1. - ABSTRACT

Casa La Carcabina. Detached single-family house in Muros del Nalón. Asturias

1.1. - BUILDING DATA

PASSIVE HOUSE DESIGNER: Amaya Salinas de León, architect/ www.amayasalinas.com

La Carcabina house is a single family house located on a plot of 1,000.00 m2 in Muros del Nalon (Asturias/Spain), at an altitude of 127 m. and at a distance of 1000 m. from the Cantabrian Sea.

Year of construction: 2015

Passivhaus database number: 4596

U-value external wall: 0,176 W/m^{2}k

PHPP heating demand: 14,9 Kwh/m^{2}a

U-value exterior floor slab: 0,181 W/m^{2}k

PHPP primary energy demand: 99 Kwh/m^{2}a

U-value roof: 0,193 W/m^{2}k/ 0,116 W/m^{2}k

Pressure test n_{50}: 0,46/h

U-value window: 0,176 W/m^{2}k

Heat recovery ventilation: 82,7%

Special features:

- Minimization of energy consumption for energy saving in a home with a unique typology and size.
- Use of materials and building systems with low environmental impact.
- Use of renewable energy in order to reduce CO2 emissions.
- Use of groundwater for irrigation and outdoor shower.
- Reduced construction period (four and a half months)

1.2. - PROJECT DESCRIPTION

The project has been designed and built following the PassivHaus premises and green building criteria, according to which, the energy efficiency and bioclimatic architecture that integrates building guarantee almost zero energy consumption.

Formally, the programme requirements of the owners and the configuration of the plot with different orientations were determining factors when designing the house.

It is a housing for a second home in the northern coast of Spain, which will have a permanent use by owners and a more sporadic use by the rest of the family, so the idea of the owners was to build a home that could accommodate a large number of people at any given time and at the same time could function independently when occupancy was low.

Materials

The architecture of the Asturias western coast fishing villages consist of volumes of different colours and wooden galleries.

These two materials are reinterpreted and are used to coat the housing: the volume where the rooms are located is externally coated with continuous Siberian larch wood in both façades and roof.

These wooden pieces rest on a white base where the areas of access to the house and the living room are located.

Inside, wooden floors dominate in bedrooms and porcelain tile in transit zones and in the living room.

Energy saving

Housing project is designed according to the criteria of the standard Passivhaus, so that energy consumption is adapted to the unique functionality of the housing in order to obtain the independent function of the wooden volumes and energy consumption depending on the different degrees of occupancy.

1.2. - RESPONSIBLE PROJECT PARTICIPANTS

ARCHITECT: Amaya Salinas de León

PASSIVEHOUSE PROJECT PLANNING: Amaya Salinas de León

CERTIFYING OFFICER: Micheel Yassouf (Energiehaus)

CERTIFICATION ID: Passivhaus database number: 4596

BUILDER: TIMBERONLIVE S.L.

2. - VIEWS

2.1. - EXTERIOR VIEWS

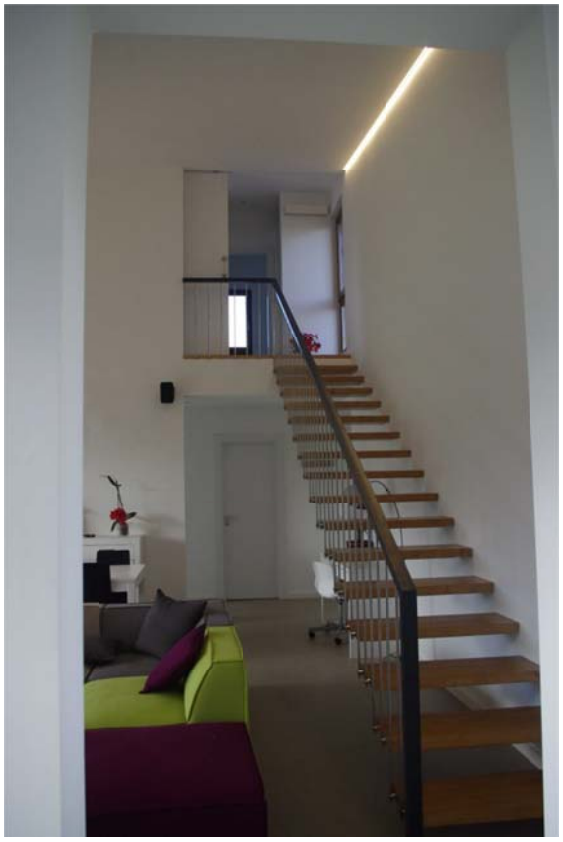
View from the north-to the left east facade

