AIRTIGHTNESS TESTING & IMPLEMENTATION AT SCALE

Analysis of New Strategies within a Constrained Project

Marine Sanchez, Passive House Specialist
RDH is one of North America’s largest PH teams

PASSIVE HOUSE CONSULTING
→ 60+ projects
→ Multi-unit experience
→ Commercial experience

FAÇADE ENGINEERING
→ Enclosure Consulting
→ Research & Forensics
→ Energy Design

PHI BUILDING CERTIFIERS
→ Close relationship with PHI
→ PER expertise

Making Buildings Better™
1. Project Background
Agar Grove

• Large urban regeneration of a neglected 60’s social housing neighbourhood in London, UK
• 500 Passive House residential units
• New build + retrofit

Phase 1A certified in spring 2018
Phase 1A

Source: Passivhaus Trust & Max Fordham
Floor Plans

**Levels 1-2**
Maisonettes + Staircase Cores/Flats

**Levels 3-4**
Staircase Cores/Flats

**Levels 5-7**
Staircase Cores/Flats
2. Airtightness Design

- Ancon Tepla-Tie low thermal conductivity wall ties. Type, embedment and wall tie setup as per engineers design and specifications. As NBS F30/210A
- Clay facing brickwork, with whole brick return as NBS F10/110A or 110B dependant on location
- Cavity fully filled with blown mineral fibre insulation as NBS F30/150A
- 200mm thick AAC blockwork as NBS F10370A
- Refer to details elsewhere for internal wall build-up
Airtightness Design

OUTSIDE
- Clay facing brickwork, with whole brick return as NBS F10/110A or 110B dependent on location.
- Cavity fully filled with blown mineral fibre insulation as NBS F30/150A.

INSIDE
- Blown mineral fibre insulation
- Airtightness layer (parge coat & tape)
- Concrete / CMU

200mm thick AAC blockwork as NBS F10/370A

Refer to details elsewhere for internal wall build-up.

Concrete column refer to SE information.
Good Airtightness Layer?

- Simple Design
  - “whole building” airtightness layer, rather than “individual” level
Good Airtightness Layer?

- **Right materials for the job**
  - concrete, parge coat & airtightness tape
Good Airtightness Layer?

• **Buildability**
  » materials easily available
  » installed externally after CMU go up
Good Airtightness Layer?

- Enclosure durability
  - Air & Water Vapour Control Layer (warm side)
  - Protected from the elements
Good Airtightness Layer?

- **Longevity**

  » Inaccessible to occupants

---

Ancon Teplo-Tie low thermal conductivity wall ties. Type, embedment and wall ties setup as per engineers design and specifications. As NBS F30/210A.

Clay facing brickwork, with whole brick return as NBS F10/16A or 11/6 dependent on location.

Cavity fully filled with blown mineral fibre insulation as NBS F30/150A.

200mm thick AAC blockwork as NBS F10/370A.

Refer to details elsewhere for internal wall build-up.

Concrete column refer to SE information.
Good Airtightness Layer?

- **Simple Design**
  - “whole building”, rather than “individual” level
- **Right materials**
  - concrete, parge coat & airtightness tape
- **Buildability**
  - installed externally, after CMU go up
- **Enclosure durability**
  - Air & Water Vapour Control Layer (warm side)
- **Longevity**
  - Inaccessible to occupants
3. Airtightness Implementation & Testing
Airtightness Sequencing

1. Structure + CMU infill
2. Tape Window Openings
3. Install Windows + Tapes
4. Install Parge Coat
Actual Installation

**Design**
Airtightness layer protected from the elements

**Manufacturer**
Installation when dry & not too cold

And during installation? **NO!**

Certainty of installation period? **NO, it was WINTER!**

Degradation = Delays, Additional Costs & Need for Remedial Work
Construction Programme

Traditional Approach
• Floor by floor approach
• Overlapping of trades
• AT layer inaccessible & incomplete

Passive House
• Rigorous airtightness testing
• Forensics tests to investigate & fix while airtightness layer is still exposed

» Whole building test impossible while airtightness layer exposed

» Incurring unfeasible delays & costs

Implementation of non-standard testing solutions
Suite-by-Suite Testing

- Review of each element
- Adjustment of poorly performing strategies (windows)
- Retesting to confirm strategy delivering required airtightness performance

Drawings: Hawkins Brown
Suite-by-Suite Testing

- Review of each element
- Adjustment of poorly performing strategies (windows)
- Retesting to confirm strategy delivering required airtightness performance

Qualitative testing, but no reliable ACH figure.
Testing Results - Airtightness
Floor-by-Floor Testing

