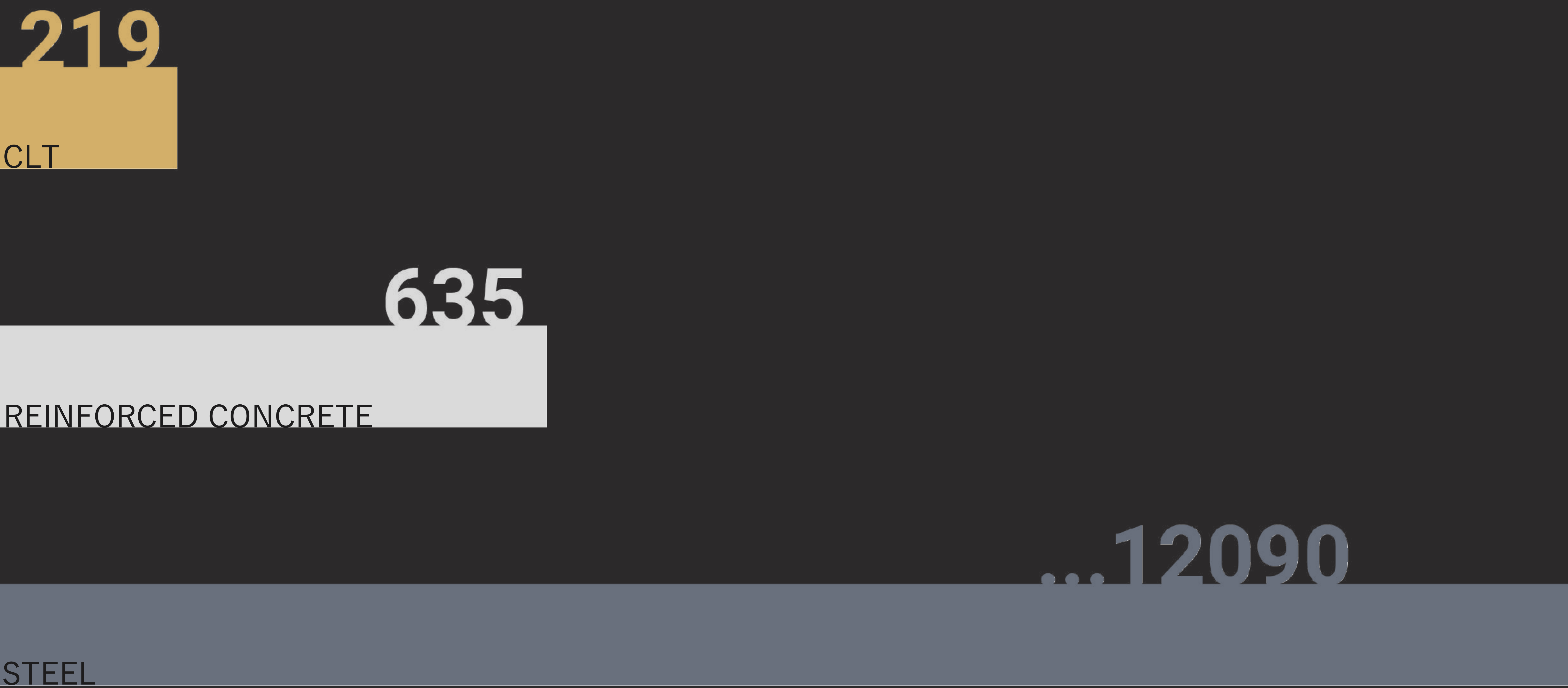
de baes architects
Cross-Laminated Timber

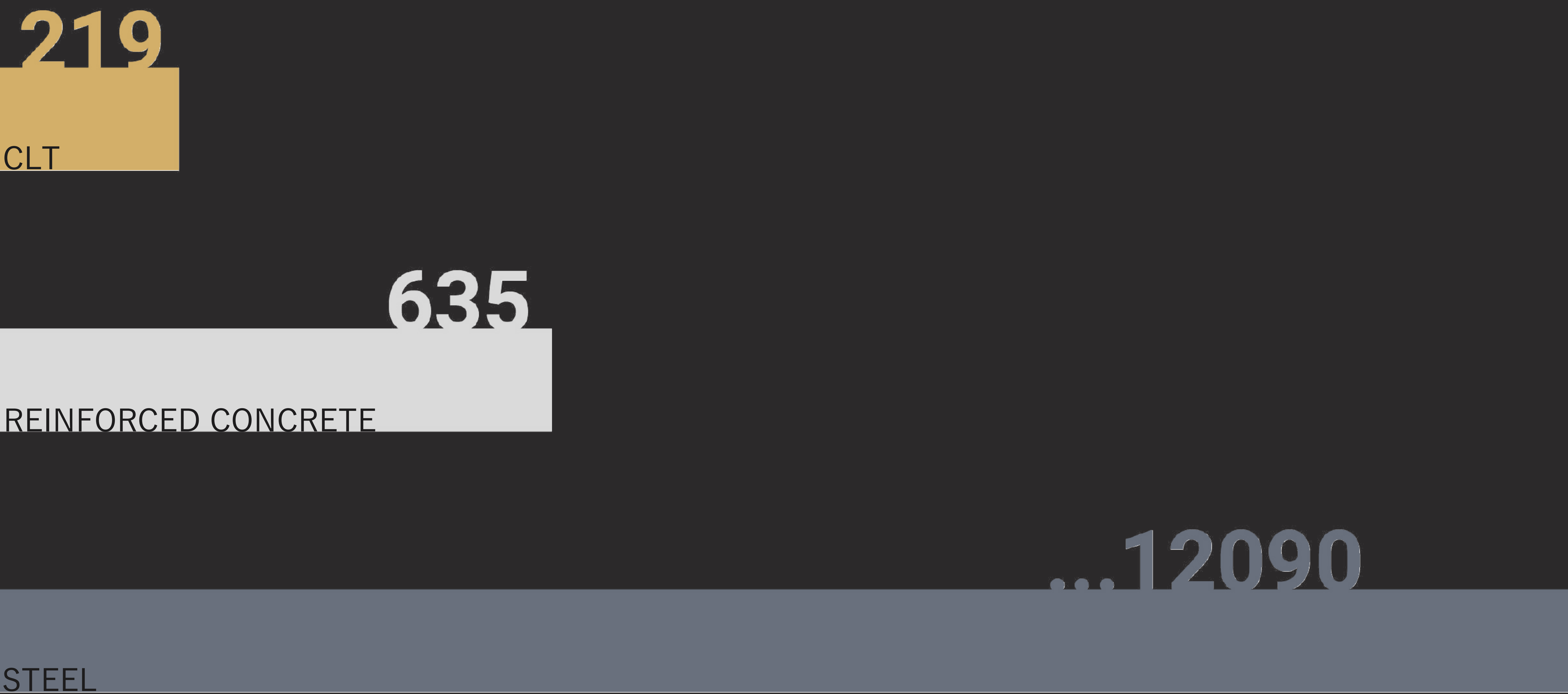
Two of the world’s most widely used building materials are also some of the least sustainable.

On average, manufacturing a cubic meter of steel releases 12,090 kg of carbon dioxide into the atmosphere, and manufacturing the same volume of concrete releases 410 kg of carbon dioxide in the atmosphere.



Together, the two materials account for about 16% of annual global carbon emissions alone.

Reference: Ellis, L. D., Badel, A. F., Chiang, M. L., Park, R. J.-Y. & Chiang, Y.-M. Proc. Natl Acad. Sci. USA 117, 12584–12591 (2020).



Despite this, over 1.86 billion tons of steel and 10 billion tons of concrete are produced each year.
That makes concrete the second-most consumed material around the world behind water.

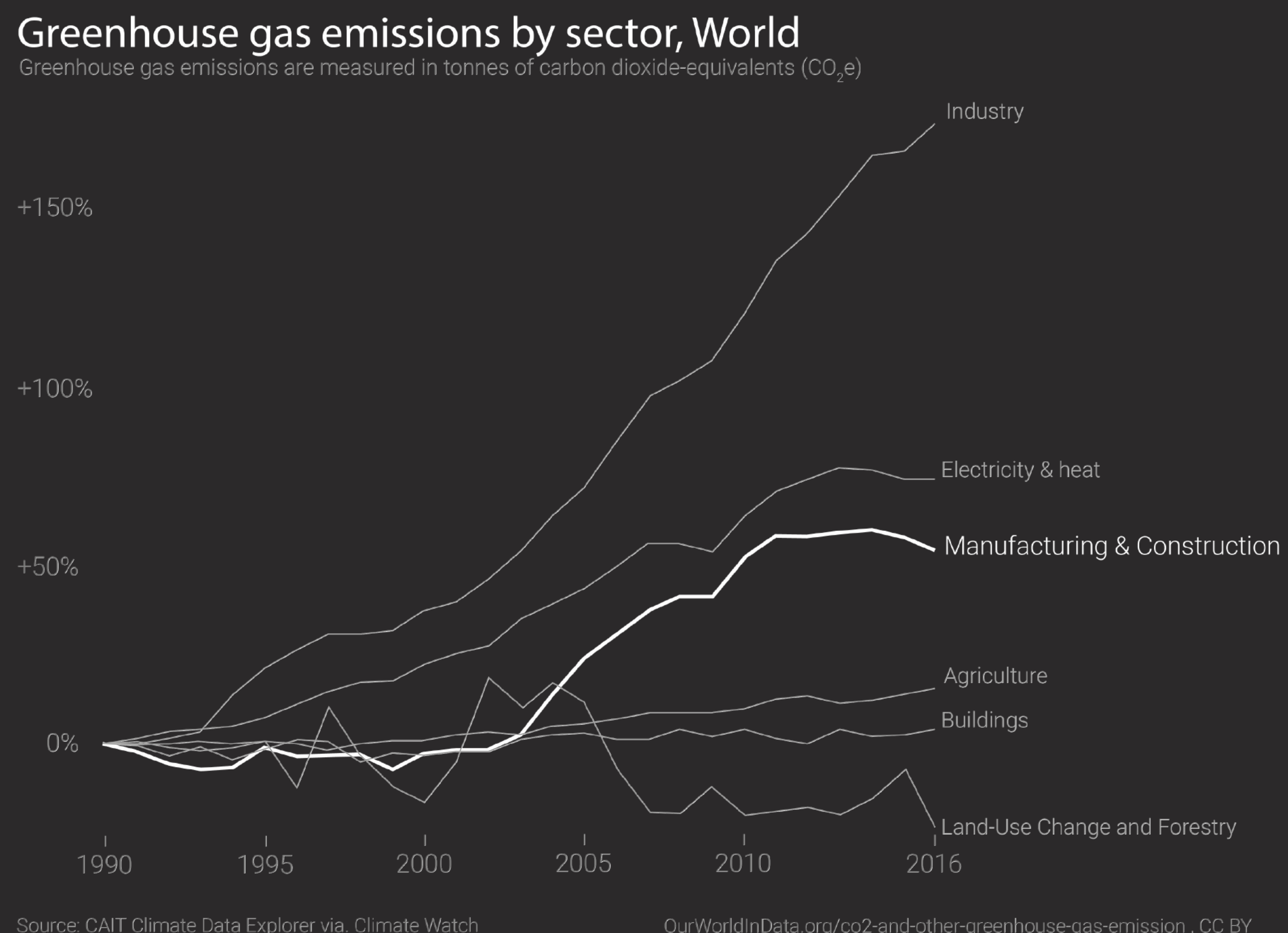
Reference: https://www.mckinsey.com/industries/metals-and-mining/our-insights/decarbonization-challenge-for-steel

Until recently, there was no viable alternative to the materials. Concrete and steel were widely available, affordable, and structurally versatile. They are the building blocks of our world...