View from the south-to the right west facade

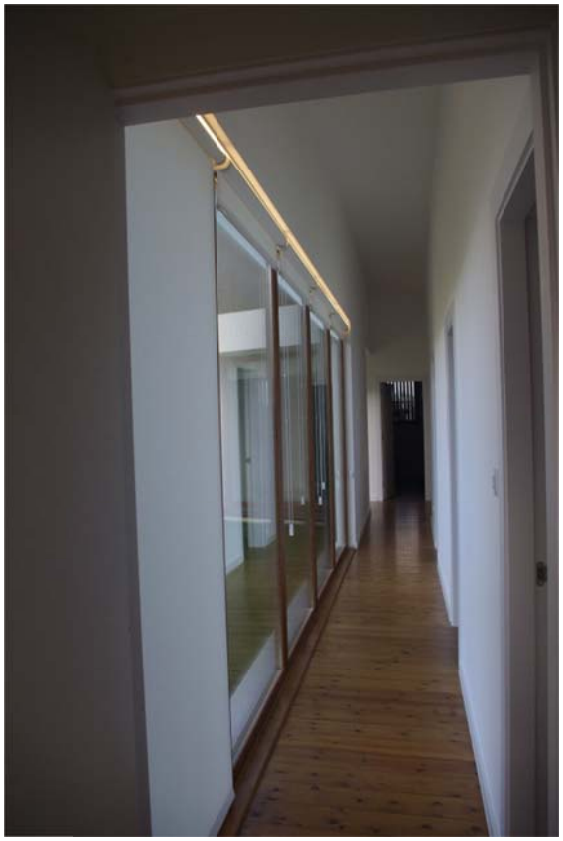
View from the south

Entrance view

2.2. - INTERIORS VIEWS



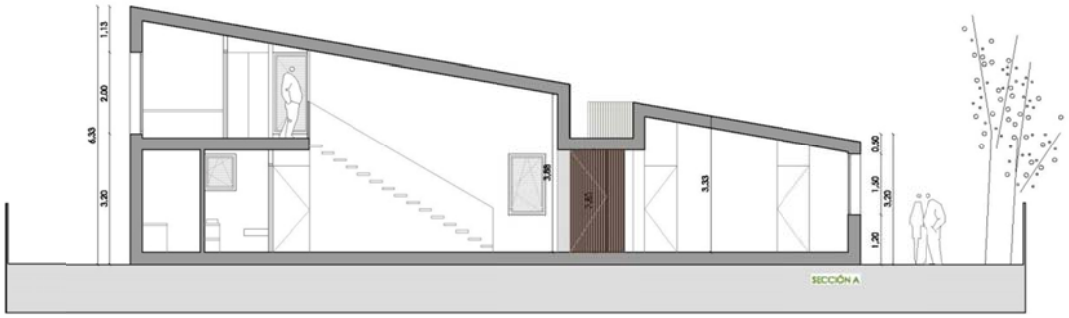
Living room

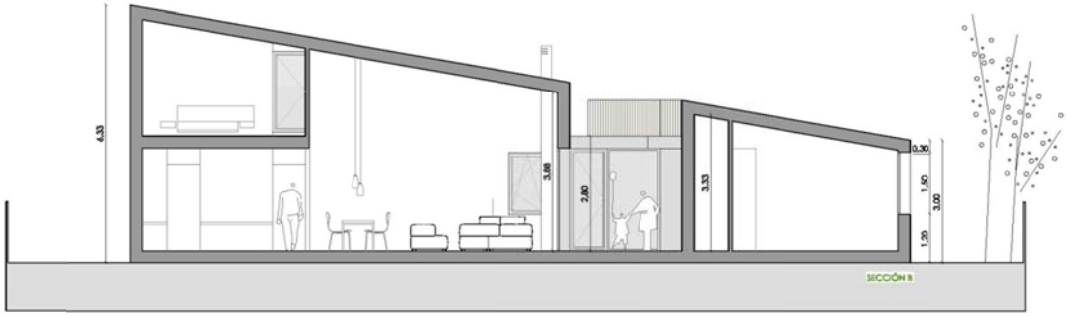


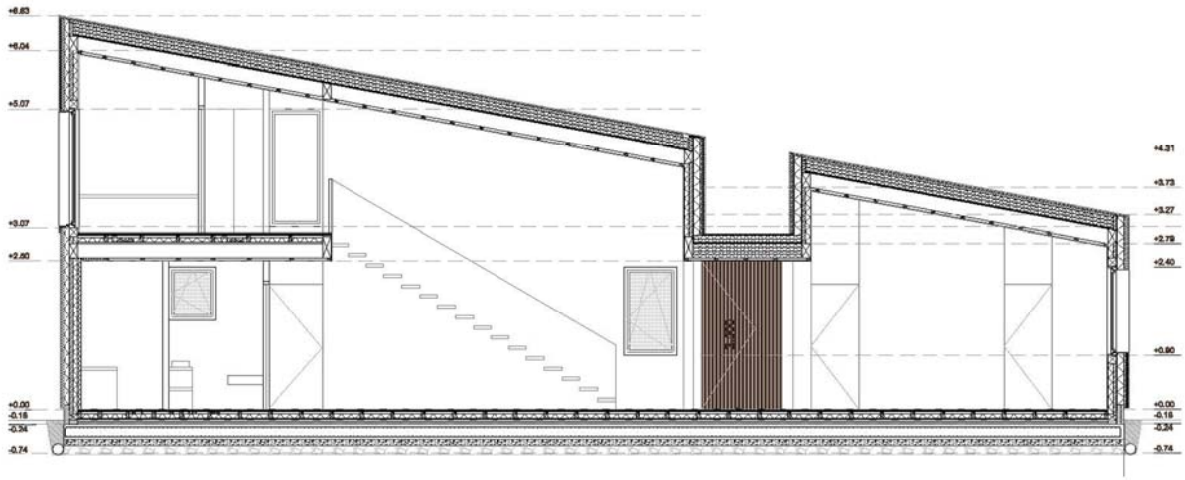
Bedrooms gallery

Kitchen

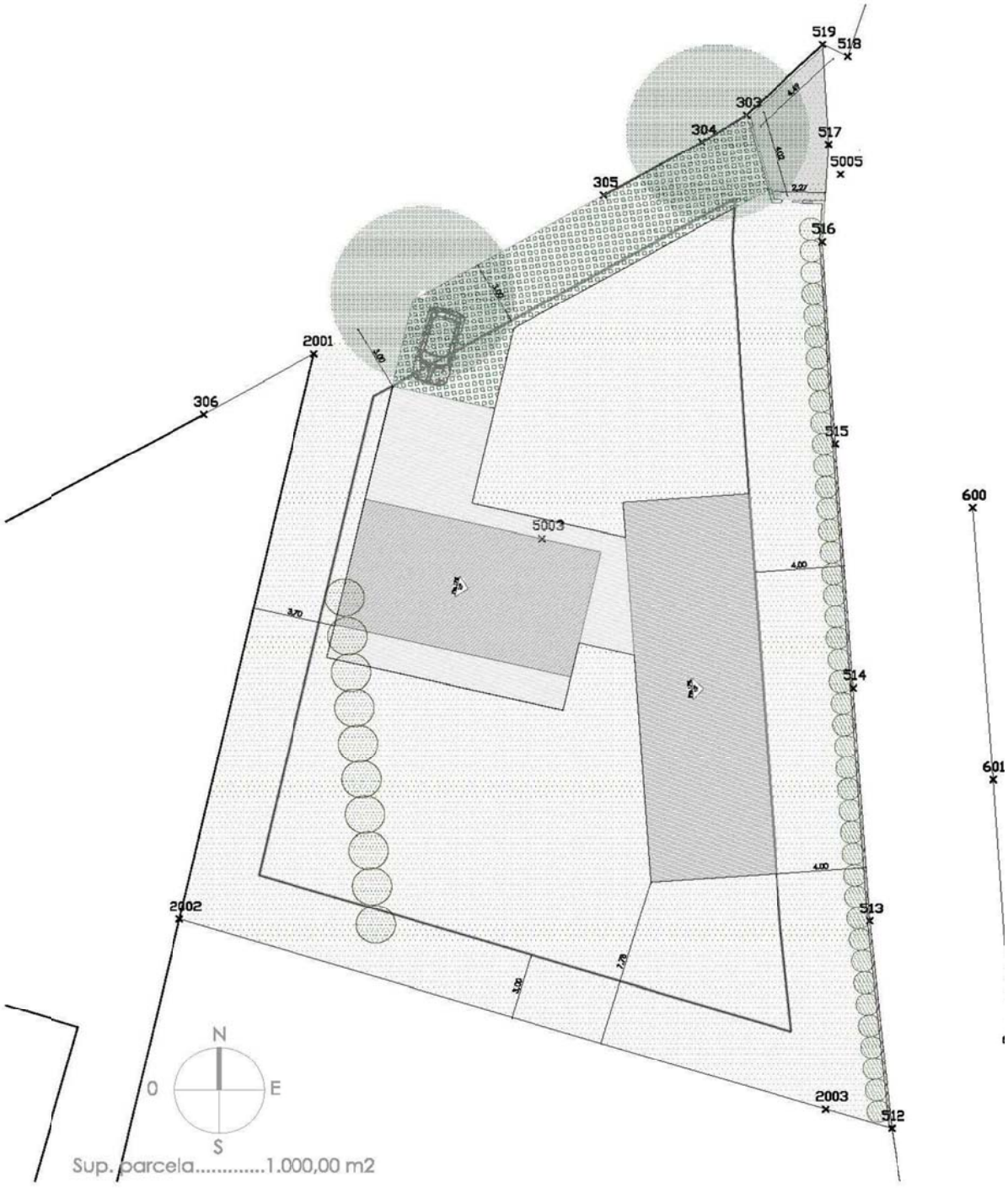
3. SECTIONS DRAWINGS



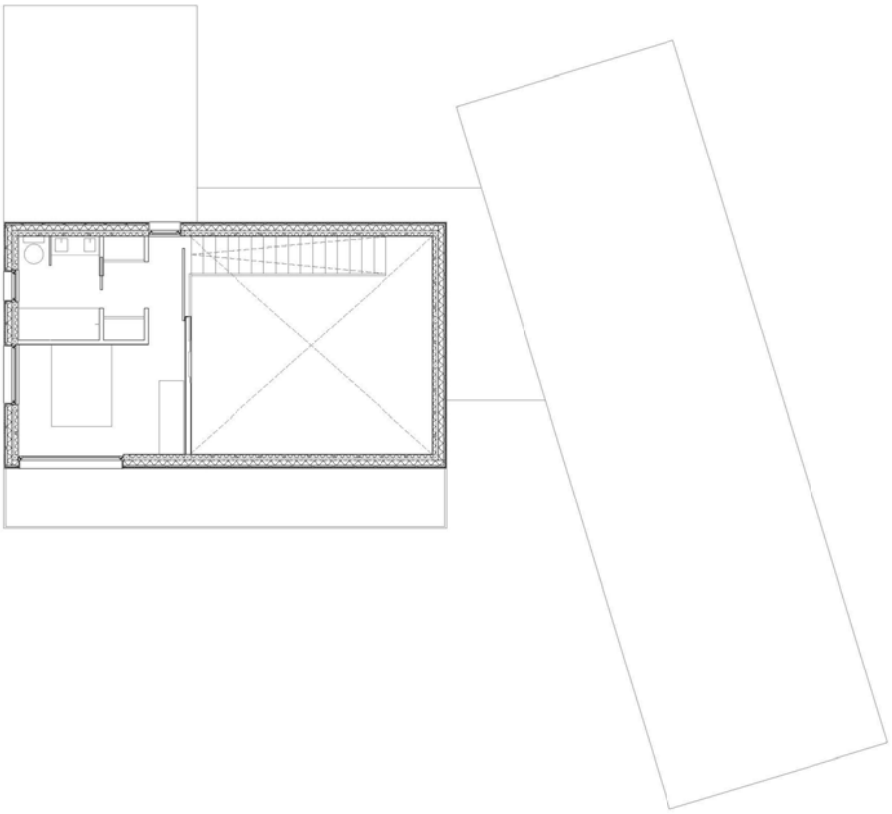


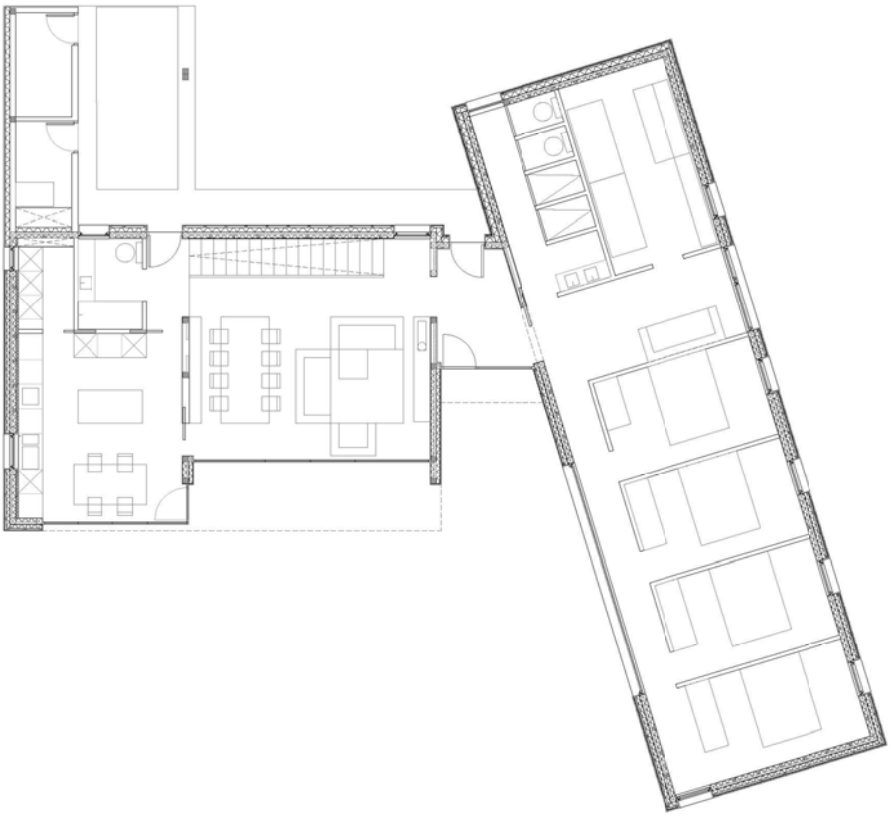


4. SITE PLAN, FLOOR PLANS AND ELEVATIONS

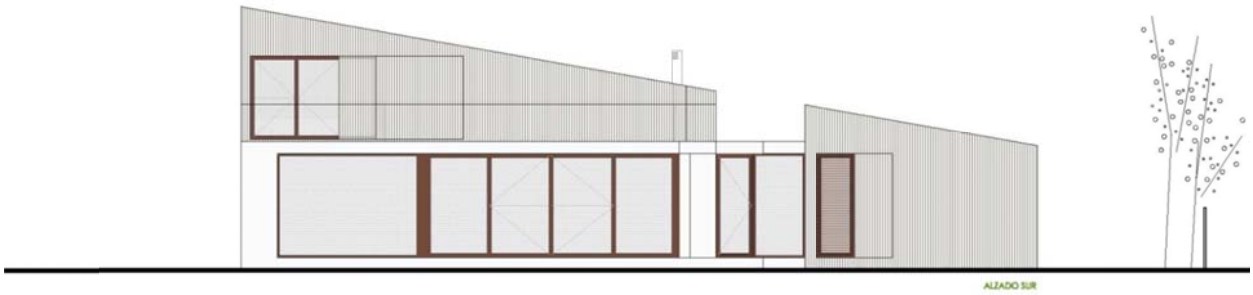


Site plan

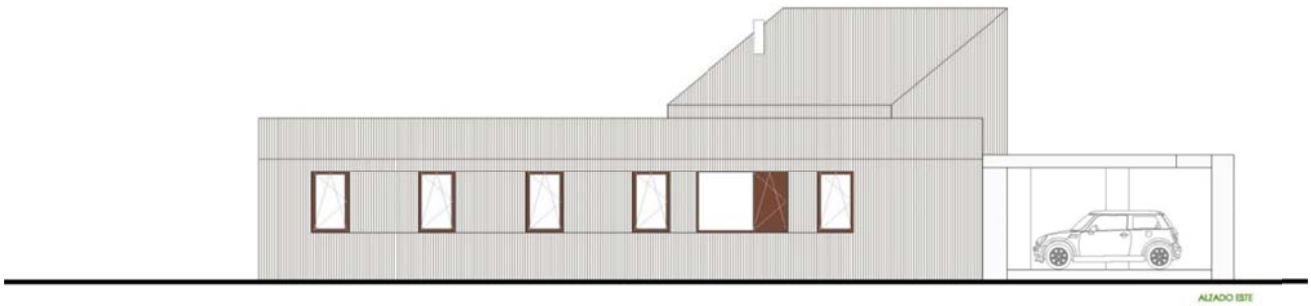


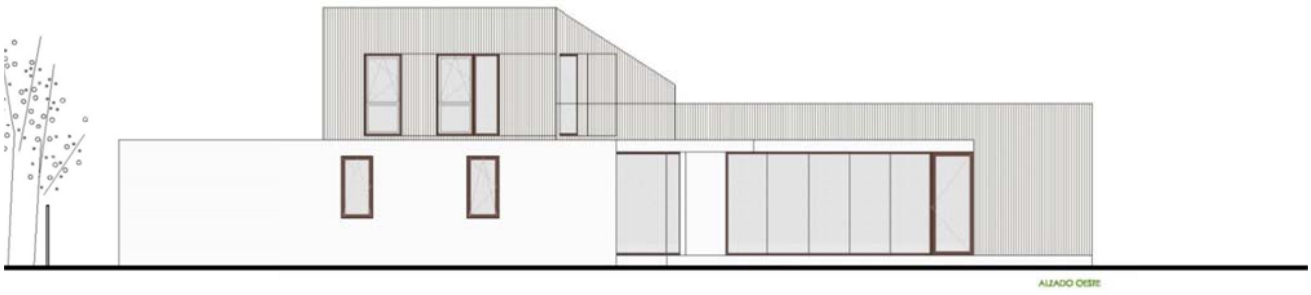


Ground floor/ first floor



North and south elevation





East and west elevation

5. CONSTRUCTION DETAILS

Foundation

The foundation is formed by a reinforced concrete slab of 15 cm. thick, extruded polystyrene insulation 80mm. thick, and a facilities box with Rockwool filling 120mm. thick.