- Temporary works
  - Risers, lift shafts
  - Staircases
  - Services penetration
  - Temporary air path
- Internal leaks
  (adjacent floors above & below)

Quantitative testing, but not representative of true performance

Drawings: Hawkins Brown
Testing Results - Airtightness

Airtightness (ACH @ 50Pa)

- Suite L2 Test 1: 7
- Suite L2 Test 2: 3
- Suite L2 Test 3: 26
- Suite L2 Test 4: 7
- Suite L2 Test 5: 3
- Suite L2 Test 6: 26
Floor-by-Floor Testing: Co-pressure

- Pressurization of floors above and below, to obtain “true” airtightness level
- Difficulty of implementation
Testing Results - Airtightness

Airtightness (ACH @ 50Pa)

- Suite L2 Test 1: 7
- Suite L2 Test 2: 3
- Suite L2 Test 3: 26

Note: The graph shows a range of airtightness results for various locations, with a horizontal line indicating the standard threshold.
Whole Building Testing

- Confirm airtightness testing plan (early!)
- Organise kit (blower doors, gauges, tubes ...)
- Do site walk-around (day before) + set-up
- Be ready for complications!
Whole Building Testing
## Whole Building Testing

### APPENDIX IV - Data Recorded

<table>
<thead>
<tr>
<th>Metric</th>
<th>Value 1</th>
<th>Value 2</th>
<th>Value 3</th>
<th>Value 4</th>
<th>Value 5</th>
<th>Value 6</th>
<th>Value 7</th>
<th>Value 8</th>
<th>Value 9</th>
<th>Value 10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Whole Building Testing</td>
<td>2023.5</td>
<td>2023.6</td>
<td>2023.7</td>
<td>2023.8</td>
<td>2023.9</td>
<td>2024.0</td>
<td>2024.1</td>
<td>2024.2</td>
<td>2024.3</td>
<td>2024.4</td>
</tr>
<tr>
<td>Vertical</td>
<td>30.5</td>
<td>30.6</td>
<td>30.7</td>
<td>30.8</td>
<td>30.9</td>
<td>31.0</td>
<td>31.1</td>
<td>31.2</td>
<td>31.3</td>
<td>31.4</td>
</tr>
<tr>
<td>Horizontal</td>
<td>30.5</td>
<td>30.6</td>
<td>30.7</td>
<td>30.8</td>
<td>30.9</td>
<td>31.0</td>
<td>31.1</td>
<td>31.2</td>
<td>31.3</td>
<td>31.4</td>
</tr>
<tr>
<td>Fan Type</td>
<td>High Efficiency</td>
<td>High Efficiency</td>
<td>High Efficiency</td>
<td>High Efficiency</td>
<td>High Efficiency</td>
<td>High Efficiency</td>
<td>High Efficiency</td>
<td>High Efficiency</td>
<td>High Efficiency</td>
<td>High Efficiency</td>
</tr>
<tr>
<td>Fan BF Number</td>
<td>123456</td>
<td>654321</td>
<td>123456</td>
<td>654321</td>
<td>123456</td>
<td>654321</td>
<td>123456</td>
<td>654321</td>
<td>123456</td>
<td>654321</td>
</tr>
<tr>
<td>Pressure</td>
<td>12.34</td>
<td>12.34</td>
<td>12.34</td>
<td>12.34</td>
<td>12.34</td>
<td>12.34</td>
<td>12.34</td>
<td>12.34</td>
<td>12.34</td>
<td>12.34</td>
</tr>
<tr>
<td>Temperature</td>
<td>12.34</td>
<td>12.34</td>
<td>12.34</td>
<td>12.34</td>
<td>12.34</td>
<td>12.34</td>
<td>12.34</td>
<td>12.34</td>
<td>12.34</td>
<td>12.34</td>
</tr>
<tr>
<td>Static pressure</td>
<td>12.34</td>
<td>12.34</td>
<td>12.34</td>
<td>12.34</td>
<td>12.34</td>
<td>12.34</td>
<td>12.34</td>
<td>12.34</td>
<td>12.34</td>
<td>12.34</td>
</tr>
<tr>
<td>Velocity</td>
<td>12.34</td>
<td>12.34</td>
<td>12.34</td>
<td>12.34</td>
<td>12.34</td>
<td>12.34</td>
<td>12.34</td>
<td>12.34</td>
<td>12.34</td>
<td>12.34</td>
</tr>
<tr>
<td>Temperature</td>
<td>12.34</td>
<td>12.34</td>
<td>12.34</td>
<td>12.34</td>
<td>12.34</td>
<td>12.34</td>
<td>12.34</td>
<td>12.34</td>
<td>12.34</td>
<td>12.34</td>
</tr>
<tr>
<td>Static pressure</td>
<td>12.34</td>
<td>12.34</td>
<td>12.34</td>
<td>12.34</td>
<td>12.34</td>
<td>12.34</td>
<td>12.34</td>
<td>12.34</td>
<td>12.34</td>
<td>12.34</td>
</tr>
<tr>
<td>Velocity</td>
<td>12.34</td>
<td>12.34</td>
<td>12.34</td>
<td>12.34</td>
<td>12.34</td>
<td>12.34</td>
<td>12.34</td>
<td>12.34</td>
<td>12.34</td>
<td>12.34</td>
</tr>
<tr>
<td>Temperature</td>
<td>12.34</td>
<td>12.34</td>
<td>12.34</td>
<td>12.34</td>
<td>12.34</td>
<td>12.34</td>
<td>12.34</td>
<td>12.34</td>
<td>12.34</td>
<td>12.34</td>
</tr>
<tr>
<td>Static pressure</td>
<td>12.34</td>
<td>12.34</td>
<td>12.34</td>
<td>12.34</td>
<td>12.34</td>
<td>12.34</td>
<td>12.34</td>
<td>12.34</td>
<td>12.34</td>
<td>12.34</td>
</tr>
<tr>
<td>Velocity</td>
<td>12.34</td>
<td>12.34</td>
<td>12.34</td>
<td>12.34</td>
<td>12.34</td>
<td>12.34</td>
<td>12.34</td>
<td>12.34</td>
<td>12.34</td>
<td>12.34</td>
</tr>
<tr>
<td>Temperature</td>
<td>12.34</td>
<td>12.34</td>
<td>12.34</td>
<td>12.34</td>
<td>12.34</td>
<td>12.34</td>
<td>12.34</td>
<td>12.34</td>
<td>12.34</td>
<td>12.34</td>
</tr>
</tbody>
</table>

