A corking idea

Matthew Barnett Howland's research into sustainable building materials has led him to design and construct a house made from cork blocks

Cork may seem the unlikeliest of structural materials, but so successfully did architect Matthew Barnett Howland utilise its properties that a house he built for himself – using 1,268 tongue-and-grooved cork blocks – was shortlisted for the 2019 Royal Institute of British Architects' Stirling Prize.

It was a project more than five years in the making, borne out of Barnett Howland's interest in environmental performance and sustainability, coupled with his desire to construct a house out of a single bio-renewable material with breathable wall insulation. Research funding secured from Innovate UK and the Engineering and Physical Sciences Research Council provided the means to explore and develop ideas about whole-life building performance – and, in particular, whether cork could deliver all the separate functions required by a traditional building envelope.

Working with Dido Milne from CSK Architects (where he is now Director and leads research development) and Oliver Wilton from the Bartlett School of Architecture, Barnett Howland envisaged a small (45m²) one-bedroom house in the back garden of his Eton home. It was assembled from interlocking blocks that were manufactured offsite and is equally capable of being disassembled. Additional collaborators were drawn in: Professor Peter Walker of the University of Bath, who examined creep and shear; and Arup, whose structural and fire engineers ensured the project's compliance with building regulations.

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Explaining the genesis of the project, Barnett Howland says: "I was very interested in developing a house based on simple, solid forms of construction, and cork was the means by which that concept could be realised.

"We had an inkling that it could be used structurally, because we've seen it used in compression – it's used to form an anti-vibration base for machinery. So we thought it had some structural capacity. And because it's breathable insulation, we thought maybe it could deal with moisture transfer across the building envelope as it's partly hydrophobic, partly hygroscopic. And as part of our construction kit we introduced timber into the mix to create a combination of cork and timber."

Composite cork

Vertical loads are taken through the cork in compression. Most lateral and shear loads are taken through the timber elements: a ground-floor timber ring

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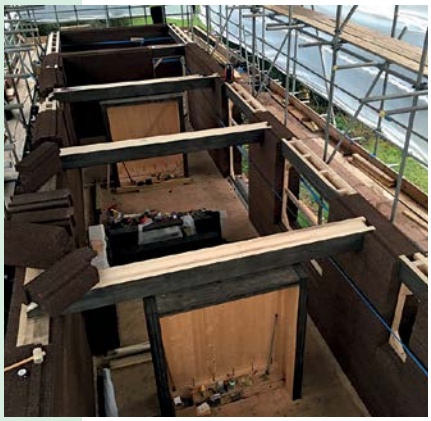
The pyramid-like roof features timber weatherboarding to deal with wind-driven rain



› The blocks consist of granulated and rebonded cork, while lateral loads are handled by timber beams

beam above ground, with cross-laminated timber (CLT) panels dropped into that to form a solid timber deck. In the middle of the house are two CLT 'wardrobes' – structural timber cores – and at eaves level are another ring beam around the whole building and a series of valley beams.

Structural solidity comes from the ladder of timber beams at eaves level, which are tied down to the structural timber cores. This means the lateral load is taken through into the CLT floor and out to the ground floor ring beam. But all the vertical load is taken through the cork.

The building blocks are not pure cork straight from the tree – they are a composite form. They have been granulated and cooked, then bonded back together in their own juices. However, water can find a route between the granules. That meant the problem of wind-driven rain had to be solved by placing timber weatherboarding on its roof, which is built from the cork blocks into series of striking beehive-like pyramids with roof lights at the top. The roof was made airtight only by introducing a narrow strip of expanding foam tape to the internal face of the joints between the blocks.

The cork blocks were made by Portuguese company Amorim – the biggest cork manufacturer in the world – which joined as a project partner.

Amorim had been developing a denser form of its high-grade cork insulation product, MD Facade, which at 150kg/m^3 has a density about one-third that of softwood. However, this was the first time that it has been used in a structure for full-time habitation. "The product is entirely plant based – 93% of the energy used in its manufacture comes from cork biomass from the harvest, so even the energy used to cook it is pretty low carbon. That's what makes it an unusual product," says Barnett Howland.

Engineering the finishes

As the house lacks linings and voids to house services in, these were pre-routed into the CLT floor and into the timber structural wardrobes. A small bathroom pod, which is a CLT box, also accommodates all the associated services.

After fire tests for the roof were undertaken by BRE Group, the fire sprinkler system was fitted so as to avoid treating the interior with chemicals or linings and maintain the material purity of the cork. "We want to be able to disassemble the cork and put it straight back into the soil – a proper cradle-to-cradle model," Barnett Howland says.

The foundations are screw piles. Barnett Howland says: "We were trying to do it without any wet trades, and without any cement or concrete. [The foundations are] lightweight and removable, which is part of our light footprint concept again."

No glue was used in the connections between the cork structure, timber structure and built-in joinery. Says Barnett Howland: "You could always be purer; you could try and make doors and windows without any glue. But that's pretty tricky.

"We did design bespoke windows and doors, a whole system for this project. In the jams of the blocks around openings, there's a continuous rebate. Into that you push a batten, so it's mechanically located. Then you bolt through the window frame onto that batten. You could take out a window in less than half an hour.

"The gap between the window and the structure was filled with an expanding foam tape, which is a shame, because this is a petrochemical product. But on the other hand, it's removable – so at the end of the building's life, it's not stuck to anything."

Milne's parents are now living happily in the cork house – and enjoying the architecturally rich experience. Meanwhile, Barnett Howland is working on new cork construction projects and looking at ways to expand the market applicability of the cork system by making it cheaper to build.

"The blocks required a lot of machining, which creates extra cost. It's actually a pretty expensive form of construction. It ended up being like a cork construction system for Prada, as it were – it's quite high end. Part of our research at the moment is about how we can row back a bit on some of the decisions we made in the cork house and think through a simpler and therefore more cost-effective system. The impact of the house is in the model of construction and habitation and design that it delivered, not necessarily in the future delivery of thousands of cork houses." be

For more details, see bit.ly/MBHCorkHouse

IMAGE: MATTHEW BARNETT HOWLAND