Bearing structure

The bearing structure of the floors on the first floor and the roof are designed with heavy laminated timber frame, timber to timber connections and brackets 140x140 mm. in pillars and 140 x 240/360 mm., in girders. In the design of the structure it was taken into account that all the jambs and lintels of the windows and the facades' doors are structural, with the same wooden sections that the rest of the structure.

Between the porticoes of the main structure and flush with the outer face of it, a plywood panel of 60 mm is settled, which serves first as a solid sealing layer, obtaining the overall bracing of the structure and second as continuous bearing for the various external finishing.

Flush with the inside of the frames and within them, it is settled a substructure of 60x80 mm. modulated at distances of 600 mm. through which the facilities pass and the interior insulation is placed, serving as bearing for the interior finishing.




Horizontal structure

The floor structure of the first floor of the house is solved with unidirectional framework of laminated joists 100x240mm. settled every 600 mm. and resting on the walls of heavy laminated timber frame.

The inclined roof structure of the housing is formed by beams of 140x240 mm. and 140x280 mm., on which the rafters rest 100x240 mm. assembled using dovetail.

The whole roof structure rests on the walls of heavy laminated timber frame.

Enclosures

The walls of the house are composed of different layers that are listed below from inside to outside:

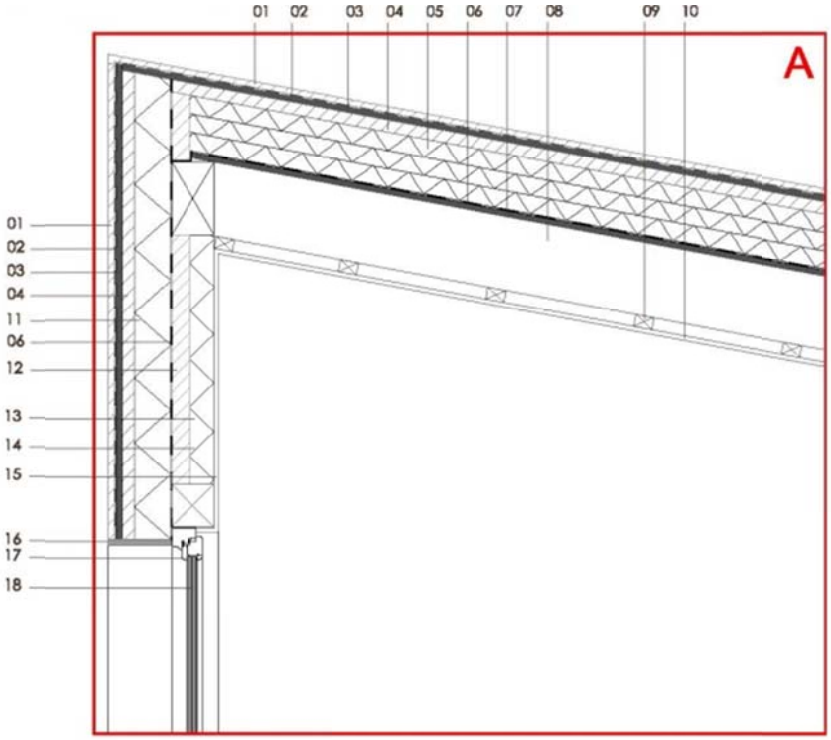
- 1 plasterboard 15 mm.
- 2 Rockwool blankets 40 mm between substructures
- Facilities fitting
- Inside substructure 60 x 80 mm flush with the inner face of the main structure
- Main structure with pillars with 140x 140 mm section and beams of equal section and several edges
- Plywood 60 mm thick placed between frames, flush with the outer face of them.
- Air tightness sheet and vapour barrier DA Proclima or similar.
- Rock wool insulation high density e = 120mm. composed of two blankets 60 mm. anchored to the main structure and laminated panels closure as outer continuous insulation.
- Structural panel, Superpan Tech P5 19 mm. water proof tongue-and-grove on the high density Rockwool insulation.
- Waterproof and breathable sheet ProClima Silitex Fronta Lamina Quattro or similar.
- Outside closure with larch profiles 21 x 68 mm settled vertically and maximum span between profiles 15 mm placed on the wooden structural panel P5 SuoerPan Tech.
- Plastic paint coating.

Windows and doors

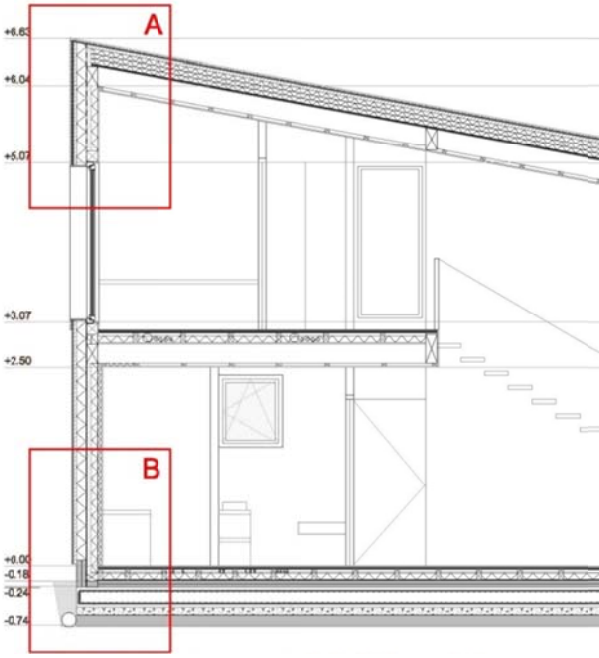
Native brown laminate wood is used for the openings, 80 x 70 mm, varnished with 3 coats of water-based varnish Renner top quality.

With regards to glasses, large fixed windows of the kitchen and living room will be security glasses with a triple composition Stardit 4 + 4 - 8-3 - 8-5, chamber filled with argon gas and low emissivity treatment.

For the rest of the windows, we will use a triple glazing 4-10-4-10-4, chamber filled with argon gas and low emissivity treatment.



5.1 Roof and wall connection (pitched roof)



CUBIERTA Y FACHADA VENTILADA

01. Perfiles de alerce de 21x68 mm en posición perpendicular a la pendiente y con una luz máxima entre perfiles de 15 mm.
02. Lámina impermeable y transpirable Delta Fassade o similar.
03. Panel estructural machihembrado hidrófugo SuperPan Tech P5 de 19 mm. o similar.
04. Rastrel de amarre de 40x60 mm.
05. Lana de roca de alta densidad y conductividad térmica 0,038 W/mk e=180 mm.
06. Lámina de hermeticidad de aire y permeable al vapor de agua Delta Vent S Plus.
07. Panel estructural machihembrado hidrófugo Superpan Tech P5 de 19 mm. o similar.
08. Cabios de cubierta de 100 x240 mm. interejes de 600 mm.
09. Subestructura de madera de 400x600 mm.
10. Falso techo de placa de yeso laminado e=15 mm.
11. Lana de roca de alta densidad y conductividad térmica 0,038 W/mk e=120 mm.
12. Panel laminado colocado entre pórticos enrasado con la cara exterior de los mismos e=60 mm.
13. Subestructura de madera de 600x800 mm.
14. Lana de roca e=80 mm. y conductividad térmica 0,036 W/mk
15. Placa de yeso laminado e=150 mm
16. Remate de ventana de madera de alerce color natural
17. Carpintería exterior de madera de castaño laminado autóctono de 80x70 mm., barnizada al agua.
18. Acristalamiento triple bajo emisivo con cámara rellena de gas argón 4+10+4+10+4.
19. Enfoscado de corcho proyectado.
20. Trasdosado para paso de instalaciones formado por rastrel de madera de 60x40 mm. y aislamiento de lana de roca e=40 mm. y conductividad térmica 0,037 W/mk.
21. Zócalo de XPS e=120 mm. y conductividad térmica 0,034 W/mk.
22. Durmiente de madera laminada 140 x100 mm.
23. Placa de vidrio celular bajo durmientes e=80mm. y conductividad térmica 0,05 W/mk
24. Drenaje perimetral

5	Cubierta inclinada alerce						

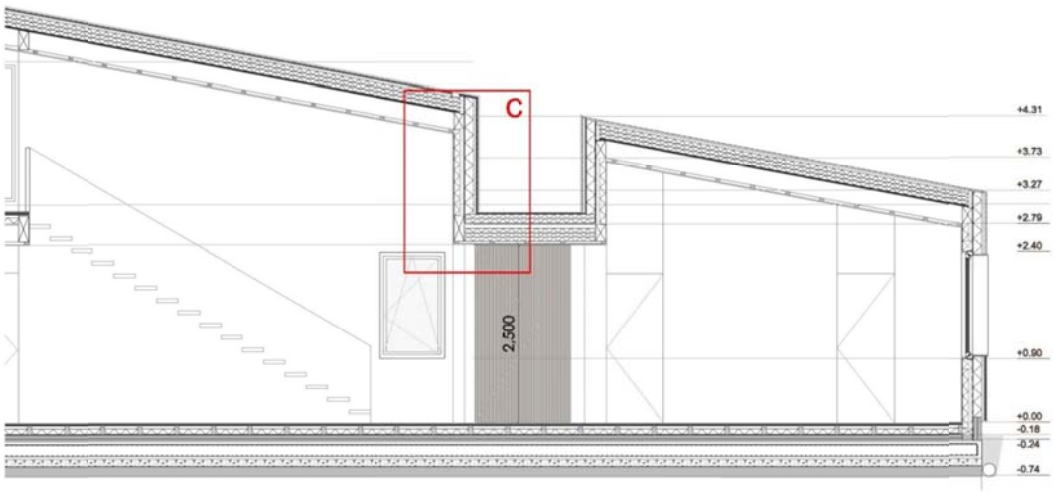
Resistencia térmica superficial [m²K/W] interior R_{si}: 0,10
exterior R_{se}: 0,04

