NATURALLY HIGH PERFORMANCE INSULATION

Warm climate - Passivhaus system
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ISOBIO | **A radical approach to using natural construction materials at scale**

ISOBIO system proposes an innovative strategy to bring bio-based construction materials into the mainstream. A key innovation consists of the use of pre-treated bio-based aggregates for construction, which include insulation materials, hygrothermal and moisture buffering materials, binders, sol-gel and resins.

The panels are highly insulated, thus allowing rooms to be thermally stable during summer, winter or when the temperature outside abruptly changes. In addition, these panels are highly resistant to mould formation as they are highly diffusive in the presence of moisture. All these allow the buildings to be breathable and energy efficient while providing optimal comfort for the residents once installed.
The new building insulation system can be divided into the following compartments:

1. Claytec clay plaster
2. CSB Lignicell panel
3. CAVAC Biofib Trio insulation + timber battens
4. Intello airtight and vapour control dynamic membrane
5. OSB 3 timber board
6. CAVAC Biofib Trio insulation + timber studs
7. CAVAC rigid insulation board
8. BCB exterior render
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7. CAVAC rigid insulation board
8. BCB exterior render
ISOBIO | Panel assembly

These are all sandwiched together to form the new building’s panel. It can be constructed in the following order:

1. The wood studs are joined together using screws to form a structural frame with a 600mm interaxial distance between profiles. The height of the frame can be adjustable to the structure dimensions and the void is filled with BioFib Trio insulation material.

2. After, OSB3 panels are fixed to the frame using nails or screws and a Intello Proclima membrane is attached to OSB3 panels using staples.

3. Timber battens are added on above it using screws. They are installed horizontally again vertical disposition of the structural frame. A BioFib Trio insulation material fills the void between timber battens.

4. The last layer from the interior side is formed by CSB panels, which are fixed on top followed by the clay plaster. This plaster is made out of earthen clay, hemp powder, pumice and sand.

5. Flipping over the entire board, ISOBIO rigid panels (made out of commercial hemp and a thermosetting bio-based binder) are added on top of as the last external panel using screws. Finally they are followed by a hemp lime render which is the exterior finishing of the new building system.
ISOBIO | Functions

The overall structure allows an even distribution with regards to the load-bearing capacity of the panel. The frame provides structural resistance to the whole system while maintaining the final structure as a single unit when the rest of the layers are added.

The OSB3 timber board has an acoustic insulation similar to the wooden frame. It also has a low humidity content and low thermal conductivity. The BioFib Trio insulation is a material composed of hemp, flax, cotton fibers and thermoplastic fibers. Both the OSB3 panel and BioFib trio insulation materials provide high thermal insulation, thus providing comfort for residents during cold or hot seasons.

The Proclima intello membrane is used as a vapour check and airtightness barrier that prevents structural damage and mould formation in the system due to its high diffusion capacity. It is also a non-toxic material, just like the other materials used to build this wall panel.

The CSB panels, which also increase the thermal insulation of the system, act as a moisture buffering layer while providing mechanical stability to the panel’s overall structure. The addition of the Clay plaster, as interior finishing layer, reinforced this property and added fire resistance properties to the system.

From the external side the combination of the ISOBIO rigid panel and the Hemp lime render acts as a fire retardant and improves hygrothermal properties, such as water repellency, protecting the system from the environmental effects and thus further preventing mould formation.
ISOBIO | *Construction details*

As part of the project, there has been produced a collection of 7 opaque construction details for warm climate (Seville, Spain).

The details show typical connections for ground floor & wall junctions, intermediate floor & wall, roof & wall and panel to panel junctions. Information relating to water-proofing, airtightness and vapour control is included.

All details have been modelled with 2-dimensional thermal bridge software, and designed to minimise heat loss and ensure minimum internal surface temperatures to avoid surface mould growth and condensation. Fabric U-values have been sized to meet the limiting heating and cooling demands required by the Passivhaus standard, using the PHPP (Passive House Planning Package) modelling tool for each climate (15 kWh/m²·a for space heating and 16 kWh/m²·a for space cooling in the warm-temperature climate).

The result is a set of construction details that comply with the Passivhaus standard, offering practical information to architects, contractors, developers and engineers who are looking to use the ISOBIO system in a low-embodied energy, nearly-zero energy construction.

