CASA SPANO'

2017

Relazione Villa Unifamiliare, Via Ugo Foscolo, Castiglione Torinese 10090 (TO), allegati grafici
CASA SPANO’ in Castiglione Torinese, Torino, Italy - project ID 4595
Residential detached house in Castiglione Torinese common, street Via Ugo Foscolo

Project Designer
Passive House Planner: Arch. Massimo Carosso
Architecture: Arch. Massimo Carosso
Structure: Arch. Fabrizio Carosso
System: Arch. Massimo Carosso; Ing. Stefano Fenoglio

THE HOUSE
The architecture was the basis, the leitmotiv of the construction of these building.
I don’t know how many of you can happen to get a client that when he will commission an house he talks about Le Corbusier’s architecture or Picasso’s picture. Unfortunately for me was the first time.
At this stage we had fun to play with some cubes; we’ve raised them, doubled, moved, pierced. Furthermore the cubes are reflected with the introduction of the pool, that it can reflects more angles than existing ones. White shapes, large windows, plan roofs (it was the first building with a plan roof before the submission to SUE)

Specific Building Characteristics with reference to the treated floor area

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
<th>PHPP Annual heating demand</th>
<th>PHPP Annual cooling demand</th>
<th>PHPP primary energy demand</th>
</tr>
</thead>
<tbody>
<tr>
<td>U-value external wall - ambient</td>
<td>0.106 W/m²K</td>
<td>11.04 kWh/m²a</td>
<td>5 kWh/m²a</td>
<td>72 kWh/m²a</td>
</tr>
<tr>
<td>U-value external wall - ground</td>
<td>0.169 W/m²K</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>U-value roof</td>
<td>0.136 W/m²K</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>U-value window</td>
<td>0.87 W/m²K</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heat recovery</td>
<td>79.9%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pressure test n_50</td>
<td>0.5 h⁻¹</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Relazione Villa Unifamiliare, Via Ugo Foscolo, Castiglione Torinese 10090 (TO), allegati grafici
Description of the construction task
On three levels, it’s composed with frame structure in c.a. with c.a. blocks cladding and with eps covering.

Management of the yard and Budget
The first contract has focused all the construction works, excavations, insulations, and external arrangements.
Then the next contract included the furniture and the sistemation of the hardware.
Like this we’ve managed to play the PHPP as soon as that the building was advancing.

Pictures of elevations

1. South - Est view
2. North - West view
3. South - Est view
Pictures of the interior

1. Living room
2. Scale
3. Master bedroom
4. Kitchen
5. Bathroom
6. Bathroom
7. hallway
Implementation Plan
Trasversal cross section and elevations

North view
scale 1:100

South view
scale 1:100

Relazione Villa Unifamiliare, Via Ugo Foscolo, Castiglione Torinese 10090 (TO), allegati grafici
Implementation Plan
Trasversal cross section and elevations

West view
scale 1:100

East view
scale 1:100
Implementation Plan
Trasversal cross section and elevations

Trasversal cross

scale 1:100

Legenda
1. Bedroom
2. Hallway
3. Master bedroom
4. Porticato
5. Entry
6. Bedroom
7. Hallway
8. Ironing room

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Floor Plans
Floor layout

First floor plan

scale 1:100

Legenda
1. Hallway
2. Technical room
3. Bathroom
4. Ironing room
5. Entry
6. Porticato
7. Bedroom
8. Kitchen
9. Living room
10. Master bedroom
11. Roof garden

Relazione Villa Unifamiliare, Via Ugo Foscolo, Castiglione Torinese 10090 (TO), allegati grafici
Construction details
Attic's details and solutions of the heat bridges

The building having a heated basement, in addition to the ceiling insulation the following thermal bridges were corrected:
- thermal bridge caused by vertical structures on the basement;
- thermal bridge caused by basement ceiling continuing outside the heated volume on exterior green areas.