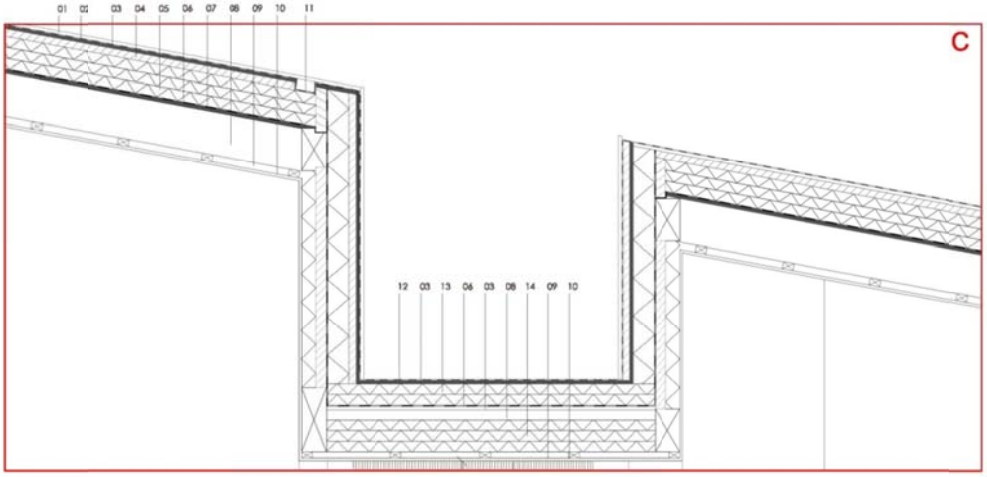
	Superficie parcial 1	λ [W/(m·K)]	Superficie parcial 2 (opcional)	λ [W/(m·K)]	Superficie parcial 3 (opcional)	λ [W/(m·K)]	Espesor [mm]
1.	Tablero P5	0,120					19
2.	Barrera de vapor	0,000					0
3.	Aislamiento de lana de roca alta densidad	0,038					180
4.	Tablero P5	0,120					19
5.	Impermeabilización						
6.	Alerce exterior						
7.							
8.							

Porcentaje superficie parcial 1: 100% | Porcentaje superficie parcial 2: | Porcentaje superficie parcial 3: | Total: 21,8 cm

Suplemento al valor-U: W/(m²K) **Valor-U: 0,193** W/(m²K)

5.1. Roof and wall connection (lobby roof)





CUBIERTA INCLINADA VENTILADA
01. Perfiles de alerce de 21x68 mm en posición perpendicular a la pendiente y con una luz máxima entre perfiles de 15 mm.
02. Lámina impermeable y transpirable Delta Fassade o similar.
03. Panel estructural machihembrado hidrófugo SuperPan Tech P5 de 19 mm. o similar.
04. Rastrel de amarre de 40x60 mm.
05. Lana de roca de alta densidad y conductividad térmica 0,038 W/mk e=180 mm.
06. Lámina de hermeticidad de aire y permeable al vapor de agua Delta Vent S Plus.
07. Panel estructural machihembrado hidrófugo Superpan Tech P5 de 19 mm. o similar.
08. Cabios de cubierta de 100 x240 mm. interejes de 600 mm.
09. Subestructura de madera de 400x600 mm.
10. Falso techo de placa de yeso laminado e=15 mm.
11. Canalón oculto de aluminio.

CUBIERTA PLANA
12. Impermeabilización bicapa
13. Lana de roca de alta densidad e=120 mm.y conductividad térmica 0,038 W/mk
14. Lana de roca e=160 mm. y conductividad térmica 0,036 W/mk .

Nr. elem. cons.	Denominación de elemento constructivo	¿Aislamiento interior?
7	Cubierta plana vestíbulo	

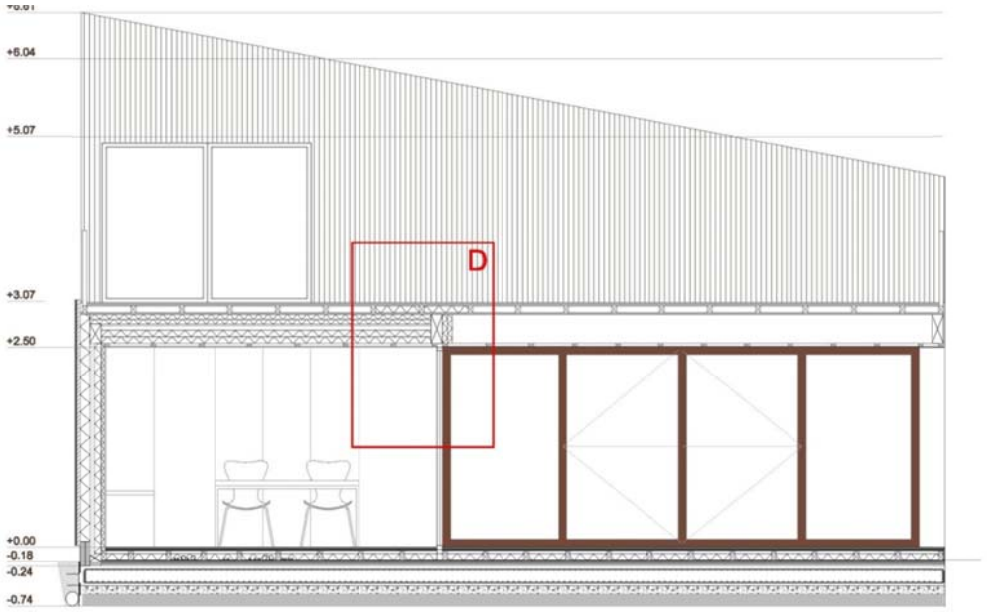
Resistencia térmica superficial [m²K/W] interior R_{si}: 0,10 exterior R_{se}: 0,04

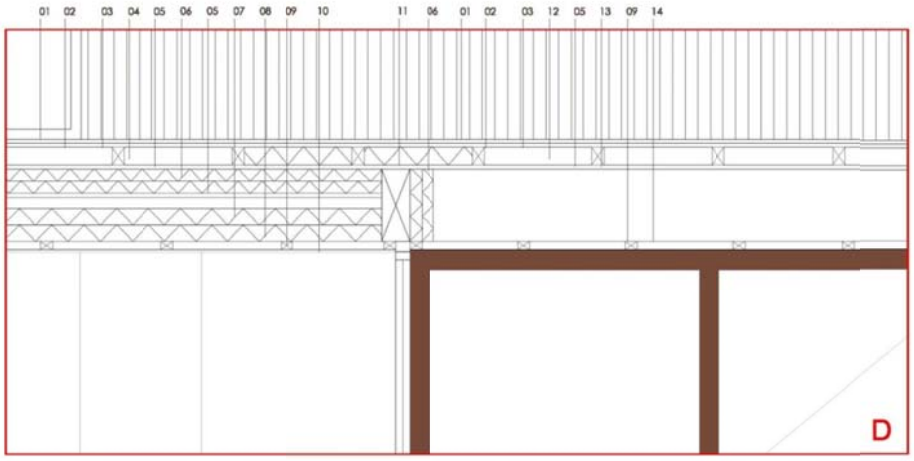
	Superficie parcial 1	λ [W/mK]	Superficie parcial 2 (opcional)	λ [W/mK]	Superficie parcial 3 (opcional)	λ [W/mK]	Espesor [mm]
1.	Placa de yeso clavada con rastreles	0,250	Rastreles	0,130			55
2.	Aislamiento de lana de roca	0,036	Viguetas	0,130			240
3.	Tablero P5	0,120					19
4.	Barrera de vapor	0,000					0
5.	Lana de roca alta densidad	0,038					120
6.	Tablero P5	0,120					19
7.	Impermeabilización						
8.							

Porcentaje superficie parcial 1	Porcentaje superficie parcial 2	Porcentaje superficie parcial 3	Total
80%	20,0%		45,3 cm

Suplemento al valor-U: W/(m²K) **Valor-U:** 0,116 W/(m²K)

5.1. Roof and wall connection (kitchen roof)





TERRAZA SUR

01. Perfil de alerce siberiano pátina gris colocado a hueso
02. Imprimación resinosa de Schlüter antracita sobre lámina Schlüter-Kerdi o similar
03. Lámina impermeable Schlüter Kerdi sobre panel estructural SuperPan Tech P5 de 19 mm. o similar.
04. Rastrel de 60 x 80/55 mm. clavado a las viguetas en sentido transversal a éstas.
05. Panel estructural machihembrado hidrófugo SuperPan Tech P5 de 19 mm. o similar.
06. Lana de roca de alta densidad e=120 mm.y conductividad térmica 0,038 W/mk.
07. Estructura de viguetas 100x240 mm.
08. Lana de roca e=160 mm. y conductividad térmica 0,036 W/mk
09. Rastrel de 40x60 mm. clavado a cabios por su cara inferior en sentido transversal.
10. Placa de cartón yeso e=12,5 mm. acabado pintura plástica lisa.
11. Aislamiento térmico rígido entre rastreles e=80 mm.
12. Rastrel de 60 x 100/75 mm. clavado a las viguetas en sentido transversal a éstas.
13. Estructura de viguetas de 100x360 mm.
14. Placa de cartón yeso hidrófuga para exteriores e=12,5 mm.

