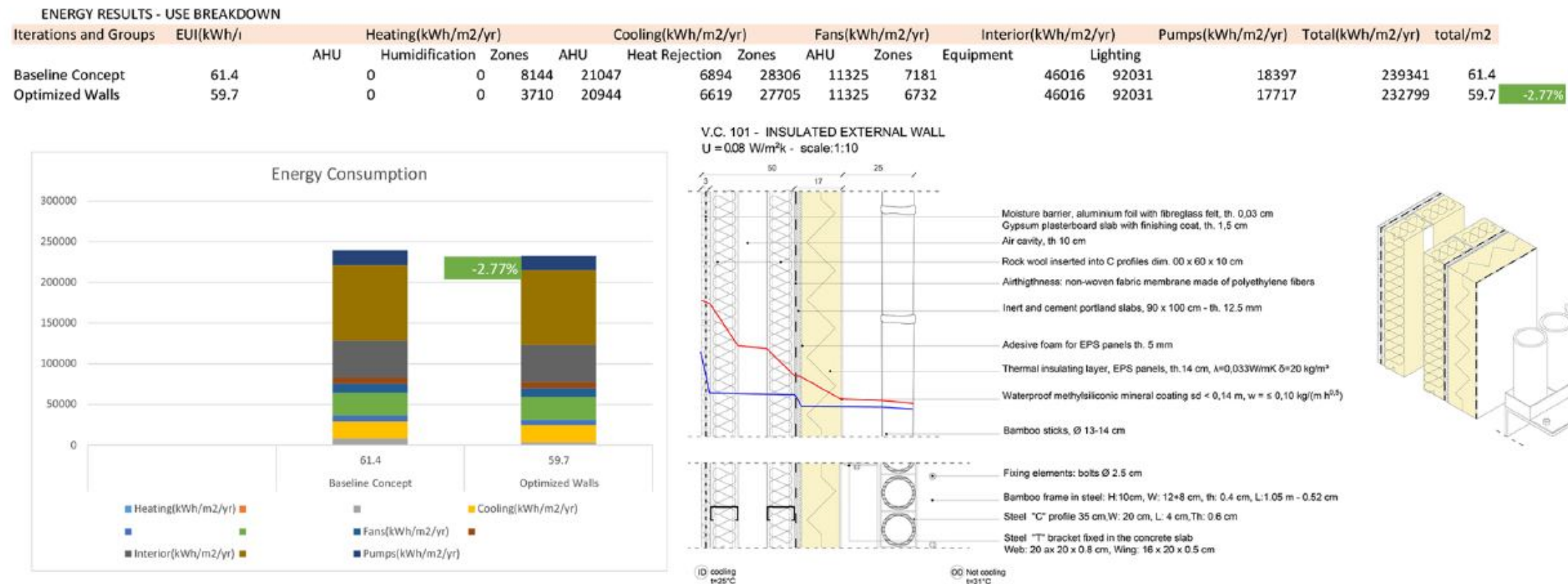
DIFFUSER

IN THE CASE OF THE DIFFUSERS, WE CHOSE TO HAVE DECENTRALIZED DIFFUSION TECHNOLOGY, IN THIS CASE THE HEAT RECOVERY, DEHUMIDIFICATION AND COOLING HAPPENS SEPERATELY FOR EACH UNIT WHICH NOT ONLY HELPS WITH THE BILLING SEPERATION BETWEEN UNITS BUT ALSO FURTHER OPTIMIZES THE USAGE IN THE SENSE THAT WE WOULDN'T HAVE UNWANTED RUNNING OF THE HVAC SYSTEM.



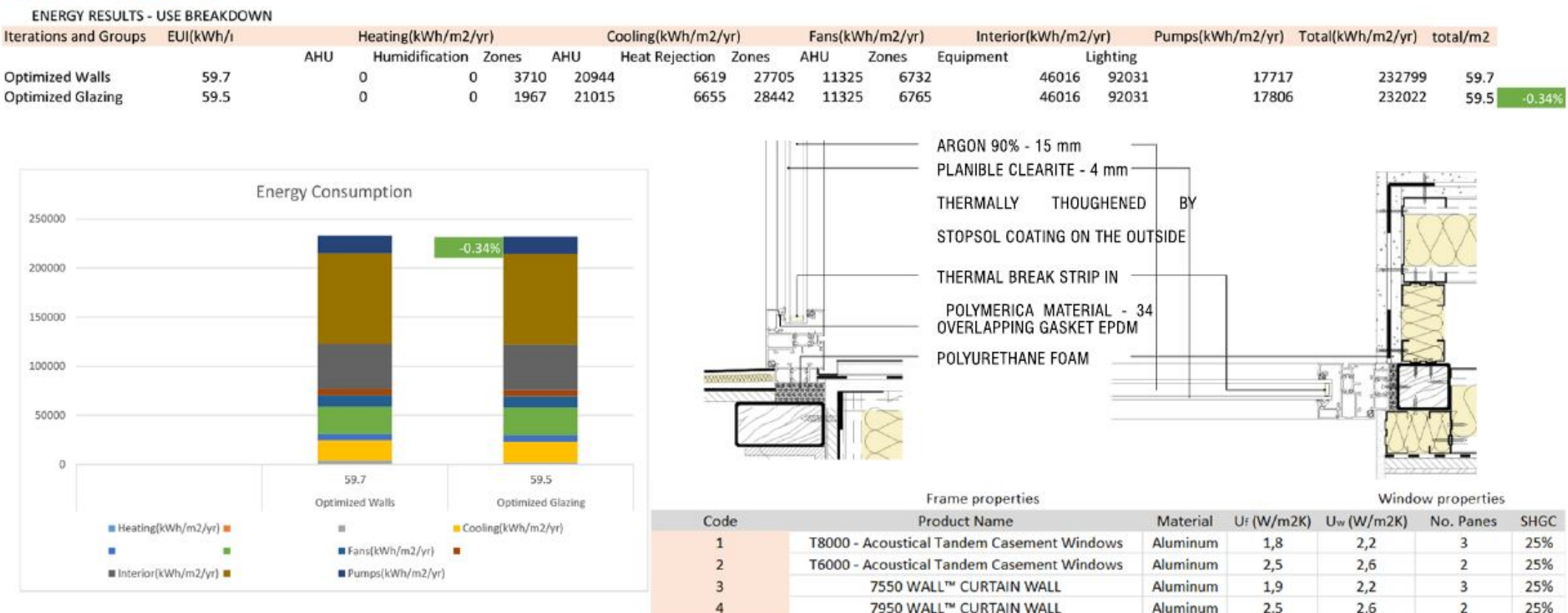
ENVELOPE OPTIMIZATION - STEP 1

FIRST STEP OF THE ENVELOPE OPTIMIZATION IS TO IMPROVE THE U VALUE OF THE OPAQUE WALLS CONSIDERING THE RISK OF CONDENSATION DUE TO HIGH RELATIVE HUMIDITY AVERAGE OF THE HONG KONG AND ALSO THE FACT THAT THE OPAQUE PART OPPOSITE OF THE TRANSPARENT PART HAS A HIGH POTENTIAL OF HEATING UP ON THE SURFACE AND GENERATING DISCOMFORT.



ENVELOPE OPTIMIZATION - STEP 2

SECOND STEP WAS TO OPTIMIZE THE GLAZING PART OF THE ENVELOPE IN BOTH CASES OF U-VALUE OF THE GLAZING ASSEMBLY AND SOLAR HEAT GAIN VALUE. THE OPTIMIZATION WAS DONE BY GENERATING RESPONSE CURVES FOR A RANGE OF U-VALUE AND SHGC FOR EACH FACE OF THE BUILDING AND THEN GENERATING A CONFIGURATION PROVIDING THE NEEDED PERFORMANCE.

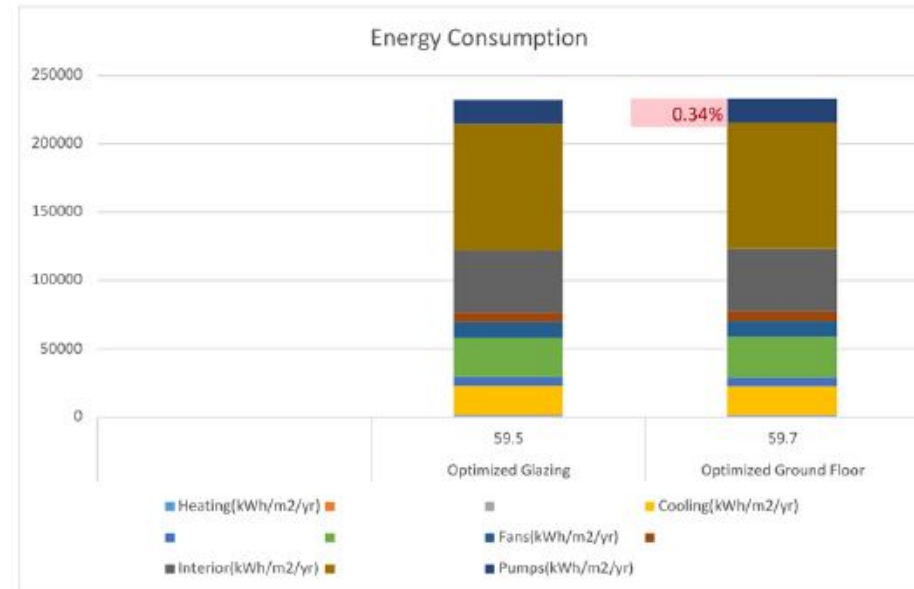


ENVELOPE OPTIMIZATION - STEP 3

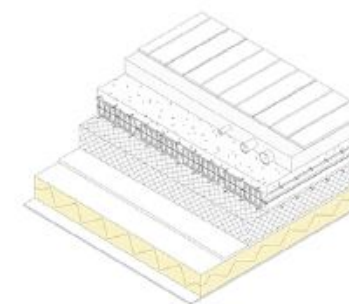
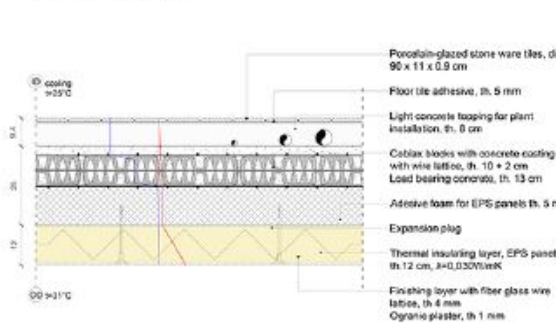
THIRD STEP OF THE ENVELOPE OPTIMIZATION IS TO OPTIMIZE THE GROUND FLOOR CHARACTERISTICS, SPECIFICALLY, THE U-VALUE OF THE WHOLE ASSEMBLY FOR BOTH THE GROUND FLOOR IN TOUCH WITH THE SOIL AND THE LOWEST FLOOR ABOVE THE PLATFORM WHICH HOLDS THE WHOLE RESIDENTIAL FLOORS WHICH IS IN TOUCH WITH EXTERNAL CLIMATE. ALTHOUGH THE CHOSEN ASSEMBLY IS SLIGHTLY LESS PERFORMING THAN THE DEFAULT BASELINE BUT IT IS THE ASSEMBLY THAT WORKS FOR US IN THE CASE OF COMFORT.