3. Floor countertop  Ground floor
1. Parquet + Aluminum mat PU
2. Self-leveling
3. Plate protect integral
4. Lightweight screed + installations
5. Plate in C.A
6. Extruded polyethylene fabric (Guttalbeta star)
7. Insulator FLOORMATE 700 A (2120 mm)
8. Leveling layer Rck 150

3B. Floor countertop  Basement
1. Ceramic floor + Glue
2. Self-leveling
3. Plate protect integral
4. Lightweight screed + installations
5. Plate in C.A
6. Extruded polyethylene fabric (Guttalbeta star)
7. Insulator FLOORMATE 700 A (2120 mm)
8. Leveling layer Rck 150

4. Floor on pilotis
1. Parquet + Aluminum mat PU
2. Self-leveling
3. Plate protect integral
4. Lightweight screed + installations
5. Floor in lateroimento
6. ROFIX EPS F 031 LAMBDAPOR (220 mm) with glue ROFIX UNISTAR LIGHT
7. Shaving
Construction details
Attic's details and solutions of the heat bridges

Basement floor plan

Section B-B

Linear heat bridge PT1
scale 1:20

<table>
<thead>
<tr>
<th>Element</th>
<th>Sigla</th>
<th>Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ponte termico lineare</td>
<td>PT1</td>
<td>28.20 m</td>
</tr>
</tbody>
</table>

Relazione Villa Unifamiliare, Via Ugo Foscolo, Castiglione Torinese 10090 (TO), allegati grafici
Construction details
Attic's details and solutions of the heat bridges

Basement floor plan

Section B-B

Linear heat bridge PT2 scale 1:20

<table>
<thead>
<tr>
<th>Element</th>
<th>Sigla</th>
<th>Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ponte termico lineare</td>
<td>PT2</td>
<td>22.50 m</td>
</tr>
</tbody>
</table>

Relazione Villa Unifamiliare, Via Ugo Foscolo, Castiglione Torinese 10090 (TO), allegati grafici
Construction details
Attic’s details and solutions of the heat bridges

First floor plant

Section B-B

linear heat bridge PT7  scale 1:20

Elemento  Sigla  Lunghezza
Ponte termico lineare  PT7  16,20 ml

Relazione Villa Unifamiliare, Via Ugo Foscolo, Castiglione Torinese 10090 (TO), allegati grafici
Construction details
Attic’s details and solutions of the heat bridges

First floor plant

Section B-B
Linear heat bridge PT8 scale 1:20

<table>
<thead>
<tr>
<th>Element</th>
<th>Sigla</th>
<th>Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ponte termico lineare</td>
<td>PT8</td>
<td>11,10 m</td>
</tr>
</tbody>
</table>
Construction details
Roof’s details and solutions of the heat bridges

7. Roof garden
1. Wooden floor positioned on spacers
2. TNT in poliprene isotattico SARNAFELT 400 g/mq
3. Insulator DOW ROOFMATE SL A (3mm)
4. Waterproof membrane in flexible polyolefin SARNAFIL TG 68-18
5. TNT in poliprene isotattico SARNAFELT 400 g/mq
6. Slope scaling
7. Floor in latero cemento
8. Shaving

8. Roof
1. Gravel
2. TNT in poliprene isotattico SARNAFELT 400 g/mq
3. Insulator DOW ROOFMATE SL A (3mm)
4. Waterproof membrane in flexible polyolefin SARNAFIL TG 68-18
5. TNT in poliprene isotattico SARNAFELT 400 g/mq
6. Slope scaling
7. Floor in latero cemento
8. Shaving
Construction details
Roof's details and solutions of the heat bridges

Section B-B

Linear heat bridge PT4

<table>
<thead>
<tr>
<th>Element</th>
<th>Sigla</th>
<th>Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ponte termico lineare</td>
<td>PT4</td>
<td>11.05 m</td>
</tr>
</tbody>
</table>

Relazione Villa Unifamiliare. Via Ugo Foscolo, Castiglione Torinese 10090 (TO), allegati grafici
Construction details

Roof's details and solutions of the heat bridges

Section B-B

Linear heat bridge PT5

scale 1:20

<table>
<thead>
<tr>
<th>Element</th>
<th>Sigla</th>
<th>Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ponte termico lineare</td>
<td>PT5</td>
<td>24.65 m</td>
</tr>
</tbody>
</table>

Relazione Villa Unifamiliare, Via Ugo Foscolo, Castiglione Torinese 10090 (TO), allegati grafici
Construction details
Roof’s details and solutions of the heat bridges