6	Cubierta plana cocina

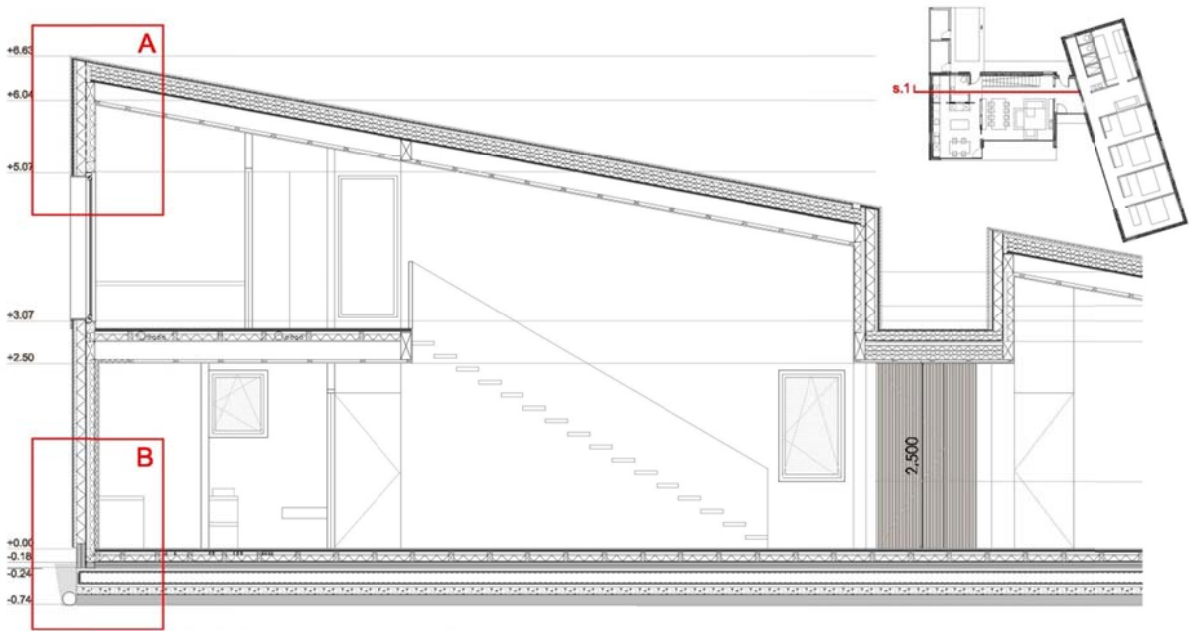
Resistencia térmica superficial [m²K/W] — interior R_{si}: 0,10 — exterior R_{se}: 0,04

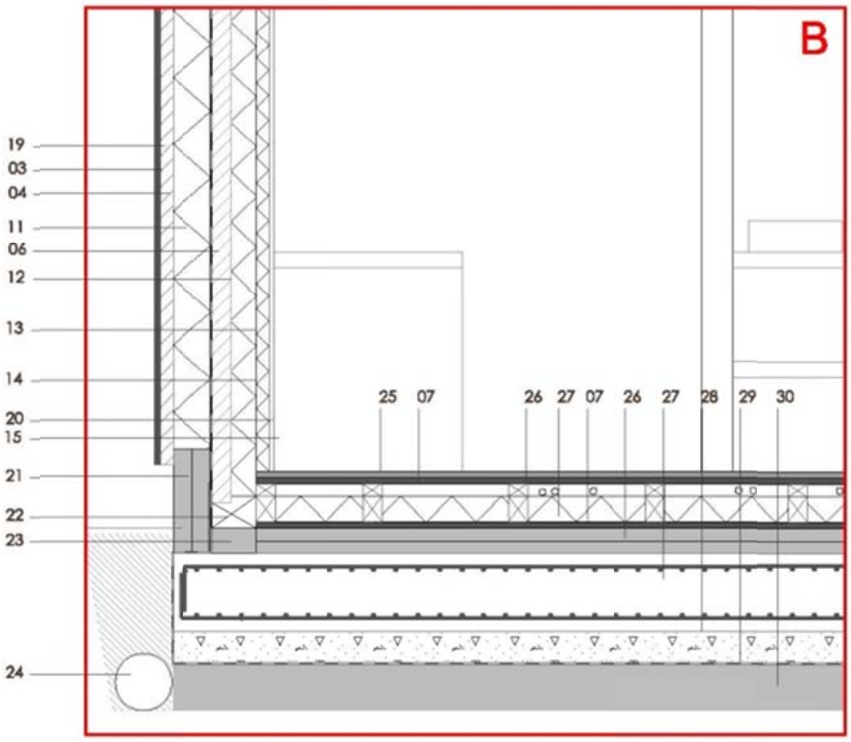
	Superficie parcial 1	λ [W/mK]	Superficie parcial 2 (opcional)	λ [W/mK]	Superficie parcial 3 (opcional)	λ [W/mK]	Espesor [mm]
1.	Placa de yeso clavada con rastrel	0,250	Rastreles	0,130			55
2.	Aislamiento de lana de roca	0,036	Viguetas	0,130			240
3.	Tablero P5	0,120					19
4.	Barrera de vapor	0,000					0
5.	Aislamiento de lana de roca alta densidad	0,038					120
6.	Tablero P5	0,120					19
7.	Impermeabilización						
8.							

Porcentaje superficie parcial 1	Porcentaje superficie parcial 2	Porcentaje superficie parcial 3	Total
80%	20,0%		45,3 cm

Suplemento al valor-U: W/(m²K) — **Valor-U: 0,116** W/(m²K)

5.2 Floor and wall connection





SUELO Y CIMENTACIÓN
25. Gres porcelánico
26. Doble rastrel para formación de cajón de instalaciones de 120 r de alto.
27. Lana de roca e=80 mm. y conductividad térmica 0,037 W/mk
28. Doble panel de poliestireno extruido e=80 mm. y conductividad térmica 0,034 W/mk.
29. Losa de hormigón armado e=250 mm.
30. Hormigón de limpieza e=100 mm.
31. Lámina impermeable de polietileno con geotextil
32. Encachado de piedra y zahorras compactadas como base de apoyo de la cimentación e=150 mm.

8	Losa de cimentación						

Resistencia térmica superficial [m²K/W] interior R_{si}: 0,17 exterior R_{se}: 0,00

	Superficie parcial 1	λ [W/(mK)]	Superficie parcial 2 (opcional)	λ [W/(mK)]	Superficie parcial 3 (opcional)	λ [W/(mK)]	Espesor [mm]
1.	Pavimento cerámico/madera	0,170					15
2.	Tablero PS	0,120					19
3.	Paso de instalaciones						0
4.	Lana de roca	0,036	Rastreles	0,130			120
5.	Tablero PS	0,120					19
6.	Poliestireno extruido	0,034			Perinsul bajo durmient	0,050	80
7.	Losa de hormigón armado	2,300					250
8.							
		Porcentaje superficie parcial 1	Porcentaje superficie parcial 2		Porcentaje superficie parcial 3		Total
		76%	16,0%		8,0%		50,3 cr

Suplemento al valor-U: W/(m²K) **Valor-U:** 0,181 W/(m²K)

5.3 Window sections including installation drawing

Window frame information

Carpentry work is formed by a chestnut wooden frame made by the local carpenter Carpintería Claudio, with a U value of 1,54 W/m2a.

Marcos de ventana — Marcos

ID	Determinación	Valor U_f				Espesor del marco				Puente térmico en borde de vidrio				Puente térmico de instalación			
		Izquierda	Derecha	Abajo	Arriba	Izquierda	Derecha	Abajo	Arriba	$\Psi_{Borde\ vidrio}$ izquierda	$\Psi_{Borde\ vidrio}$ derecha	$\Psi_{Borde\ vidrio}$ abajo	$\Psi_{Borde\ vidrio}$ arriba	$\Psi_{instalación}$ izquierda	$\Psi_{instalación}$ derecha	$\Psi_{instalación}$ abajo	$\Psi_{instalación}$ arriba
		W/(m²K)	W/(m²K)	W/(m²K)	W/(m²K)	m	m	m	m	W/(mK)	W/(mK)	W/(mK)	W/(mK)	W/(mK)	W/(mK)	W/(mK)	W/(mK)
01ud	Fijo. Madera de castaño autóctono	1,54	1,54	1,54	1,54	0,078	0,078	0,078	0,078	0,040	0,040	0,040	0,040	0,022	0,022	0,022	0,022
02ud	Oscilobatiente. Madera de castaño autóctono	1,54	1,54	1,54	1,54	0,104	0,104	0,104	0,104	0,040	0,040	0,040	0,040	0,022	0,022	0,022	0,022
03ud	Oscilaparalela. Madera de castaño autóctono	1,54	1,54	1,54	1,54	0,104	0,104	0,104	0,104	0,040	0,040	0,040	0,040	0,022	0,022	0,022	0,022
04ud	Balconeras contra terreno V5 y V10	1,54	1,54	1,54	1,54	0,078	0,078	0,078	0,078	0,040	0,040	0,040	0,040	0,022	0,022	0,000	0,022
05ud	Balconeras contra terreno V6, V7 y V8	1,54	1,54	1,54	1,54	0,104	0,104	0,104	0,104	0,040	0,040	0,040	0,040	0,022	0,022	0,000	0,022
06ud																	

Glazing information

Window glasses are argon filled triple glazing and warm edge spacers (with thermal bridge spacer ψ=0,04).

Two kinds of glasses have been used:

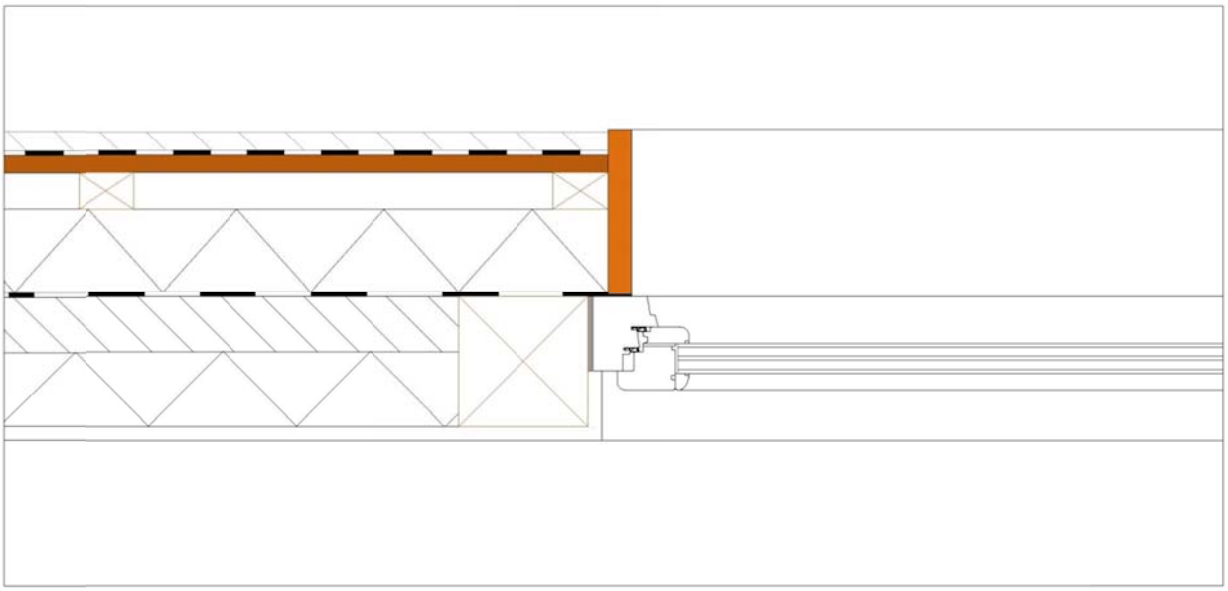
4low e/10ar/4/10ar/4 low e, with 0,84 W/m2k Ug value and 0,50 g value, for the small windows.