The table below shows a summary of the results of thermal bridge calculations:

<table>
<thead>
<tr>
<th>Code</th>
<th>Detail</th>
<th>$\Psi$ [W/m-K]</th>
<th>$\Theta_{Si}$ [°C]</th>
<th>fRsi [-]</th>
</tr>
</thead>
<tbody>
<tr>
<td>TB 01</td>
<td>Slab on grade - External wall</td>
<td>-0,096</td>
<td>16,76</td>
<td>0,89</td>
</tr>
<tr>
<td>TB 02</td>
<td>Suspended floor over ventilated crawl space -</td>
<td>-0,022</td>
<td>16,59</td>
<td>0,89</td>
</tr>
<tr>
<td></td>
<td>External wall</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TB 03</td>
<td>Slab over strip footing - External wall</td>
<td>-0,103</td>
<td>16,76</td>
<td>0,89</td>
</tr>
<tr>
<td>TB 04</td>
<td>Intermediate floor - External wall</td>
<td>0,032</td>
<td>17,47</td>
<td>0,92</td>
</tr>
<tr>
<td>TB 05</td>
<td>Pitched roof - External wall</td>
<td>-0,025</td>
<td>17,02</td>
<td>0,91</td>
</tr>
<tr>
<td>TB 06</td>
<td>Flat roof - External wall</td>
<td>-0,051</td>
<td>16,82</td>
<td>0,89</td>
</tr>
<tr>
<td>TB 07</td>
<td>Panel connection</td>
<td>0,020</td>
<td>18,12</td>
<td>0,94</td>
</tr>
</tbody>
</table>
TB 01. Slab on grade - External wall

1. BCB render
2. CAVAC rigid insulation board
3. CAVAC Biofib Trio insulation + timber studs (red pine)
4. OSB 3 board
5. Intello membrane
6. CAVAC Biofib Trio insulation + timber battens (red pine)
7. CSB Lignicell panel
8. Claytec clay plaster
9. Airtight tape
10. Timber batten 50x200 mm
11. Cellular glass insulation
12. Suspended floor
13. Timber floor
14. EPDM membrane / 2-layer polymer bitumen
15. Lean mortar
16. Building paper
17. Gravel
18. Polypropylene filter fleece
Linear thermal bridge calculation UNE-EN-ISO 10211:2007

Linear thermal bridge coefficient: \( \Psi = -0.096 \, \text{W/m·K} \)  \( \Psi < 0.04 \, \text{W/m·K} \)

Surface condensation & mould growth calculations UNE-EN-ISO 13788:2012

Minimum internal surface temperature: \( \Theta_{\text{Si}} = 16.76 \, ^\circ\text{C} \) \( \text{Si} \geq 16.70 \, ^\circ\text{C} \)

Temperature factor: \( f_{\text{Rsi}} = 0.89 \) \( f_{\text{Rsi}} \geq 0.89 \)
ISOBIO | **Construction details**

TB 02. Suspended floor over ventilated crawl space - External wall

1. BCB render
2. CAVAC rigid insulation board
3. CAVAC Biofib Trio insulation + timber studs (red pine)
4. OSB 3 board
5. Intello membrane
6. CAVAC Biofib Trio insulation + timber battens (red pine)
7. CSB Lignicell panel
8. Claytec clay plaster
9. Airtight tape
10. Timber batten 50x200 mm
11. Cellular glass insulation
12. Suspended floor
13. Timber floor
14. EPDM membrane / 2-layer polymer bitumen
15. Lean mortar
16. Building paper
17. Gravel
18. Polypropylene filter fleece
Linear thermal bridge calculation UNE-EN-ISO 10211:2007

Linear thermal bridge coefficient: \( \Psi = -0.022 \text{ W/m·K} \)

\( \Psi < 0.04 \text{ W/m·K} \)

Surface condensation & mould growth calculations UNE-EN-ISO 13788:2012

Minimum internal surface temperature: \( \Theta_{Si} = 16.59 \degree C \)

\( Si \geq 16.70 \degree C \)

Temperature factor: \( f_{Rsi} = 0.89 \)

\( f_{Rsi} \geq 0.89 \)
ISOBIO | Construction details

TB 03. Slab over strip footing - External wall

1. BCB render
2. CAVAC rigid insulation board
3. CAVAC Biofib Trio insulation + timber studs (red pine)
4. OSB 3 board
5. Intello membrane
6. CAVAC Biofib Trio insulation + timber battens (red pine)
7. CSB Lignicell panel
8. Claytec clay plaster
9. Airtight tape
10. Timber batten 50x200 mm
11. Cellular glass insulation
12. Suspended floor
13. Timber floor
14. EPDM membrane / 2-layer polymer bitumen
15. Lean mortar
16. Building paper
17. Gravel
18. Polypropilene filter fleece
### Linear thermal bridge calculation UNE-EN-ISO 10211:2007

| Linear thermal bridge coefficient: $\Psi = -0.103\ W/m\cdot K$ | $\Psi < 0.04\ W/m\cdot K$ | ✔ |

