



**Oliver Wilton  
Matthew Barnett  
Howland**

**Cork  
Construction**



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**1 (previous)** Cork House  
main façade.

**2** Cork House, detail.

## Project Details

Author	Oliver Wilton
Co-author	Matthew Barnett Howland
Title	Cork Construction
Output Type	Building and construction system
Date	2014 to 2019
Total Budget	£600,000

### Stage One, Cork Casket, 2014 to 2015

Output Type	Preliminary research, including a small building
Principal Investigators	Oliver Wilton and Matthew Barnett Howland
Structural Advice	Andrew Lawrence, Global Timber Specialist, Arup (via £5,000 of internal funding)
Materials and Technical Advice	Amorim UK gave free issue and advice on the expanded cork
Research Funding	Part-funded by a £5,000 Innovation Voucher from Innovate UK

### Stage Two, Cork Construction Kit, 2015 to 2018

Output Type	Building construction system
Principal Investigators	Matthew Barnett Howland, MPH Architects, industry lead; Oliver Wilton, UCL PI
Structural Testing and Characterisation	Pete Walker, University of Bath PI
Cork Supply and Technical Advice	Amorim UK, industry partner
Market Advice	Nigel Gervis, Technical Director, Ty Mawr

PROJECT DETAILS

Structural Engineering Consultants	Andrew Lawrence, Global Timber Specialist, Arup; Gavin Maloney, Senior Engineer, Advanced Digital Engineering, Arup
Fire-Safety Engineering Consultant	Graeme Flint, Senior Fire Engineer, Arup
Building Thermal-Performance Modelling	Jake Hacker, Associate, Advanced Digital Engineering, Arup
Lab-Testing Consultant (fire and wind-driven rain)	Building Research Establishment (BRE), Watford; Preliminary fire characterisation work at BRE Centre for Fire Safety Engineering, University of Edinburgh
Robotics Advice	Peter Scully, UCL
Research Assistants	Michael Arnett, Emma Kate Matthews
Research Funding	£189,820 Building Whole Life Performance competition, Innovate UK 102474, EPSRC grants EP/N509048/1 and EP/N50905X/1; Commercial partner in-kind contributions brought the total funding to £270,055

**Stage Three, Cork House, 2017 to 2019**

Output Type	Building
Function	House (ancillary dwelling in the grounds of a larger house)
Location	Eton, Berkshire
Clients	Matthew Barnett Howland and Dido Milne
Practical Completion	January 2019
Budget	Circa £300,000
Area	60 m <sup>3</sup> + 15 m <sup>3</sup> covered terrace
Architects	Matthew Barnett Howland with Dido Milne and Oliver Wilton

Structural Engineering Consultants	Andrew Lawrence, Global Timber Specialist, Arup; Gavin Maloney, Senior Engineer, Advanced Digital Engineering, Arup
Fire-Safety Engineering Consultant	Graeme Flint, Senior Fire Engineer, Arup
Whole-Life Carbon Assessment	Sturgis Carbon Profiling LLP
Main Contractor	Matthew Barnett Howland
Cork Supply	Amorim Isolamentos
CNC Milling	Wup Doodle Ltd
Assembly of Large Components	M&P Construction
Structural Accoya and CLT Supply	NFP Europe/SBM Fastwood
Bespoke Accoya Doors and Windows	Whyte and Wood
Steel Screwpile Foundations	ABC Anchors
Fire Detection (Design and Installation)	Impulse Engineering Ltd
Fire Suppression (Design and Installation)	Residential Sprinkler Solutions
Copper Rainwater Goods	Good Directions Ltd

PROJECT DETAILS



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3 Aerial view.

## Statement about the Research Content and Process

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### Description

This research encompasses the development of the Cork Construction Kit – a radically simple new form of solid cork and timber construction – and the design and building of Cork House – the first building of its type, with exceptionally strong whole-life environmental sustainability performance.

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### Questions

1. How can a new form of construction be proposed that uses whole-life environmental sustainability principles?
2. How much material and constructional complexity can be removed from a construction whilst still meeting building codes?
3. Can interlocking cork blocks be used to create a structural building envelope?
4. What might the resulting architectural language and whole-life performance be?

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### Methodology

An innovative interdisciplinary methodology was developed and used across the various stages of the research:

1. Cork Casket: Discourse, critical analysis, conjecture, design, making, trial and error, basic building performance evaluation;
2. Cork Construction Kit: Hypothesis, design and engineering, material formulation and testing, robotic milling, lab testing, construction, building performance evaluation;
3. Cork House: System development, design, making, whole-life carbon assessment, building performance evaluation.

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### Dissemination

Articles by the authors have featured in *The Journal of Architecture* and *Fabricate 2020: Making Resilient Architecture*. Cork House has been discussed in numerous articles in international print publications (*Frankfurter Allgemeine Zeitung*, *Icon*, *La Repubblica*, *The Observer*, *The Financial Times*, amongst others) and online (*Detail*, *Reuters*, *World Economic Forum*). The work has also featured on national television, notably *Grand Designs House of the Year*. It has been presented in invited lectures in the UK, USA, Australia and Asia.

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## Project Highlights

The project won £189,820 research funding from Innovate UK and EPSRC.

A 10,000-word article by the authors won the 2019 RIBA President's Award for Design and Technical Research, and was published in *The Journal of Architecture*.

Cork House has won several prizes, including the Stephen Lawrence Prize, The Manser Medal, Wood Gold Award, RIBA National Award and the RIBA South Sustainability Award. It was shortlisted for the 2019 RIBA Stirling Prize.

Cork House features as an exemplary case study for sustainable building in the UIA's guidebook *An Architecture Guide to the UN17 Sustainable Development Goals* (2018).

It is discussed in several other books educating on environmental sustainability, including Barnabus Calder's *Architecture: Buildings and Energy from Prehistory to the Present*, published by Pelican (2021).

## Introduction

The aim of this research is to develop a new, radically simple form of solid, dry-jointed cork and timber construction. The system has outstanding whole-life performance, and creates a model for exceptionally low-carbon building. Cork blocks manufactured from forestry waste interlock for easy assembly to create structures that are low energy to inhabit and easy to disassemble for reuse. An architectural language of cork stereotomy has been developed that reimagines historic dry-stone construction using a palette of different materials.

The research was undertaken from 2014 to 2019 in three steps:

- Cork Casket was curiosity-driven research, including hypothesising and making;
- Cork Construction Kit developed the design hypothesis and involved extensive prototyping and lab testing to address structure, fire and weathertightness; a cork cabin was created and the system design established and evaluated;
- Cork House focused on creating and evaluating the first house of its type. It is permanent, replicable and designed to meet local building codes.

The research demonstrates the potential for simple new forms of off-site plant-based construction. It addresses key challenges relating to whole-life environmental sustainability performance and the need to reduce complexity and increase quality and productivity in the construction industry.

## INTRODUCTION



4 Approach to Cork House.

## Aims and Objectives

The aim of this research is to rethink the wall, and the building envelope more broadly, by developing a radically simple new form of plant-based construction. This is in response to the authors' observations that contemporary forms of construction tend to meet current performance requirements through an aggregate approach, with a multiplicity of divergent components and layers. This adds complexity at every stage of a building's lifecycle, and often ends in destructive demolition and the downgrading of resources because the building is too costly to disassemble. The intention here is to develop a construction system with outstanding whole-life environmental sustainability performance, using plant-based materials, in a system that is easy to assemble, low energy to inhabit and easy to disassemble at the end of a building's life.

Expanded cork was identified as being a suitable material, combined with engineered timber. Specific objectives include developing a form of construction made of expanded cork blocks and engineered timber – the Cork Construction Kit – and testing this system in the first building of its type – Cork House. Cork House was then evaluated as a pilot project for the Cork Construction Kit. More broadly, it acts as an exemplar for a radical, research-based approach that contributes to whole-life building performance.

## Questions

### **1. How can a new form of construction be proposed that uses whole-life environmental sustainability principles?**

Current forms of construction have strengths and weaknesses regarding their environmental sustainability performance, considering each stage in a building's lifecycle. These strengths and weaknesses have effectively been designed over a lengthy period of evolution in response to changing building performance norms and requirements. This research asks what might be achieved with a new form of construction developed in consideration of sustainability principles at each building lifecycle stage. What might it be made of? Where might these materials come from? How might its components be shaped and assembled into a building? What might its inhabitational character be? What might happen at the end of a building's life?

### **2. How much material and construction complexity can be removed from a construction whilst still meeting building codes?**

Current forms of construction are often complex, having evolved to meet changes in building requirements and codes using an accretive arrangement that adds further elements to established configurations. They often consist of numerous layers and components made from different materials, assembled by a range of specialist tradesmen in an intricate process that results in buildings with significant built-in complexity. This complexity adds challenges to the architectural design process and each stage of a building's lifecycle, which often ends in destructive demolition due to excessive disassembly costs.