...from our towering metropolises...

...to massive infrastructure projects...

...and architectural masterpieces.



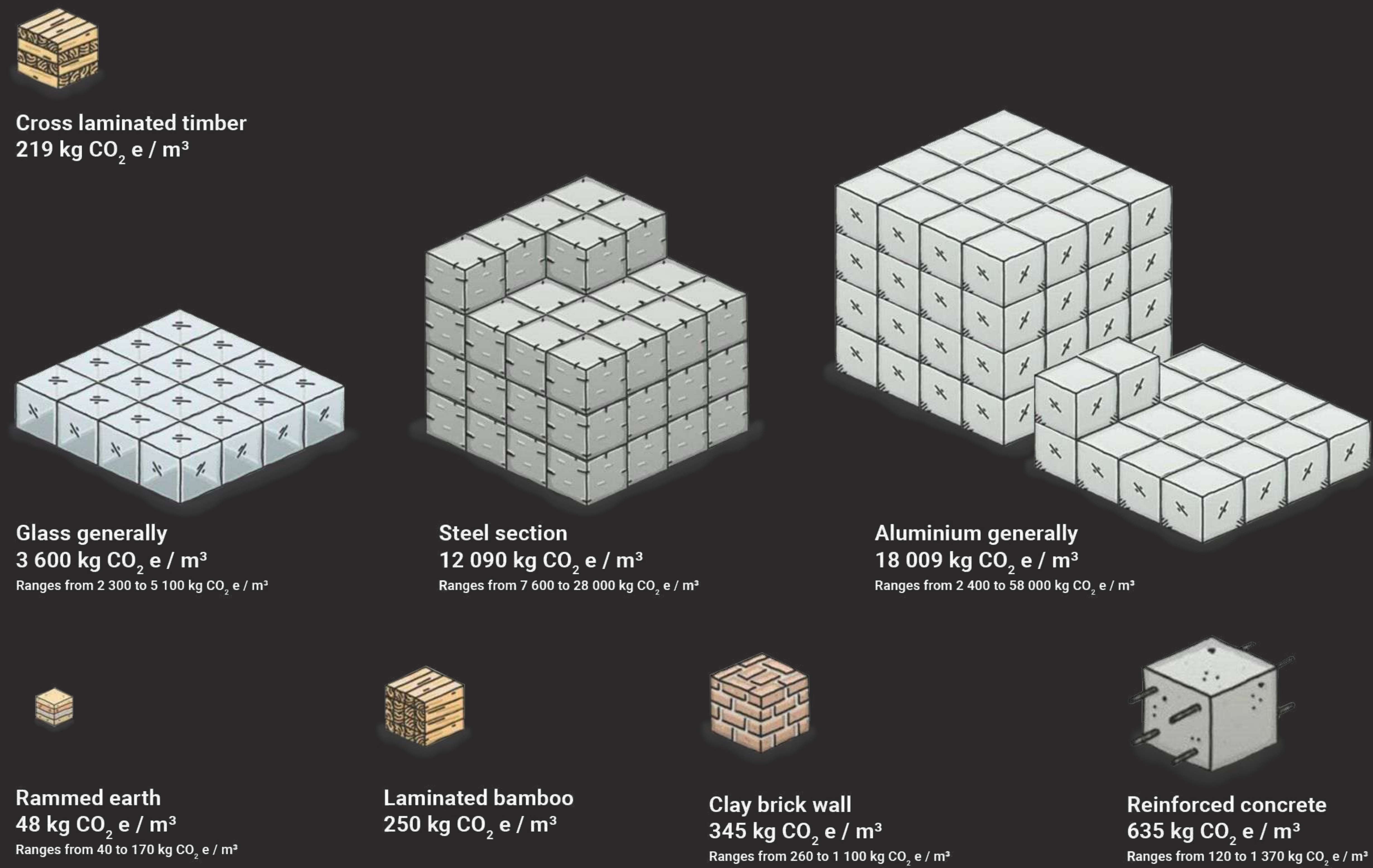
But now, as the environmental crisis becomes more dire than ever and global carbon emissions continue to rise to unprecedented heights...

...a new way of building sustainably is promising a greener future.

Cross-laminated timber (CLT), an engineered wood product made by gluing sheets of wood together crosswise, is gaining popularity as an alternative to concrete and steel.

Unlike other engineered woods, like glue-laminated timber or parallel-strand-lumber, CLT has two-directional spanning capacity, meaning it can replace concrete slabs for floors, walls, and roofs.

This makes it possible to design buildings from houses to skyscrapers with completely timber structures.

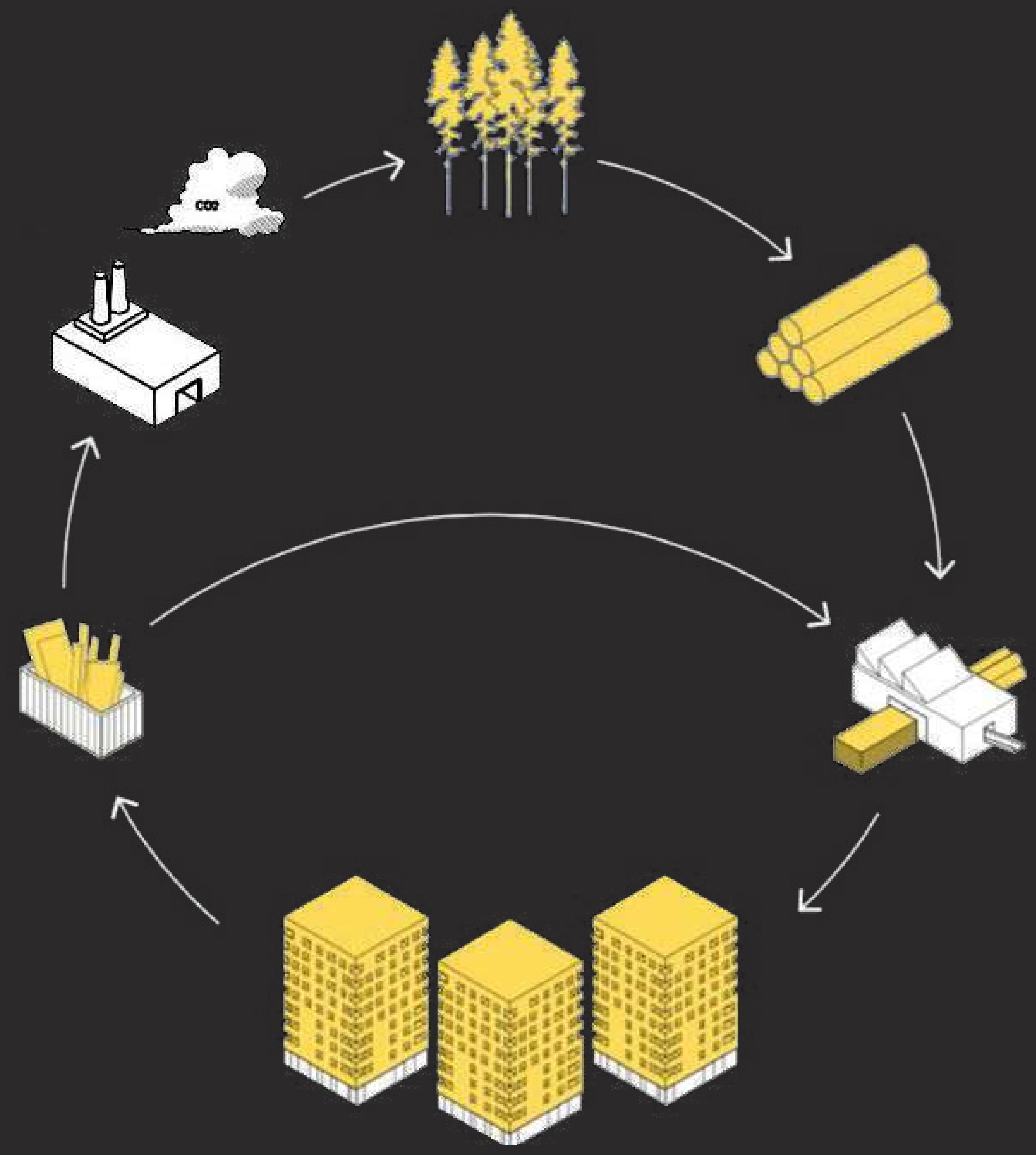


And the material can reduce the carbon footprint of a building’s structure by 80% compared to using concrete.

That’s why we at de baes architects have been researching and implementing new ways of using CLT to create sustainable, high-functioning, and aesthetically distinguished buildings. Here’s what we’ve learned.

Section II Benefits of CLT

CLT offers a host of benefits. First and foremost, it is ***sustainable.***
Life-cycle analyses demonstrate that CLT can be a carbon-negative material.



