



Project information

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| Completion date: | January 2019 |
| Building type: | Private house |
| Location: | Eton, Berkshire |
| Architect: | Matthew Barnett Howland with Dido Milne and Oliver Wilton |
| Executive architect: | MPH Architects |
| Client: | Matthew Barnett Howland and Dido Milne |
| Structural engineer: | Arup |
| M & E consultant: | Arup (Fire) |
| Main contractor: | Matthew Barnett Howland assisted by M&P London Contractors |
| CNC machining: | Wup Doodle, Norfolk |
| Joinery: | Whyte and Wood. Nic Rhode Furniture, Tom Graham Workshop |
| Timber supplier: | NFP Europe Ltd |
| Timber elements: | Structure, walls, floor, pyramid roofs, windows, doors, internal joinery |
| Timber species: | PEFC- and FSC-certified Western red cedar, spruce CLT, American white oak, Cradle to Cradle Gold Certified Accoya (Radiata Pine). Cork oak bark (Quercus Suber), Portugal |

Introduction

Cork House is unique; it is the built form of a radical new approach to construction and sustainable design. The architects, Matthew Barnett Howland, Dido Milne and Oliver Wilton, set out to re-think a building from first principles, considering each stage of its life, including whole-life carbon, material life-cycle and design for disassembly. They examined alternatives to the complex assemblies of composite materials which make up modern wall systems. Could a single solid material be used as an alternative? Their research led them to expanded cork, a bio-renewable material with a remarkably sustainable life cycle. In its solid form, it integrates structure, insulation, external and internal finish.

The walls and the five corbelled roof pyramids of Cork House are made of monolithic cork blocks, solid from inside to outside, which interlock so they can be built without mortar, glue, insulation, plaster or render. The system is carbon negative, designed for self-build assembly, and at the end of the building's life the cork can be re-used.

It is an innovative building, but one which also had to respect the idyllic and historic context of its site. Its home is the riverside garden of a Grade II listed 19th century mill house, purchased a decade ago by Howland and Milne, who became not only architects but also clients and builders. The house nestles amid mature trees and acts as a gateway into a walled garden. It is linear in plan, 18 metres

long, and consists of five bays, each topped with a pyramidal roof. The cork blocks which form the pyramidal roofs are clad with cedar weatherboards and rainwater is discharged via copper-lined valleys and copper rainwater goods.

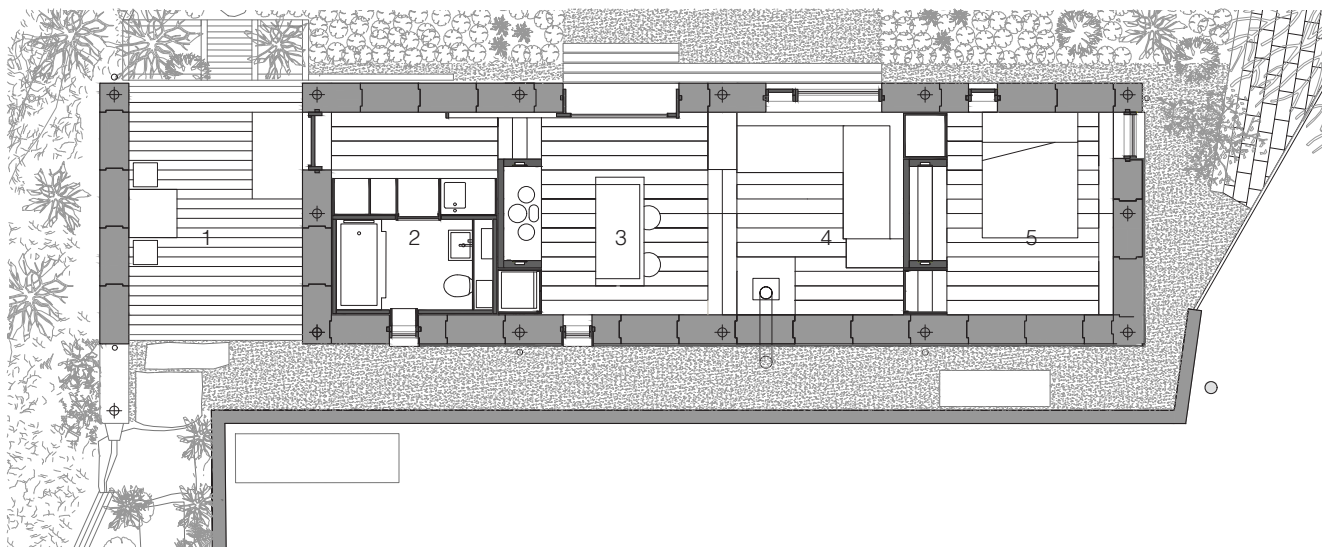
The first bay, the threshold between the two gardens, creates a space for sheltered outside living; the next bay is an entrance foyer and a generous bathroom with a sleeping loft above it. Two further pyramidal roofs enclose a kitchen/living room, with a bedroom in the final module beyond. Inside the house, the exposed cork walls are warm to the touch and create a rich sensory environment involving touch, sound and even smell.