### **3. Can interlocking cork blocks be used to create a structural building envelope?**

Expanded cork is 100% plant-based, made from other industry by-product and forestry waste. Traditionally used as insulation board, it has more recently been adopted to clad buildings. This research investigates whether expanded cork blocks can be used to fulfil all of the functions of the building envelope, providing satisfactory structural, fire and airtightness performance, and weather resistance in addition to the material's established roles. The research addresses whether an interlocking cork-block system can be used to create a building envelope that is easy to assemble and disassemble at the end of a building's life.

### **4. What might the resulting architectural language and whole-life performance be?**

The key areas of research interest were cork stereotomy (the shaping of cork blocks), the architectural tectonics of the Cork Construction Kit and the resultant architectural language and inhabitational character of Cork House. What might the lifecycle be for a building using the system, and what might its whole-life environmental sustainability performance be, including its carbon performance?

## Context

This research is situated in a number of specific contexts, relating to the questions addressed by the work and also the authors' broader research interests and areas of activity:

### Environmental sustainability and whole-life building performance

There is increasing recognition that our planet is in a climate-change and biodiversity-loss emergency caused predominantly by human activity. The construction and operation of buildings contributes significantly to this emergency, accounting for 39% of energy and process-related carbon dioxide emissions in 2018 (International Energy Agency 2019). The environmental impact of a work of architecture accrues over its entire life. This can be reduced by using a whole-life approach, addressing each stage of a building's creation and use. This approach is rarely used at present, with recent UK design and regulatory efforts focusing mainly on ways to reduce operational energy and associated carbon emissions. Key areas that currently receive limited attention include embodied carbon reduction, ways to reduce the biodiversity impact of building materials, ways to simplify construction in order to reduce unmanageable complexity and designing for disassembly to enable material reuse at the end of a building's life. There is significant potential to improve environmental performance via incremental improvements relating to each building lifecycle stage. Alongside this, developments in engineered plant-based materials and digital design and fabrication workflows are making radical new forms of environmentally sustainable construction possible, which is the context for this research.

### Simple forms of architecture

The research is informed by the lineage of masonry architecture and makes an original contribution by using plant-based blocks for load-bearing walls and corbelled roofs. It is informed by dry-stone construction, which is historically built by simply placing one stone on top of another (5, 7). The work rethinks and extends this approach to create a simple form of architecture made of cork and timber that meets current building performance requirements.

Many forms of construction use complex assemblies of divergent components and layers to meet building performance requirements (6). This research stands counter to that, developing a system that is materially and constructionally simple. It is located in contemporary, solid, low-carbon forms of construction, such as the stone projects of architect Gilles Perraudin (2013) (8) and the rammed earth projects of architect Martin Rauch, e.g. Lehmhaus Rauch (2008). The research is original within the field, differentiated by its use of plant-based materials in dry-jointed assemblies and compression structures for roofs, alongside its focus on whole-life performance.

**5** The Lion Gate, Mycenae, Greece, 1250 BC.

**6** Contemporary timber frame wall with brick outer leaf.

**7** Borie dry-stone huts in France, eighteenth century.

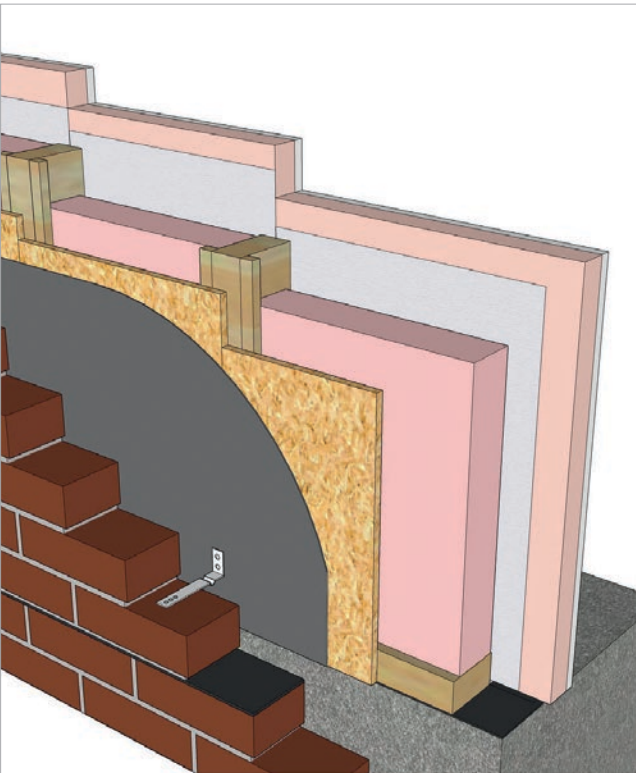
**8** Gilles Perraudin, Museo Del Vino, Corsica, 2012.



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### **Cork oak and expanded cork**

The material context for the research is cork, specifically the outer bark of the cork oak tree, *Quercus suber*. Cork oak landscapes have been present in the Mediterranean basin for millennia and support significant biodiversity. Cork is harvested around once a decade in a process that does not harm the tree **(9–10)**. It has been used in construction for thousands of years, with cork roof planks and thermal insulation dating back at least to Roman times. The material used here is expanded cork, formed into billets by cooking granulated waste cork in autoclaves, which is then bonded by suberin that naturally occurs in the cork **(11)**. The resultant billets are 100% plant-based and are typically carbon-negative due to the atmospheric carbon absorbed by the cork during growth. The material also helps to sustain biodiverse cork oak landscapes by helping to fund their operation. Uses include thermal insulation and occasionally external cladding and internal linings. This research develops an original application for expanded cork, extending its role to the primary structure and weathertight envelope of a building.



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**9-10** Cork being stripped from a tree in the Portuguese Montado.

**11** Waste cork manufactured into expanded cork billets at Amorim, Portugal.

## Methodology

A rigorous interdisciplinary methodology was developed, enabling the research to move forwards from initial curiosity to the creation of Cork House. This joined-up methodology was critical in enabling the research to address matters across the building's lifecycle, utilising interdisciplinary expertise and methods beyond typical architectural research.

**12-3** Initial cork fabrication and assembly investigations.

**14-5** Assembling the Cork Casket.

### 1. Cork Casket, 2014 to 2015

This was a preparatory step, with discussion between the authors determining the area of research. A critique of the complexity of current forms of construction and an appreciation of historic dry-stone building led the authors to consider the potential for a simple cork-block construction system. The potential whole-life performance of such a system was investigated and scoping work was undertaken for subsequent steps.

The research involved sketch designing, making and evaluating (**12-3**). Fabrication was straightforward, using analogue woodworking tools which gave a tactile understanding of the material. The Cork Casket was created using cork blocks to form walls and a corbelled roof (**15**). Each course of blocks was located with timber dowels and bonded with lime mortar (**14**), which ensured that it would not blow away. Disadvantages included cost, complexity and increased construction time due to the dowels and mortar.

A basic building performance evaluation revealed that the building leaked, in part due to a design defect. Thermal and humidity monitoring of Cork Casket and a reference building constructed using PIR insulation to the same U-value indicated that Cork Casket was more thermally stable and a little cooler, perhaps due to lower airtightness. The Cork Casket gave a sense of the architectural potential of using expanded cork in a structural building envelope. It also showed how introducing additional materials can cause problems, informing the decision to resolutely pursue a dry-jointed system.

METHODOLOGY



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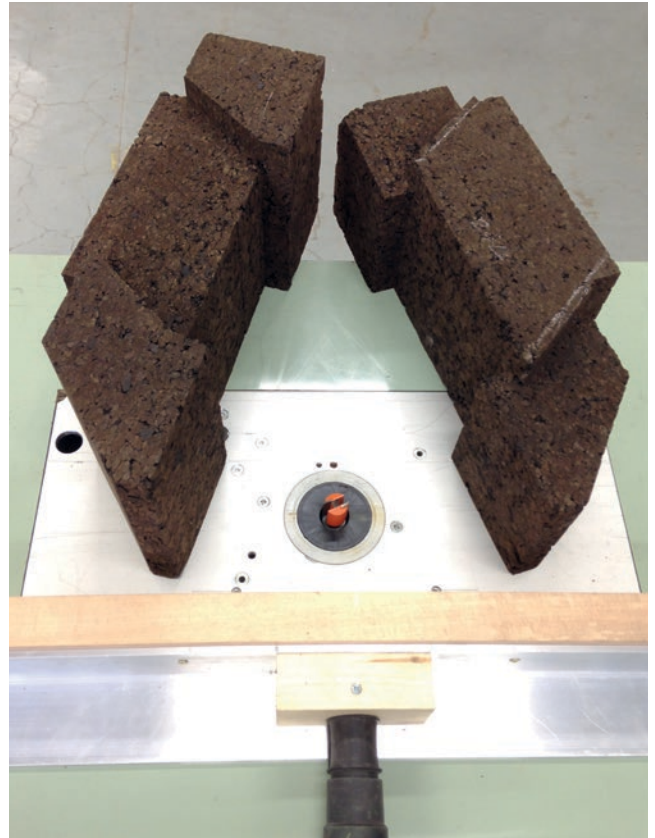
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## 2. Cork Construction Kit, 2015 to 2018

### Hypothesis and preliminary system development

The overarching hypothesis of this research is that it is possible to replace all layers and components of the contemporary building envelope with a simple assembly of expanded cork and engineered timber **(19)**. Research to test and realise this involved an intricate cycle: hypothesise, design, make, test, evaluate and reconsider material selection, block geometry, assembly arrangements, architectural design, structural, fire safety and weathertightness performance, etc.