ENERGY RESULTS - USE BREAKDOWN

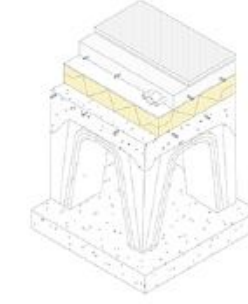
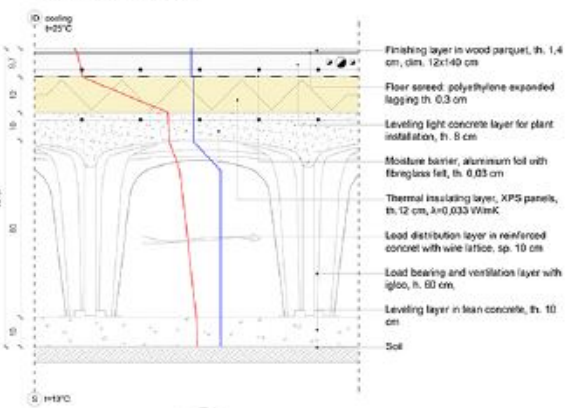
Iterations and Groups	EUI(kWh/i)	Heating(kWh/m2/yr)			Cooling(kWh/m2/yr)			Fans(kWh/m2/yr)		Interior(kWh/m2/yr)		Pumps(kWh/m2/yr)	Total(kWh/m2/yr)	total/m2
		AHU	Humidification	Zones	AHU	Heat Rejection	Zones	AHU	Zones	Equipment	Lighting			
Optimized Glazing	59.5	0	0	1967	21015	6655	28442	11325	6765	46016	92031	17806	232022	59.5
Optimized Ground Floor	59.7	0	0	1682	20761	6485	30040	11325	6960	46016	92031	17529	232829	59.7 0.34%



H.C. 104 - SLAB ABOVE OUTDOOR SPACES
U = 0.2 W/m²K - scale: 1:10



H.C. 103 - INSULATED SLAB IN CONTACT WITH THE GROUND
U = 0.25 W/m²K - scale: 1:10

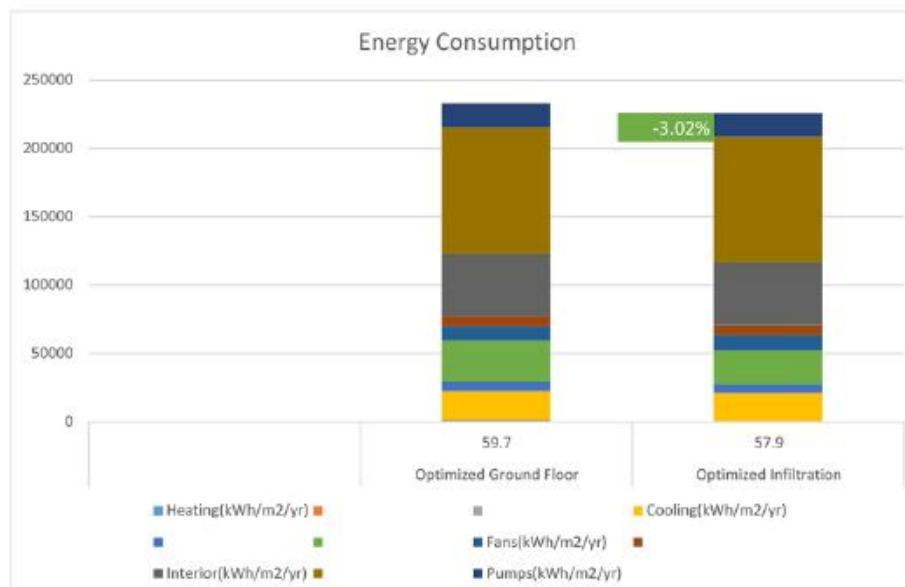


ENVELOPE OPTIMIZATION - STEP 4

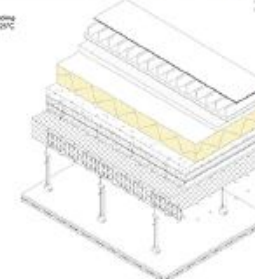
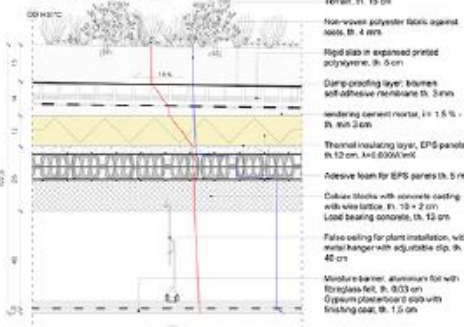
FOURTH STEP IS TO OPTIMIZE THE ROOFS OF THE BUILDING CONSIDERING DIFFERENT SOLUTIONS FOR VARYING USAGE BUT EQUALLY PERFORMING IN THE CASE OF CLIMATE, SUCH AS RAIN-WATER CONTROL WALKABILITY, VIBRATION CONTROL (IN CASE OF EQUIPMENTS INSTALLATIONS ON THE ROOF) AND MOST IMPORTANTLY RELATED TO ENERGY OPTIMIZATION OF THE BUILDING: THE U-VALUE OF THE WHOLE ASSEMBLY.

ENERGY RESULTS - USE BREAKDOWN

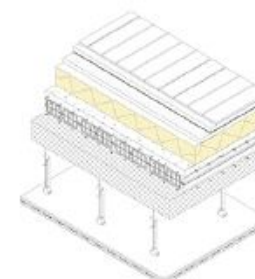
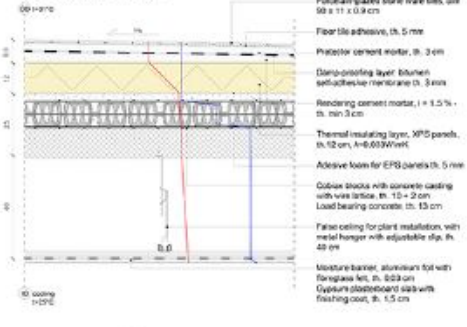
Iterations and Groups	EUI(kWh/i)	Heating(kWh/m2/yr)			Cooling(kWh/m2/yr)			Fans(kWh/m2/yr)		Interior(kWh/m2/yr)		Pumps(kWh/m2/yr)	Total(kWh/m2/yr)	total/m2
		AHU	Humidification	Zones	AHU	Heat Rejection	Zones	AHU	Zones	Equipment	Lighting			
Optimized Ground Floor	59.7	0	0	1682	20761	6485	30040	11325	6960	46016	92031	17529	232829	59.7
Optimized Infiltration	57.9	0	0	696	20519	6073	25074	11325	7021	46016	92031	16669	225424	57.9 -3.02%