As the architect explains: 'The resultant architectural form is new and yet familiar, a progressive reimagining of ancient structures and simple construction principles that considerably exceeds contemporary building performance requirements. With a focus on what is solid, simple and sustainable, the project is also an innovative response to some of the complexities and conventions of modern building practices'.

Long section



Plan



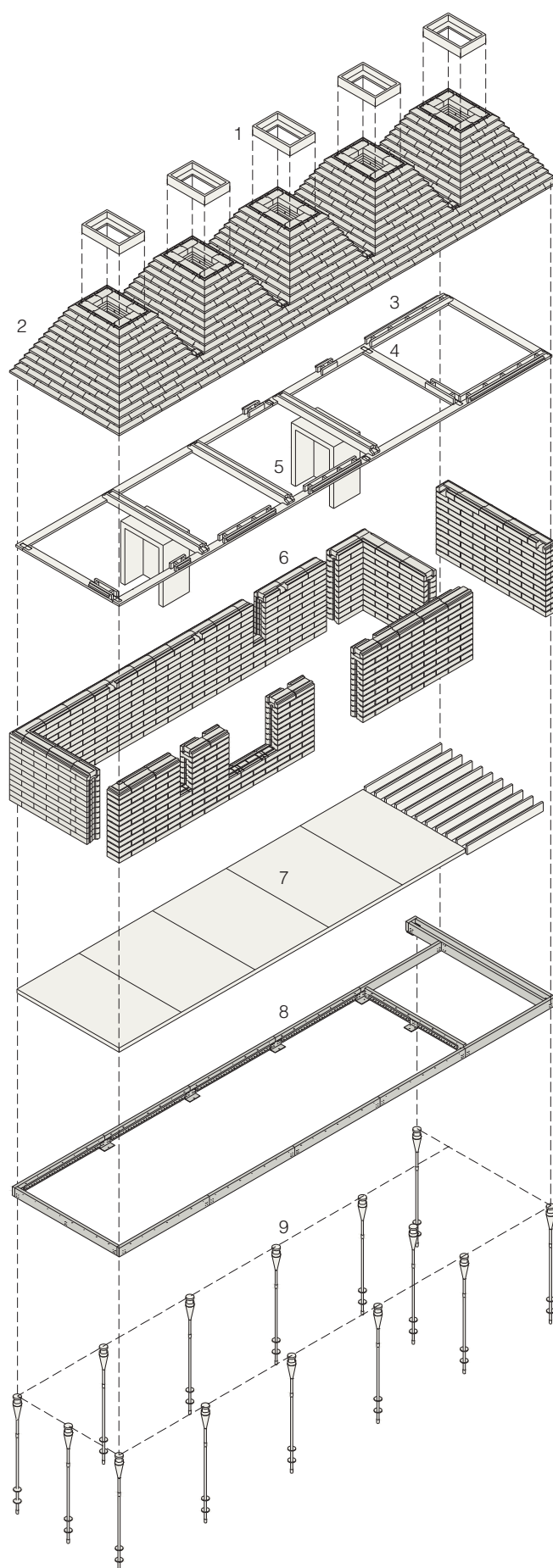
Site plan



Key

- 1 outdoor living
- 2 bathroom
- 3 cooking and eating
- 4 living room
- 5 bedroom
- 6 walled garden
- 7 Cork House
- 8 Tangier Mill
- 9 water filter plant
- 10 River Thames

Exploded isometric of cork house construction



Key

- 1 rooflight in Accoya frame
- 2 cork roof blocks
- 3 Accoya ring beam and lintel
- 4 Accoya valley beam
- 5 spruce CLT structural wardrobe
- 6 cork solid wall blocks
- 7 spruce CLT floor panel
- 8 Accoya ring beam
- 9 Steel screw pile with extension leg



The walls and roof were fabricated from solid expanded cork blocks.