Section B-B
Linear heat bridge PT6  scale 1:20

<table>
<thead>
<tr>
<th>Element</th>
<th>Sigla</th>
<th>Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ponte termico lineare</td>
<td>PT6</td>
<td>20,90 ml</td>
</tr>
</tbody>
</table>

Relazione Villa Unifamiliare, Via Ugo Foscolo, Castiglione Torinese 10090 (TO), allegati grafici
Construction details
Solutions of the heat bridges

Section A-A

<table>
<thead>
<tr>
<th>Element</th>
<th>Sigla</th>
<th>Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>Puntual heat bridge</td>
<td>PTA</td>
<td>1.50 ml</td>
</tr>
<tr>
<td>Puntual heat bridge</td>
<td>PTB</td>
<td>0.22 ml</td>
</tr>
</tbody>
</table>

Relazione Villa Unifamiliare, Via Ugo Foscolo, Castiglione Torinese 10090 (TO), allegati grafici
Construction details
Vertical walls's details

1. Shaved wall 1
   1. Shaving
   2. Ytong block Clima
   3. ROFIX EPS F 031 LAMBDAPOR (220 mm) with glue ROFIX UNISTAR LIGHT
   4. Shaving

5. Wall against the ground
   1. Shaving
   2. Ytong block Clima
   3. Wall in C.A.
   4. Hydrostop fondamenta Wurth
   5. Insulator DOW ROOFMATE SL A (1"x200 mm)
   6. Lobed alveolar membrane DELTA-NP DRAIN

2. Shaved wall 2
   1. Shaving
   2. Wallmate WB-A (25 mm)
   3. Concrete wall
   4. Wallmate WB-A (25 mm)
   5. ROFIX EPS F 031 LAMBDAPOR (200 mm) with glue ROFIX UNISTAR LIGHT
   6. Shaving

6. Wall in C.A.
   1. Shaving
   2. Wall in C.A.
   3. Wall in C.A.
   4. Hydrostop fondamenta Wurth
   5. ROFIX EPS F 031 LAMBDAPOR (220 mm) with glue ROFIX UNISTAR LIGHT
   6. Shaving
Construction details
Horizontal shading factor
Construction details
Horizontal shading factor

Section B-B

LEGENDA

The amount referred to the window F1N06 - 06
The amount referred to the fixed window
The amount referred to the mobile window

scale 1:100

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Construction details
Windows_abaco serramenti

Windows installed in Case Spanò are REHAU model. For the all elements we had used triple-glazed windows, which to control solar gain and glare.

Description:

<table>
<thead>
<tr>
<th>id</th>
<th>Description</th>
<th>g-Value</th>
<th>Uₜ-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>01ud</td>
<td>Hausplus Triie</td>
<td>0.58</td>
<td>0.60</td>
</tr>
</tbody>
</table>

Dimensioni serramento
Sezione orizzontale 1:20

Vertical Shading Factor
Sezione orizzontale 1:20

Blindrahmen 72 GENEÖ® mit TM
Flügel Z 57 GENEÖ® mit TM
\[ U = 0.82 \text{ W/m}^2\text{K} \]
\[ \psi_1 = 0.030 \text{ W/m}K \]
Anschlussbreite: 115 mm

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Relazione Villa Unifamiliare, Via Ugo Foscolo, Castiglione Torinese 10090 (TO), allegati grafici

Legenda
- $d_{veal}$
- $o_{veal}$

Blendrahmen 72 GENE® mit TM
Flügel Z 57 GENE® mit TM
$U_1 = 0.82 \, W/m^2K$
$\psi_1 = 0.030 \, W/mK$
Ansichtsbreite: 115 mm

Stulpprofil GENE®
2 Flügel Z 57 GENE® mit TM
$U_1 = 0.85 \, W/m^2K$
$\psi_1 = 0.030 \, W/mK$
Ansichtsbreite: 142 mm