H.C. 100 - GREEN ROOF
U = 0.14 W/m²K - scale: 1:10



H.C. 101 - ACCESSIBLE ROOF
U = 0.18 W/m²K - scale: 1:10



SUMMARY - ENVELOPE OPTIMIZATION

ENERGY RESULTS - USE BREAKDOWN

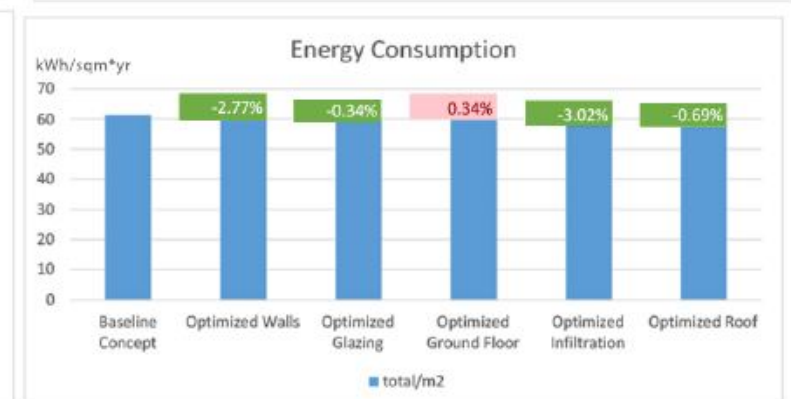
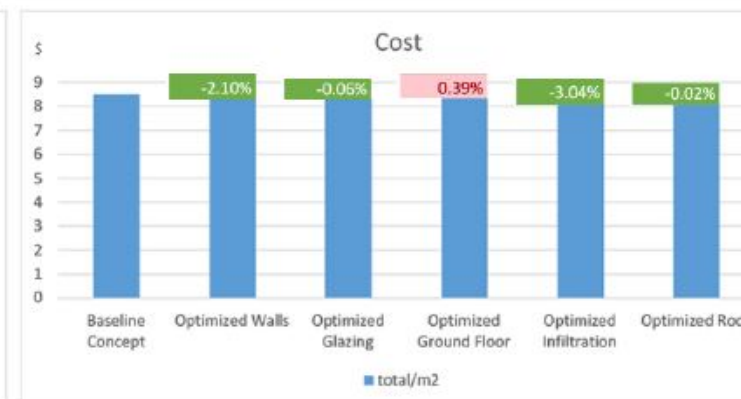
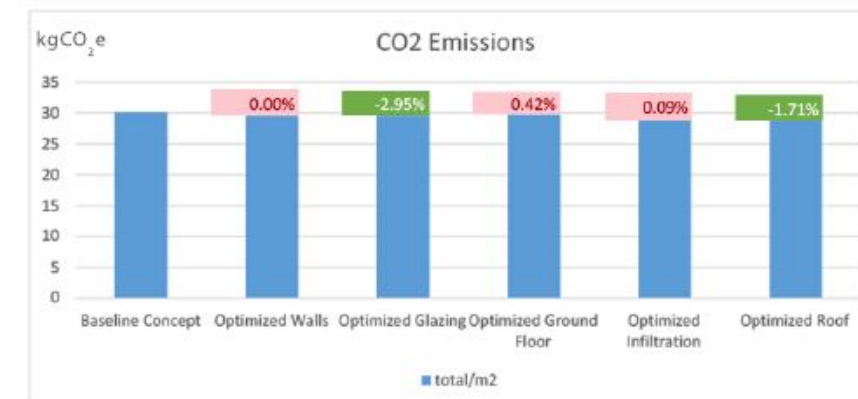
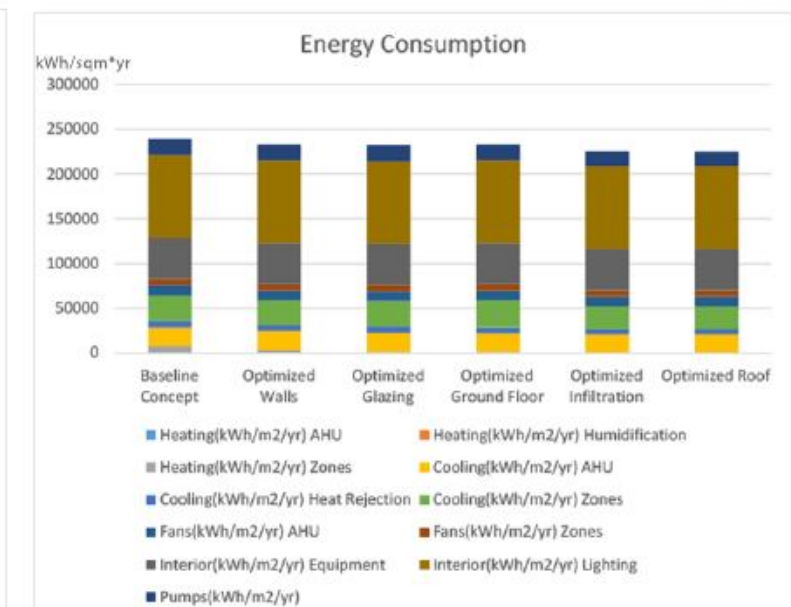
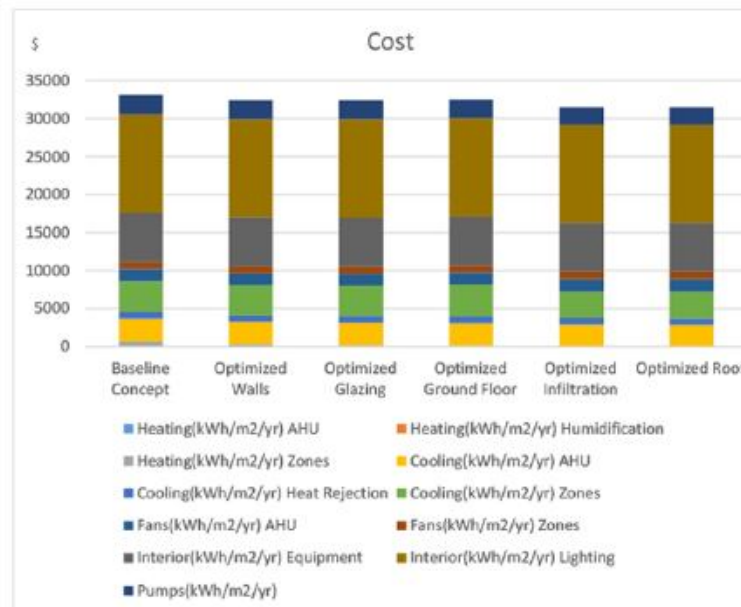
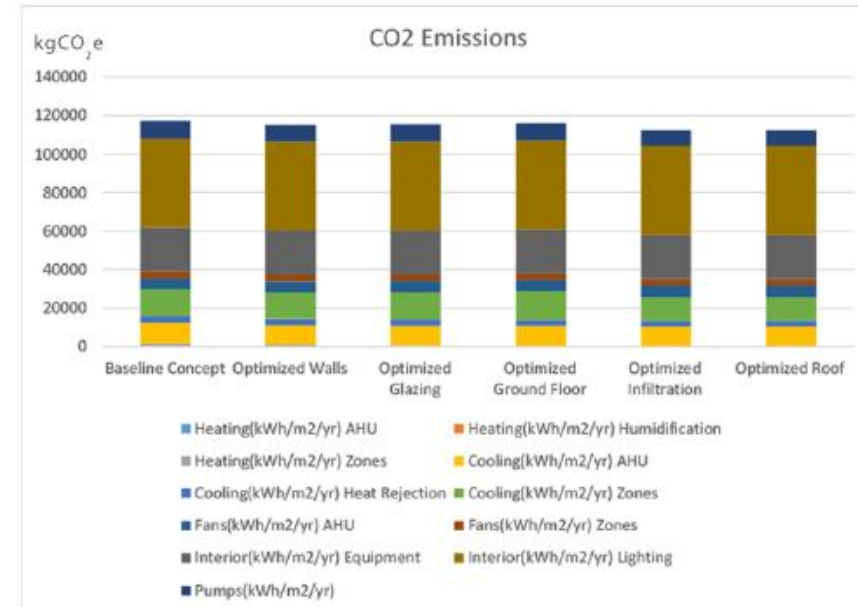
Iterations and Groups	EUI(kWh/m2/yr)	Heating(kWh/m2/yr)		Cooling(kWh/m2/yr)		Fans(kWh/m2/yr)		Interior(kWh/m2/yr)		Pumps(kWh/m2/yr)	Total(kWh/m2/yr)	total/m2		
		AHU	Humidi Zones	AHU	Heat Rejection	Zones	AHU	Zones	Equipment				Lighting	
Baseline Concept	61.4	0	0	8144	21047	6894	28306	11325	7181	46016	92031	18397	239341	61.4
Optimized Walls	59.7	0	0	3710	20944	6619	27705	11325	6732	46016	92031	17717	232799	59.7
Optimized Glazing	59.5	0	0	1967	21015	6655	28442	11325	6765	46016	92031	17806	232022	59.5
Optimized Ground Floor	59.7	0	0	1682	20761	6485	30040	11325	6960	46016	92031	17529	232829	59.7
Optimized Infiltration	57.9	0	0	696	20519	6073	25074	11325	7021	46016	92031	16669	225424	57.9
Optimized Roof	57.5	0	0	466	20526	6078	25192	11325	7018	46016	92031	16643	225295	57.5

COST RESULTS - USE BREAKDOWN

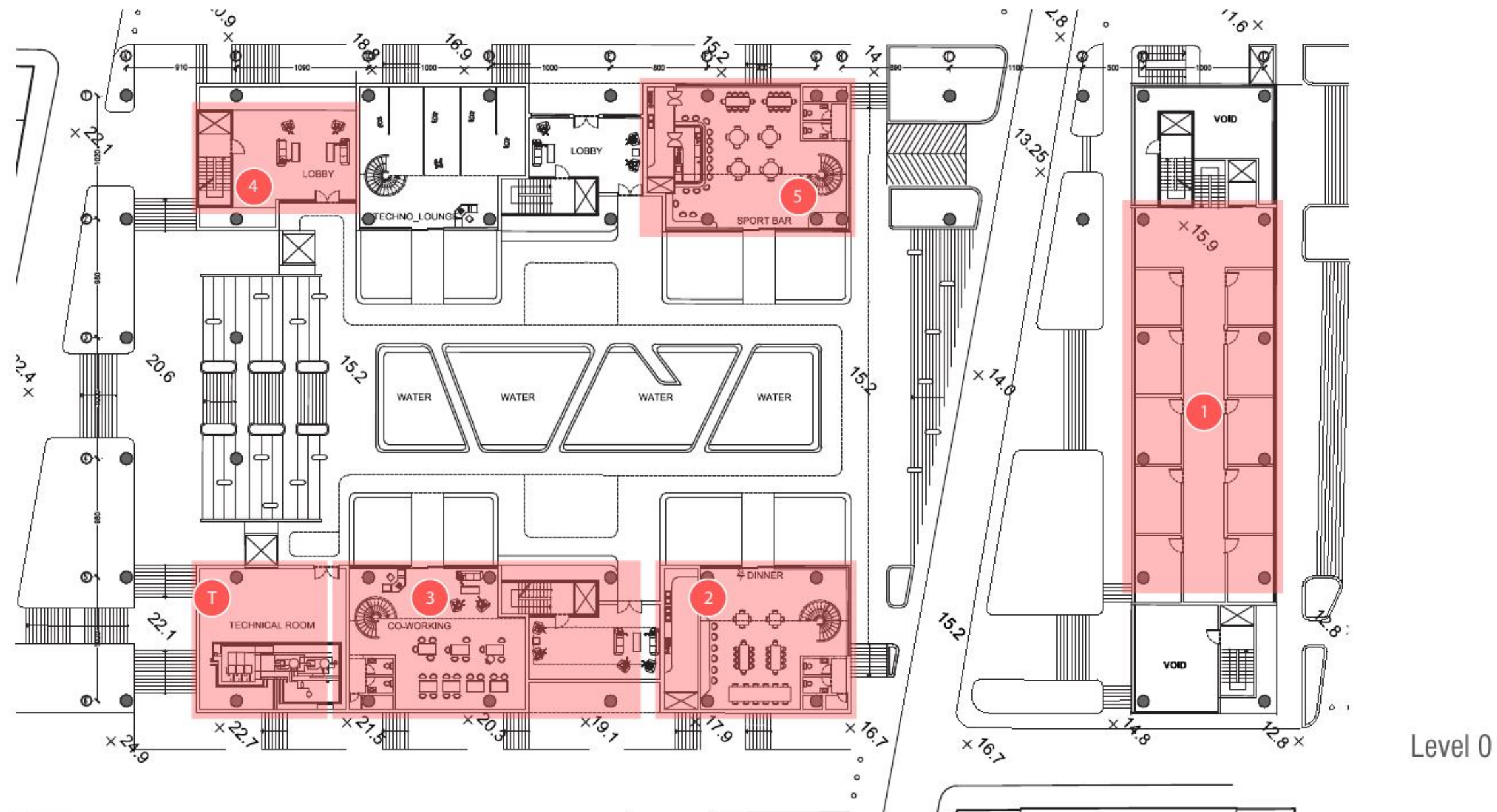
Iterations and Groups	Electricity Cost Tariff	Gas Cost Tariff	Heating(\$)			Cooling(\$)			Fans(\$)		Interior(\$)		Pumps(\$)	Total(\$)	total/m2		
	\$/kWh/m2/yr	\$/kWh/m2/yr	AHU	Humidi	Zones	AHU	Heat Rejection	Zones	AHU	Zones	Equipment	Lighting					
Baseline Concept	0.14	0.09	0	0	733	2947	965	3963		1586	1005	6442	12884	2576	33101	8.49615	
Optimized Walls	0.14	0.09	0	0	334	2932	927	3879		1586	942	6442	12884	2480	32406	8.317762	-2.10%
Optimized Glazing	0.14	0.09	0	0	177	2942	932	3982		1586	947	6442	12884	2493	32385	8.312372	-0.06%
Optimized Ground Floor	0.14	0.09	0	0	151	2907	908	4206		1586	974	6442	12884	2454	32512	8.344969	0.39%
Optimized Infiltration	0.14	0.09	0	0	63	2873	850	3510		1586	983	6442	12884	2334	31525	8.091632	-3.04%
Optimized Roof	0.14	0.09	0	0	42	2874	851	3527		1586	983	6442	12884	2330	31519	8.090092	-0.02%