The use of cork

Expanded cork is a material with a unique and traditional ecological origin. Mediterranean cork oak forests, grown for centuries to make wine stoppers for local vineyards, are landscapes which are rich in biodiversity. The bark of the cork oak is harvested every nine years without felling or harming the trees or disturbing the forest. Expanded cork is manufactured from the waste product of the harvest. In addition, expanded cork has superb thermal performance, is excellent in compression and is entirely bio-renewable.

The Cork House project utilised an evolved version of a cork construction system researched and developed from 2015 to 2018 by MPH Architects, the Bartlett School of Architecture UCL, University of Bath, Amorim UK and Ty-Mawr, with subcontractors including Arup and BRE. The research explored design hypotheses and prototypes, and built constructional models to scale. A robotic milling technique was developed at the Bartlett to shape the cork blocks. Test panels were laboratory-tested to address a range of performance criteria, with the University of Bath focusing on structural testing and BRE undertaking fire performance and rain tightness testing. A small prototype building was created and monitored to help establish performance through the seasons under real weather conditions.

The research was part-funded by Innovate UK and EPSRC under the 2015 Building Whole Life Performance funding competition. It established the viability of the cork construction system for a range of applications, and de-risked the system sufficiently for application on its first live project.

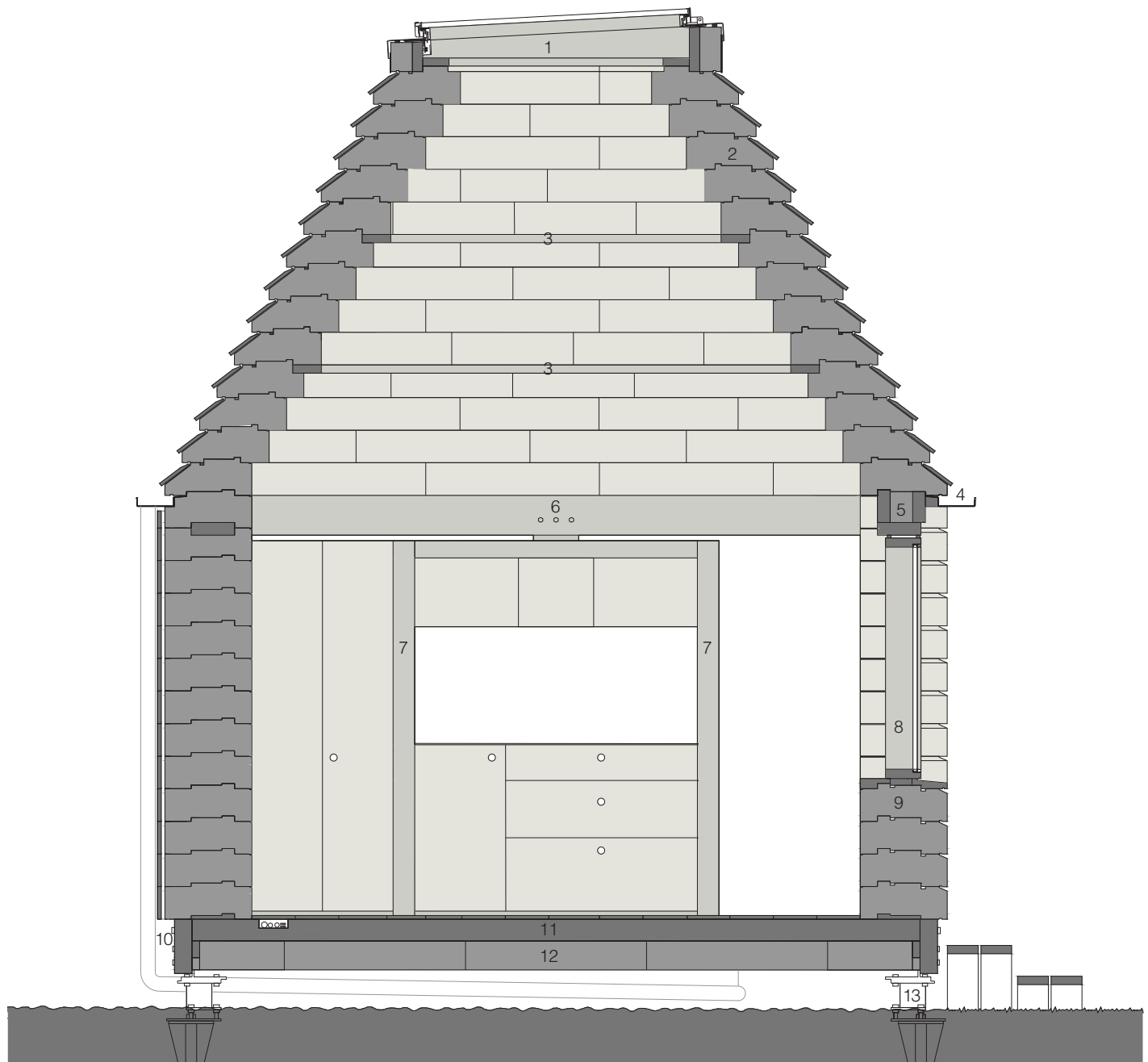


The bark of the cork oak is harvested every nine years.