Dimensioni serramento
Sezione orizzontale 1:20

Sezione verticale 1:20

F1S 01, F1S 02, F1S 03, FTE 02 (Battente + Vasistas - Battente)
Prospetto 1:20

Construction details
Windows and skirting
Blindrahmen 86 GENE® mit TM festverglast
\[ U_1 = 0.69 \text{ W/m}^2\text{K} \]
\[ \psi_\psi = 0.030 \text{ W/mK} \]
Ansichtsbreite: 88 mm

Pfosten 98 GENE® mit TM
Flügel Z 57 GENE® mit TM
\[ U_1 = 0.82 \text{ W/m}^2\text{K} \]
\[ \psi_\psi = 0.030 \text{ W/mK} \]
Ansichtsbreite: 141 mm

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Construction details
Windows - abaco serrament
Construction details

description on the airtight envelope

The air seal corresponding to the plaster profile. Suitable tapes were made in the discontinuities corresponding to the plant and window frames.

Installation instructions for window frames

LEGENDA

- Polyurethane foam for window frame
- Plaster profile
- Shaving profile
- Sealing film Int/Ext
- Butyl tape
- Pre-compressed tape
- Thermal cutting board

Air tightness profile

Heated enclosure

Airtight

Nastratura implants
Construction details
description on the airtight envelope

We had made 2 blower - door - test:

The first test was done to verify the site tapes. The measurement takes into account:
1- Greater internal volume (There are no screeds and plasterwork)
2- Of the windows that had to be registered
Losses have occurred in:
1- Overflow systems
2- Passing through the windowsill

The second test was carried out after the work had started on the weaknesses found in the first measurement and after recording the windows.

<table>
<thead>
<tr>
<th>Caratteristiche Edificio</th>
<th>x relazione castiglione</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volume netto, V:</td>
<td>411</td>
</tr>
<tr>
<td>Altezza involucro:</td>
<td>0</td>
</tr>
<tr>
<td>Superficie:</td>
<td>150</td>
</tr>
<tr>
<td>Superficie involucro, A_{BAR}:</td>
<td>685</td>
</tr>
<tr>
<td>Altitudine:</td>
<td>216</td>
</tr>
<tr>
<td>Esposizione al vento involucro</td>
<td>Edificio altamente esposto</td>
</tr>
<tr>
<td>Accuratezza delle misure</td>
<td>5%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Risultati</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Flusso d’aria a 50 Pa, V_{50} [m³/h]</td>
<td>205,5</td>
</tr>
<tr>
<td>Ricambi d’aria orari a 50 Pa, n_{50} [l/h]</td>
<td>0,50</td>
</tr>
<tr>
<td>Permeabilità a 50 Pa, q_{50} [m³/h/m²]</td>
<td>0,300</td>
</tr>
<tr>
<td>Portata specifica infiltrazione a 50 Pa, w_{50} [m³/h/m²]</td>
<td>1,371</td>
</tr>
<tr>
<td>Effective leakage area at 50 Pa, A_{L} [cm²]</td>
<td>62,65</td>
</tr>
<tr>
<td>Equivalent leakage area at 50 Pa [cm²]</td>
<td>102,5</td>
</tr>
<tr>
<td>Normalized Leakage Area [cm²/m²]:</td>
<td>0,092</td>
</tr>
</tbody>
</table>

Test Method
- METOD A -

Results

Combined trial data

<table>
<thead>
<tr>
<th></th>
<th>Risultati</th>
<th>Intervallo di confidenza 95%</th>
<th>Incertezza</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flusso d’aria a 50 Pa, V_{50} [m³/h]</td>
<td>205,5</td>
<td>186,5</td>
<td>226,5</td>
</tr>
<tr>
<td>Ricambi d’aria orari a 50 Pa, n_{50} [l/h]</td>
<td>0,50</td>
<td>0,4455</td>
<td>0,5550</td>
</tr>
<tr>
<td>Permeabilità a 50 Pa, q_{50} [m³/h/m²]</td>
<td>0,300</td>
<td>0,267</td>
<td>0,333</td>
</tr>
<tr>
<td>Portata specifica infiltrazione a 50 Pa, w_{50} [m³/h/m²]</td>
<td>1,371</td>
<td>1,221</td>
<td>1,521</td>
</tr>
<tr>
<td>Effective leakage area at 50 Pa, A_{L} [cm²]</td>
<td>62,65</td>
<td>56,90</td>
<td>69,05</td>
</tr>
</tbody>
</table>
Construction details

description on the airtight envelope

<table>
<thead>
<tr>
<th></th>
<th>102,5</th>
<th>93,25</th>
<th>113,0</th>
<th>+/-9,7%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equivalent leakage area at 50 Pa [cm²]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Normalized leakage area at 50 Pa [cm²/m²]</td>
<td>0,092</td>
<td>0,082</td>
<td>0,102</td>
<td>+/-10,9%</td>
</tr>
</tbody>
</table>
**Construction details**
description on the airtight envelope