CO2e RESULTS - USE BREAKDOWN

Iterations and Groups	Electricity CO2e rate	Gas CO2e rate	Heating(kg		Cooling(kgCO2e)			Fans(kgCO2e)		Interior(kgCO2e)		Pumps(kgCO2e)	Total(kgCO2e)	total/m2		
	kgCO2e /kWh/m2/yr	kgCO2e /kWh/m2/yr	AHU	Humidi Zones	AHU	Heat Rejection	Zones	AHU	Zones	Equipment	Lighting					
Baseline Concept	0.5	0.216	0	0	1759	10524	3447	14153	5663	3590	23008	46016	9199	117359	30.12295	
Optimized Walls	0.5	0.216	0	0	801	10472	3310	13852	5663	3366	23008	46016	8859	115347	29.60652	-1.71%
Optimized Glazing	0.5	0.216	0	0	425	10507	3327	14221	5663	3383	23008	46016	8903	115453	29.63373	0.09%
Optimized Ground Floor	0.5	0.216	0	0	363	10381	3243	15020	5663	3480	23008	46016	8764	115938	29.75821	0.42%
Optimized Infiltration	0.5	0.216	0	0	150	10259	3036	12537	5663	3511	23008	46016	8335	112515	28.87962	-2.95%
Optimized Roof	0.5	0.216	0	0	101	10263	3039	12596	5663	3509	23008	46016	8321	112516	28.87988	0.00%



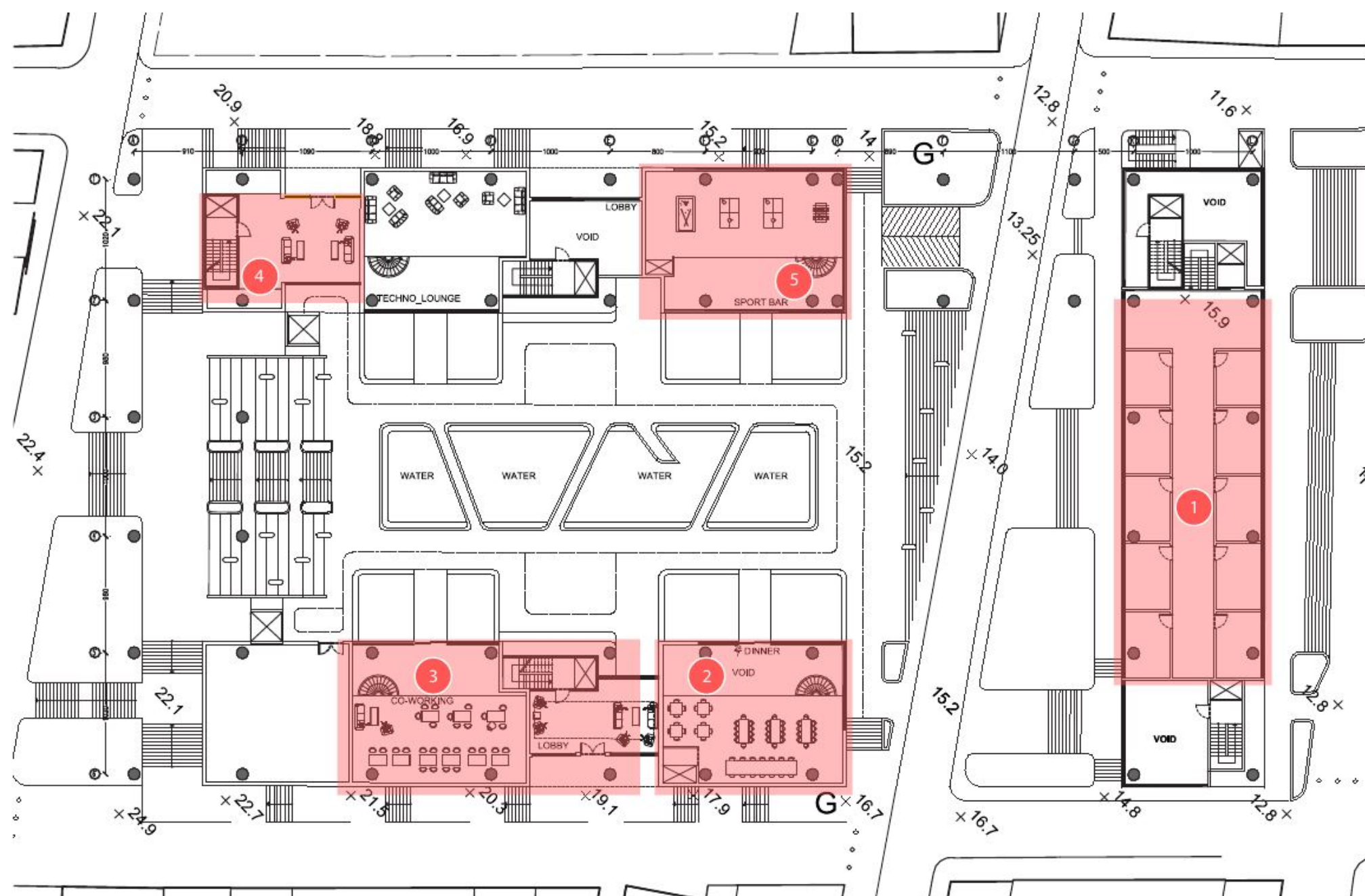
Requirements have been set according to the codes ASHRAE 9001 (Thermal environmental conditions for human occupancy) and ASHRAE 62 (Ventilation for acceptable indoor air quality)



T Technical space
 Hours schedule HVAC: -
 Setpoint/Setback temp.: -
 Days schedule: 7 days (Mon-Sun)
 Outside air rate: 0,3 L/s*m2
 Occupant density: -
 Metabolic rate: -
 People gains: -
 Lighting (min): 100 lux
 Lighting power: 2.5 W/m2
 Equipment power: -

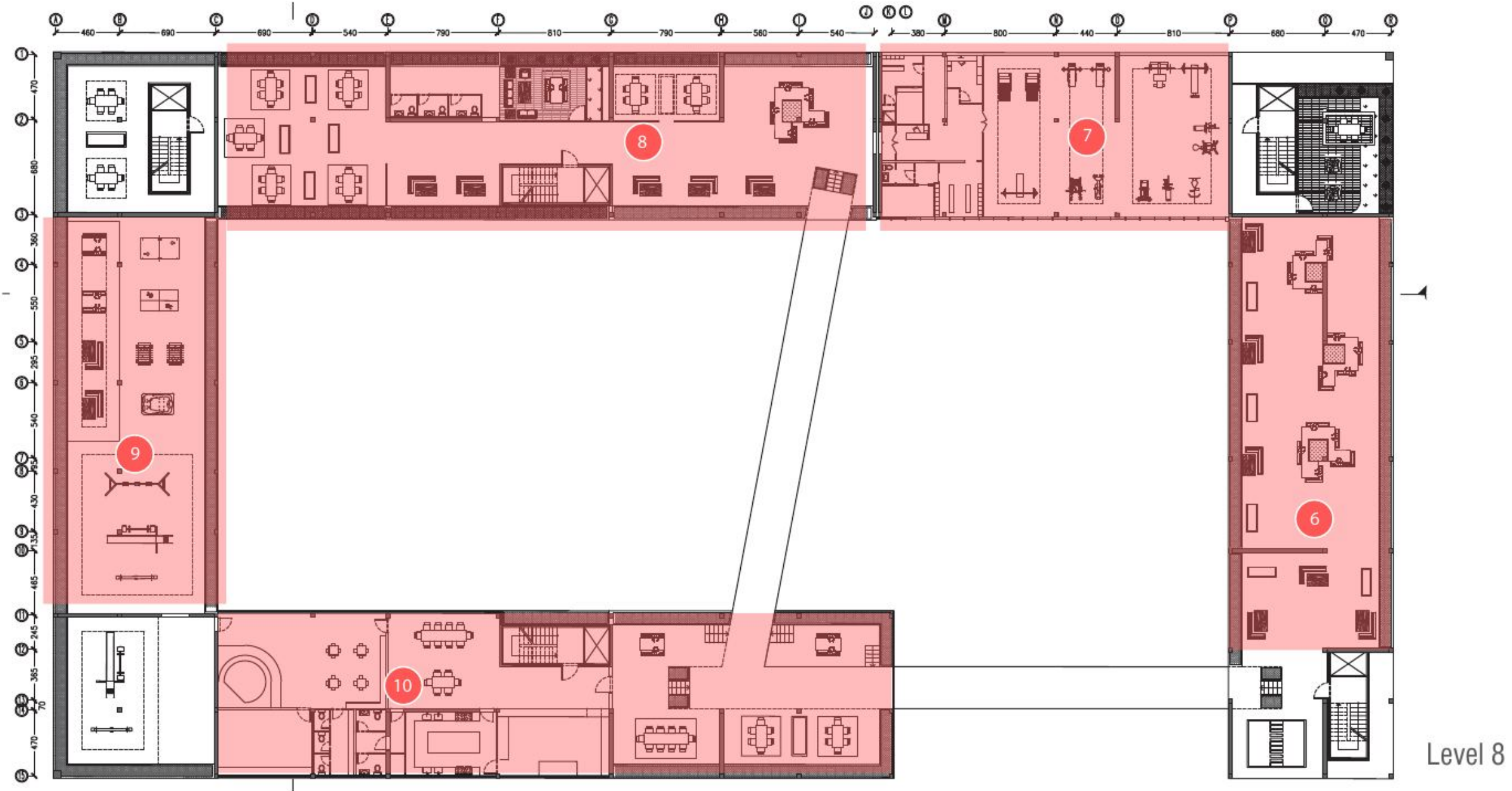
1 Commercial
 Hours schedule HVAC: 8-19.30
 Setpoint/Setback temp.: 21-24/12-28 °C
 Days schedule: 6 days (Tue-Sun)
 Outside air rate: 3,8 L/s*pers. - 0,3 L/s*m2
 Occupant density: 7 m2/pers.
 Metabolic rate: 1,2 Met
 People gains: 70 W/m2
 Lighting (min): 300 lux
 Lighting power: 7.5 W/m2
 Equipment power: 5 W/m2

2 Restaurant
 Hours schedule HVAC: 11-15 / 19-24
 Setpoint/Setback temp.: 21-24/12-28 °C
 Days schedule: 7 days (Mon-Sun)
 Outside air rate: 3,8 L/s*pers. - 0,9 L/s*m2
 Occupant density: 1,75 m2/pers.
 Metabolic rate: 1,2 Met
 People gains: 70 W/m2
 Lighting (min): 300 lux
 Lighting power: 7.5 W/m2