The hypothesis asked a lot of expanded cork in areas of undetermined potential: structure, weathertightness and fire safety. Preliminary work considered these matters with a range of prototype assemblies. A tongue-and-groove geometry, a little like plant-based Lego, was identified to give a mechanical interlock with weathertightness potential, and rudimentary testing gave confidence to proceed with this approach **(16–8)**.



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**16** Block interlock tests.

**17** Prototype tongue-and-groove roof blocks.

**18** Rudimentary watertightness testing.

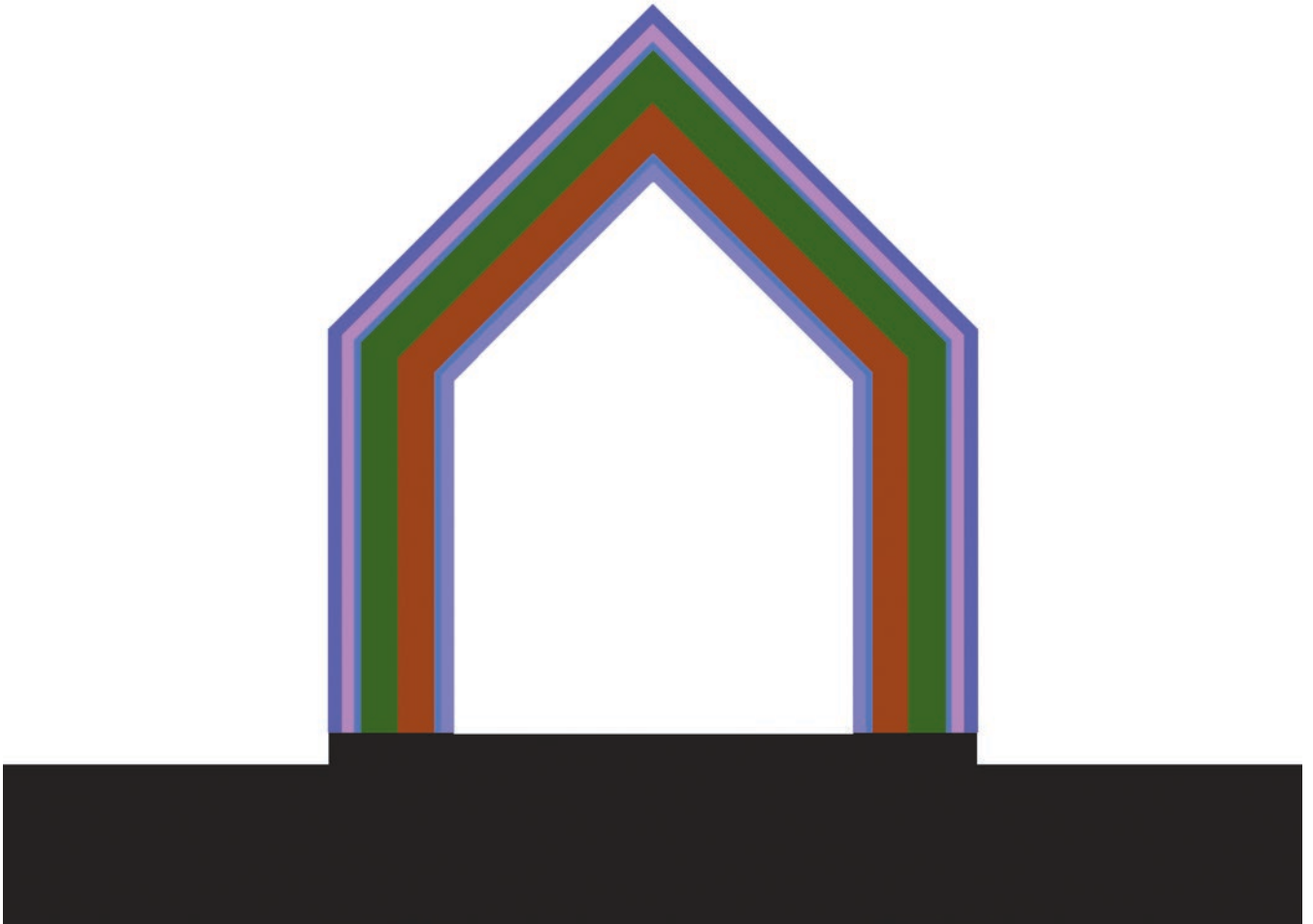
METHODOLOGY



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**19** (left) Contemporary construction typically incorporates many elements and layers to meet performance requirements; (right) the hypothesis for the Cork Construction Kit is that it will deliver this performance with far-less complexity.



### Material selection

Expanded cork is typically manufactured in blocks, with densities ranging from around 120 kg/m<sup>3</sup> to 160 kg/m<sup>3</sup>. It has good thermal and acoustic performance, chemical stability, the ability to contribute to high indoor air quality and negative Global Warming Potential (GWP). It is relatively light and friable for use as a structural building material, so initial research with the cork producer Amorim investigated the creation of denser blocks of around 230 kg/m<sup>3</sup>. These suffered from defects, including large cracks due to issues with heat dissipation and differential expansion after cooking. Work undertaken by the University of Bath and Arup determined cladding-grade blocks of 140 kg/m<sup>3</sup> to 160 kg/m<sup>3</sup> density to have sufficient structural performance; there are also applicability benefits to using a standard grade of block, so this was selected. Cork is used in compression, and is complemented by timber in areas of structural bending, including acetylated (rot-resistant) timber beams and CLT floor deck.

### Block geometry and fabrication

Prototype cork-block geometries were developed and machined from 1,000 × 500 × 220 mm billets. Geometric complexity increased as block designs developed due to the many roles the blocks were playing; this was the price for keeping the material palette simple. Analogue fabrication became problematic due to the time taken to fabricate a block and challenges in achieving high tolerances. A bespoke robotic milling method was, therefore, developed. Block geometry enabled all cutting with a single 125 × 14 mm cutter for speed and efficiency. All subsequent blocks were

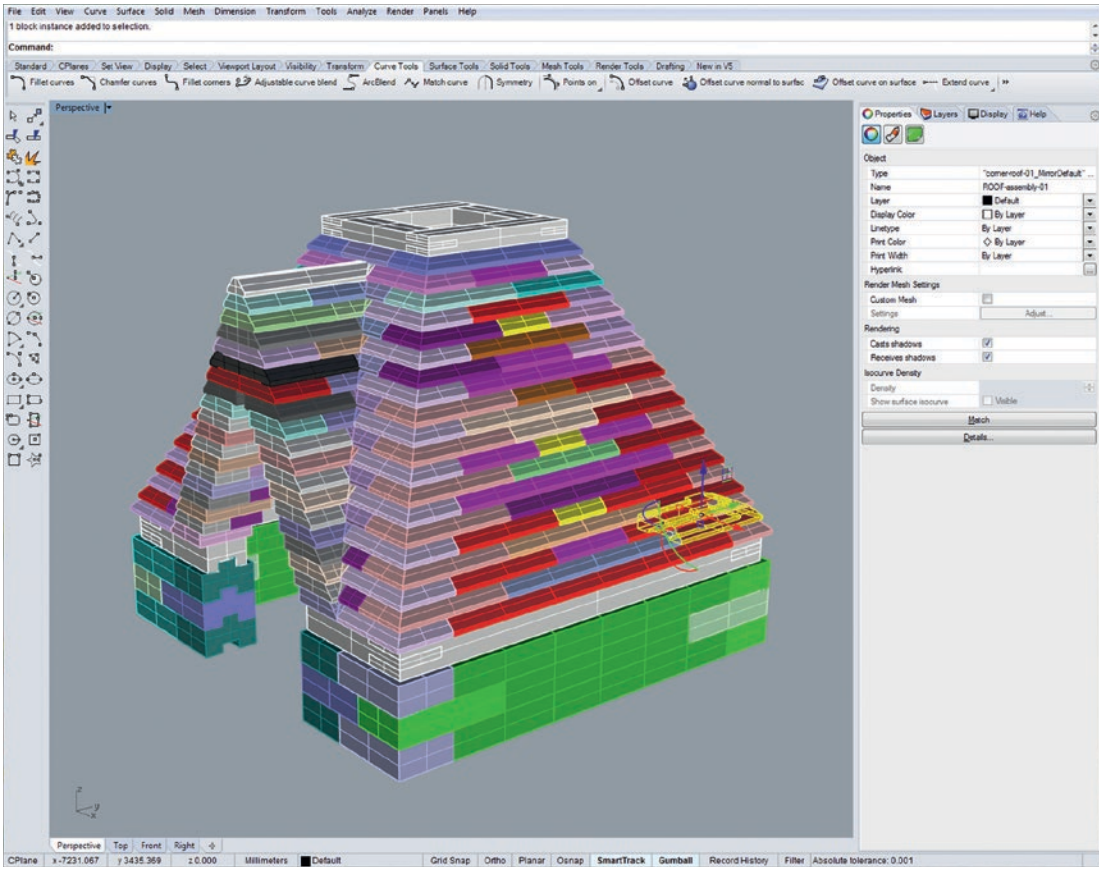
fabricated in this way, using a six-axis Kuka KR60HA industrial robot, with the cork billet held in place by a vacuum bed fitted to a two-axis positioner **(22)**. After much development work, an average cutting time of around 15 minutes per block was established. Potential uses were explored for the cork granules that are a by-product of milling **(26–7)**.