**Appendix – Dati del Test**

**Pressurizza Test**
Test Data: 2015-10-07  
Ora: 14:44 - 14:55

<table>
<thead>
<tr>
<th>Environmental Conditions</th>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td>Wind speed:</td>
<td>0: Calmo</td>
<td>from the</td>
</tr>
<tr>
<td>Operator Location:</td>
<td>Interno the building</td>
<td></td>
</tr>
<tr>
<td>Initial Bias Pressure:</td>
<td>-1,10 Pa</td>
<td></td>
</tr>
<tr>
<td>Final Bias Pressure:</td>
<td>-0,57 Pa</td>
<td></td>
</tr>
<tr>
<td>Barometric Pressure</td>
<td>101,3 kPa</td>
<td>from Misurazione diretta</td>
</tr>
</tbody>
</table>

**Pressurizza Risultati**

<table>
<thead>
<tr>
<th>Coefficiente di correlazione, r [%]:</th>
<th>99,65</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Risultati</th>
<th>95% confidenza</th>
<th>Incertezza</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Lower</td>
<td>Upper</td>
<td></td>
</tr>
<tr>
<td>Esponente $\Delta P$, n:</td>
<td>0,893</td>
<td>0,75552</td>
<td>1,03081</td>
</tr>
<tr>
<td>Coefficiente di portata, $C_{env}$</td>
<td>6,3791</td>
<td>4,050</td>
<td>10,05</td>
</tr>
<tr>
<td>Coefficiente di infiltrazione, $C_{i}$</td>
<td>6,3861</td>
<td>4,054</td>
<td>10,06</td>
</tr>
<tr>
<td>Flusso d'aria a 50 Pa, $V_{50}$ [m$^3$/h]</td>
<td>210,23</td>
<td>188,5</td>
<td>234,5</td>
</tr>
<tr>
<td>Ricambi d'aria orari a 50 Pa, $n_{50}$ [/h]</td>
<td>0,5115</td>
<td>0,4500</td>
<td>0,5730</td>
</tr>
<tr>
<td>Permeabilità a 50 Pa, $q_{50}$ [m$^3$/h/m$^2$]</td>
<td>0,3069</td>
<td>0,270</td>
<td>0,344</td>
</tr>
<tr>
<td>Portata specifica infiltrazione a 50 Pa, $w_{50}$ [m$^3$/h/m$^2$]</td>
<td>1,4016</td>
<td>1,2330</td>
<td>1,5701</td>
</tr>
<tr>
<td>Effective leakage area at 50 Pa, $A_{L}$ [cm$^2$]</td>
<td>64,08</td>
<td>57,45</td>
<td>71,47</td>
</tr>
<tr>
<td>Equivalent leakage area at 50 Pa [cm$^2$]</td>
<td>105,1</td>
<td>94,19</td>
<td>117,2</td>
</tr>
<tr>
<td>Normalized leakage area at 50 Pa [cm$^2$/m$^2$]</td>
<td>0,0936</td>
<td>0,082</td>
<td>0,105</td>
</tr>
</tbody>
</table>

**Pressione indotta [Pa]**

<table>
<thead>
<tr>
<th>15,1</th>
<th>14,5</th>
<th>25,5</th>
<th>43,1</th>
<th>43,4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fan #1, Range C1</td>
<td>Pressione al ventilatore [Pa]</td>
<td>30,5</td>
<td>27,5</td>
<td>58,5</td>
</tr>
<tr>
<td></td>
<td>Flusso [m$^3$/h]</td>
<td>79,08</td>
<td>70,77</td>
<td>124,2</td>
</tr>
<tr>
<td>Flusso totale, $V_{t}$ [m$^3$/h]</td>
<td>79,08</td>
<td>70,77</td>
<td>124,2</td>
<td>192,9</td>
</tr>
<tr>
<td>Flusso corretto, $V_{env}$ [m$^3$/h]</td>
<td>78,01</td>
<td>69,81</td>
<td>122,5</td>
<td>190,3</td>
</tr>
</tbody>
</table>
Construction details
description on the airtight envelope