Level 1,2

- | | | |
|--|--|---|
| <p>3 Study/co-working
 Hours schedule HVAC: 8-22
 Setpoint/Setback temp.: 21-24/12-28 °C
 Days schedule: 7 days (Mon-Sun)
 Outside air rate: 2,5 L/s*pers. - 0,3 L/s*m2
 Occupant density: 3 m2/pers.
 Metabolic rate: 1 Met
 People gains: 60 W/m2
 Lighting (min): 500 lux
 Lighting power: 6 W/m2
 Equipment power: 12W/m2</p> | <p>4 Lobby
 Hours schedule HVAC: 9-16
 Setpoint/Setback temp.: 21-24/12-28 °C
 Days schedule: 5 days (Mon-Fri)
 Outside air rate: 2,5 L/s*pers. - 0,3 L/s*m2
 Occupant density: 17 m2/pers.
 Metabolic rate: 1 Met
 People gains: 60 W/m2
 Lighting (min): 300 lux
 Lighting power: 5 W/m2
 Equipment power: 5 W/m2</p> | <p>5 Bar
 Hours schedule HVAC: 7-24
 Setpoint/Setback temp.: 21-24/12-28 °C
 Days schedule: 7 days (Mon-Sun)
 Outside air rate: 3,8 L/s*pers. - 0,9 L/s*m2
 Occupant density: 2 m2/pers.
 Metabolic rate: 1,2 Met
 People gains: 70 W/m2
 Lighting (min): 300 lux
 Lighting power: 7.5 W/m2
 Equipment power: 5 W/m2</p> |
|--|--|---|



- 6** common area
Hours schedule HVAC: 7-24
10 Setpoint/Setback temp.: 20-25/18-28 °C
Days schedule: 7 days (Mon-Sun)
Outside air rate: 2,5 L/s*pers. - 0,3 L/s*m2
Occupant density: 2 m2/pers.
Metabolic rate: 0,8 Met
People gains: 45 W/m2
Lighting (min): 300 lux
Lighting power: 7.5 W/m2
Equipment power: 5 W/m2

- 7** Gym
Hours schedule HVAC: 8.30-21.30
9 Setpoint/Setback temp.: 20-25/12-28 °C
Days schedule: 6 days (Mon-Sat)
Outside air rate: 10 L/s*pers. - 0,3 L/s*m2
Occupant density: 7 m2/pers.
Metabolic rate: 4 Met
People gains: 235 W/m2
Lighting (min): 750 lux
Lighting power: 10 W/m2
Equipment power: -

- 8** Study/co-working
Hours schedule HVAC: 8-22
Setpoint/Setback temp.: 21-24/12-28 °C
Days schedule: 7 days (Mon-Sun)
Outside air rate: 2,5 L/s*pers. - 0,3 L/s*m2
Occupant density: 3 m2/pers.
Metabolic rate: 1 Met
People gains: 60 W/m2
Lighting (min): 500 lux
Lighting power: 6 W/m2
Equipment power: 12W/m2



Level 4,6,10

11 common area
 Hours schedule HVAC: 7-24
 Setpoint/Setback temp.: 20-25/18-28 °C
 Days schedule: 7 days (Mon-Sun)
 Outside air rate: 3.5 L/s*pers. - 0,4 L/s*m2
 Occupant density: 7 m2/pers.
 Metabolic rate: 0,8 Met
 People gains: 45 W/m2
 Lighting (min): 300 lux
 Lighting power: 7.5 W/m2
 Equipment power: 5 W/m2

12 Kitchen and dining room
 Hours schedule HVAC: 7-14 / 18-22
 Setpoint/Setback temp.: 20-25/18-28 °C
 Days schedule: 7 days (Mon-Sun)
 Outside air rate: 1.5 L/s*pers. - 0.75 L/s*m2
 Occupant density: 2 m2/pers.
 Metabolic rate: 2 Met
 People gains: 100 W/m2
 Lighting (min): 500 lux
 Lighting power: 8 W/m2

13 55m unit
 Hours schedule HVAC: 6-11.30 / 17-22
 Setpoint/Setback temp.: 20-25/18-28 °C
 Days schedule: 7 days (Mon-Sun)
 Outside air rate: 12 L/s*pers. - 0,4 L/s*m2
 Occupant density: 27 m2/pers.
 Metabolic rate: 0,7 Met
 People gains: 40 W/m2
 Lighting (min): 150 lux
 Lighting power: 5 W/m2



Level 5,7,9

14 35m unit
Hours schedule HVAC: 6-11.30 / 17-22
Setpoint/Setback temp.: 20-25/18-28 °C
Days schedule: 7 days (Mon-Sun)
Outside air rate: 7.5 L/s*pers. - 0,4 L/s*m2
Occupant density: 18 m2/pers.
Metabolic rate: 0,7 Met
People gains: 40 W/m2
Lighting (min): 150 lux
Lighting power: 5 W/m2

15 15m unit
Hours schedule HVAC: 6-11.30 / 17-22
Setpoint/Setback temp.: 20-25/18-28 °C
Days schedule: 7 days (Mon-Sun)
Outside air rate: 6.5 L/s*pers. - 0,4 L/s*m2
Occupant density: 15 m2/pers.
Metabolic rate: 0,7 Met
People gains: 40 W/m2
Lighting (min): 150 lux
Lighting power: 5 W/m2

C Circulation space
Hours schedule HVAC: 6-24
Setpoint/Setback temp.: 20-25/18-28 °C
Days schedule: 7 days (Mon-Sun)
Outside air rate: 0.2 L/s*m2
Occupant density: 50 m2/pers.
Metabolic rate: 2 Met
People gains: 120 W/m2
Lighting (min): 100 lux
Lighting power: 2.5 W/m2
Equipment power: -

COMFORT ANALYSIS

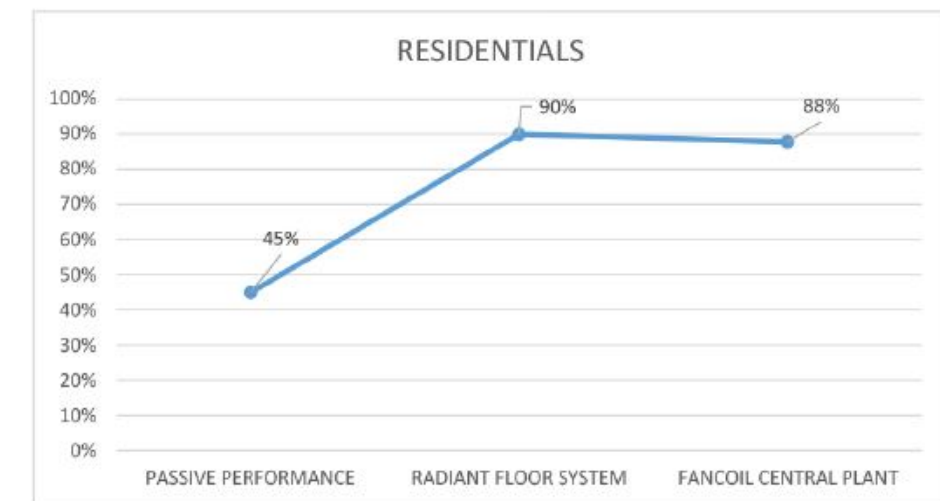
IN THIS STEP WE SIMULATED THE COMFORT ANALYSIS BASED ON OPERATIVE TEMPERATURE WHERE AS A ZONE PASSES AS INSIDE COMFORT ZONE IF AND ONLY IF THE OPERATIVE TEMPERATURE IS INSIDE THE RANGE OF 20°C TO 26°C FOR 98% OF THE OCCUPIED HOURS. FIRST OF ALL WE CHALLENGE THE BUILDING PERFORMANCE UNDER NO HVAC SYSTEM TO ACQUIRE A WHOLESOME GRIP ON BUILDING'S PASSIVE PERFORMANCE. THEN THE SIMULATION WAS DONE FOR BOTH COMMERCIAL AND RESIDENTIAL PARTS OF THE BUILDING ON THE TWO MOST REASONABLE SYSTEMS WE HAD FOUND THROUGH HVAC OPTIONEERING PART. FOR THE RESIDENTIALS WE CONSIDERED RADIANT FLOOR SYSTEM AND FANCOIL CENTRAL PLANT SYSTEM. IN THE CASE OF THE COMMERCIALS WE SIMULATED THE BUILDING UNDER FANCOIL CENTRAL PLANT SYSTEM AND VRF FANCOILS.



RESIDENTIALS

NUMBER OF ZONES	1655640
ZONES INSIDE COMFORT RANGE 98% OF THE OCCUPIE HOURS	744600
ZONES INSIDE COMFORT RANGE 96-98% OF THE OCCUPIE HOURS	402960
ZONES INSIDE COMFORT RANGE LESS THAN 96%% OF THE OCCUPIE HOURS	508080

PASSIVE PERFORMANCE	RADIANT FLOOR SYSTEM	FANCOIL CENTRAL PLANT
45%	90%	88%



	PASSIVE PERFORMANCE			RADIANT FLOOR SYSTEM			FANCOIL CENTRAL PLANT		
	HOURLY	TOTAL	%	HOURLY	TOTAL	%	HOURLY	TOTAL	%
NUMBER OF ZONES	1655640	189		1655640	189		1655640	189	
ZONES INSIDE COMFORT RANGE 98% OF THE OCCUPIE HOURS	744600	85	45%	1489200	170	90%	1454160	166	88%
ZONES INSIDE COMFORT RANGE 96-98% OF THE OCCUPIE HOURS	402960	46	24%	131400	15	8%	166440	19	10%
ZONES INSIDE COMFORT RANGE LESS THAN 96%% OF THE OCCUPIE HOURS	508080	58	31%	35040	4	2%	35040	4	2%



CONCLUSION

IT IS EASY TO COMPREHEND THAT THE RADIANT FLOOR SYSTEM PROVIDES AN SLIGHTLY BETTER PERFORMANCE IN CASE OF OPERATIVE TEMPERATURE INSIDE THE UNITS BUT IT IS WIDELY OUT OF RANGE IN THE COMMON ZONES WHICH NOT ONLY RECEIVES A HIGH AMOUNT OF SOLAR RADIATION DUE TO WIDE GLAZING RATIOS BUT ALSO BECAUSE OF THE HIGHER DEMAND FOR THE VENTILATION. THUS, DUE TO THE FACT THAT EVEN WITH THE RADIANT FLOOR SYSTEM OPERATING WE NEED MECHANICAL

VENTILATION TO PROVIDE COMFORT IN CASE OF FRESH AND DEHUMIDIFIED AIR, IT IS UNREASONABLE TO USE TWO DIFFERENT SYSTEMS AND WE ARE WILLING TO COMPENSATE THAT SLIGHT LACK IN PERFORMANCE. AND WE WILL GO WITH THE FAN COIL CENTRAL PLANT SYSTEM FOR THE WHOLE BUILDING.

NATURAL VENT

IN THE CASE OF NATURAL VENTILATION DUE TO THE VERY HIGH AMOUNT OF AVERAGE RELATIVE HUMIDITY ALL AROUND THE YEAR IN THE HONG KONG CENTRAL LOCATION COUPLED WITH THE HIGH AVERAGE TEMPERATURE PLUS THE BAD ODOURS GENERATED DUE TO THE SOROUNDING RESTAURANTS ALL AROUND THE SITE (ACCORDING TO HONG KONG BUILDING DEPARTMENT LAW) NATURAL VENTILATION SHOULD NOT BE CONSIDERED IN THE DESIGNING OF HVAC SYSTEMS BUT THE OPTION OF OPERABLE WINDOWS ARE PROVIDED ON THE FACADE FACING THE CITY.