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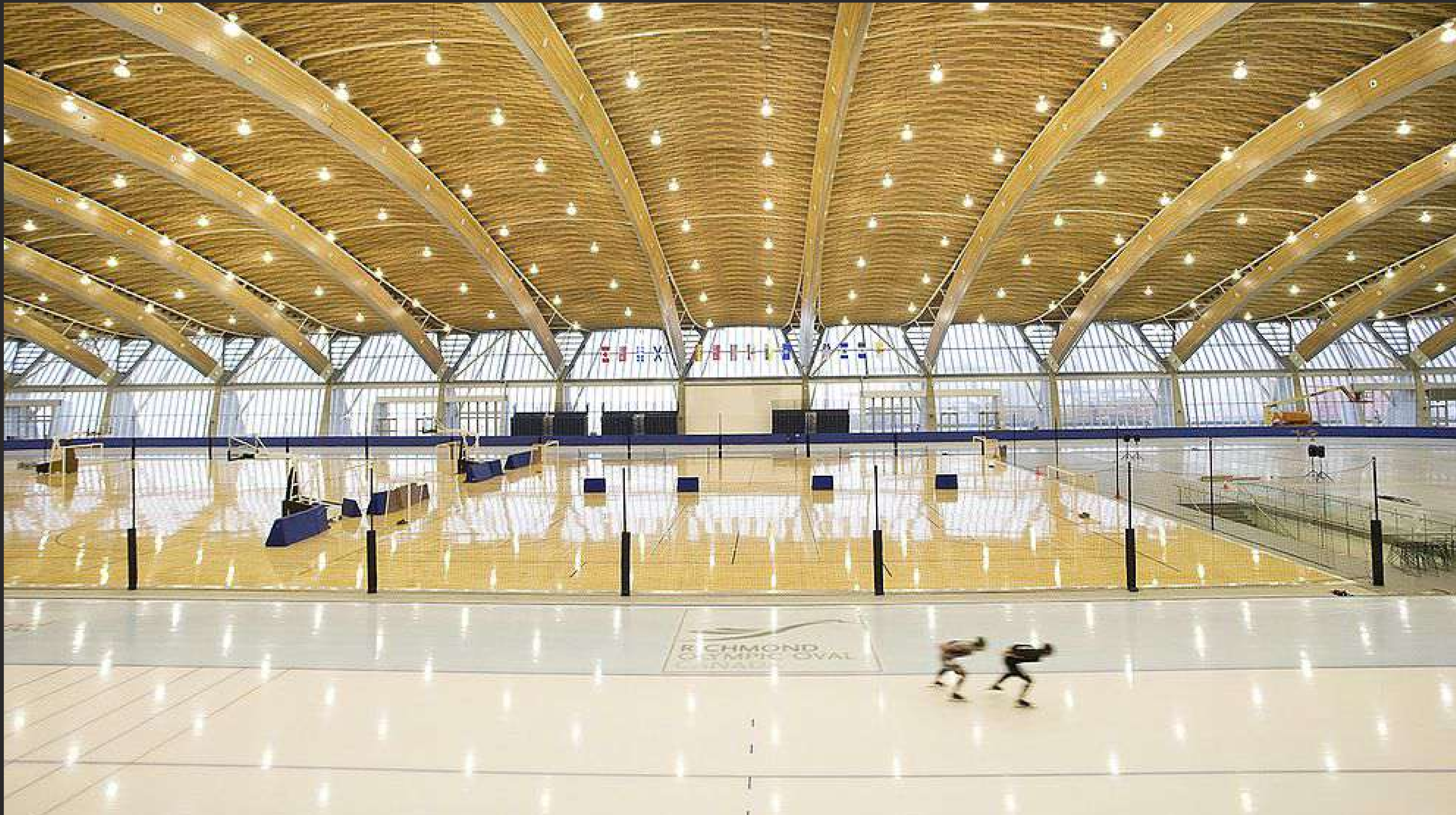
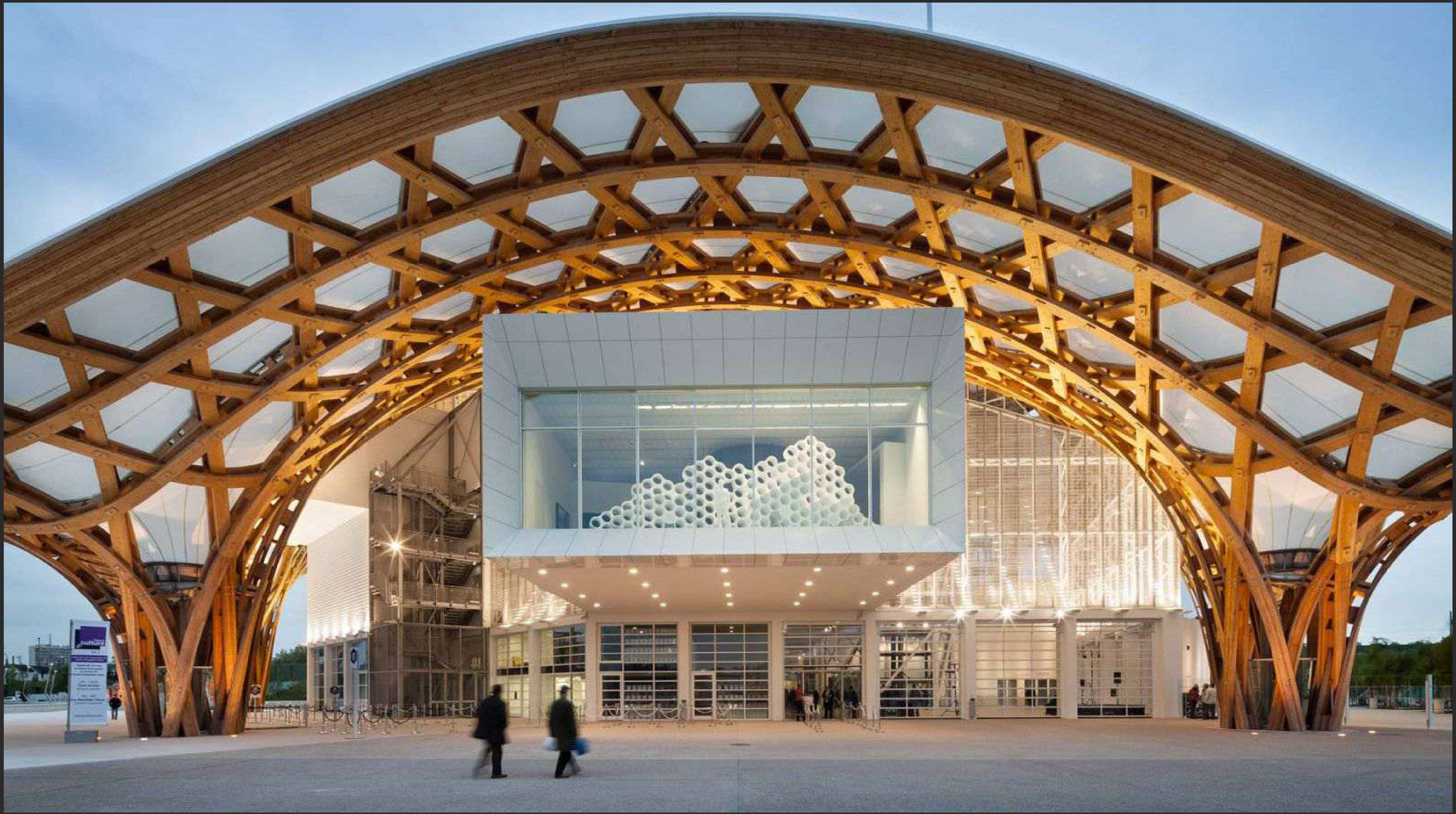
But the benefits of CLT go beyond that. The material is inherently *aesthetically pleasing.*
It creates warm, inviting environments.

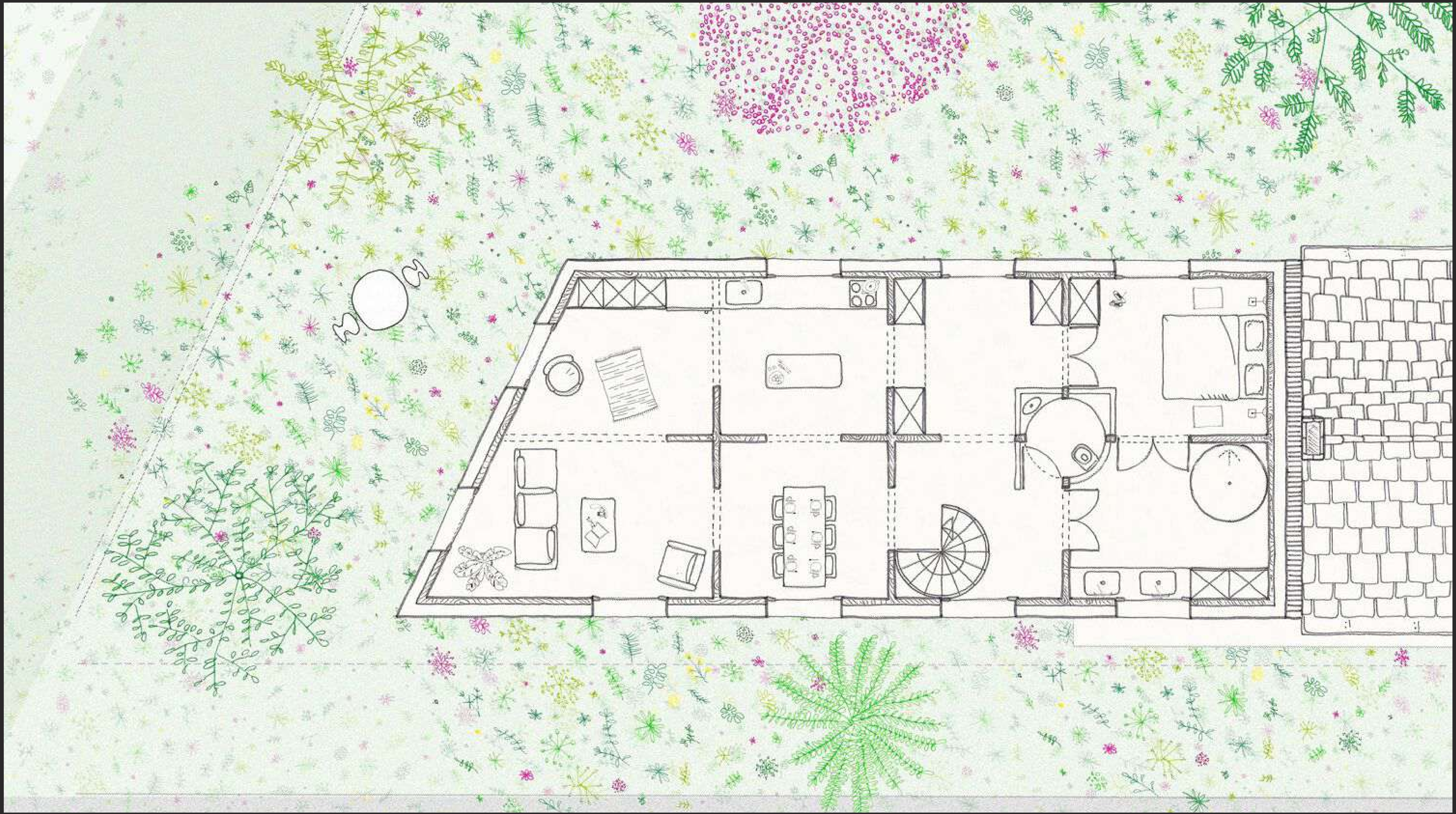
More, along with other engineered woods, CLT is ***structurally versatile.***
These materials can create distinctive architectural expressions like cantilevers...