### Surface condensation & mould growth calculations UNE-EN-ISO 13788:2012

| Minimum internal surface temperature: $\Theta_{Si} = 16.76\ ^\circ C$ | $Si \geq 16.70\ ^\circ C$ | ✔ |

| Temperature factor: $f_{Rsi} = 0.89$ | $f_{Rsi} \geq 0.89$ | ✔ |
ISOBIO | **Construction details**

TB 04. Intermediate floor - External wall

1. BCB render
2. CAVAC rigid insulation board
3. CAVAC Biofib Trio insulation + timber studs (red pine)
4. OSB 3 board
5. Intello membrane
6. CAVAC Biofib Trio insulation + timber battens (red pine)
7. CSB Lignicell panel
8. Claytec clay plaster
9. Airtight tape
10. CLT timber floor panel
Linear thermal bridge calculation UNE-EN-ISO 10211:2007

Linear thermal bridge coefficient: $\Psi = 0.032 \text{ W/m} \cdot \text{K}$  
$\Psi < 0.04 \text{ W/m} \cdot \text{K} \; \checkmark$

Surface condensation & mould growth calculations UNE-EN-ISO 13788:2012

Minimum internal surface temperature: $\Theta_{Si} = 17.47 \, ^\circ\text{C}$  
$Si \geq 16.70 \, ^\circ\text{C} \; \checkmark$

Temperature factor: $f_{Rsi} = 0.92$  
$f_{Rsi} \geq 0.89 \; \checkmark$
1. BCB render
2. CAVAC rigid insulation board
3. CAVAC Biofib Trio insulation + timber studs (red pine)
4. OSB 3 board
5. Intello membrane
6. CAVAC Biofib Trio insulation + timber battens (red pine)
7. CSB Lignicell panel
8. Claytec clay plaster
9. Airtight tape
10. CAVAC Biofib Trio insulation
11. Timber beams
12. Insulated suspended ceiling with CAVAC
13. CAVAC Biofib Trio insulation + timber joists (red pine)
14. Ceramic tiles + timber structure
15. Open diffusion roofing membrane
### Linear thermal bridge calculation UNE-EN-ISO 10211:2007

Linear thermal bridge coefficient: \( \Psi = -0.025 \text{ W/m·K} \) \( \Psi < 0.04 \text{ W/m·K} \)

### Surface condensation & mould growth calculations UNE-EN-ISO 13788:2012

Minimum internal surface temperature: \( \Theta_{Si} = 17.02 ^\circ\text{C} \) \( Si \geq 16.70 ^\circ\text{C} \)

Temperature factor: \( f_{Rsi} = 0.91 \) \( f_{Rsi} \geq 0.89 \)
1. BCB render
2. CAVAC rigid insulation board
3. CAVAC Biofib Trio insulation + timber studs (red pine)
4. OSB 3 board
5. Intello membrane
6. CAVAC Biofib Trio insulation + timber battens (red pine)
7. CSB Lignicell panel
8. Claytec clay plaster
9. Airtight tape
10. Insulated suspended ceiling with CAVAC Biofib Trio insulation + timber beams
11. Cross laminated timber roof slab
12. EPDM membrane / 2-layer polymer bitumen
13. Cellular glass insulation
14. Polypropylene filter fleece
15. Gravel
### Linear thermal bridge calculation UNE-EN-ISO 10211:2007

Linear thermal bridge coefficient: $\Psi = -0.051 \text{ W/m·K}$

$\Psi < 0.04 \text{ W/m·K}$ ✓

### Surface condensation & mould growth calculations UNE-EN-ISO 13788:2012

Minimum internal surface temperature: $\Theta \ Si = 16.82 ^\circ \text{C}$

$\ Si \geq 16.70 ^\circ \text{C}$ ✓

Temperature factor: $fRsi = 0.89$

$fRsi \geq 0.89$ ✓
1. BCB render
2. CAVAC rigid insulation board
3. CAVAC Biofib Trio insulation + timber studs (red pine)
4. OSB 3 board
5. Intello membrane
6. CAVAC Biofib Trio insulation + timber battens (red pine)
7. CSB Lignicell panel
8. Claytec clay plaster
9. Airtight tape
Linear thermal bridge calculation UNE-EN-ISO 10211:2007

Linear thermal bridge coefficient: $\Psi = 0.020 \text{ W/m·K}$ $\Psi < 0.04 \text{ W/m·K}$

Surface condensation & mould growth calculations UNE-EN-ISO 13788:2012

Minimum internal surface temperature: $\Theta_{Si} = 18.12 \degree\text{C}$ $Si \geq 16.70 \degree\text{C}$

Temperature factor: $f_{Rsi} = 0.937$ $f_{Rsi} \geq 0.89$
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