COMFORT ANALYSIS

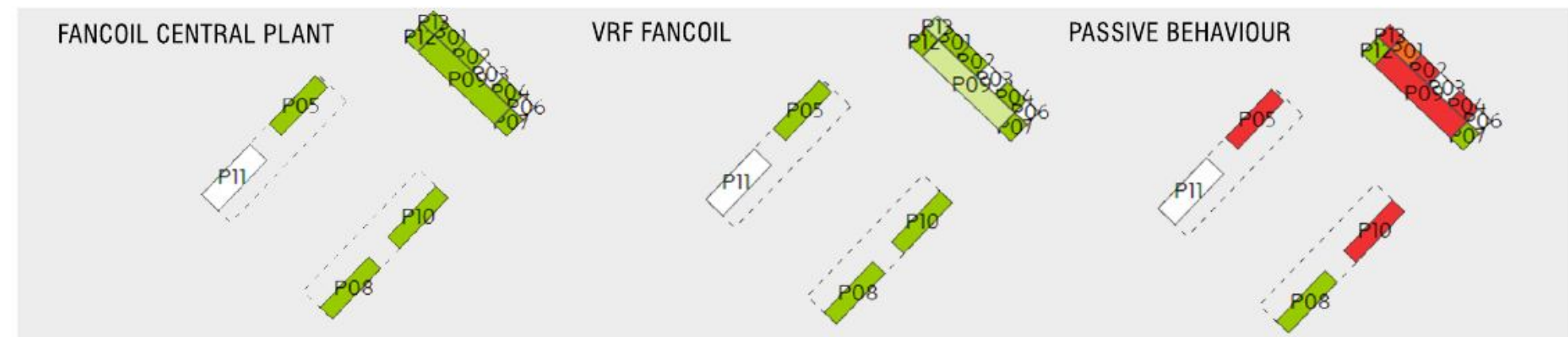
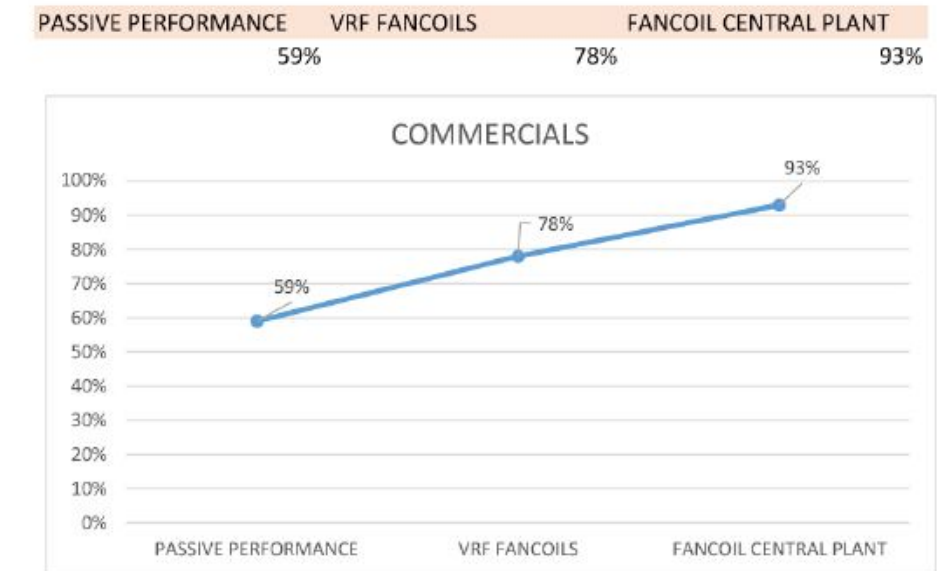
IN THIS STEP WE SIMULATED THE COMFORT ANALYSIS BASED ON OPERATIVE TEMPERATURE WHERE AS A ZONE PASSES AS INSIDE COMFORT ZONE IF AND ONLY IF THE OPERATIVE TEMPERATURE IS INSIDE THE RANGE OF 20°C TO 26°C FOR 98% OF THE OCCUPIED HOURS. FIRST OF ALL WE CHALLENGE THE BUILDING PERFORMANCE UNDER NO HVAC SYSTEM TO ACQUIRE A WHOLESOME GRIP ON BUILDING'S PASSIVE PERFORMANCE. THEN THE SIMULATION WAS DONE FOR BOTH COMMERCIAL AND RESIDENTIAL PARTS OF THE BUILDING ON THE TWO MOST REASONABLE SYSTEMS WE HAD FOUND THROUGH HVAC OPTIONEERING PART. FOR THE RESIDENTIALS WE CONSIDERED RADIANT FLOOR SYSTEM AND FANCOIL CENTRAL PLANT SYSTEM. IN THE CASE OF THE COMMERCIALS WE SIMULATED THE BUILDING UNDER FANCOIL CENTRAL PLANT SYSTEM AND VRF FANCOILS.



COMMERCIALS

NUMBER OF ZONES
ZONES INSIDE COMFORT RANGE 98% OF THE OCCUPIED HOURS
ZONES INSIDE COMFORT RANGE 96-98% OF THE OCCUPIED HOURS
ZONES INSIDE COMFORT RANGE LESS THAN 96% OF THE OCCUPIED HOURS

PASSIVE PERFORMANCE			FANCOIL CENTRAL PLANT			VRF FANCOILS		
HOURLY	TOTAL	%	HOURLY	TOTAL	%	HOURLY	TOTAL	%
236520	27		236520	27		236520	27	
140160	16	59%	219000	25	93%	183960	21	78%
43800	5	19%	17520	2	7%	26280	3	11%
52560	6	22%	0	0	0%	26280	3	11%

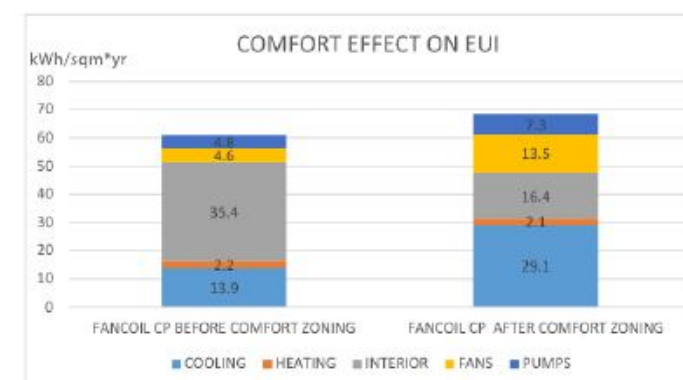


CONCLUSION

IT IS EASILY COMPREHENDABLE THAT THE ZONES RECEIVING DIRECT SUN MORE HOURS DURING THE YEAR (THE NORTHERN PART OF THE COMMERCIALS) ARE SUBJECTED TO MORE ISSUES IN THE CASE OF COMFORT MOSTLY DUE TO THE HIGH GLAZING RATIO BUT THE FANCOIL CENTRAL PLANT COULD EASILY OFFSET THIS ISSUE AND PROVIDE A VERY GOOD COMFORT IN THE CASE OF OPERATIVE TEMPERATURE. THE ODOUR CONTROL ALSO ONLY WORKS FOR THE TOP TWO FLOORS OF THAT PART OF THE COMMERCIALS AND THE GROUND FLOOR IS DEDICATED TO FOOD SERVICE UNITS.

OVERALL IMPACT OF THE COMFORT ZONING ON ENERGY CONSUMPTION

	EUI	COOLING	HEATING	INTERIOR	FANS	PUMPS
FANCOIL CP BEFORE COMFORT ZONING	60.9	13.9	2.2	35.4	4.6	4.8
FANCOIL CP AFTER COMFORT ZONING	68.4	29.1	2.1	16.4	13.5	7.3

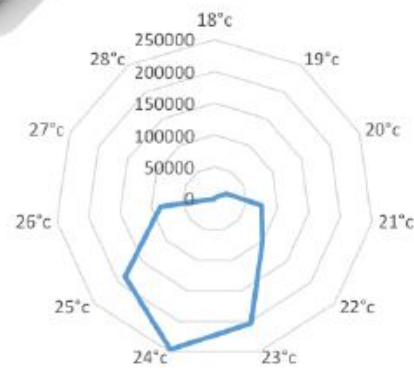


THE AMOUNT OF ENERGY CONSUMPTION DUE TO COOLING INCREASE BY 109% TO PROVIDE THE NEEDED COMFORT TO THE ALL OF THE DIFFERENT ZONES OF THE BUILDING BUT THE AMOUNT OF ENERGY CONSUMPTION DUE TO THE INTERIOR EQUIPMENT DECREASES BY 49% DUE TO THE FACT THAT THE STANDARD POWER UNITS ON ASHRAE ARE OLDER THAN TECHNOLOGY AVAILABLE TODAY, SO UPDATING THAT TO THE LATEST STANDARDS WOULD SOLVE THAT ISSUE.

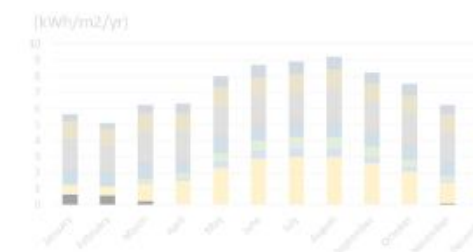
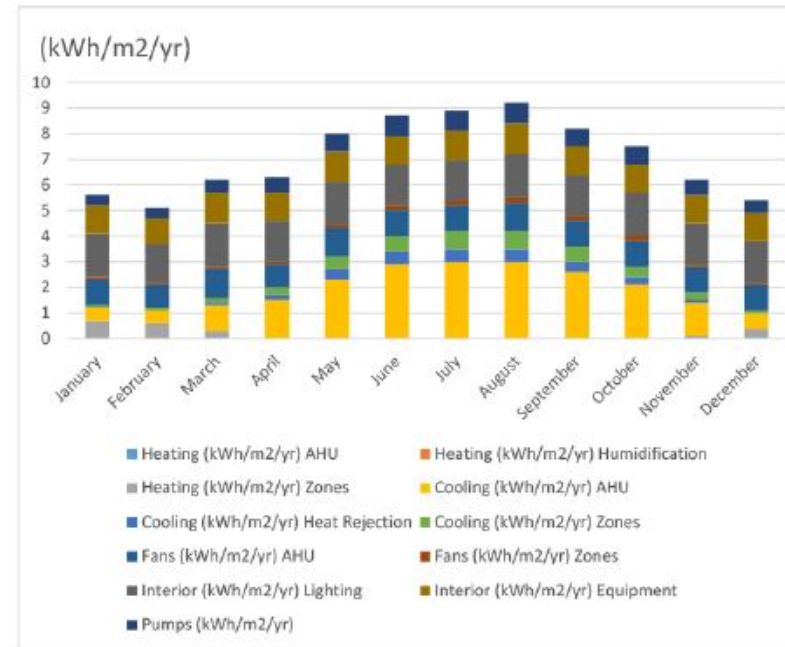
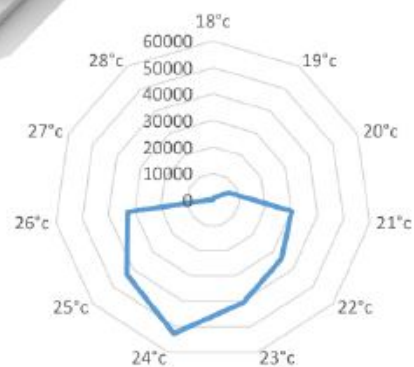
COMFORT ANALYSIS