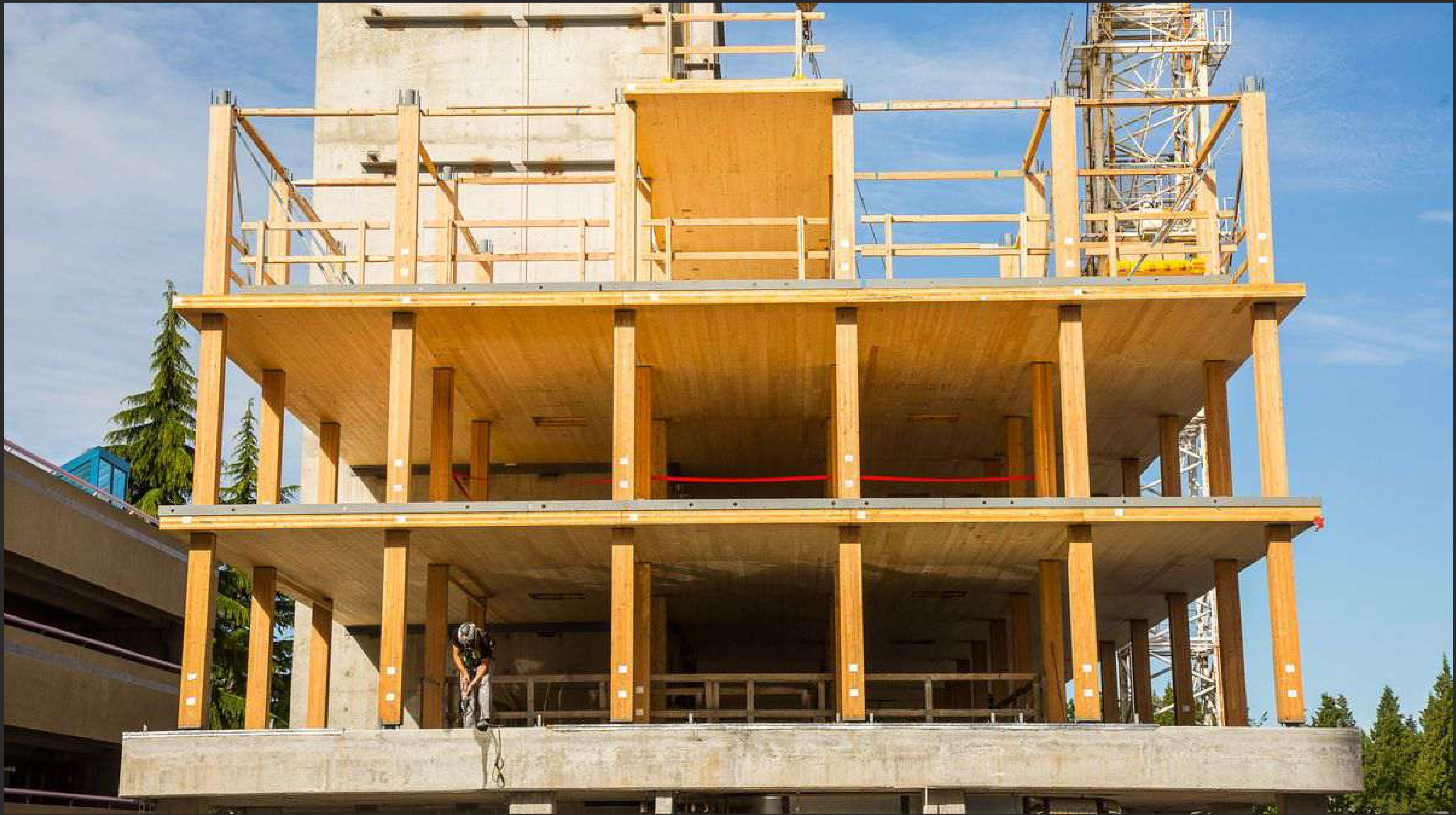
...long-span spaces...



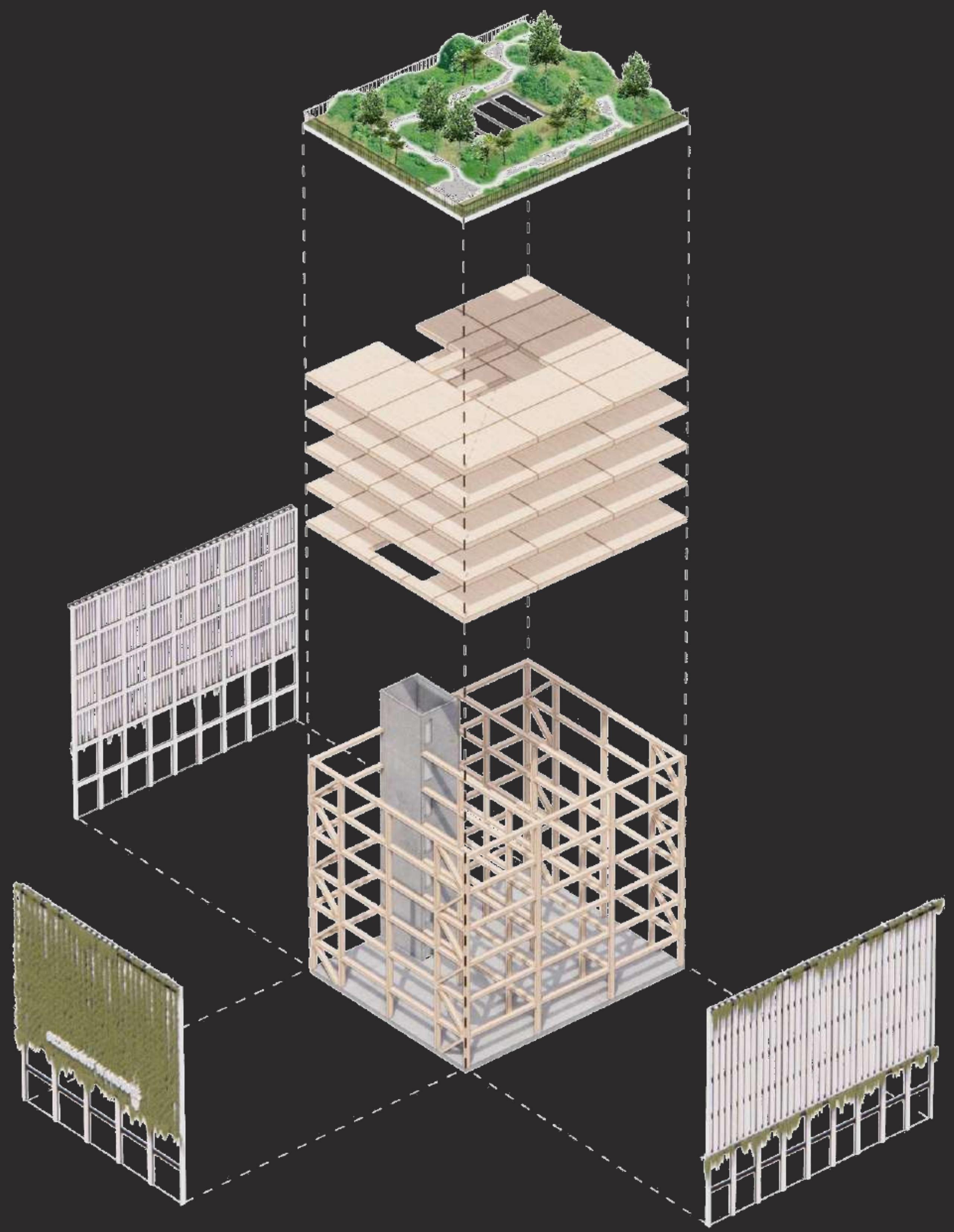
...and curving organic forms.



Since CLT elements are prefabricated, the material lends itself to *modular buildings* that can be adapted over time...