<table>
<thead>
<tr>
<th>Errore [%]</th>
<th>3,1%</th>
<th>-4,6%</th>
<th>3,6%</th>
<th>1,7%</th>
<th>-3,5%</th>
</tr>
</thead>
</table>

5 gradini di pressione indotti per 25 secondi ciascuna. (required 25 seconds).

10 $\Delta P$ a flusso nullo rilevate per 10 secondi ciascuna. (required 10 seconds).

| Medie $\Delta P$ a flusso nullo: | $\Delta P_{01} -1,10$ | $\Delta P_{01} -1,11$ | $\Delta P_{01} + 0,22$ |
| iniziale [Pa] | fimale [Pa] | $\Delta P_{02} -0,57$ | $\Delta P_{02} -0,66$ | $\Delta P_{02} + 0,11$ |

$\Delta P$ a flusso nullo, iniziale [Pa]

| -2,96 | -3,50 | -1,36 | -0,31 | -0,68 | -0,59 | -0,36 | -0,40 | -0,31 | -0,44 |

$\Delta P$ a flusso nullo, finale [Pa]

| -0,01 | -0,31 | -0,23 | -0,03 | -0,37 | -0,55 | -0,72 | -1,02 | -1,03 | -1,42 |

Pressione indotta vs. Flusso - Pressurizza

![Graph showing the relationship between pressure drop and airflow](image-url)
Construction details
description on the airtight envelope

Pressione indotta - Pressurizza

Depressurizzare Test
Test Data: 2015-10-07
Ora: 15:34 - 15:45

Environmental Conditions

| Wind speed: | 0: Calmo | from the |
| Operator Location: | Interno the building |
| Initial Bias Pressure: | -1,72 Pa |
| Final Bias Pressure: | -1,14 Pa |
| Barometric Pressure | 101,3 kPa | from Misurazione diretta |

Depressurizzare Risultati

| Coefficiente di correlazione, r [%]: | 99,76 |
| Risultati | 95% confidenza | Incertezza |
| Lower | Upper |
| Esponente ΔP, n: | 0,717 | 0,62596 | 0,80893 |
| Coefficiente di portata, C_{env} [m³/h/Pa]: | 12,164 | 9,112 | 16,24 |
| Coefficiente di infiltrazione, C_{i} [m³/h/Pa]: | 12,140 | 9,095 | 16,21 |
| Flusso d'aria a 50 Pa, V_{50} [m³/h] | 200,97 | 184,7 | 218,7 | +/-8,5% |
| Ricambi d'aria orari a 50 Pa, n_{50} [/h] | 0,4890 | 0,4410 | 0,5370 | +/-9,8% |
| Permeabilità a 50 Pa, q_{50} [m³/h/m²] | 0,2934 | 0,265 | 0,322 | +/-9,8% |
| Portata specifica infiltrazione a 50 Pa, w_{50} [m³/h/m²] | 1,4398 | 1,2082 | 1,4714 | +/-9,8% |
| Effective leakage area at 50 Pa, A_{l} [cm²] | 61,26 | 56,30 | 66,66 | +/-8,8%
| Equivalent leakage area at 50 Pa [cm²] | 100,4 | 92,29 | 109,3 | +/-8,5% |