**20** Preliminary Cork Cabin assembly in SolidWorks.

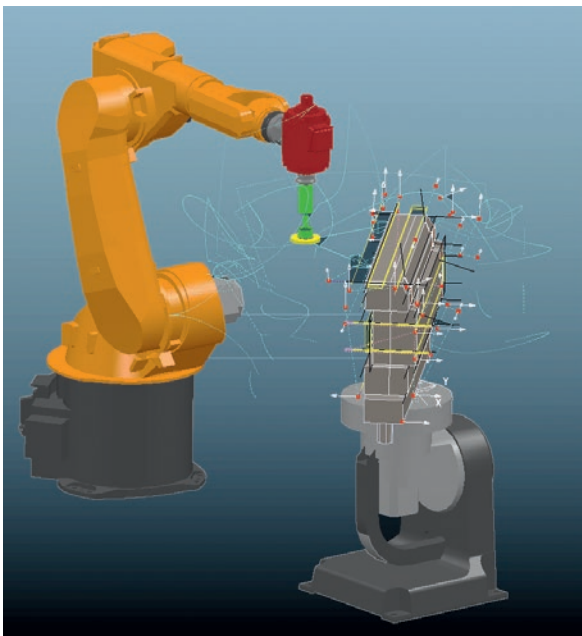
**21** Toolpath generation with PowerMill Robot.

**22** A cork wall block being milled.

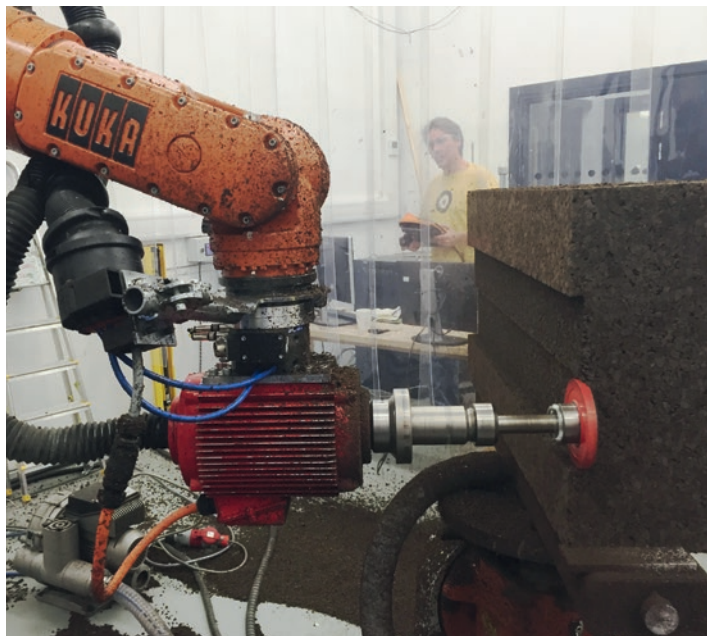
# METHODOLOGY



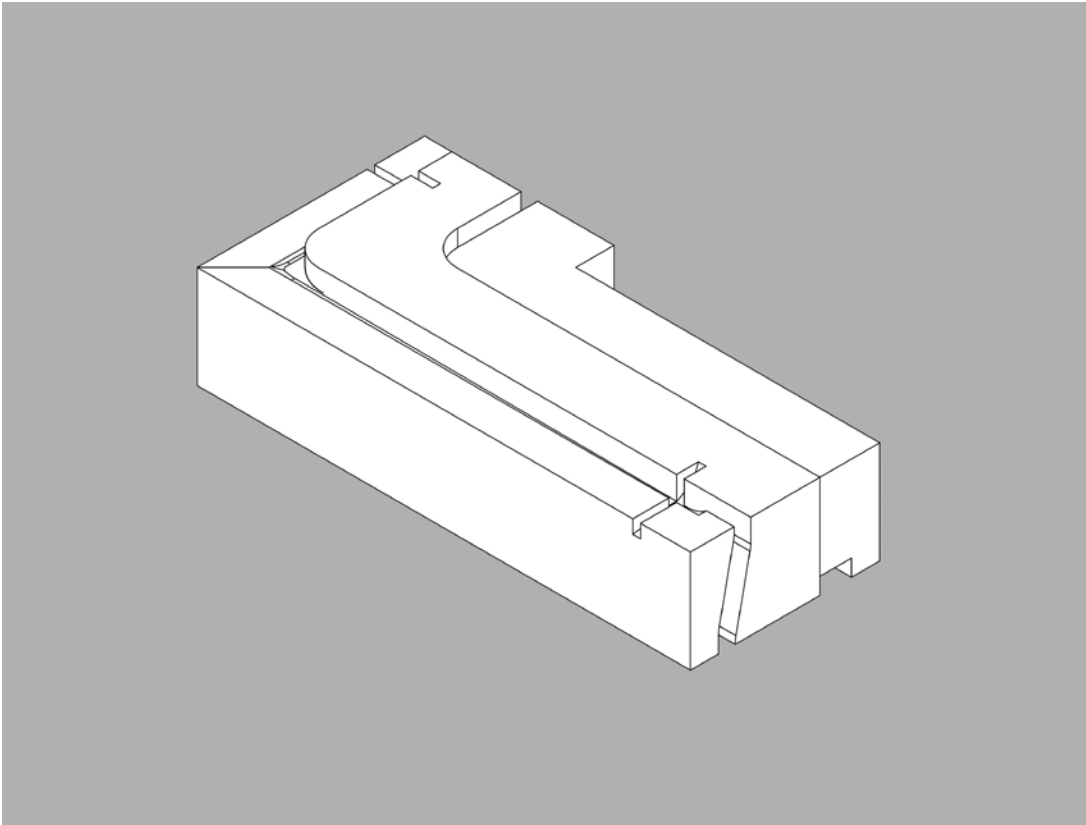
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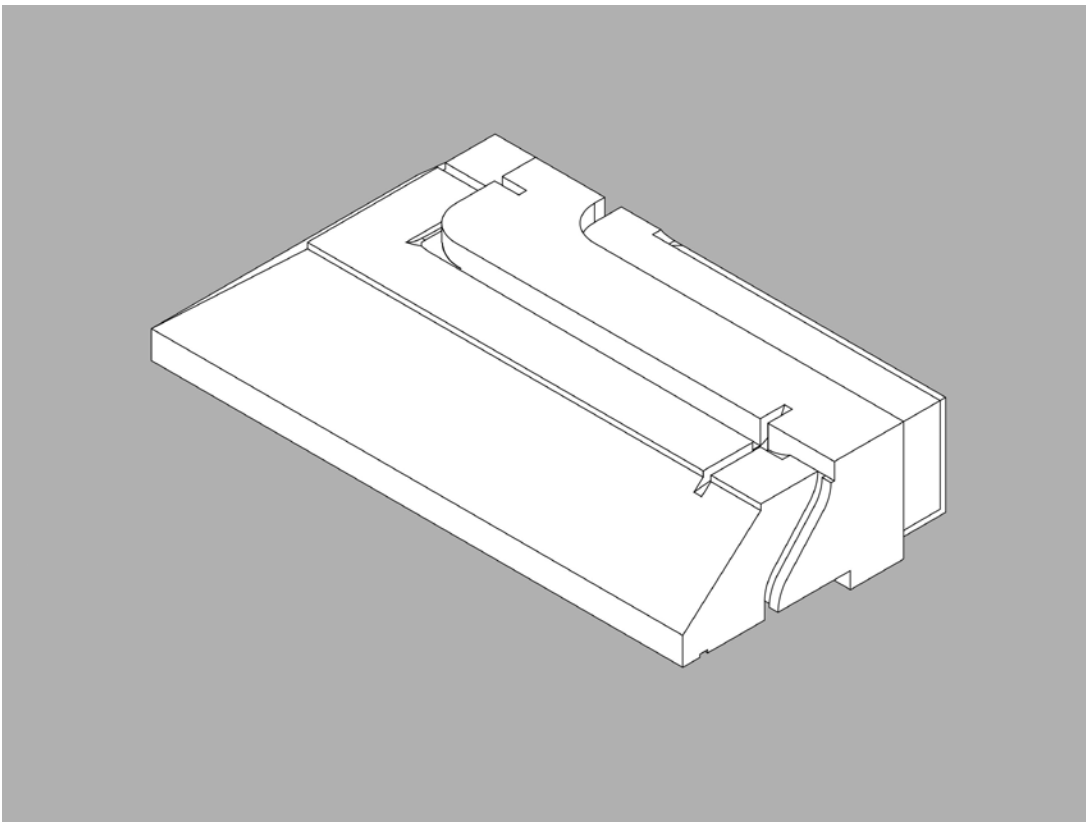
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**23** Wall block design.