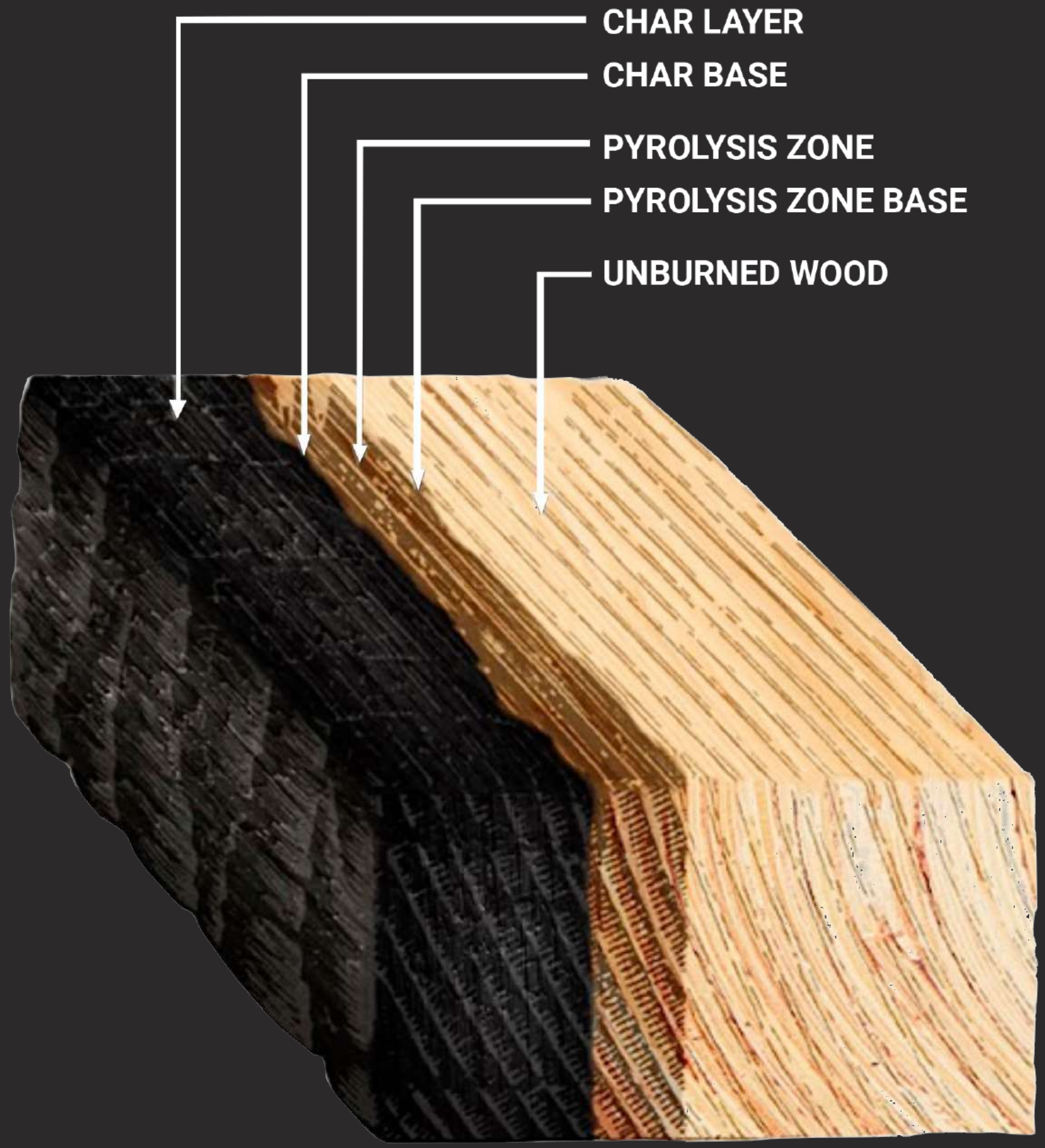


...and allows for dramatically fast construction times. The structure of Brock Commons, an 18-story tower at the University of British Columbia, was erected in only eight weeks.



CLT is also *fully recyclable.* A CLT-building that has outlived its functional life-span can be dismantled and the wood can be sustainably reused in a new building.

Since it is *lightweight,* CLT is an excellent structural choice for extensions to existing buildings as it avoids the need for costly structural reinforcement.



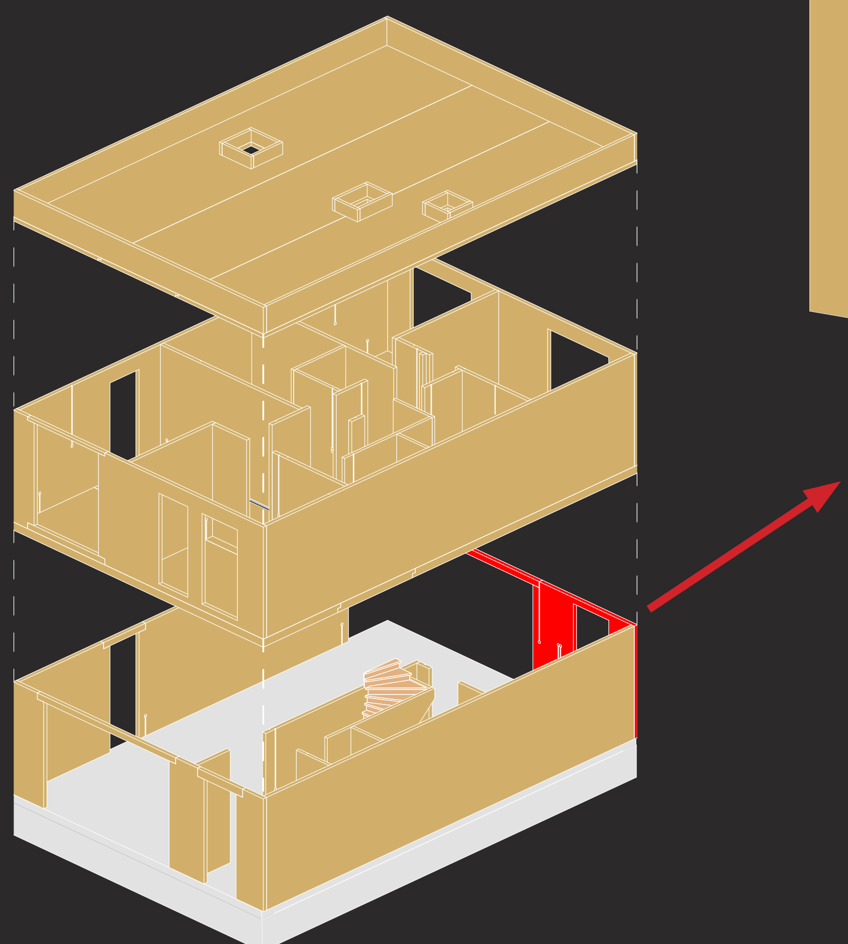
And, because it chars when exposed to flames, CLT is *naturally fire-resistant,* unlike steel which requires expensive fire-proofing.