Relazione Villa Unifamiliare, Via Ugo Foscolo, Castiglione Torinese 10090 (TO), allegati grafici
Construction details

description on the airtight envelope

<table>
<thead>
<tr>
<th>Normalized leakage area at 50 Pa [cm²/m²]</th>
<th>0,0894</th>
<th>0,081</th>
<th>0,098</th>
<th>+/-9,8%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pressione indotta [Pa]</td>
<td>-14,5</td>
<td>-16,7</td>
<td>-21,6</td>
<td>-33,1</td>
</tr>
<tr>
<td>Fan #1, Range C1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pressione al ventilatore [Pa]</td>
<td>13,9</td>
<td>16,0</td>
<td>21,7</td>
<td>41,5</td>
</tr>
<tr>
<td>Flusso [m³/h]</td>
<td>78,30</td>
<td>84,32</td>
<td>99,63</td>
<td>142,9</td>
</tr>
<tr>
<td>Flusso totale, V_r [m³/h]</td>
<td>78,30</td>
<td>84,32</td>
<td>99,63</td>
<td>142,9</td>
</tr>
<tr>
<td>Flusso corretto, V_{env} [m³/h]</td>
<td>79,24</td>
<td>85,33</td>
<td>100,8</td>
<td>144,6</td>
</tr>
<tr>
<td>Errore [%]</td>
<td>3,2%</td>
<td>0,6%</td>
<td>3,8%</td>
<td>0,3%</td>
</tr>
</tbody>
</table>

5 gradini di pressione indotti per 30 secondi ciascuna. (required 30 seconds).

10 ΔP a flusso nullo rilevate per 10 secondi ciascuna. (required 10 seconds).

| Medie ΔP a flusso nullo:                     |       |       |       |
| iniziale [Pa]                               | ΔP01 -1,72 | ΔP02 -1,14 | ΔP01+ 0,19 |
| finale [Pa]                                 | ΔP02 -1,14 | ΔP02 -1,27 | ΔP02+ 0,23 |

| ΔP a flusso nullo, iniziale [Pa]             | -1,75 | -2,11 | -0,31 | -0,75 | -2,03 | -2,75 | -1,35 | -1,78 | -2,48 | -1,78 |
| ΔP a flusso nullo, finale [Pa]              | -1,95 | -1,75 | -0,42 | -0,05 | -0,80 | -1,56 | -1,10 | -0,91 | -1,18 | -1,84 |
Construction details
ventilation plan for the ductwork

Ventilation plan for the central unit / type /specific values

It was used the Zehnder ComfoAir 350 ventilation unit with the following characteristics:
• Comfort ventilation for up to 350 m³/h
• Heat recovery with an efficiency of up to 84%
• CO2 control
• Automatic 100% summer bypass
• Infinitely variable frost protection function: efficient even at low temperatures
• Digital control unit with weekly timer as standard
• Passivhaus Institut accredited (heat recovery efficiency 84%)

According to PHPP calculation, the device has an effective heat recovery efficiency of 79.9% and an electric efficiency of 0.29 Wh / m³

Scheme of the plant
Construction details
ventilation plan for the ductwork

High efficiency double flow double-flow heat recuperator (certificated PHI 84%). Features:
1- Portata 350 mc/h
2- Sensore CO₂
3- Automatic by pass for free cooling
4- System anti-freezing
5- Scambiatore di calore
Efficienza: 80,2 %
P° - 70,1% int.
Qh>1,5 kwh/m2 a 10%
Construction details
ventilation plan for the ductwork

Posa VMC in opera
Internal distribution d=75 mm / Tubazioni in EPP d=160 mm (\( \lambda = 0.042 \text{ W/mK} \))
Bocchette portata max 30 mc/h
Construction details

**heat supply**

**Regulation:** Thermostat in each room, control electrotechnical heads on manifolds

**Solar thermal collectors:** 2.36 m² inclination 3°, forced circulation by emptying

**Distribution:** Radiant floor

**Ventilconvettore:** 4.54 kW

**Generator:** Heat pump 4kW complete circulation pump for heating with storage tank by 300L
Construction details
Impianto ACS

[Diagram with labeled parts and legend:
- Generator ACS
- AC Lavatrice h 60 cm
- AC Lavabo h 85 cm
- AC Bidet h 35 cm
- LEGENDA:
  - Red: Hot water
  - Blue: Cold water
  - Dashed: Main circulation
  - Schema ACS quote]

Relazione Villa Unifamiliare, Via Ugo Foscolo, Castiglione Torinese 10090 (TO), allegati grafici
Important PHPP results