RESIDENTIALS

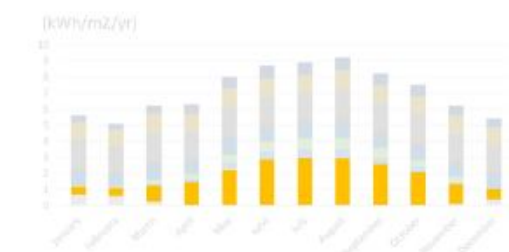


COMMERCIALS



MID-SEASON

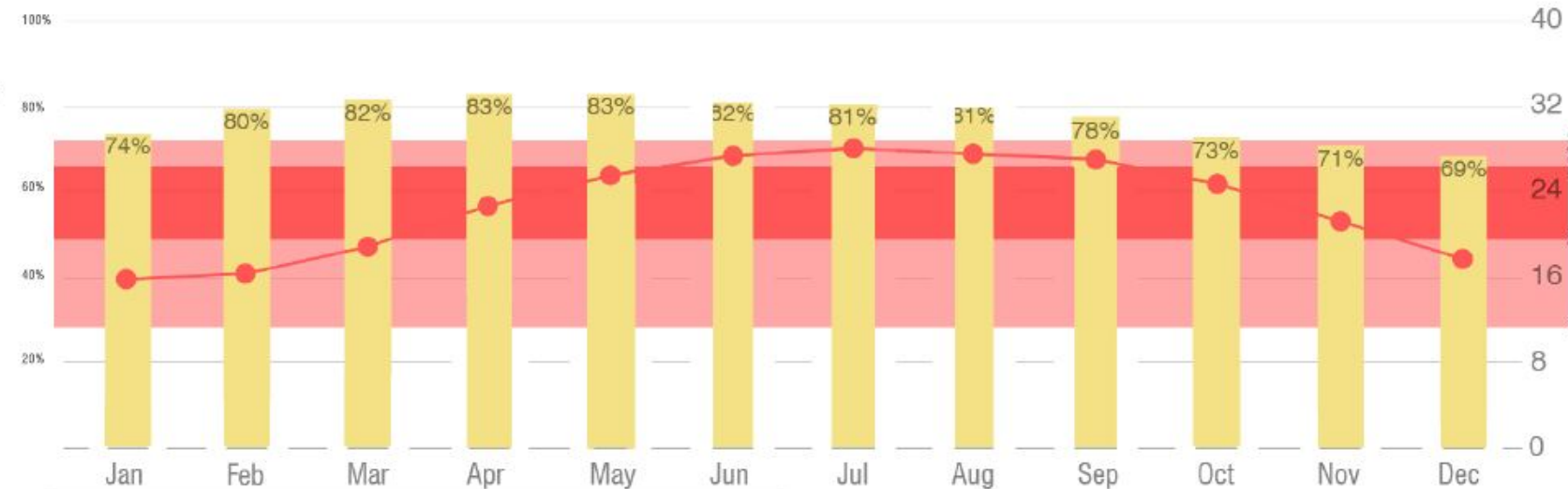
WE HAVE NO HEATING SEASON BUT IN DEC-MAR WE HAVE MUCH LOWER LOAD ON COOLING EQUIPMENT AND THE MOST OF IT'S OPERATION IS ON HEAT REJECTION. BUT THE **FANS** WORK FOR THE MECHANICAL VENTILATION. V



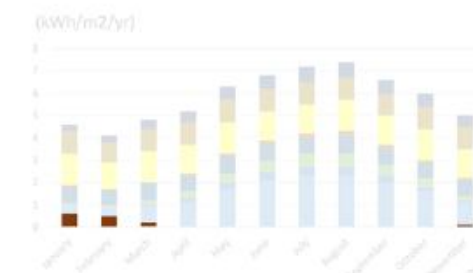
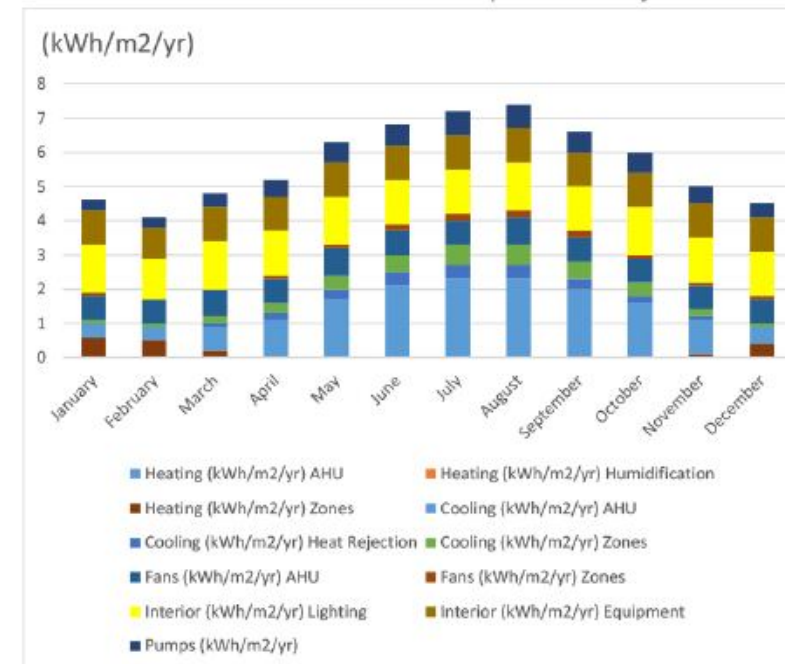
COOLING SEASON

ALTHOUGH THE COOLING EQUIPMENT IS WORKING ALL THROUGH THE YEAR BUT APR-NOV IT IS THE MAIN ENERGY COSUMING EPUIMENT IN THE BUILDING AND IS WORKING AT ITS MOST CAPACITY TO PROVIDE COMFORT INSIDE THE BUILDING

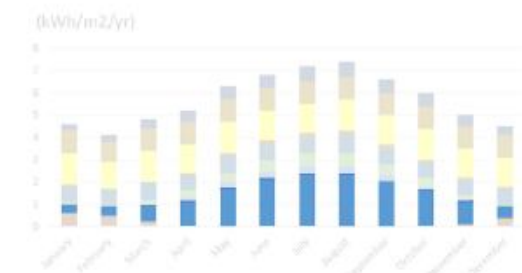
RELATIVE HUMIDITY



AVERAGE TEMP. (°C)



MID-SEASON



COOLING SEASON

ON-SITE GENERATION

TO OFFSET A PART OF THE ENERGY CONSUMPTION PHOTOVOLTAIC PANELS ARE IMPLEMENTED OVER THE ROOF AND ON SOME PARTS OF THE FACADE SPECIFICALLY THE PARTS IN WHICH WE HAVE ISSUE WITH TOO MUCH ANNUAL SUN EXPOSURE,

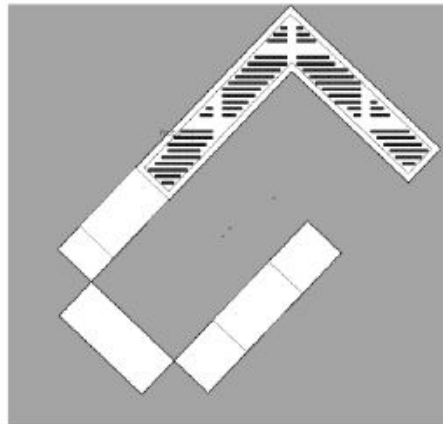
THUS IN THOSE PARTS WE IMPLEMENT TRANSPARENT PV PANELS AS PART OF AS PART OF THE CURTAINWALL SYSTEM.

THIS SYSTEM WITH 30% TRANSPARENCY WILL HELP US SOLVE THE ISSUE AND ALSO WILL PROVIDE US WITH AN ADDITIONAL 1.57 kWh/yr.m² ENERGY PRODUCTION. THIS ENERGY WOULD DECREASE THE ENERGY DEMAND ON HVAC SYSTEM BY 26%.

THE INVESTMENT TO ENERGY PRODUCTION ENERGY IS ONLY 0.01\$ PER kWh AND THE PAYBACK PERIOD IS LESS THAN A YEAR. IN A PERIOD OF 30 YEARS, THE SAVINGS ON ENERGY EXPENSES USING THIS SYSTEM CAN BECOME UP TO 40 TIMES OF THE INITIAL INVESTMENTS.



sunpower pv pane -
Dimension: 181*157 cm



AREA: 186 m²



AREA: 729 m²

ON ROOF

PANEL SPECIFICATIONS

BRAND & MODEL	N° FACES	N° PANELS	P. power(Wp)	P. weight(kg)	TOTAL WEIGHT (kg)	Azimuth	Tilt	Relativetilt
SunPower:SPR-220-WHT	2	196	220	15	2940	180	37	37



TOTAL GENERATION 66364.44 kWh/yr

HONG KONG TARRIFS

Electricity Cost Tariff \$/kWh/m2/yr	Gas Cost Tariff \$/kWh/m2/yr	Electricity CO2e rate kgCO2e /kWh/m2/yr	Gas CO2e rate kgCO2e /kWh/m2/yr
	0.14	0.09	0.5
			0.216

ANNUAL SAVINGS

Electricity (\$/kWh/m2/yr)	Gas (\$/kWh/m2/yr)	Electricity (kgCO2e /kWh/m2/yr)	Gas (kgCO2e /kWh/m2/yr)
\$	0.46	\$	0.30
			1.64
			0.71

TOTAL GENERATION PER m² 6.28 kWh/yr.m²

PERCENTAGE OF TOTAL CONSUMPTION 9.18%

ON FACADE

PANEL SPECIFICATIONS

BRAND & MODEL	N° FACES	N° PANELS	SHGC	U-Value (W/m ² K)	TRANSPARENCY	Azimuth	Tilt	Relativetilt
ONYX PV CRYSTALLINE GLASS (CUSTOMIZED)	2	155	19%	15	30%	135	90	90