4+4 low e/8 ar/3/ 8 ar/ 5 low e with 1,04 with 1,04 W/m2k Ug value and 0,47 g value, for the big windows.

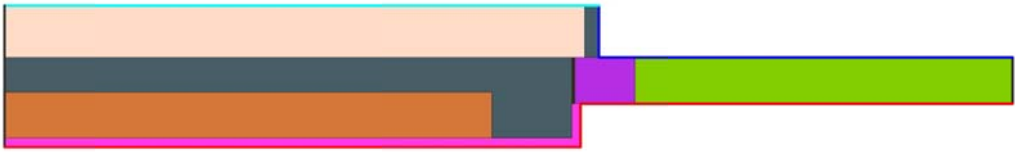
Acristalamiento — Acristalamiento

ID	Determinación	Valor g	Valor-Ug
			W/(m²K)
01ud	Acristalamiento bajo emisivo triple 4+10+4+10+4	0,50	0,84
02ud	Acristalamiento bajo emisivo triple seguridad 4+4+8+3+8+5	0,47	1,04

Window installation drawing



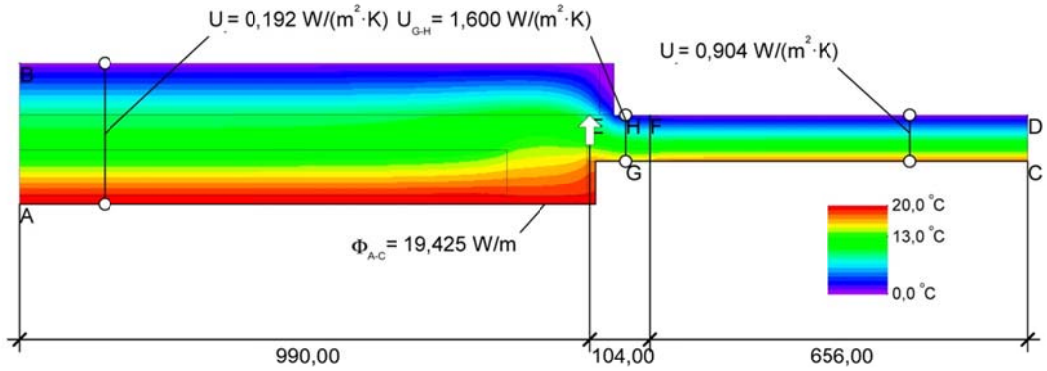
Thermal bridge calculation of the window installation



Material	λ[W/(m·K)]	ε
Acristalamiento	0,086	
Marco madera	0,176	
Plaster, gypsum, sand	0,800	
Silicone, pure	0,350	
Timber 500 kg/m3 (softwoods)	0,130	
climowool DF1, DF1/V, DF1-A, DF1-H, HRF2	0,039	
climowool FD1, FD1/V, KD1, KD1/V, KF2	0,037	

Boundary Condition	q[W/m²]	θ[°C]	R[(m²·K)/W]	ε
Exterior, normal		0,000	0,040	
Exterior, ventilated		0,000	0,130	
Interior, normal, horizontal		20,000	0,130	
Symmetry/Model section	0,000			

Cálculo del puente térmico de la instalación de la ventana (PSI).

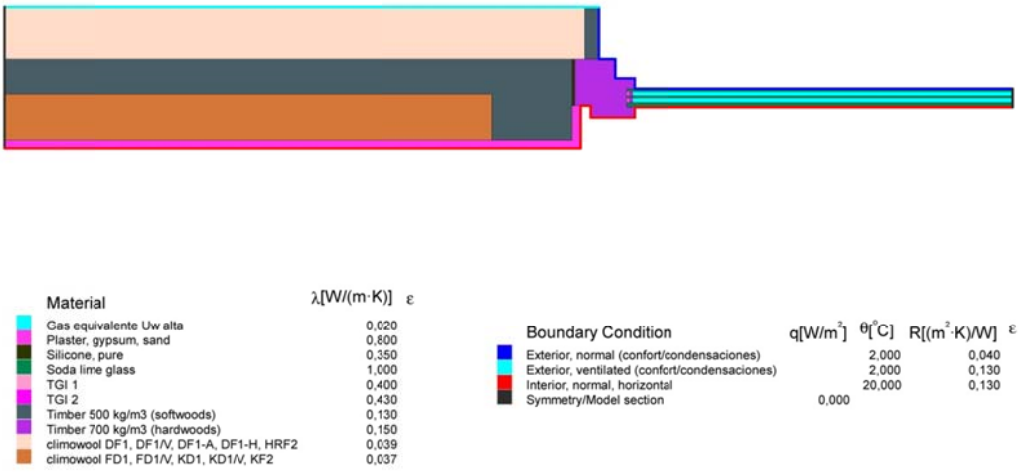


$$\psi_{A\text{-}E\text{-}C,\cdot} = \frac{\Phi}{\Delta T} - U_1 \cdot b_1 - U_2 \cdot b_2 - U_3 \cdot b_3 = \frac{19{,}425}{20{,}000} - 0{,}192 \cdot 0{,}990 - 1{,}600 \cdot 0{,}104 - 0{,}904 \cdot 0{,}656 = 0{,}022\ W/(m \cdot K)$$

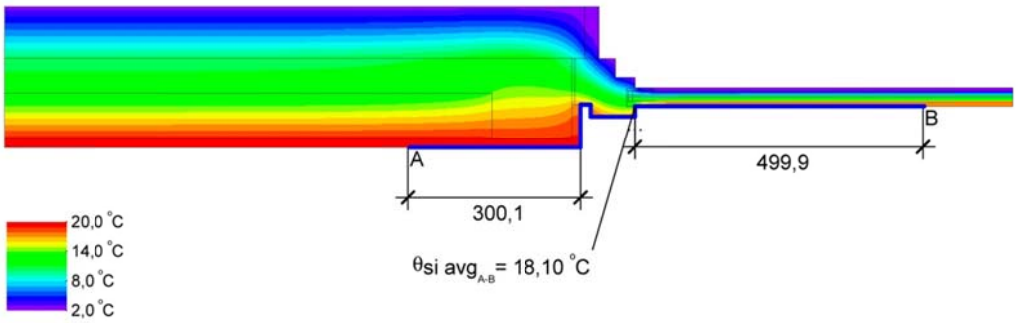
Comfort justification and hygiene criteria

Although the glass and woodwork which is used in the project does not meet the strict criteria of PHI, set for the Central European Climate (≤0,8 W/m2k Uw and Uw instl≤0,,85W/m2k), the criteria of comfort and hygiene have been justified following the rules EN-ISO-7730 and EN-13788. The performance of the most critical detail has been simulated by using the finite element tool Flixino to measure the critical temperatures and check the suitability of the implemented solution.

Comfort criteria



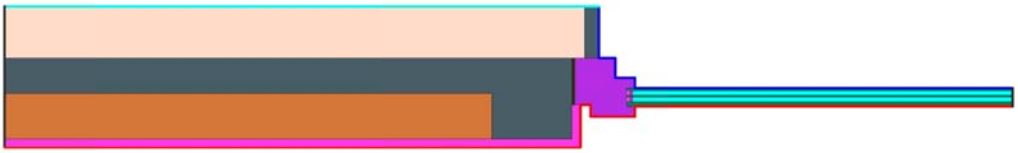
Comprobación del cumplimiento con los criterios de confort



Para la justificación del cumplimiento de los criterios de confort se ha calculado la temperatura superficial interior media con unas condiciones de temperatura media exterior durante las 12 horas más frías del año (cálculo con Meteonorm). La temperatura superficial interior media en la superficie de envolvente señalizada es de 18.10 ºC. Al ser superior a 17ºC, se cumple con la normativa de confort UNE EN ISO 7730 y con lo establecido por el PHI.

In order to justify compliance with the comfort criteria, the average internal surface temperature has been calculated with external temperature conditions during the coldest 12 hours of the year (calculation with Metenorm). The average interior surface temperature on the surface of the marked skin is 18.10ºC. Being higher than 17ºC, it complies with the UNE EN ISO 7730 comfort regulations and with the requirements of the PHI.

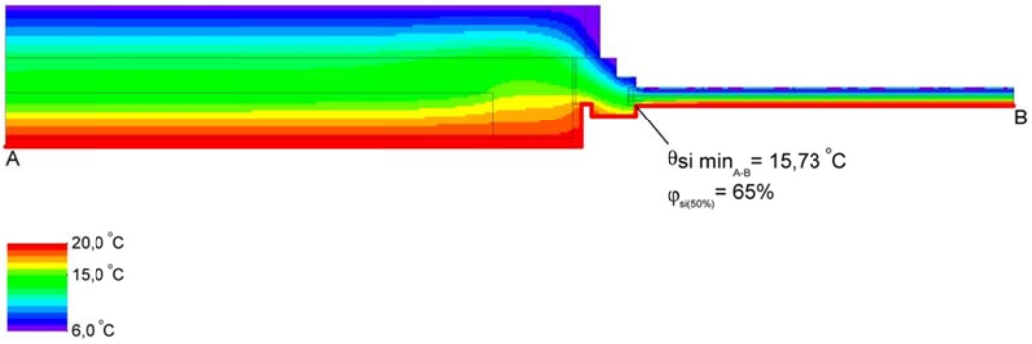
Hygiene criteria



Material	λ[W/(m·K)]	ε
Gas equivalente Uw alta	0,020	
Plaster, gypsum, sand	0,800	
Silicone, pure	0,350	
Soda lime glass	1,000	
TGI 1	0,400	
TGI 2	0,430	
Timber 500 kg/m3 (softwoods)	0,130	
Timber 700 kg/m3 (hardwoods)	0,150	
climowool DF1, DF1/V, DF1-A, DF1-H, HRF2	0,039	
climowool FD1, FD1/V, KD1, KD1/V, KF2	0,037	

Boundary Condition	q[W/m²]	θ[°C]	R[(m²·K)/W]	ε
Exterior, normal (higiene)		6,000	0,040	
Exterior, ventilated (higiene)		6,000	0,130	
Interior, normal, horizontal		20,000	0,130	
Symmetry/Model section	0,000			

Comprobación del cumplimiento con los criterios de higiene



Para la justificación del cumplimiento con los criterios de higiene se ha calculado la temperatura superficial interior mínima con unas condiciones exteriores de temperatura media durante la semana más fría del año. La temperatura superficial interior mínima es de 15,73 ºC llegando, en el punto más desfavorable, a una humedad relativa del 65%. Al no superar una humedad relativa del 80%, no hay peligro de formación de mohos.

To justify compliance with the hygiene criteria, the minimum internal surface temperature has been calculated with an outside average temperature during the coldest week of the year. The minimum internal surface temperature is 15,73 ° C reaching, at the most unfavourable point, a relative humidity of 65%. When not exceeding a relative humidity of 80%, there is no danger of mould formation.