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Unit</th>
<th>Value</th>
<th>Criteria</th>
<th>Alternative criteria</th>
<th>Fulfilled?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treated floor area m²</td>
<td></td>
<td>149,8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Space heating</td>
<td>Heating demand kWh/(m²a)</td>
<td>11,04</td>
<td>≤ 15</td>
<td>-</td>
<td>yes</td>
</tr>
<tr>
<td></td>
<td>Heating load W/m²</td>
<td>12</td>
<td></td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Space cooling</td>
<td>Cooling &amp; dehum. demand kWh/(m²a)</td>
<td>5</td>
<td>≤ 17</td>
<td>17</td>
<td>yes</td>
</tr>
<tr>
<td></td>
<td>Cooling load W/m²</td>
<td>11</td>
<td>≤</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Frequency of overheating (&gt; 25 °C) %</td>
<td>-</td>
<td>≤</td>
<td>-</td>
<td>yes</td>
</tr>
<tr>
<td></td>
<td>Frequency excessively high humidity (&gt; 12 g/kg) %</td>
<td>9,33</td>
<td>≤</td>
<td>10</td>
<td>yes</td>
</tr>
<tr>
<td>Airtightness</td>
<td>Pressurization test result n&lt;sub&gt;50&lt;/sub&gt; 1/h</td>
<td>0,5</td>
<td>≤ 0,6</td>
<td></td>
<td>yes</td>
</tr>
<tr>
<td>Non-renewable Primary Energy (PE)</td>
<td>PE demand kWh/(m²a)</td>
<td>72</td>
<td></td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>Primary Energy</td>
<td>PER demand kWh/(m²a)</td>
<td>37</td>
<td>≤ 60</td>
<td>60</td>
<td>yes</td>
</tr>
<tr>
<td>Renewable (PER)</td>
<td>Generation of renewable energy kWh/(m²a)</td>
<td>17</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Cost
Constructions cost is 1.500 € per square meter of usable area.

Year of construction
The project started October 2014 and finished February 2016.

Architectural design
From an architectural point of view, Case Spanò has a very long history. This project has been characterized by an energy efficiency goal; in addition, ground floor spaces were dedicated to green areas and private parking areas, thus connecting the building to the surrounding urban fabric.

A family of three people, fasting with certifications, so it was my job to approach them in this world, saying that we would have spent a little bit more in the construction phase but that we would have gained in terms of comfort / well-being and spared in the phase of management. Moreover, the municipality of Castiglione was deeply interested in the project.

Forms of facade, colors and materials also refer to the main historic buildings of the great architect Le Corbusier and paintings by Picasso.

Services planning
The system used for heating, cooling and hot sanitary water has been described in some of the previous paragraph.

To summarize:
- production is made by one heat pumps;
- the fluids are then delivered to the units via a hyper isolated distribution system;
- emission is integrated in the mechanical ventilation system;
Structural physics
Great attention has been put over the following aspects:
- acoustic behaviour;
- calculation of thermal bridges;
- evaluation of the surface and interstitial moisture.
Structures were firstly calculated by a software in order to comply with Italian law limits and then verified by on-site measurements.

Acoustic
Results were extremely positive and are summarized in the following table:

<table>
<thead>
<tr>
<th>Analyzed structure</th>
<th>Law requirement</th>
<th>Calculated result</th>
<th>measured result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wall to the outside M2</td>
<td>R'w ≥ 50 dB</td>
<td>53 (-2; -8) dB</td>
<td>65,6 dB con f=1000 Hz</td>
</tr>
<tr>
<td>Floor to the outside S1</td>
<td>L'n,w ≤ 63 dB</td>
<td>53 (-1; -5) dB</td>
<td>62,2 dB con f=1000 Hz</td>
</tr>
</tbody>
</table>

Thermal bridges
Thermal bridges were calculated to verify both energy loss and surface temperature. PSI values were inserted in the PHPP calculation; surface temperature met comfort criterion (Tsi, min > 17 °C).

Moisture
All structure were verified according to EN 13788:2003 with positive result.

Bibliography
This project was presented at:
- “Casa Naturale”, numero 84, 2016
- “La Nuova Voce”, Mercoledì 29 Giugno 2016
- Presentazione al passivhaus days, Novembre 2016