**24** Roof block design.

**25** The first wall made using robotically milled cork blocks.

**26** Cork lime terrazzo made by Ty Mawr using cork-milling by-product.

**27** Cork fuel briquette made using cork-milling by-product.

### Technical design and testing

Technical design, engineering and lab testing was critical to system development. The suitability of expanded cork as a primary structure was undetermined at the start. The initial structural design hypothesis was developed in detail with Arup, and closely informed by lab testing at the University of Bath, addressing compression, shear and creep characterisation **(29)**. Testing of material samples progressed to testing system assemblies. The corbelled roof arrangement was selected due to the minimal falsework needed and the sheltering interiors that resulted.

Expanded cork has relatively poor fire resistance, similar to many plant-based materials, and is Euroclass E-rated. Lab testing, including ‘BS 476 Part 3: 2004 incorporating amendments A1: 2006 and A2: 2007 – External fire exposure to roofs’, was undertaken in order to characterise spread of flame and fire penetration of the system **(30)**.

The suitability of expanded cork as a weathertight building envelope was undetermined at the outset, and the interlocking block-to-block design was developed according to a specific hypothesis on how to keep air in and water out. This meant using a stepped block profile for airtightness and incorporating drainage and air-pressure neutralisation slots to reduce the risk of wind-driven rain being sucked through the dry joints under adverse weather conditions. This approach was then tested with a series of wind-driven rain tests **(28)** in accordance with ‘CEN FprEN 15601:2012 – Hygrothermal performance of buildings’ at BRE. In the first round of testing, the wall performance was satisfactory but the roof leaked. The likely cause was water trickling down through cracks and crevices, formed during manufacture, within the cork blocks. The roof system was redesigned with timber

weatherboarding to inclined faces and was retested, producing satisfactory results. For further detail on technical design and testing, see pp. 68–95.

**28** (top left) Wall panel being tested for wind-driven rain; (bottom left) the first roof panel being tested, which leaked; (right) the second roof panel being tested.

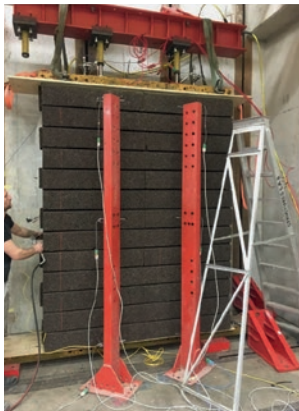
**29** (left) Structural testing of cork material; (right) wall assembly.

**30** Roof test panel laid horizontally after testing. Charring indicates the visible extent of fire penetration.

METHODOLOGY



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## The Cork Cabin

The Cork Cabin was created and tested to inform the development of the system as a whole, including ease of assembly and real-world performance. Design development included the use of a constructional model **(32)**. The final iteration of the cabin used 202 dry-jointed cork blocks, assembled without glue or mortar. These were preassembled to ensure a satisfactory fit, then disassembled for transport to site and assembly **(31)**. Timber elements included eaves and skylight beams, front door and CLT floor deck. A skylight let in daylight and added weight. 10-mm-thick removable foam airtightness tape was fitted to the interior faces of the cork-block joints to improve airtightness.

The cabin proved straightforward to assemble, with the cork blocks – weighing up to 15 kg each – easy to move by hand and position with a rubber mallet **(31)**. The completed cabin was tested for air permeability and surpassed current UK Building Regulation requirements, with 8.53 m<sup>3</sup>/h.m<sup>2</sup> of air leakage at an imposed pressure differential of 50 Pa. A thermal imaging survey revealed air leakage at timber-to-timber joints and others without airtightness tape **(33)**. The system design was, therefore, revised to incorporate airtightness tape in these locations. The cabin was subject to thermal and humidity monitoring from summer 2017 to winter 2018. It was initially constructed without timber weatherboarding on the roof and leaked after several months, in-line with the first BRE lab test, whereupon it was retrofitted with timber weatherboarding and stopped leaking **(35)**.

## The resulting construction system

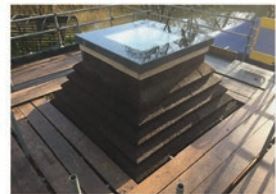
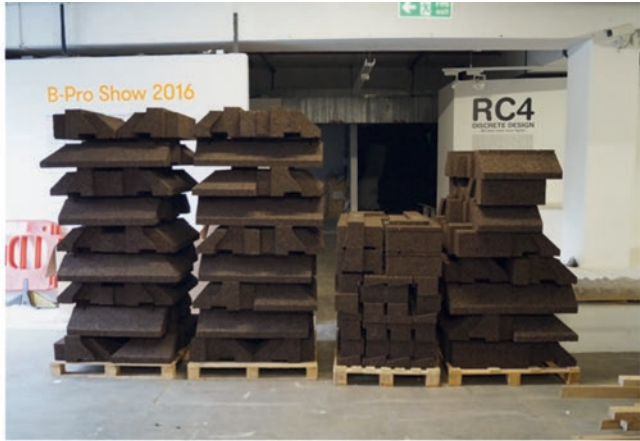
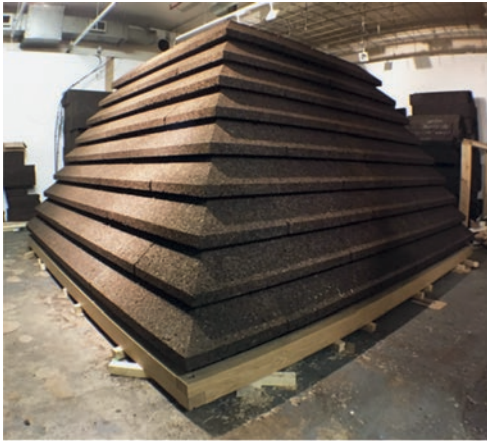
The Cork Construction Kit was sufficiently developed and de-risked with the intention that it could then be applied to single-storey pilot projects, such as houses, classrooms, community buildings and home offices. The research and development of a new form of construction, with reference to whole-life environmental sustainability principles, produced a viable dry-jointed cork-block system augmented by timber components to produce a structural building envelope that is easy to assemble and disassemble.

**31** (top) Cabin roof assembled at The Bartlett and then disassembled ready for transport to site; (bottom) the cabin being assembled on site.

**32** 1:5-scale constructional model of the cabin during design development.

**33** Thermal image of the interior of the cabin's roof. The dark tone shows air leakage during air-pressure test.

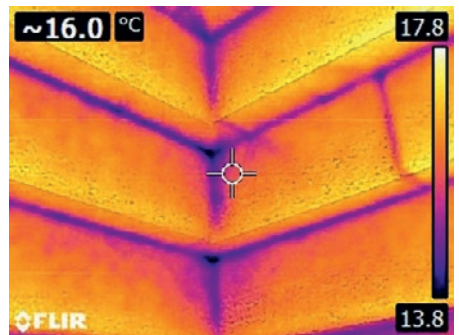
METHODOLOGY



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**34** (left) Cork Casket;  
(right) Cork Cabin.



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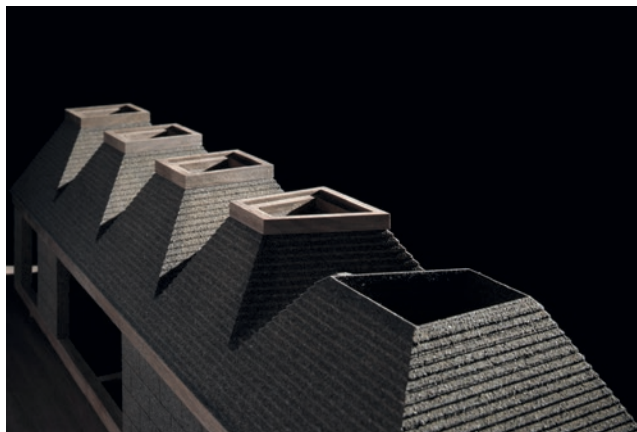
**35** Detail of cedar weatherboarding retrofitted to cabin roof.