The expanded cork blocks were prefabricated to interlock in plan and section.

Detail cross section through cork house



Key

- 1 steel rooflight in Accoya frame
- 2 cork roof blocks overlaid with cedar weatherboards
- 3 Accoya minor ring beam
- 4 copper gutter
- 5 Accoya ring beam and lintel
- 6 Accoya valley beam
- 7 spruce CLT structural wardrobe
- 8 Accoya window frame
- 9 solid cork wall blocks
- 10 Accoya ring beam
- 11 spruce CLT floor panel
- 12 cork insulation
- 13 steel screw pile with extension leg



Two pyramidal roofs with rooflights enclose the kitchen/living room.



The corbelled cork roof blocks are overlaid with cedar weatherboards and drain into copper valley gutters.

Construction

The construction was designed as a prefabricated kit-of-parts. The blocks of expanded cork (1,268 of them) were CNC-machined off-site using a digital machine cutting process that could produce a block every five minutes. The blocks are generally one metre x 500mm in size and light enough to be assembled on-site by hand. They are profiled so that they interlock in both plan and section with friction-fit joints, without the use of mortar or glue. The blocks are supported at ground floor level on an Accoya ring beam and spruce cross-laminated timber (CLT) floor panels which, in turn, transfer all loads to 14 removeable steel screwpile foundations.

The cork wall structure is in pure compression and all lateral loads are taken through an Accoya ring beam and valley beams, both integrated into the cork block structure at eaves level. Accoya lintels combine with the eaves ring beam to form a U-beam over window and door openings.

The five quadrilateral pyramid roofs were made using the same principles of interlocking joints, but each block is corbelled in from the one below, creating a series of five truncated pyramids, each surmounted with a triple-glazed rooflight fixed to an Accoya frame. Accoya is used for structural beams, windows, doors and steps, and two sets of smaller Accoya ring beams are incorporated into each roof pyramid to stiffen the centre of the roof planes, providing support during assembly without falsework, and regulating the roof geometry.

The CLT floor panels are finished with unplanned cross-sawn oak floorboards (screwed rather than nailed for ease of disassembly). All internal built-in joinery is made from spruce Tilly board and loose furniture is made from reclaimed spruce CLT boards.

Extensive testing resulted in minor modifications. To improve airtightness, a 10mm rebate for a removable foam insert was incorporated into the joints, and the external sloping surfaces of the cork corbels which create the pyramids were lined with western red cedar weatherboards, which drain rainwater into copper-clad valleys between the pyramids and discharge into a series of copper gutters. As part of the fire engineering scheme, Class 0 fire-rated western red cedar was used to line the rear façade externally, and sprinklers were installed internally to avoid any internal coating or lining of the cork.

Awards

The cork blocks and all other connections are mechanical and accessible, and the whole house is 'designed for disassembly' so that the cork can be re-used at the end-of-building-life as either biological or technical nutrients. This innovative and radically simple form of biogenic construction is carbon negative at completion and has exceptionally strong whole-life performance including estimated whole-life carbon emissions of 618kg CO₂ eq/m².

RIBA Stirling Prize shortlist 2019
RIBA Stephen Lawrence Prize 2019
RIBA National Award 2019
RIBA South Sustainability Award 2019
RIBA President's Awards for Research 2019 Shortlist
The Manser Medal – AJ House of the Year Shortlist
The Wood Awards Gold Winner 2019
The Wood Awards Private Winner 2019



The silver-grey cork pyramids of Cork House emerge from a riverside garden, with Eton College Chapel in the distance.

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TRADA

t +44 (0) 1494 569601
f +44 (0) 1494 565487
e membership@trada.co.uk
w trada.co.uk

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BM TRADA

Chiltern House Stocking Lane Hughenden Valley High Wycombe Buckinghamshire HP14 4ND UK
t +44 (0) 1494 569600 **f** +44 (0) 1494 565487 **e** bmtrada.com/bookshop **w** bmtrada.com