### Other Data Recorded

- **Average Static pressure at all locations:** Value 1
- **Differential pressure:** Value 2
- **Fan flow pressure:** Value 3
- **Corrected flow:** Value 4
- **Pressure at each:** Value 5
- **Temperature:** Value 6
- **Static pressure:** Value 7
- **Velocity:** Value 8
- **Temperature:** Value 9
- **Static pressure:** Value 10

### Additional Details

- **Whole Building Testing**
- **Vertical Flow:** Value 11
- **Horizontal Flow:** Value 12
- **Flow Efficiency:** Value 13
- **Temperature:** Value 14
- **Static pressure:** Value 15
- **Velocity:** Value 16
- **Temperature:** Value 17
- **Static pressure:** Value 18
- **Velocity:** Value 19
- **Temperature:** Value 20
- **Static pressure:** Value 21
- **Velocity:** Value 22
- **Temperature:** Value 23
- **Static pressure:** Value 24
- **Velocity:** Value 25
- **Temperature:** Value 26
- **Static pressure:** Value 27
- **Velocity:** Value 28
- **Temperature:** Value 29
- **Static pressure:** Value 30
Testing Results - Airtightness

Airtightness (ACH @ 50Pa)

Suite L2 Test 1
Suite L2 Test 2
Suite L2 Test 3
Suite L2 Test 4
Suite L2 Test 5
Suite L2 Test 6
Suite L1 Test
Floor L3 Test
Floor L3 Retest
Floor L4 Test
Floor L4 Retest
Floor L5 Upper Test
Floor L5 Lower Test
Floor L5 Lower Retest
Floor L6 Lower Test
Floor L6 Lower Retest
Floor L6 Upper Test
Floor L7 Test
Floor L4 Copressure
Floor L5 Lower...
Floor L5 Upper...
Floor L7 Upper...
Floor L3 Copressure
Floor L1 + L2 Copressure
Whole Building Test

7 3 26
Testing Results - Air Permeability

Air Permeability (m³/hr.m²)
Summary

- Plan ahead: good design is not enough!

- Need for:
  » Excellent design and improve it further to make installation and testing
  » Excellent buildability (installation period, exposure to the weather, materials & their availability, ...)
  » Adapted construction programme & sequencing to include and facilitate meaningful
  » Design easy to test (airtightness testing plan available early)

- Air permeability giving more useful figures with interim partial testing
- Do the calculations to assess how much leakage by surface area can be tolerated
- Do 100% QA check (qualitative and/or quantitative)

- Do it once and do it right!
Thank you.

Marine Sanchez
msanchez@rdh.com