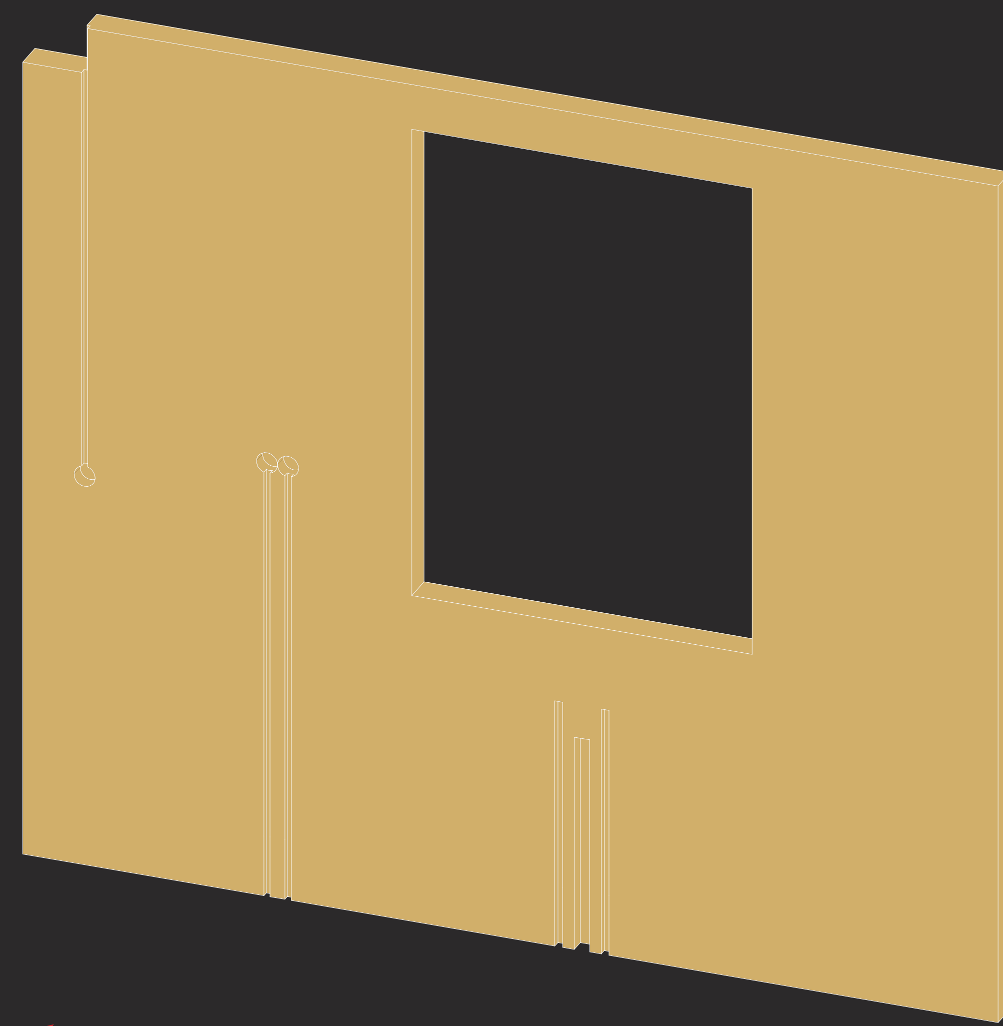
Section III Design Considerations

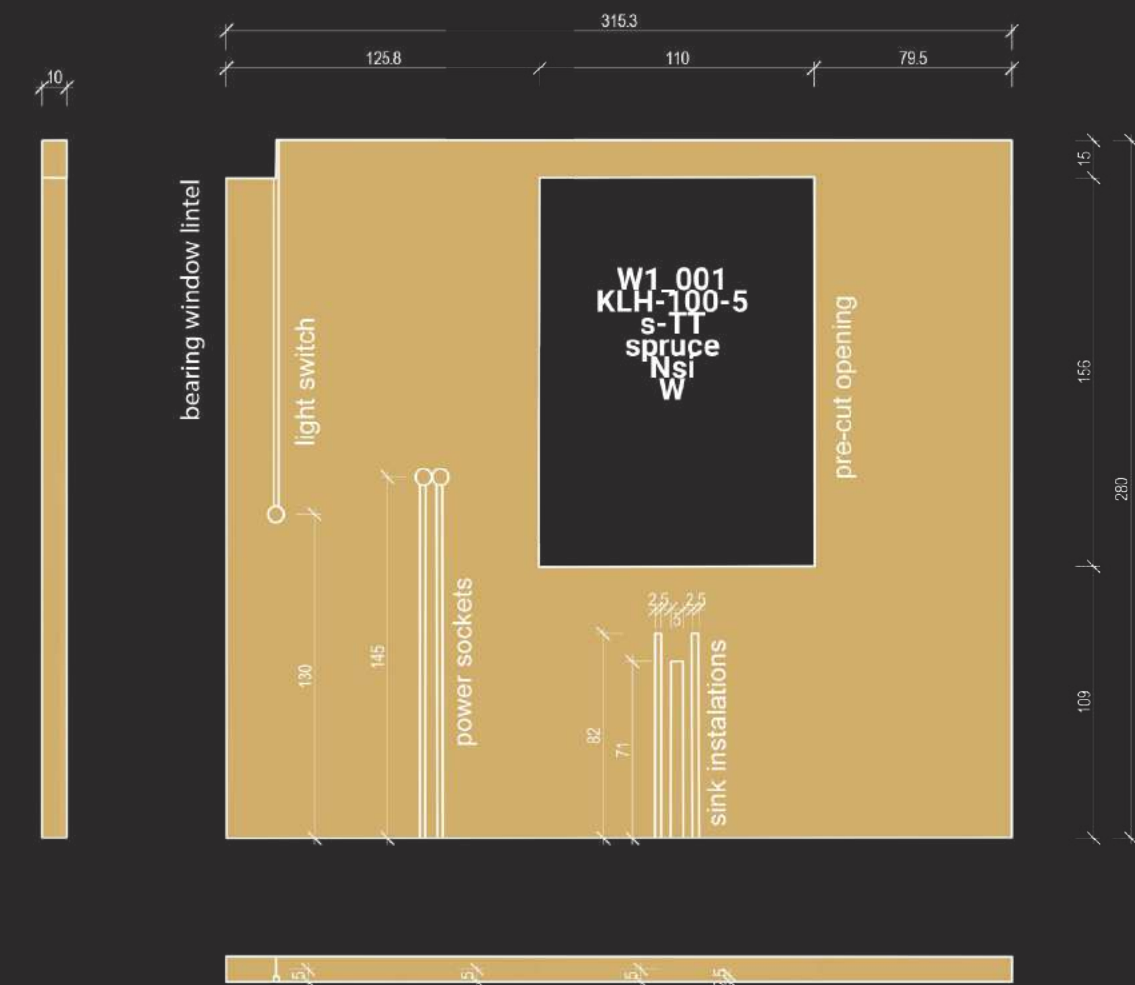
Of course, designing with CLT comes with its own considerations critical to a project's formal and functional success.

A well-designed CLT building embraces the opportunities and constraints of the material as the starting point of new formal possibilities, rather than trying to render a building designed like a concrete or steel one in timber.

CLT is not as inherently soundproof as concrete. To dampen noise and create comfortable interior environments, we often use CLT in combination with sustainable hempcrete, gravel, and acoustical treatments.

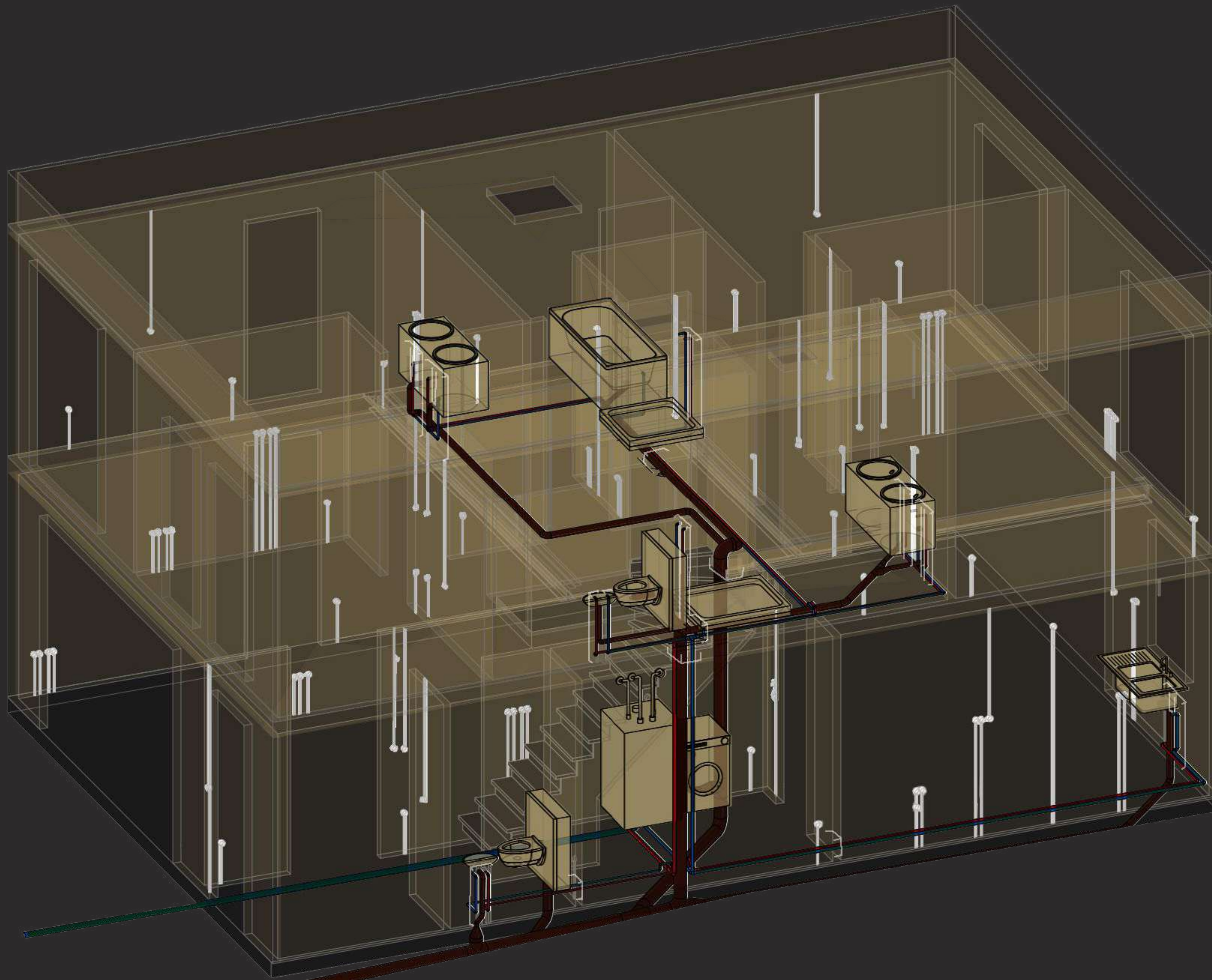




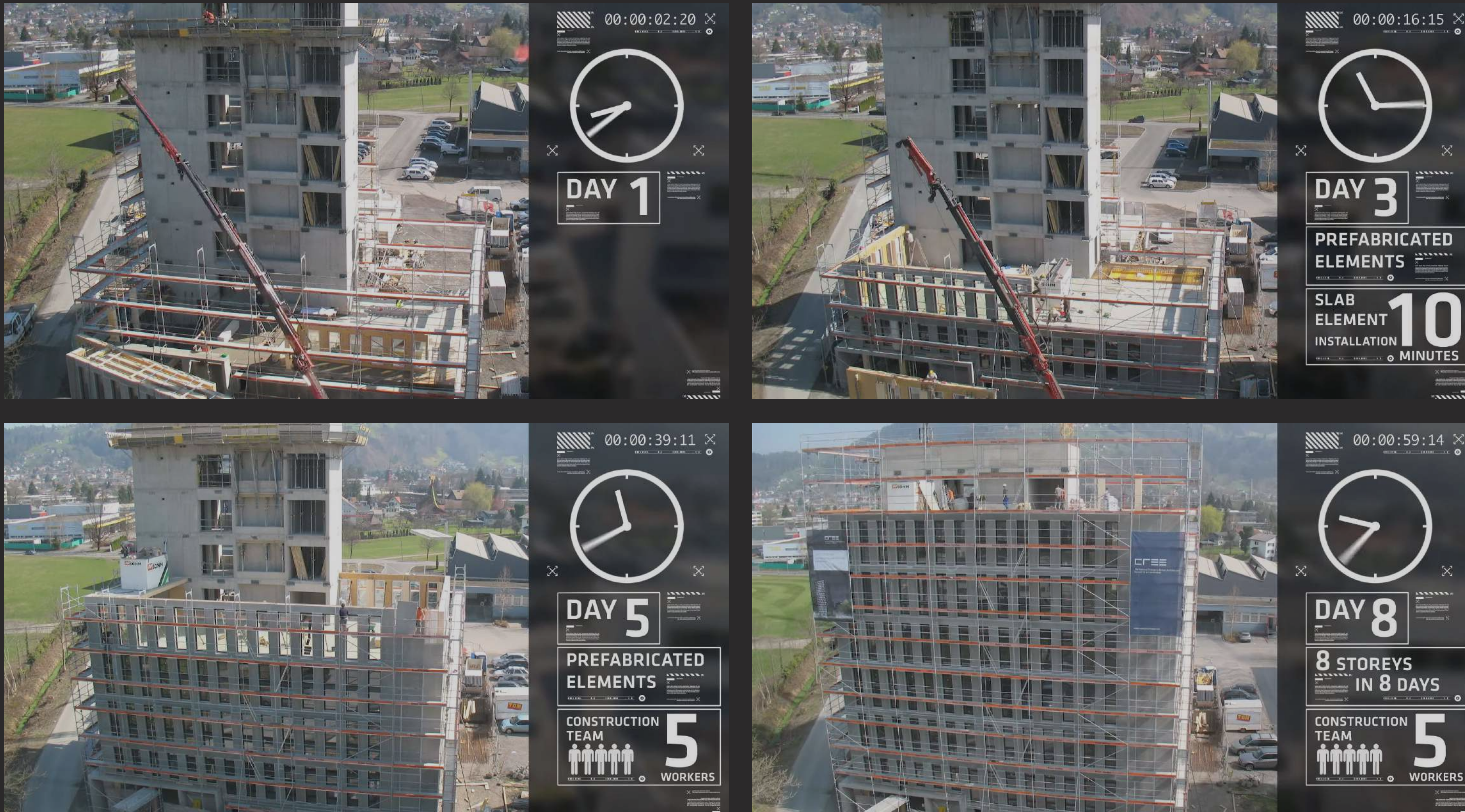


Elements description				
Container Code	lifting system	surface quality	wood type	Material: Volume
IntW-101	W	Nsi	spruce	0.70 m³
IntW-101	W	Nsi	LVL_spruc e	0.07 m³

CLT slabs are also produced offsite and need carefully planned penetrations to ensure structural stability. This means that MEP penetrations have to be fully resolved before fabrication, requiring close coordination between architectural and engineering teams.