### 3. Cork House, 2016 to 2019

The detailed design of Cork House commenced concurrent with the development of the Cork Construction Kit. The house is situated within the curtilage of a Grade II-listed mill house on a small island in the River Thames (39–40). This was a rare and ideal opportunity to put the newly developed construction system to test on a live building project. The house is the first building of its type, applying an evolved version of the Cork Construction Kit, and is fully compliant with Building Regulations.

#### Design

The house is carefully tailored to its site, nestled within its own walled garden at the rear of the mill house. Design development accommodated the evolution of the Cork Construction Kit and evolved to give a purer architectural expression of the system working in compression. The final design has a simple linear plan consisting of five structural bays. Each has a truncated pyramidal roof topped with a skylight (36). An open bay at one end is a gateway into the house and the private garden, and each internal bay has a particular use: entry, bathroom and kitchen, open-plan living and secluded bedroom.



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**36** Architectural model of early design of Cork House.

**37** Assembling the cork building envelope.

**38** Interior furniture and fittings in engineered timber.

The design utilises a prefabricated kit of parts (44, 46), including 1,268 cork blocks, which are dry assembled onsite (37). The house is supported on removable steel screw-pile foundations. A CLT deck rests on a raised timber ring beam supported by these piles. Cork-block walls and corbelled roofs are built off this deck and act in compression, taking loads down. Timber beams in the eaves take lateral wind loading, transferred into return walls and two structural CLT wardrobes. Steel-framed skylights top each roof pyramid, adding weight and structural stability, and bringing in daylight and providing ventilation in summer. A bespoke timber design is used for the windows and doors, and rainwater goods are made from copper due to its durability and low maintenance.

#### Fabrication and assembly

Five-axis CNC milling was selected as the most viable option for cork-block fabrication (47). Other building components were also prefabricated, including structural timber components and bespoke timber windows and doors. Steel screw piles and the CLT deck were installed by sub-contractors (48). The building envelope was constructed by hand, with jigs and tension straps used to control wall geometry. Issues arising during assembly relating to block tolerance and assembly sequence were addressed and satisfactorily resolved, with lessons learned regarding system design more broadly. The interior furniture and fittings continue the use of plant-based materials, utilising oak, recycled CLT and larch tri-ply (38).



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**39** Location plan, Cork House indicated in red.





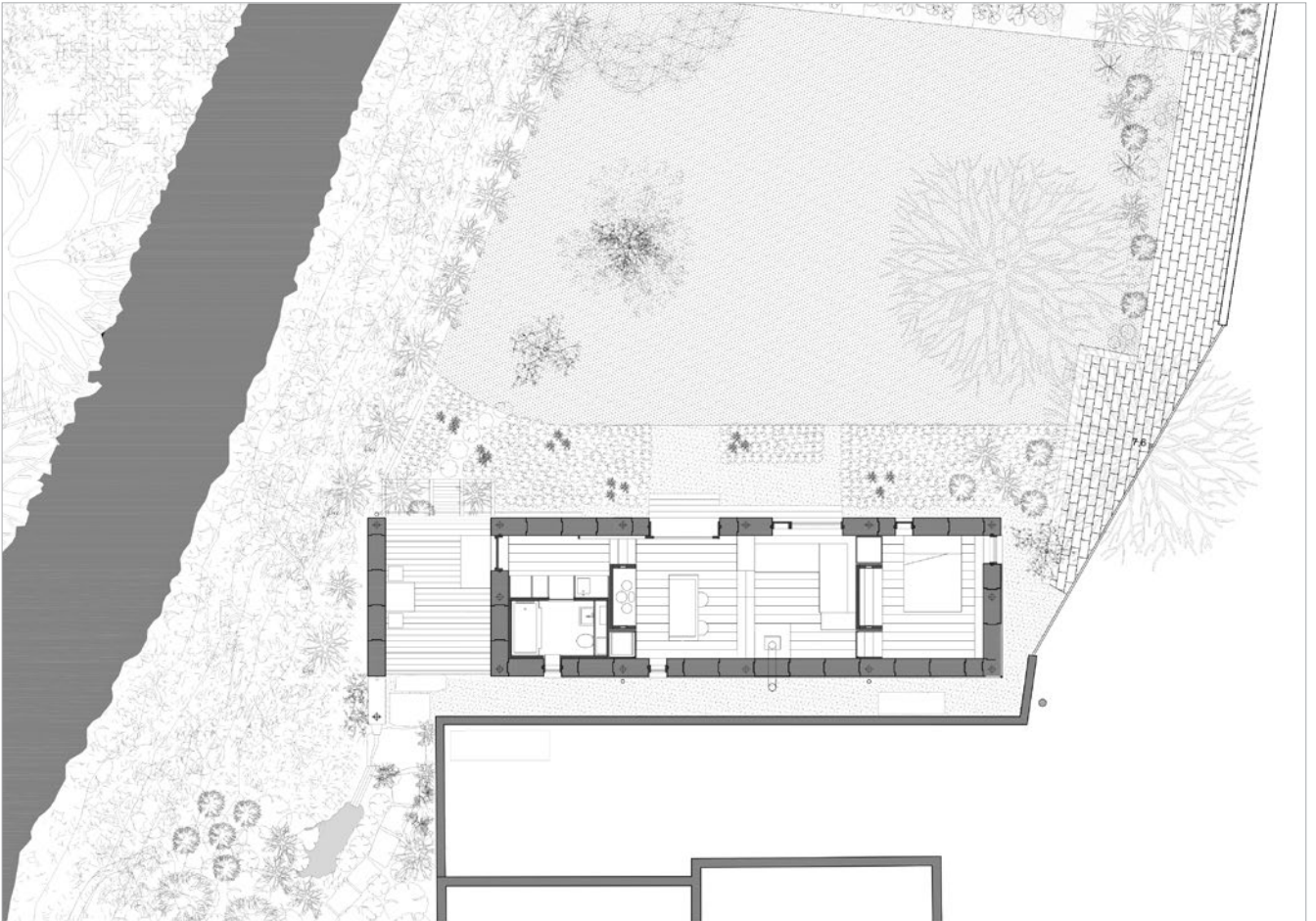
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41 Long elevation.



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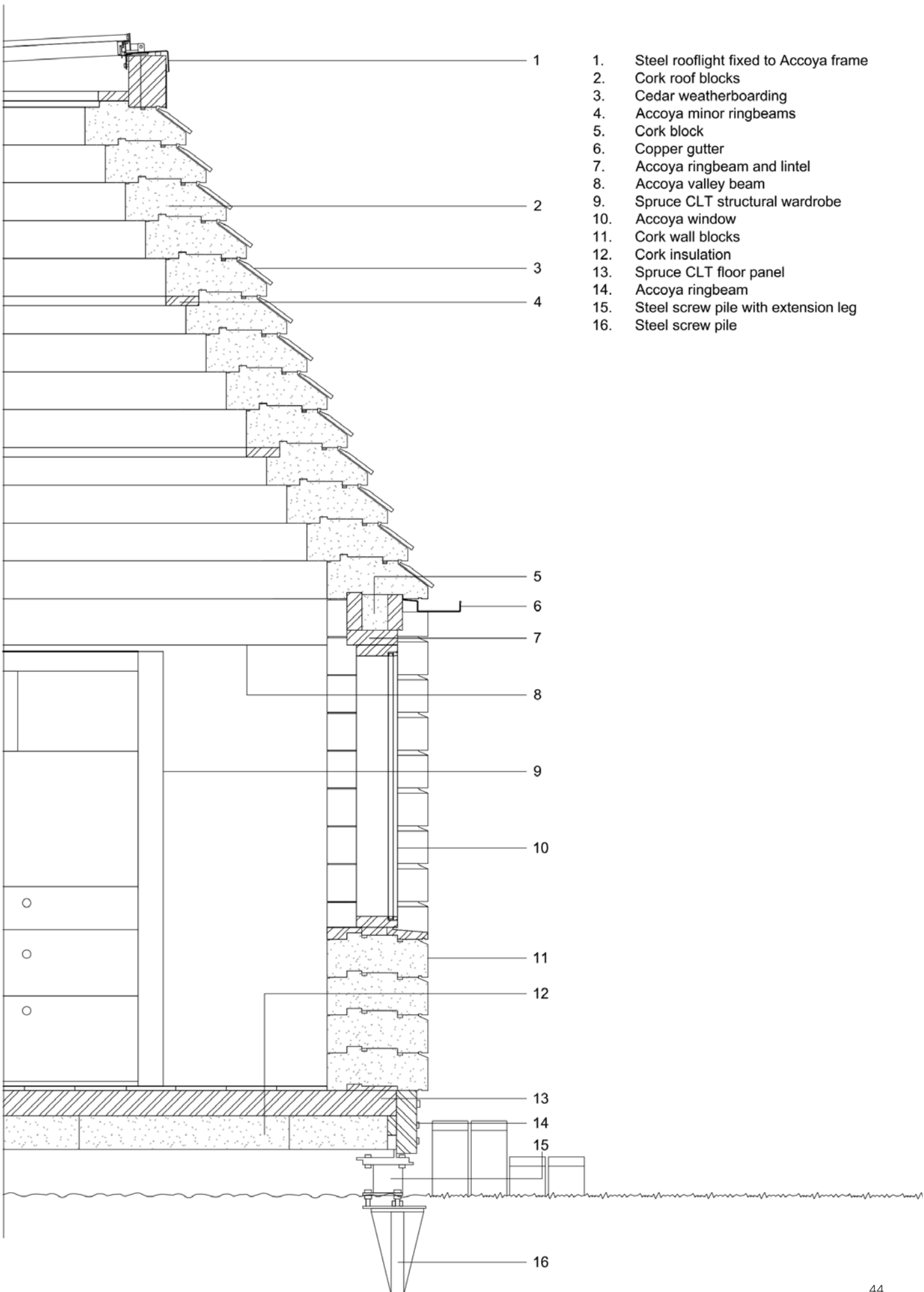
42 Long section.



