PROJECT DOCUMENTATION

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
U-value external wall: 0,176 W/m²k
U-value exterior floor slab: 0,181 W/m²k
U-value roof: 0,193 W/m²k/ 0,116 W/m²k
U-value window: 0,176 W/m²k

Passivhaus database number: 4596
PHPP heating demand: 14,9 Kwh/m²a
PHPP primary energy demand: 99 Kwh/m²a
Pressure test n50: 0.46/h

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 100x240 mm. 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-groove on the high density Rockwool insulation.
- Waterproof and breathable sheet ProClima Silifex 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.

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**5.1 Roof and wall connection**

*(pitched roof)*

![Diagram of roof and wall connection](image)
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 facade o similar.
03. Panel estructural machifilamado hidrófugo Superspan Tech PS de 19 mm. o similar.
04. Rollos de aislamiento de 40x60 mm.
05. Lona de roca de alta densidad y conductividad térmica 0,038 W/mK en 80 mm.
06. Lámina de hermeticidad de aire y permeable al vapor de agua Delta Vent S Plus.
07. Panel estructural machifilamado hidrófugo Superspan Tech PS de 19 mm. o similar.
08. Cobertíc de cubierta de 120x140 mm. Intensión de 60 mm.
09. Subestructura de madera de 40x60 mm.
10. Bajo techo de placa deyeso laminado e=30 mm.
11. Lona de roca de alta densidad y conductividad térmica 0,038 W/mK en 30 mm.
12. Panel enterrado colocado entre plástico empotrado con el corte exterior de los mismos e=60 mm.
13. Subestructura de madera de 60x80 mm.
14. Lona de roca e=80 mm. y conductividad térmica 0,038 W/mK.
15. Placa de yeso laminado e=150 mm
16. Remate de ventilación de madera de alerce color natural
17. Calzada exterior de madera de castaño enterrado autóctono de 80x70 mm. barnizada al agua.
18. Acrilicoamianto triple bajo envío con cámara rellena de gas argón A+ (A+8+10)+A.
19. Enrollable de cobre proyectado.
20. Trasladado para poros de insulaciones formando porosol de madera de 40x60 mm. y aislamiento de lana de roca e=40 mm. y conductividad térmica 0,038 W/mK.
21. Estructura de XPS e=120 mm. y conductividad térmica 0,034 W/mK.
22. Dujamente de madera laminado 140x100 mm.
23. Placa de vidrio celular bajo duermientes e=80 mm. y conductividad térmica 0,05 W/mK.
24. Drenaje perimetral

### Tabla de aislamiento térmico

<table>
<thead>
<tr>
<th>Superficie parcial 1</th>
<th>Límites</th>
<th>Superficie parcial 2 (opcional)</th>
<th>Límites</th>
<th>Superficie parcial 3 (opcional)</th>
<th>Límites</th>
<th>Espesor (mm)</th>
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<td>19</td>
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<tr>
<td>Tableros</td>
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<td>Impermeabilización</td>
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<td>Aislante exterior</td>
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<table>
<thead>
<tr>
<th>Total</th>
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</table>

<table>
<thead>
<tr>
<th>Suplemento al valor</th>
<th>0,193</th>
</tr>
</thead>
</table>
5.1. Roof and wall connection (lobby roof)

**CUBIERTA INCINADA VENTILADA**
01. Perfiles de alicante de 2x16 mm en posición perpendicular a la pendiente y con una luz máxima entre perfiles de 18 mm.
02. Lámina impermeable y transpirable Delta Flash o similar.
03. Panel estructural machihambreado hidrófugo SuperponTech PS de 19 mm. o similar.
04. Rastre de amarre de 40x60 mm.
05. Lana de roca de alta densidad y conductividad térmica 0,038 W/mK m=80 mm.
06. Lámina de armadura de alu y permeable al vapor de agua Delta Vent 5 Plus.
07. Panel estructural machihambreado hidrófugo SuperponTech PS de 19 mm. o similar.
08. Cabina de cubierta de 180x240 mm. interése de 600 mm.
09. Subestructura de madera de 200x200 mm.
10. Piso techado con plancha de yeso laminado m=15 mm.
11. Cerrajón oculto de aluminio.