Since CLT creates thick solid floor slabs—and since we often want to expose the wood—mechanical systems can not be hidden in CLT buildings the same way they can be in concrete and steel ones. Concealing these systems requires foresight and creative design thinking.



CLT can also be more expensive per unit than concrete, but accelerated construction schedules are often enough to recoup the extra up-front cost. And, in life-cycle analyses, CLT offers better returns over 10-20 year periods, as CLT retains its value better than concrete or steel.

Section IV Case Studies

Our client asked us to design a new single-family residence connected to his existing house, But his lot in the marshlands of East Flanders was narrow and could not support much additional footprint.

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In response, we designed a T-shaped volume that cantilevers the main living volume above the existing house and connects to the ground with a smaller access floor.

The structure uses cross-laminated timber which—because it is far lighter than concrete—makes the long cantilevered living space possible.

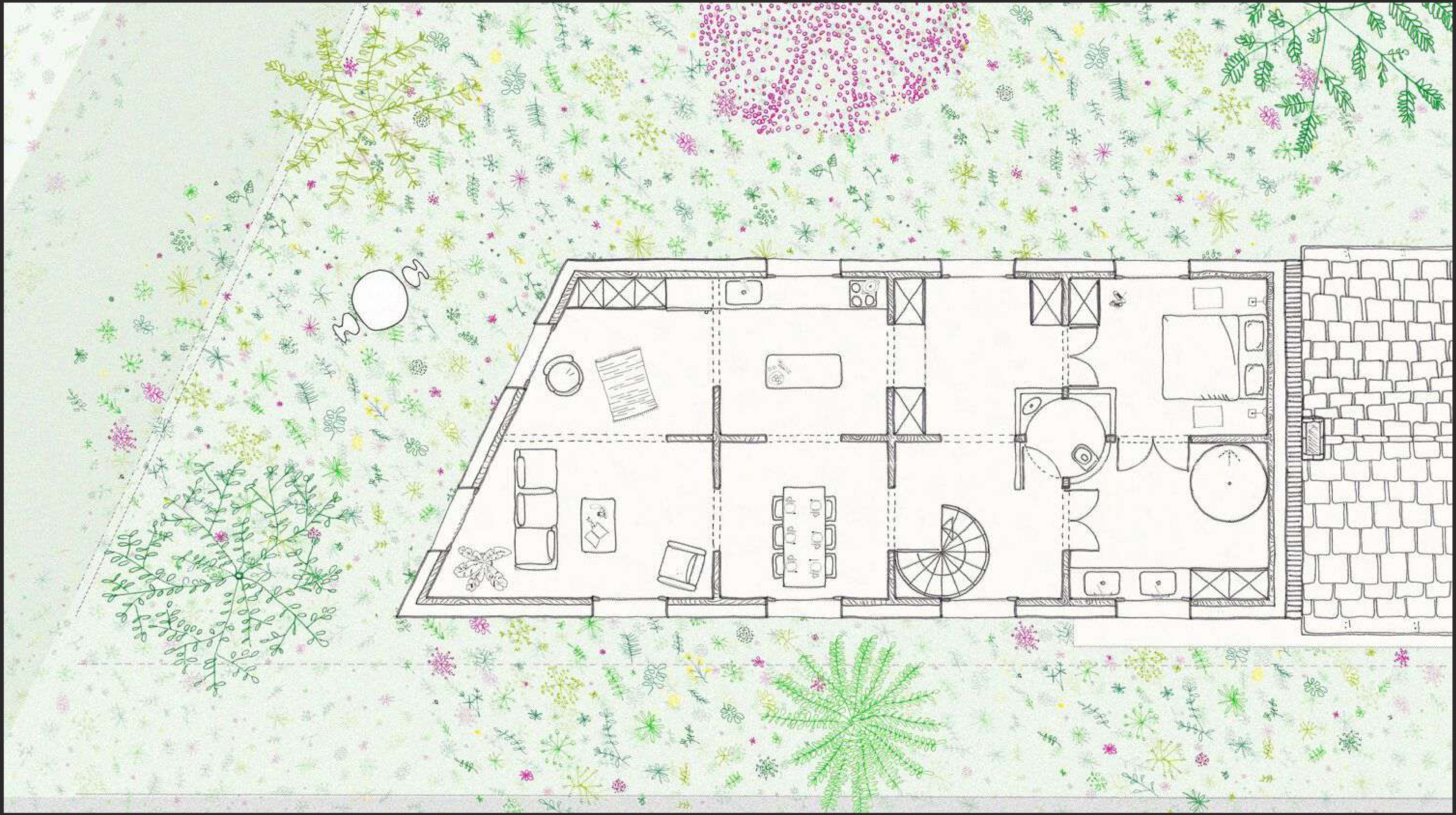
The house is also set on a floating wooden foundation, avoiding the need for a traditional concrete foundation—a carbon-intensive undertaking that would disrupt the sensitive marshland ecology.

THE CONSTRUCTION MATERIAL PYRAMID

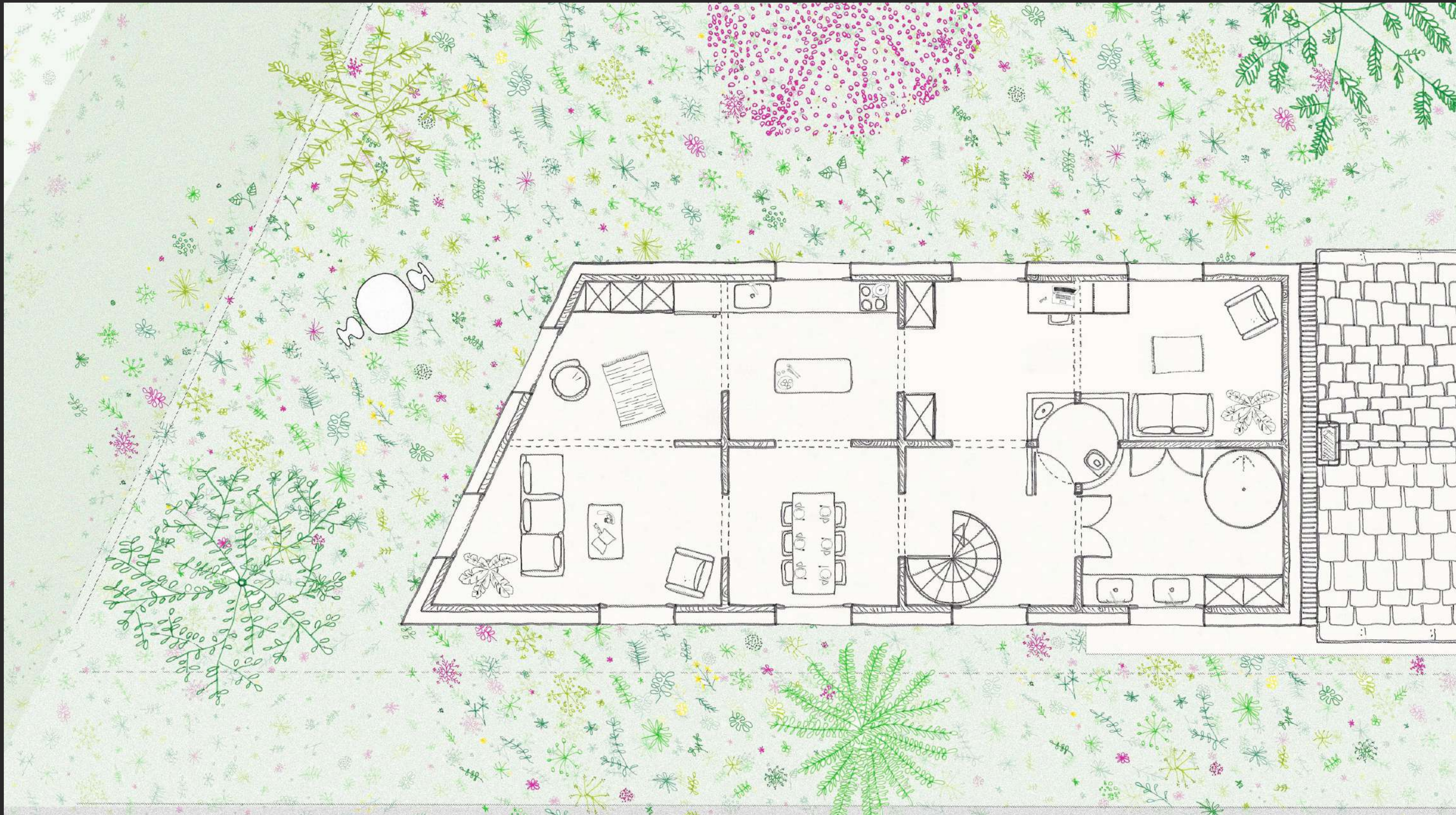
| GWP [kg $CO_{2\,eq}$ / m3]

We combined CLT with other sustainable materials to help insulate and acoustically treat the house. Renewable geocell and hempcrete, a green alternative to light concrete, insulate the walls, reducing the need for artificial heating and cooling.