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**43** Plan.

**44** Detailed section.

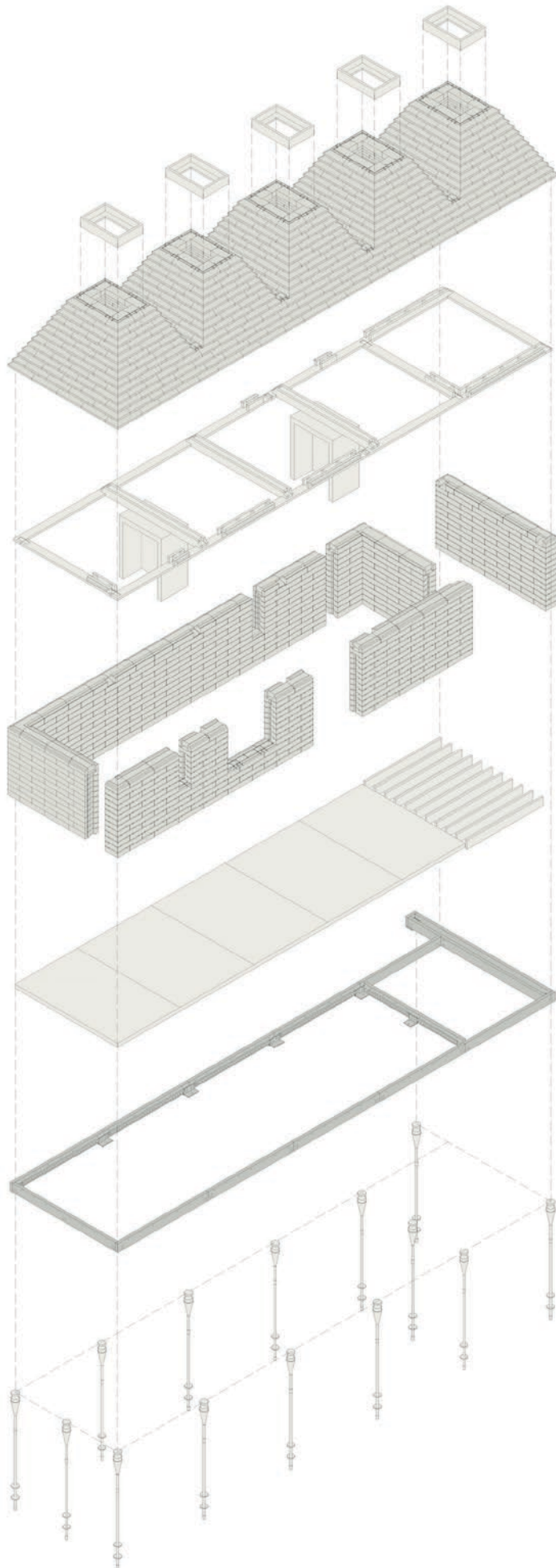


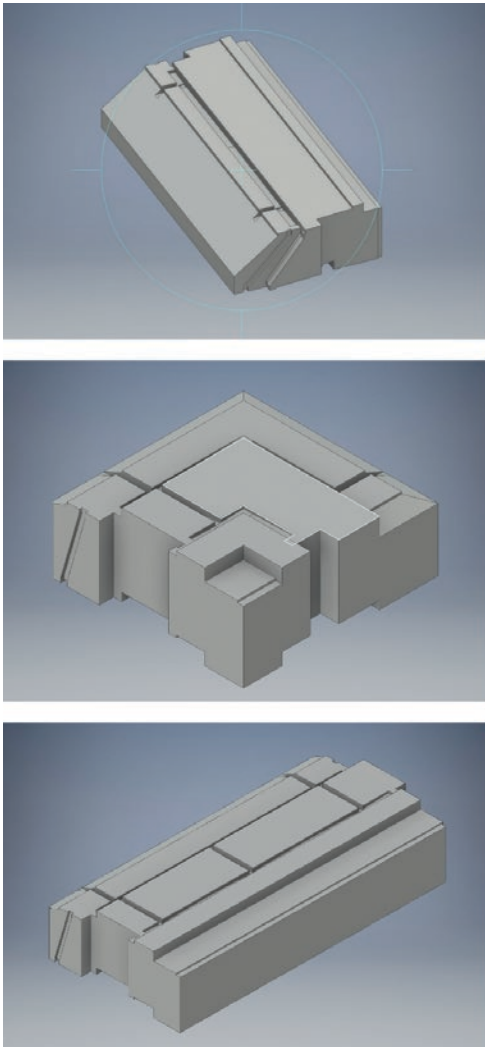


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**45** Cross section.

**46** Cork House exploded axonometric.





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**47** (left) Roof and wall blocks modelled in Autodesk Inventor; (right) CNC milling of a cork block.

## METHODOLOGY



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**48** (top) Installation of screw piles and ring beam; (below) insulating and installing CLT deck.

### Whole-life carbon assessment

The house and system are designed for outstanding whole-life performance and carbon emissions are an important part of this. Sturgis Carbon Profiling LLP undertook a whole-life carbon assessment of the house based on a 60-year lifespan. The house measured the lowest of any building ever assessed by the consultant at 618 kgCO<sub>2</sub>e/m<sup>2</sup> GIA, which includes 286 kgCO<sub>2</sub>e/m<sup>2</sup> of embodied carbon and 333 kgCO<sub>2</sub>e/m<sup>2</sup> of regulated operational carbon over the lifespan **(49)**. The house is carbon negative at completion (-18 kgCO<sub>2</sub>e/m<sup>2</sup>) due to the atmospheric carbon stored in its cork and timber components. Whole-life carbon for Cork House is less than one-sixth of that for the new build house referenced by the consultant, around one third of that for the reference timber-framed Passivhaus and under half that for the reference zero-operational carbon building **(50)**.