**CUBIERTA PLAN A**
12. Impermeabilización bicaña.
13. Lanza ce roca de alta densidad m=190 mm. y conductividad térmica 0,038 W/mK.
14. Lanza ce roca m=190 mm. y conductividad térmica 0,036 W/mK.
5.1. Roof and wall connection (kitchen roof)
5.2 Floor and wall connection

SUELO Y CIMENTACIÓN
25. Gres porcelánico
26. Doble mampostería para formación de cañón de instalaciones de 100 r de alto.
27. Lona de roca e=40 mm. y conductividad térmica 0.037 W/mK
28. Doble zocalo de poliestireno estruido e=40 mm. y conductividad térmica 0.034 W/mK.
29. Lona de hormigón armado e=250 mm.
30. Hormigón de impiesa e=100 mm.
31. Lámina impermeable de polietileno con geotextil
32. Encachado de piedra y azoharas compactadas como base de apoyo de la cimentación e=150 mm.
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/m²K.

Glazing information

Window glasses are argon filled triple glazing and warm edge spacers (with thermal bridge spacer $\psi=0.04$).

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 W/m²K Ug value and 0.47 g value, for the big windows.
Window installation drawing

Thermal bridge calculation of the window installation

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

\[
\psi_{\text{net}} = \frac{\Phi}{\Delta T} = \frac{U_{ij} b_i - U_{ij} b_j}{20,000} = \frac{19,425}{20,000} - \frac{0.192 \cdot 0.990 - 1.600 \cdot 0.104 - 0.904 \cdot 0.656}{0.222 \text{ W/(m·K)}}
\]
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 ≤0.85 W/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

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 18.10°C. Being higher than 17°C, it complies with the UNE EN ISO 7730 comfort regulations and with the requirements of the PHI.
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 to 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 airtight layer

<table>
<thead>
<tr>
<th>Technical Data</th>
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</thead>
<tbody>
<tr>
<td><strong>Product name</strong></td>
</tr>
<tr>
<td><strong>Color</strong></td>
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<tr>
<td><strong>Water vapor transmission</strong></td>
</tr>
<tr>
<td><strong>Vapor permeance</strong></td>
</tr>
<tr>
<td><strong>Breaking load</strong></td>
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<tr>
<td><strong>Elongation at break</strong></td>
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<tr>
<td><strong>Tear resistance</strong></td>
</tr>
<tr>
<td><strong>Trapezoid tearing strength</strong></td>
</tr>
<tr>
<td><strong>Fastener pull-through force</strong></td>
</tr>
<tr>
<td><strong>Water penetration resistance</strong></td>
</tr>
<tr>
<td><strong>Water impact penetration resistance</strong></td>
</tr>
<tr>
<td><strong>Water permeability</strong></td>
</tr>
<tr>
<td><strong>Longterm sag</strong></td>
</tr>
<tr>
<td><strong>Flame spread</strong></td>
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<tr>
<td><strong>Smoke developed</strong></td>
</tr>
<tr>
<td><strong>Air permeance</strong></td>
</tr>
<tr>
<td><strong>Temperature range</strong></td>
</tr>
<tr>
<td><strong>Mass per unit area</strong></td>
</tr>
<tr>
<td><strong>Roll weight</strong></td>
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<tr>
<td><strong>Roll length</strong></td>
</tr>
<tr>
<td><strong>Maximum UV (sunlight) exposure</strong></td>
</tr>
</tbody>
</table>

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).
Sealing layer on the exterior of the wooden frame

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

Windows and door casements

PASSIVE HOUSE DOCUMENTATION LA CARCABINA HOUSE AMAYA SALINAS DE LEÓN ARCHITECT/ www.amayasalinas.com
6.2 Results of pressure test on 01.10.2015