TOTAL GENERATION 16676.19 kWh/yr

ELECTRICITY GENERATED IN 35 YEARS

484,431 kWh *

TOTAL LIGHTING POINTS OPERATING 4 HOURS PER DAY

951 Lights **

AVOIDED CO₂ EMISSIONS IN 35 YEARS

325 t CO₂

BARRELS OF OIL SAVED IN 35 YEARS

285 Barrels

LITERS OF OIL SAVED IN 35 YEARS

45,324 liters

ELECTRIC CAR MILEAGE IN 35 YEARS THANKS TO THE ENERGY GENERATE

2,785,477 km

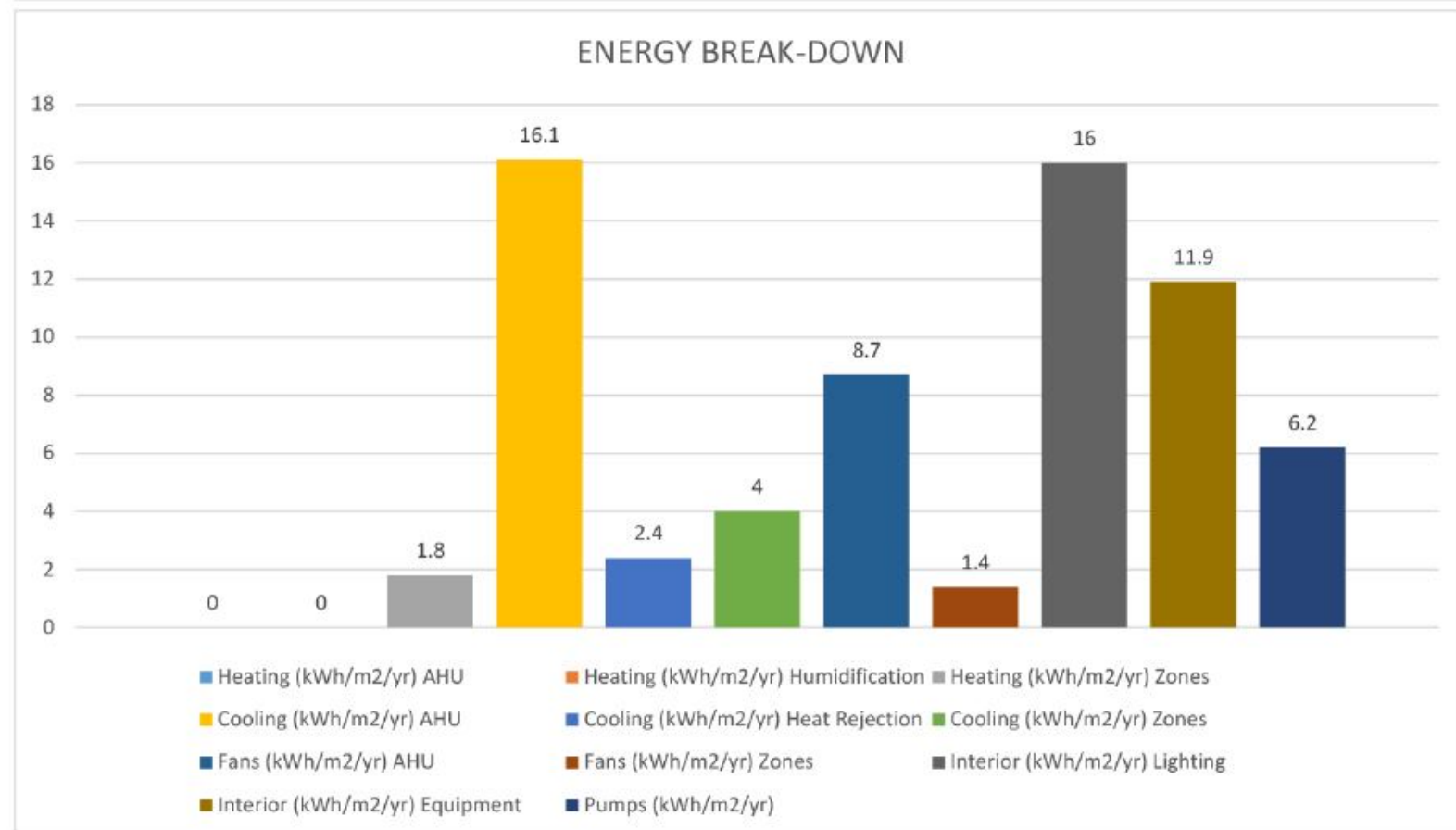
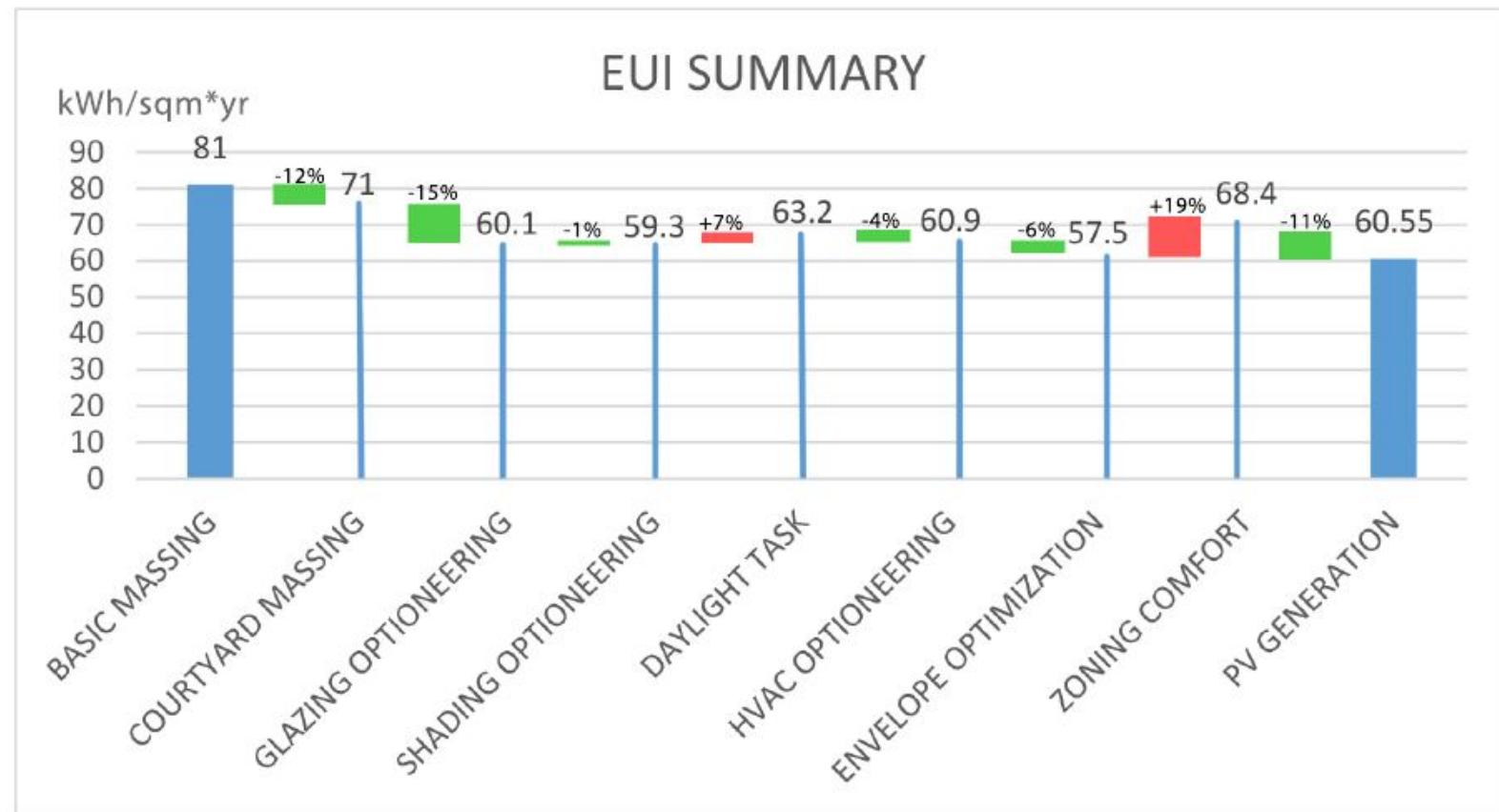
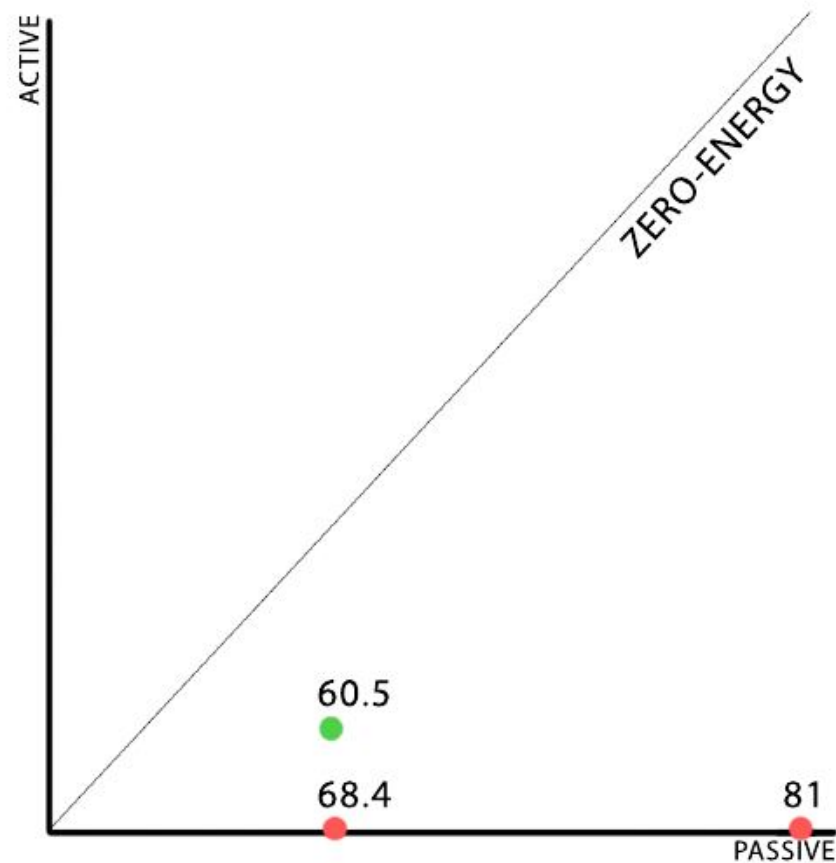
TREES PLANTED IN THE AMAZON THANKS TO THE INSTALLATION

300 Trees

TOTAL GENERATION PER m² 1.57 kWh/yr.m²

PERCENTAGE OF TOTAL CONSUMPTION 2.30%

FINAL ENERGY SUMMARY



STRUCTURE SCHEME