**49** Cork House whole-life carbon assessment.

**50** Cork House carbon comparison with reference projects.

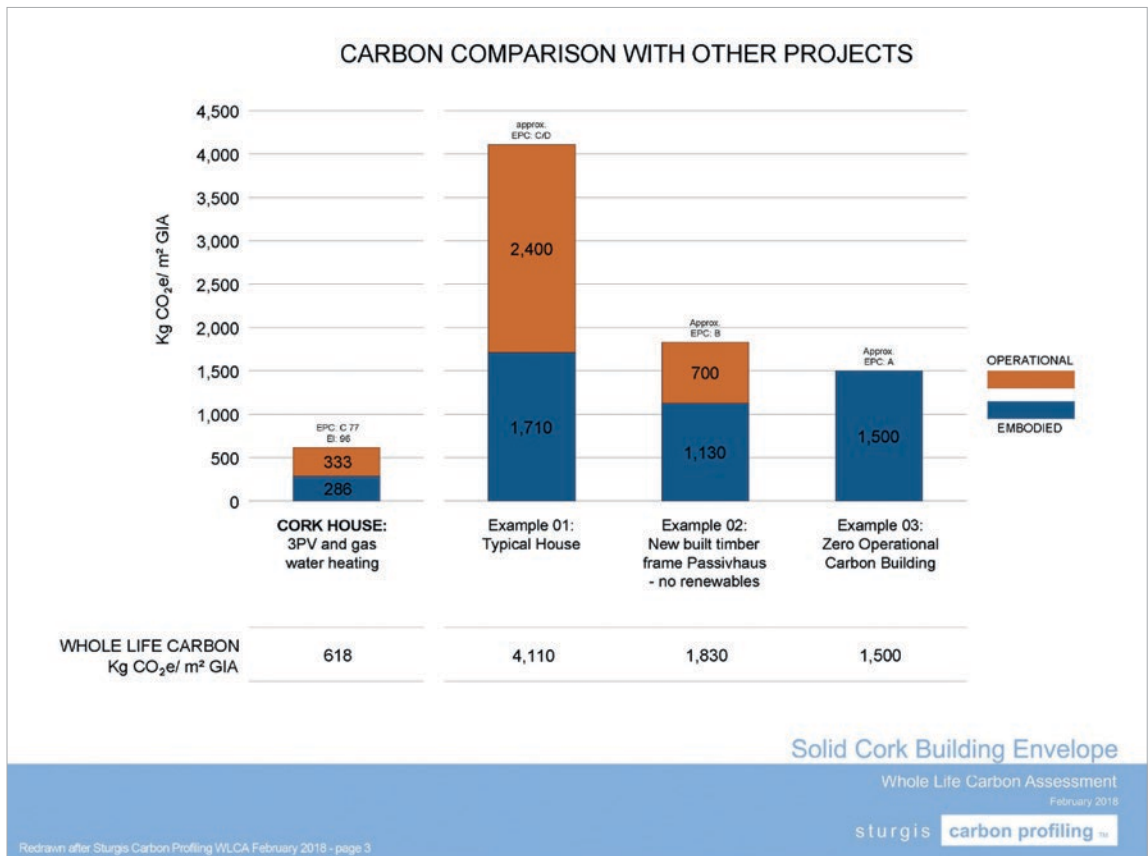
# METHODOLOGY

	Material Carbon	Transport Carbon	Waste Carbon Impact	Sitework Carbon	Carbon at Practical Completion	In-Use Stages Carbon	EOI Carbon	Whole Life Carbon	Whole Life Carbon (KgCO <sub>2</sub> e/m <sup>2</sup> )
Foundation	4,120	50	50		4,200	0	30	4,230	97
Structure	-32,230	16,560	980		-14,700	0	2,230	-12,470	-286
Internal Finishes & Fittings	-1,220	310	60	N/A	-860	10	210	-640	-15
Services/MEP	6,560	130	530		7,210	9,140	40	16,390	376
Façade	450	370	50		870	1,500	60	2,430	56
Site energy use		N/A		2,500	2,500	0	0	2,500	57
Total embodied Carbon	-22,320	17,420	1,670	2,500	-780	10,650	2,570	12,440	286
Regulated Operational Carbon (SAP)	N/A					14,480	N/A	14,480	333
<b>Total (Kg CO<sub>2</sub>e)</b>	<b>-22,320</b>	<b>17,420</b>	<b>1,670</b>	<b>2,500</b>	<b>-780</b>	<b>25,130</b>	<b>2,570</b>	<b>26,920</b>	<b>618</b>

Solid Cork Building Envelope  
Whole Life Carbon Assessment  
February 2018  
sturgis carbon profiling™

Redrawn after Sturgis Carbon Profiling WLCA February 2018 - page 3

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### Completion, inhabitation and building performance evaluation

Visiting the house in person is a rich and evocative experience that goes beyond the visual. There is a sense of the construction being a form of plant-based masonry, massive but soft and warm to the touch. The interior has a smoky aroma and calm acoustics provided by the cork-compression structures, which are sheltering, legible and readily understood (54). The CLT-lined bathroom is a playful counterpoint to the rest of the house (56).

An air permeability test of the house gave a result of  $5.64 \text{ m}^3/\text{h}\cdot\text{m}^2$  at 50 Pa, a little over half the maximum permitted by Building Regulations and significantly more airtight than the Cork Cabin. As of May 2020, the house is performing as intended. Detailed post-occupancy evaluation has commenced and will run until 2021.



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52

**51** Cedar weatherboarding and copper gutter.

**52** Plant-based masonry.



**53** The house in its garden setting.





55

**54** Interior looking towards the kitchen.

**55** Play of light in a corbelled roof pyramid.

**56 (overleaf)** Playful palette in the bathroom with CLT and brass fixtures and fittings.

**57 (overleaf)** Plant-based material from a biodiverse landscape; made using waste and by-product; cooked with steam from waste biomass; dry assembled; building form informed by lifecycle approach; disassemble at end of building life for component re-use; or recycle back into the manufacturing chain; return to earth to nourish new growth at eventual end of human use.



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## Dissemination

### Publications

- Two journal articles by the authors in *The Journal of Architecture* (2020) and *The RIBA Journal* (2020);
- One online article by the authors for *ArchDaily* (2020);
- One book chapter by the authors in *Fabricate 2020: Making Resilient Architecture* (2020);
- Featured in critical articles in print, e.g. *Financial Times* (2019), *L'Architecture d'Aujourd'hui* (2020) and *The Observer* (2019);
- The project has been critically appraised online, e.g. *Building* (2020), *La Repubblica* (2019) and *World Economic Forum* (2019).

### Group Exhibitions

- *Bioökonomie*, MS Wissenschaft, various locations, Germany (2020–21)
- *Summer Exhibition 2020*, Royal Academy of Arts, London (2020)

### Media / Television Documentaries

- *Cork House, Berkshire* (2019). Produced by BBC arts and RIBA. [www.bbc.co.uk/programmes/p07ppjg9](http://www.bbc.co.uk/programmes/p07ppjg9)
- *Building Sustainably: The Cork House* (2019). Produced by Euromaxx for Deutsche Welle. [www.dw.com/en/building-sustainably-the-cork-house/av-51725279](http://www.dw.com/en/building-sustainably-the-cork-house/av-51725279)
- *Grand Designs: House of the Year: Experimental* (2019). Directed by Orlando Fowler, James Hilton and Robin Leach. Produced by Channel 4. [www.channel4.com/programmes/grand-designs-house-of-the-year/on-demand/69780-001](http://www.channel4.com/programmes/grand-designs-house-of-the-year/on-demand/69780-001)

### Invited Lectures

- Australian Institute of Architects, online CPD (2020)
- Fabricate 2020 online, Cornell University, Ithaca (2020)
- Futurebuild, ExCel, London (2020)
- Haworth Tompkins, London (2020)
- Institute of Geographic Sciences and Natural Resources Research, Beijing (2020)
- Max Fordham, London (2020)
- University of Cambridge (2020)
- University of Westminster, London (2020)
- De Montfort University, Leicester (2019)
- de Rijke Marsh Morgan, London (2019)
- Feilden Clegg Bradley Studios, London (2019)
- RIBA, London (2019)
- Sheffield Society of Architects (2019)

### Selected Tours

- Ashden Awards (2020)
- Brendeland & Kristoffersen (2020)
- Built Engineers (2020)
- Cardiff University (2020)
- DRDH Architects (2020)
- Haptic Architects (2020)
- Open House Worldwide (2020)
- Tikari Works (2020)
- University of East London (2020)
- University of Greenwich (2020)
- University of Westminster (2020)
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- Eton College (2019)
- London Metropolitan University (2019)
- Royal Borough of Windsor and Maidenhead - Planning and Councillors (2019)
- Slough Borough Council (2019)
- Tonkin Liu (2019)
- University of Bath (2019)
- Windsor Girls' School (2019)

## Project Highlights

Cork House has won some of the most prestigious architecture awards in the UK:

- Winner, American Institute of Architects (AIA) International Design Awards 2020: Honor Award for Architecture and Sustainable Future Award (2020)
- Winner, AIA International Design Awards 2020: Sustainability (small project) and Professional (small project) (2020)
- Winner, Architecture MasterPrize, Green Architecture Award (2020)
- Winner, RIBA Stephen Lawrence Prize (2019). Awarded to the best UK architecture project with a budget of less than one million pounds
- Winner, Manser Medal (2019). Recognising the most innovative scheme in house design
- Winner, Wood Awards Gold Award (2019). Marking excellence in wood construction
- Winner, Wood Awards Private Category (2019)
- Winner, RIBA National Award (2019). For outstanding contribution to architecture
- Winner, RIBA South Sustainability Award (2019). Recognising advancement in environmental design
- Winner, RIBA South Award (2019)
- Shortlisted, RIBA Stirling Prize (2019). The highest profile architecture award in the UK

The 10,000-word article 'Cork Construction Kit' by Oliver Wilton and Matthew Barnett Howland was the winner of the 2019 RIBA President's Award for Design and Technical Research and was published in *The Journal of Architecture* in 2020.

Cork House features as an exemplary case study for sustainable building in the UIA's guidebook *An Architecture Guide to the UN17 Sustainable Development Goals* (2018).

It is discussed in several books educating on environmental sustainability, including *AV Monografías* by Arquitectura Viva (2021); Barnabus Calder's *Architecture: Buildings and Energy from Prehistory to the Present* published by Pelican (2021); Judit Kimpian, Hattie Hartman and Sofie Pelsmakers's *Energy, People, Buildings: Making Sustainable Architecture Work* from RIBA Publishing (2021); and *Out of the Woods: Architecture and Interiors Built from Wood* by Gestalten (2020).

**58 (overleaf)** View of Cork House from the mill house.











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**59 (previous)** View from the sofa into the garden.

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