<table>
<thead>
<tr>
<th>Building and Test Information</th>
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<tbody>
<tr>
<td>Test file name:</td>
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<tr>
<td>Building volume:</td>
</tr>
<tr>
<td>Building Height (from ground to top):</td>
</tr>
<tr>
<td>Floor Area:</td>
</tr>
<tr>
<td>Envelope Area:</td>
</tr>
<tr>
<td>Building Exposure to wind:</td>
</tr>
<tr>
<td>Accuracy of measurements:</td>
</tr>
</tbody>
</table>

Datos de pruebas combinadas:

<table>
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<tr>
<th></th>
<th>Resultados</th>
<th>Intervalo de confianza de 95%</th>
<th>Incertidumbre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air flow at 50Pa, V₀ [m³/h]</td>
<td>263,5</td>
<td>250,0 277,5</td>
<td>+/-5,2%</td>
</tr>
<tr>
<td>Air changes at 50Pa, nₐ₀ [l/h]</td>
<td>0,46</td>
<td>0,435 0,4910</td>
<td>+/-6,0%</td>
</tr>
<tr>
<td>Permeability at 50 Pa, q₀ [m³/h/m²]</td>
<td>0,370</td>
<td>0,348 0,393</td>
<td>+/-6,0%</td>
</tr>
<tr>
<td>Specific leakage at 50 Pa, wₐ₀ [m³/h/m²]</td>
<td>1,531</td>
<td>1,440 1,623</td>
<td>+/-6,0%</td>
</tr>
<tr>
<td>Effective leakage area at 50 Pa Aₑ [cm²]</td>
<td>80,25</td>
<td>76,20 84,50</td>
<td>+/-5,3%</td>
</tr>
<tr>
<td>Equivalent leakage area at 50 Pa Aₑ [cm²]</td>
<td>13,5</td>
<td>76,20 84,50</td>
<td>+/-5,2%</td>
</tr>
<tr>
<td>Normalized leakage area at 50 Pa [cm²/m²]</td>
<td>0,113</td>
<td>0,106 0,120</td>
<td>+/-6,0%</td>
</tr>
</tbody>
</table>
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
Insufflation unit

Extraction unit

PHPP Ventilation sheet
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: 333009 / Oviedo  
Arquitectura: Amaya Salinas de León  
Instalaciones: 

| Propietario / Cliente: Antonio Salinas Castro y Alicia de León Arco  
| Calle: Campomanes nº9-4ºD  
| CP / Ciudad: 333009 / Oviedo  
| Arquitectura: Amaya Salinas de León  
| Calle: plaza Adolfo Bartne Asa nº5-6ºA  
| CP / Ciudad: 33008/ Oviedo |

| Instalaciones: |
| Calle: |
| CP / Ciudad: |

| Año construcción: 2015  
| Nº de viviendas: 1  
| Nº de dependencias: 4.9  
| Capacidad específica: 60 WhK por m² de SRE |

| Temperatura interior invierno: 25.0 °C  
| Temperatura interior verano: 25.0 °C  
| GIC invierno: 2.1 W/m²  
| GIC verano: 3.2 W/m² |

| Superficie de referencia energética: 169.8 m²  
| Calefacción: Demanda de calefacción 14.9 kWh/(m²a)  
| Carga de calefacción 12.7 W/m²  
| Refrigeración: Demanda total refrigeración -  
| Carga de refrigeración -  
| Frecuencia de sobrecaletamiento (> 25 °C) 8.3 %  
| Energía primaria:  
| Calef., ref., techos, ACS, elect. auxiliar, lum., aparatos elect. 99 kWh/(m²a)  
| Aparatos de EP a través de electricidad solar -  
| Anorriten 0.5 kWh/(m²a)  
| Hermeticidad: Resultado ensayo de presión n50 0.5 1/h  
| 0.6 1/h |

| Requerimientos:  
| 15 kWh/(m²a)  
| 10 W/m²  
| 8.3 °C  
| 120 kWh/(m²a)  
| 69 kWh/(m²a)  
| 0.6 1/h |

| ¿Cumplido?:  
| Sí  
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| Sí |

| Pasirhaus?:  
| 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 iberoamerican 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