6. DESCRIPTION OF THE AIRTIGHT LAYER. DOCUMENTATION OF THE PRESSURE TEST RESULT

6.1 Description of the airtight layer

Due the construction system, the airtight layer of the facade has been designed on the outer face of the wood panels.

The roof sealing system is identical to the system used on the outer wall, placing the airtight film outside of the wood panels.

Technical data sheet of the air tight layer

TECHNICAL DATA SHEET

DELTA®-VENT S / PLUS

Vapor Permeable Roof Underlayment

MATERIAL

DELTA®-VENT S is a vapor permeable 3-layer synthetic roof underlayment. Its two outer layers are made of a high strength spun-bonded polypropylene (PP) fabric. They are thermally bonded to a highly vapor permeable, watertight polymeric middle layer. The fabric layer on the lower side protects the roof underlayment against damage (e.g. roughly sawn sheathing). The matte gray color of DELTA®-VENT S prevents blinding glare during installation.

PROPERTIES

DELTA®-VENT S is a highly vapor permeable roof underlayment, allowing moisture within the roof enclosure to escape through the membrane via diffusion. Its high permeability and air-tightness make it an ideal membrane for energy-efficient construction. The product is watertight and protects the roof enclosure from wind-driven rain. DELTA®-VENT S is very light-weight and tear-resistant. This membrane withstands the rigors of jobsites, as well as tough wind and weather. Its performance is unaffected by surfactants.

APPLICATION

DELTA®-VENT S is installed on the roof deck prior to the application of the final cladding system. DELTA® Accessories complement the roof underlayement installation. DELTA®-VENT S is also available in the PLUS version with a self-adhesive edge.

DELTA® products support sustainable and energy-efficient building practices, including efforts toward achieving LEED® certification (LEED® for New Construction & Major Renovations, LEED® for Core and Shell, LEED® for Existing Buildings and LEED® for Homes).

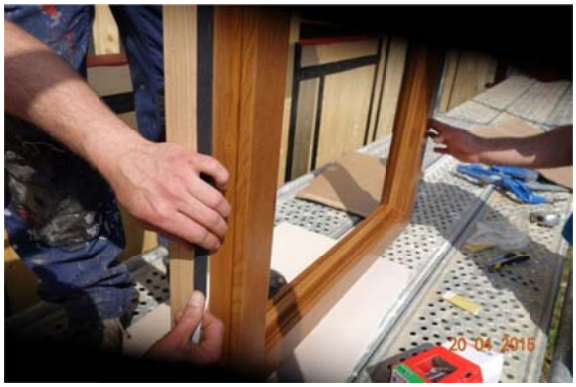
Technical Data

Product name	DELTA®-VENT S	
Color	gray	
Water vapor transmission	820 g/m²/24 h	ASTM E96-05, Proc. B
Vapor permeance	120 perms [grains/h/ft²/in Hg]	ASTM E96-05, Proc. B
Breaking load	MD 76 lb/2in	ASTM D5035-06
	CD 47 lb/2in	
Elongation at break	MD 25 %	ASTM D5035-06
	CD 65 %	
Tear resistance	MD 1078 g	ASTM D1922-06a
	CD 1588 g	
Trapezoid tearing strength	MD 22 lb	ASTM D4533-04
	CD 15 lb	
Fastener pull-through force	133 N	ASTM D3462-03
Water penetration resistance	643 cm	CAN/CGSB-4.2 #26.3-95
Water impact penetration resistance	no water passing	AATCC 42-2000
Water permeability	no water passing	CSA A220.1-06
Long term sag	no sag	CSA A220.1-06
Flame spread	25	ASTM E84-09
	NFPA Class A; UBC Class I	
Smoke developed	105	ASTM E84-09
	NFPA Class A; UBC Class I	
Air permeance	< 0.02 l/(s x m²) @ 75 Pa	ASTM E2178
Temperature range	-40 °F to +176 °F (-40 °C to +80 °C)	
Mass per unit area	> 4.4 oz/yd² (150 g/m²)	CSA A220.1-06 4.4.4
Roll weight	approx. 24 lb (11 kg)	
Roll length	164' (50 m)	
Roll width	4' 11" (1.5 m)	
Maximum UV (sunlight) exposure	Always cover as soon as possible.	
DELTA® Accessories	DELTA®-MULTI BAND 2" x 82' DELTA®-FLEXX-BAND 4" x 33' DELTA®-THAN 310 ml cartridge	

Sealing layer on the exterior of the wooden frame


Sealing between panels on the interior with SWS Tape (Soudal)

Windows and door casements



6.2 Results of pressure test on 01.10.2015

retrotec FanTestic	version:**5.8.13**	licensed to: **Termir Ingenieria**
Test date: 2015-10-01	By: **termir**	
Customer:	**Amaya salinas**	
Building address:	**vivienda Unifamiliar en Muros de Nalon, Asturias, Spain**	

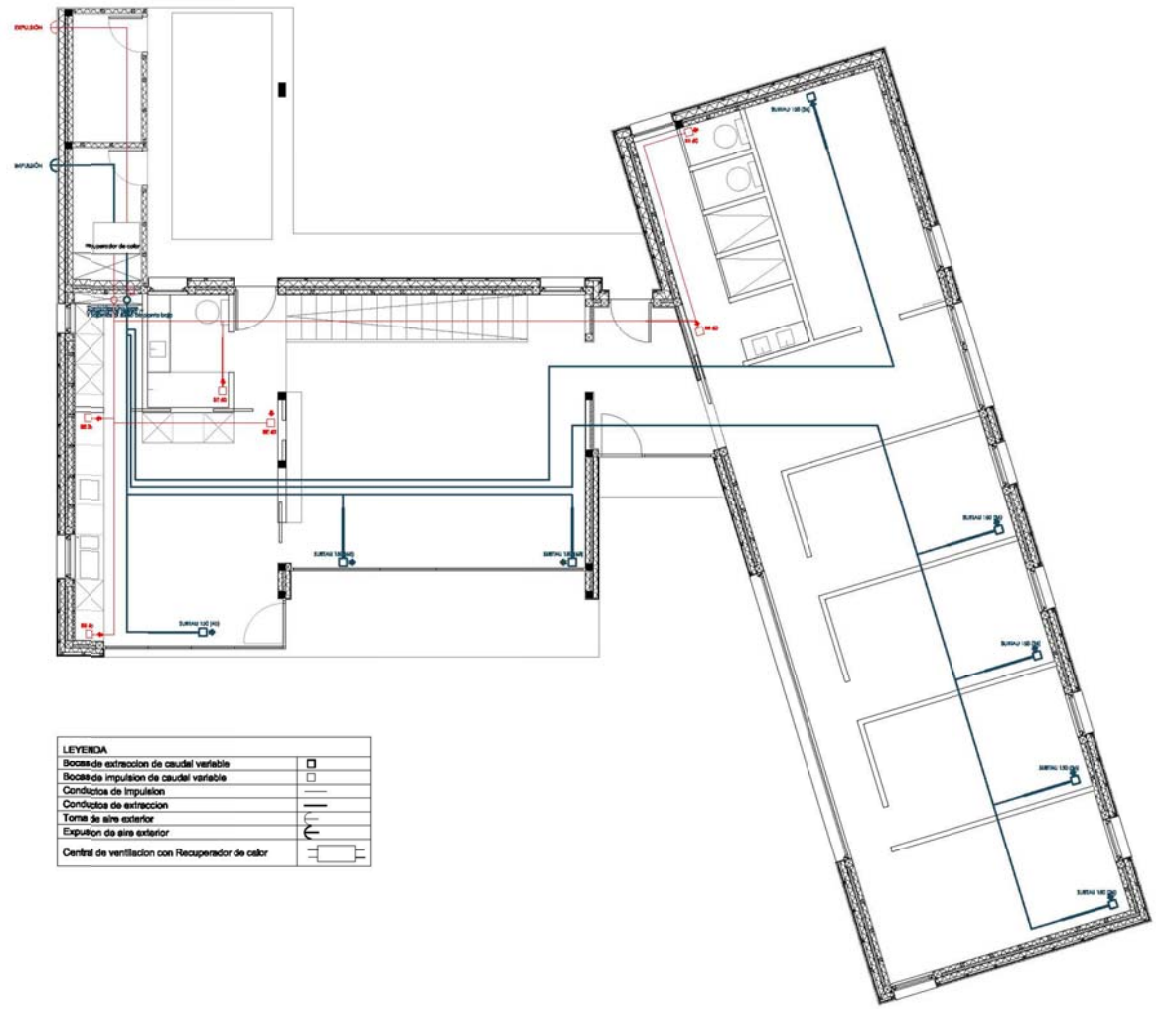
Building and Test Information	
Test file name:	**Muros de Nalon 01_10_15**
Building volume:	**568,2**
Building Height (from ground to top):	**1**
Floor Area:	**171,9**
Envelope Area:	**710,9**
Building Exposure to wind	**Edificio altamente expuesto**
Accuracy of measurements	**3%**

Datos de pruebas combinadas:

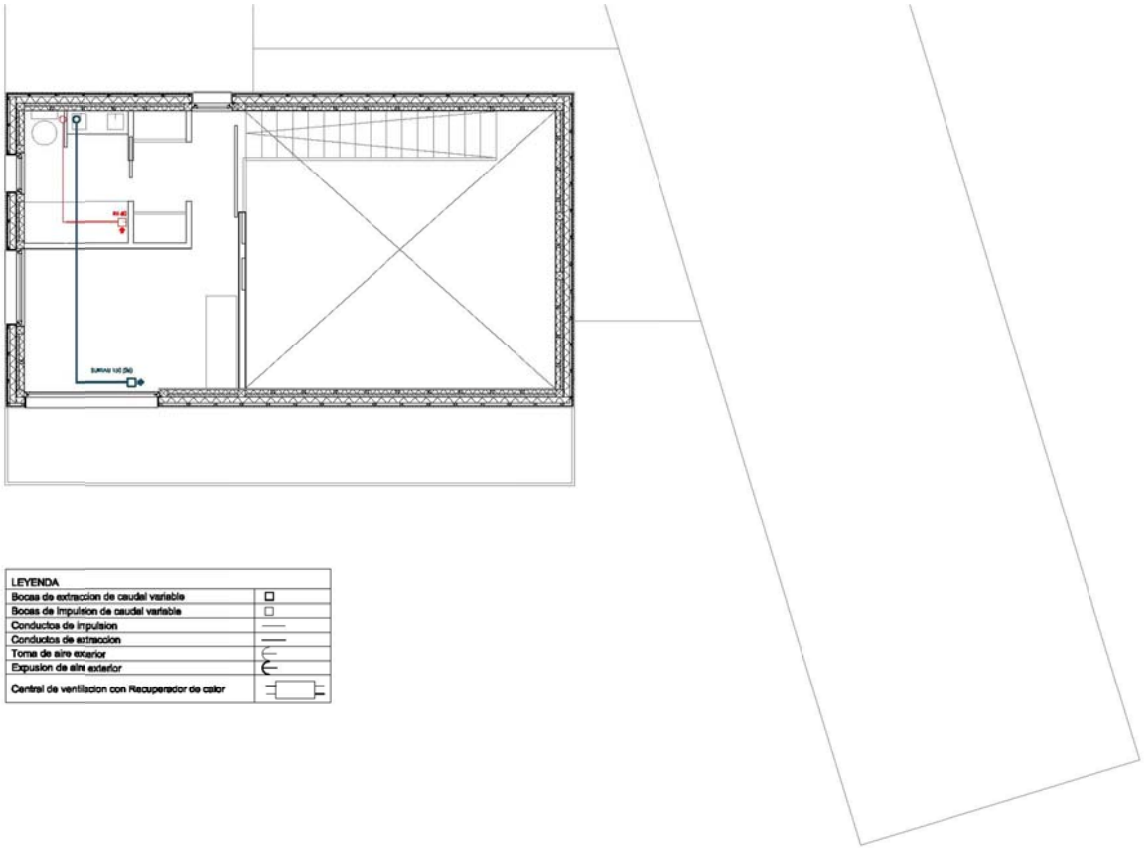
	Resultados	Intervalo de confianza de 95%		Incertidumbre
Air flow at 50Pa, V_{50} [m^3/h]	263,5	250,0	277,5	+/-5,2%
Air changes at 50Pa, n_{50} [/h]	**0,46**	0,4355	0,4910	+/-6,0%
Permeability at 50 Pa, q_{50}[$m^3/h/m^2$]	0,370	0,348	0,393	+/-6,0%
Specific leakage at 50 Pa, w_{50} [$m^3/h/m^2$]	1,531	1,440	1,623	+/-6,0%
Effective leakage area at 50 Pa, A_L [cm^2]	80,25	76,20	84,50	+/-5,3%
Equivalent leakage area at 50 Pa, A_L [cm^2]	131,5	76,20	84,50	+/-5,2%
Normalized leakage area at 50 Pa [cm^2/m^2]	0,113	0,106	0,120	+/-6,0%

7. PLANNING OF VENTILATION DUCTWORK

The housing has a mechanical ventilation system with a heat recovery unit. This unit is the model Renovent Sky 400, manufacturer by Brink Climate Systems B.V., certified by PHI with an efficient of 84% and electric power consumption 0.29 Wh/m3. It is placed outside the closure. The pipes located out the closure are EPE, with circular section (180mm) and a conductivity of 0,041W/m.k. The pipes located inside the closure are thermoplastic with rectangular section (55x110mm), auto extinguish according to UNE EN 13501-1:2002 and insulated with rock wool of 12 cm. thickness.



Ground floor ventilation system: extraction from the kitchen and the bathrooms



First floor ventilation system: extraction from the bathroom


Siber
Excellent


22 04 2015


22 04 2015


22 04 2015


07 05 2015


07 05 2015

Insufflation unit

Extraction unit

PHPP Ventilation sheet

DATOS ESTÁNDAR PARA VENTILACIÓN EQUILIBRADA

Dimensionado de la ventilación para sistemas con un solo aparato

			Cocina	Baño	Baño (sólo ducha)	WC	
Ocupación	m³/pers.	35					
Cantidad de personas	P	4,9					
Aire de impulsión por persona	m³/(P*h)	30					
Demanda de aire de impulsión	m³/h	146					
Habitaciones de extracción de aire							
Cantidad			1	2	2	0	
Demanda de extracción de aire por habitación	m³/h		60	40	20	20	
Demanda total de aire de extracción	m³/h	180					
Caudal de aire de diseño (máx.)	m³/h	391					

Cálculo de la renovación de aire media

Tipos de operación	Horas diarias de funcionamiento h/d	Factores referenciados a Máximo	Caudal de aire m³/h	Renovación de aire 1/h
Máximo		1,00	391	0,92
Standard	24,0	0,36	141	0,33
Grundlüftung			0	0,00
Minimum			0	0,00
Valor medio		0,36	Renovación de aire media (m³/h) 141	Tasa de renovación de aire media (1/h) 0,33

Selección de aparato de ventilación con recuperación de calor

		Eficiencia de RC efectiva Aparato η_{hre}	Introducción de potencia específica [Wh/m³]	Rango de aplicación [m³/h]	Protección a la congelación necesaria	Ruido del aparato < 35 dB(A)
	Aparato en el interior de la envolvente térmica					
x	Aparato en el exterior de la envolvente térmica					
Selección del aparato de ventilación	Orden: COMO EN LISTA 01ud Aparato de recuperación de calor	0,84	0,29	n.a.	n.a.	n.a.

Ir a lista de aparatos de ventilación

Conductancia del ducto de aire de impuls Ψ	W/(mK)	0,888	Cálculo, ver abajo
Longitud de ducto de aire de impulsión	m	0,8	
Conductancia del ducto de aire de extrac Ψ	W/(mK)	0,888	Cálculo, ver abajo
Longitud de ducto de aire de extracción	m	0,8	
Temp. del cuarto de instalaciones (Sólo introducir si el aparato está ubicado en el exterior de la envolvente térmica)	°C	15	

Temperatura interior (°C) 20
Temp. ext. media periodo calef. (°C) 10,9
Temp. media superficie terreno (°C) 14,9

Valor efectivo de recuperación de calor $\eta_{hre,ef}$ **82,7%**

Ef. recuperación energía (humedad) $\eta_{hrx,v}$

Eficiencia del Recuperador del intercambiador geotérmico

Eficiencia del intercambiador tierra-aire (ITA)	η^*_{ITA}	
Eficiencia de recuperación de calor del ITA	η_{ITA}	0%

Cálculo secundario
Valor-Ψ del conducto de aire de admisión o de impulsión

Diámetro interior	125	mm
Espesor del aislamiento	10	mm
¿Reflectante? ¡indicarlo con una 'x'!		
	Si	
x	No	
Conductividad térmica	0,040	W/(mK)
Caudal de aire nominal	141	m³/h
Δϑ	5	K
Diámetro exterior del tubo	0,180	m
Diámetro exterior	0,212	m
α–interior	7,66	W/(m²K)
α–Superficie	5,78	W/(m²K)
Valor-Ψ	**0,888**	**W/(mK)**
Diferencia de temp. Superficial	1,154	K

Cálculo secundario
Valor-Ψ del conducto de aire de expulsión o de extracción

Diámetro interior	125	mm
Espesor del aislamiento	10	mm
¿Reflectante? ¡indicarlo con una 'x'!		
	Si	
x	No	
Conductividad térmica	0,040	W/(mK)
Caudal de aire nominal	141	m³/h
Δϑ	5	K
Diámetro exterior del tubo	0,180	m
Diámetro exterior	0,212	m
α–interior	7,66	W/(m²K)
α–Superficie	5,78	W/(m²K)
Valor-Ψ	**0,888**	**W/(mK)**
Diferencia de temp. Superficial	1,154	K

8. HEAT SUPPLY

As a heating system there is a biomass stove model "Lou" (Edilkamin) placed in the living room. It is assumed that the use of the pellets stove cover the 50% of the building heating demand.
The remaining 50 % of the heating demand is supplied through an electrical resistance connected to the ventilation system to heat the air by Joule effect.
With these assumption, the total primary energy consumption amounts to 99 kWh / m2 (annually).

9. PHPP CALCULATIONS

Edificio:	La Carcabina						
Calle:	Reborio 57						
CP / Ciudad:	Muros de Nalón (Asturias)						
País:	España						
Tipo de edificio:	Vivienda Unifamiliar						
Clima:	[ES] - Oviedo, Asturias C1	Altitud del sitio del edificio (en [m] sobre el nivel del mar):	120				
Propietario / cliente:	Antonio Salinas Castro y Alicia de León Arce						
Calle:	Campomanes nº9-4ºD						
CP / Ciudad:	333009 / Oviedo						
Arquitectura:	Amaya Salinas de León						
Calle:	Plaza Adolfo Barthe Aza nº5-6ºA						
CP / Ciudad:	33008/ Oviedo						
Instalaciones:							
Calle:							
CP / Ciudad:							
Año construcción:	2015		Temperatura interior invierno:	20,0	°C	Volumen exterior V_e m³:	897,5
Nr. de viviendas	1		Temperatura interior verano:	25,0	°C	Refrigeración mecánica:	
Nr. de personas:	4,9		GIC invierno:	2,1	W/m²		
Capacidad específica:	60	Wh/K por m² de SRE	GIC verano:	3,2	W/m²		

Valores característicos del edificio con relación a la superficie de referencia energética y año

				Requerimientos	¿Cumplido?*
	Superficie de referencia energética	169,8	m²		
Calefacción	Demanda de calefacción	14,9	kWh/(m²a)	15 kWh/(m²a)	sí
	Carga de calefacción	12,7	W/m²	10 W/m²	-
Refrigeración	Demanda total refrigeración		kWh/(m²a)	-	-
	Carga de refrigeración		W/m²	-	-
	Frecuencia de sobrecalentamiento (> 25 °C)	8,3	%	-	-
Energía primaria	Calef., ref., deshum., ACS, elect. auxiliar, ilum., aparatos eléct.	99	kWh/(m²a)	120 kWh/(m²a)	sí
	ACS, calefacción y electricidad auxiliar	69	kWh/(m²a)	-	-
	Ahorro de EP a través de electricidad solar		kWh/(m²a)	-	-
Hermeticidad	Resultado ensayo de presión n50	0,5	1/h	0,6 1/h	sí

* Campo vacío: faltan datos; '-': sin requerimiento

Passivhaus?	sí

10. CONSTRUCTION COSTS

The construction cost is approximately of 1,250 € / m² of floor area.

11. YEAR OF CONSTRUCTION

Housing construction began in mid-March 2015 and was completed in August 2015 so that the construction time has been four months and a half.

12. EXPERIENCES

Improvements in the owners' quality of life:

The house is located in Asturias and is used as a holiday's home. These types of housing usually spend quite time closed due to weather and are very wet, and when we arrive on Friday, we have to spend 2-3 hours with the windows opened for ventilation.

This problem does not exist in our house. No moisture noticed when we go to spend weekends and housing has been closed for a few days.

In winter, the house takes little time to warm up and when it does, it keeps the temperature constant.

Better quality of the environment than in a conventional housing. He sleeps and breathes better.

13. REFERENCES

The house has been awarded the following prices:

- Finalist III iberomerican Passivhaus competition and it is part of the traveling exhibition that has been exhibited in various locations in Spain.

- Accésit XXIII in ASTURIAS AWARDS ARCHITECTURE and it is part of the exhibition currently on display in the Colegio de Arquitectos de Asturias.

- Accésit VI Premios Construcción Sostenible de Castilla y León