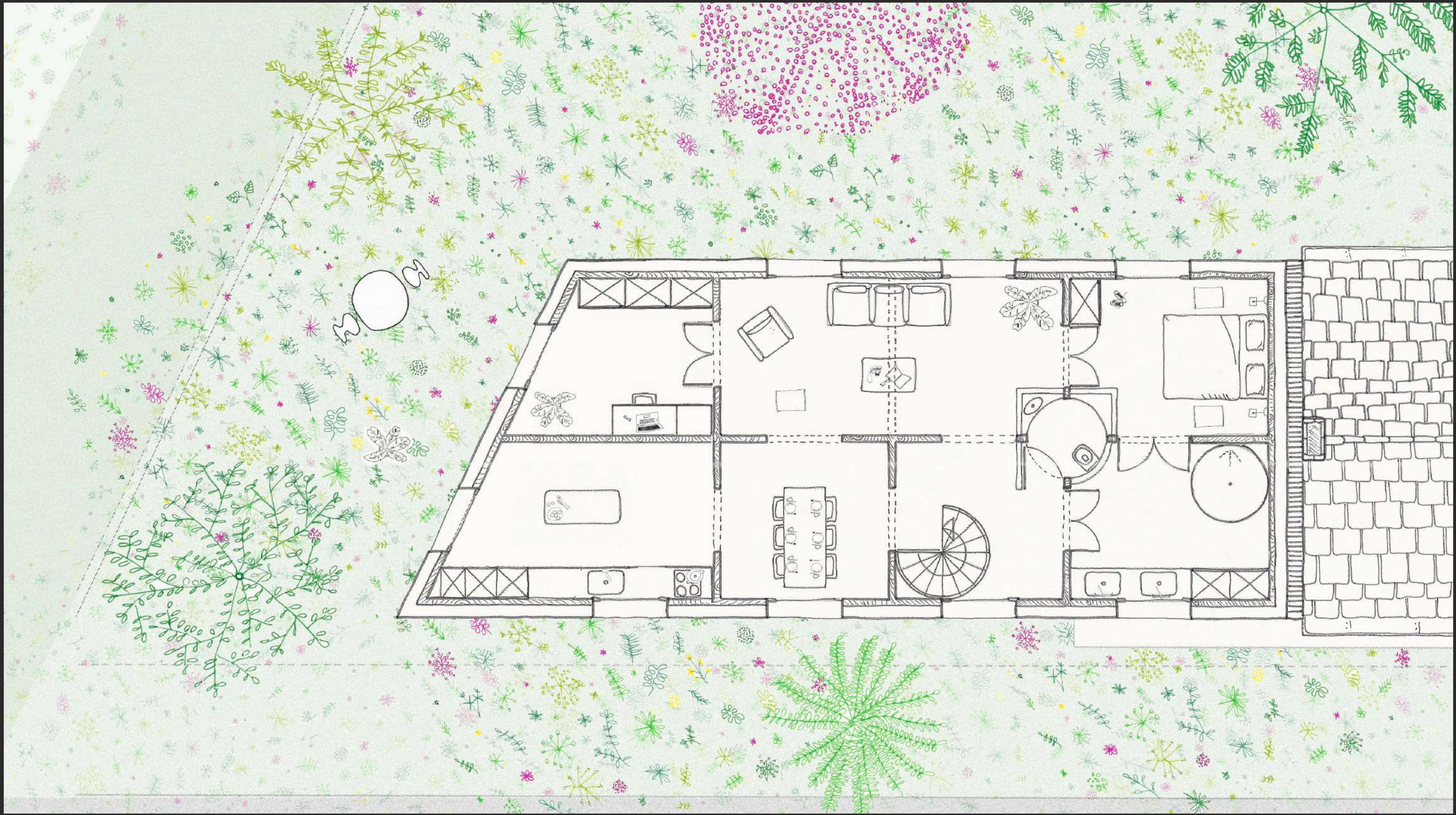
source: www.materialepyramiden.dk



We designed the house to be adaptable, taking advantage of the prefabricated CLT structure to create a modular system. Large, cruciform timber columns punctuate the interiors, dividing the space into distinct zones.



The columns make it possible to flexibly partition the home and reconfigure it over time—changing a bedroom to additional living space once a child moves out, for example.



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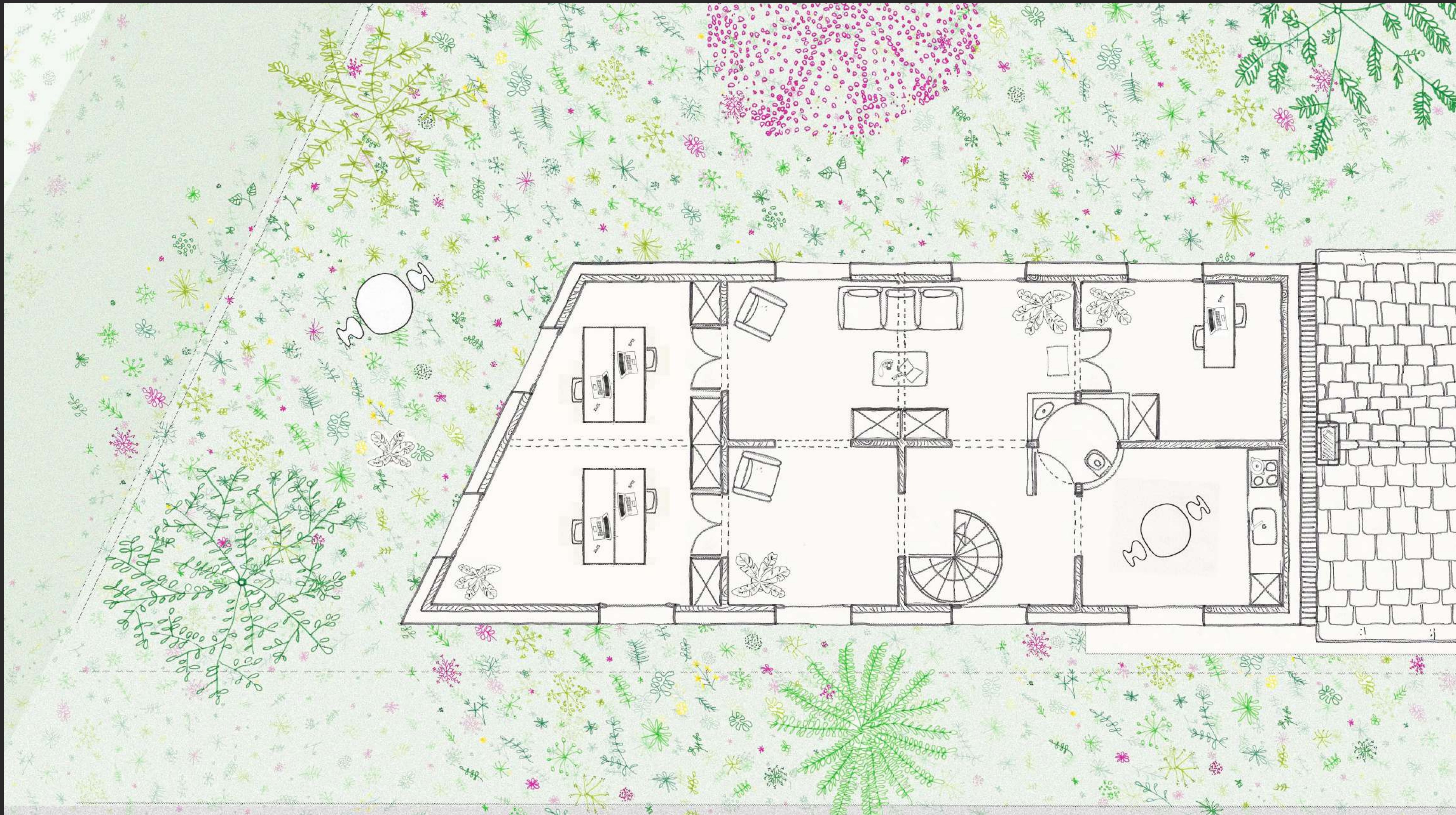

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The design showcases the inherent beauty of CLT. The columns and other pieces use traditional joinery techniques to interlock and support one another with a minimum of fasteners, lending the home a sense of craft.

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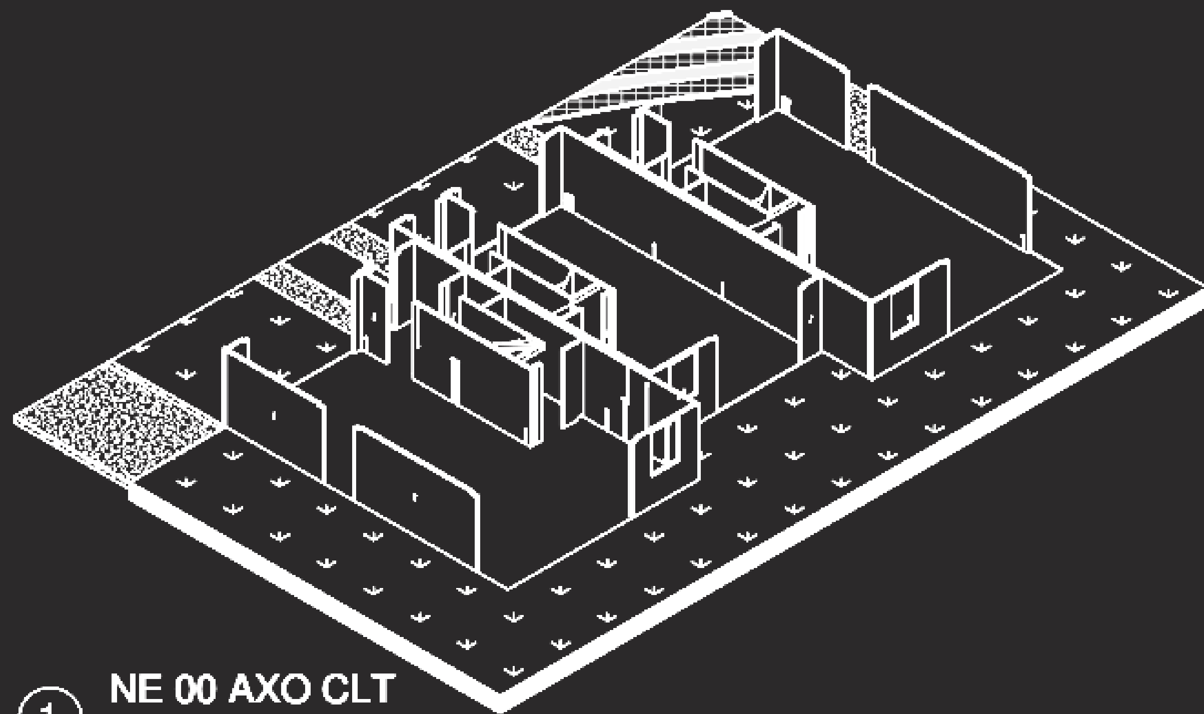
Similarly, we are designing a multi-functional pavilion for Nieuwe Voorhaven
that showcases the versatility and design potential of CLT.

We designed two options. The first uses a regular structural grid with a central core that absorbs wind load. Self-supporting window assemblies open up possibilities for different configurations.

The second option uses an irregular structural grid that absorbs wind load on its own. This means the core can be freely placed in the building. Again, self-supporting window assemblies to allow for different configurations.



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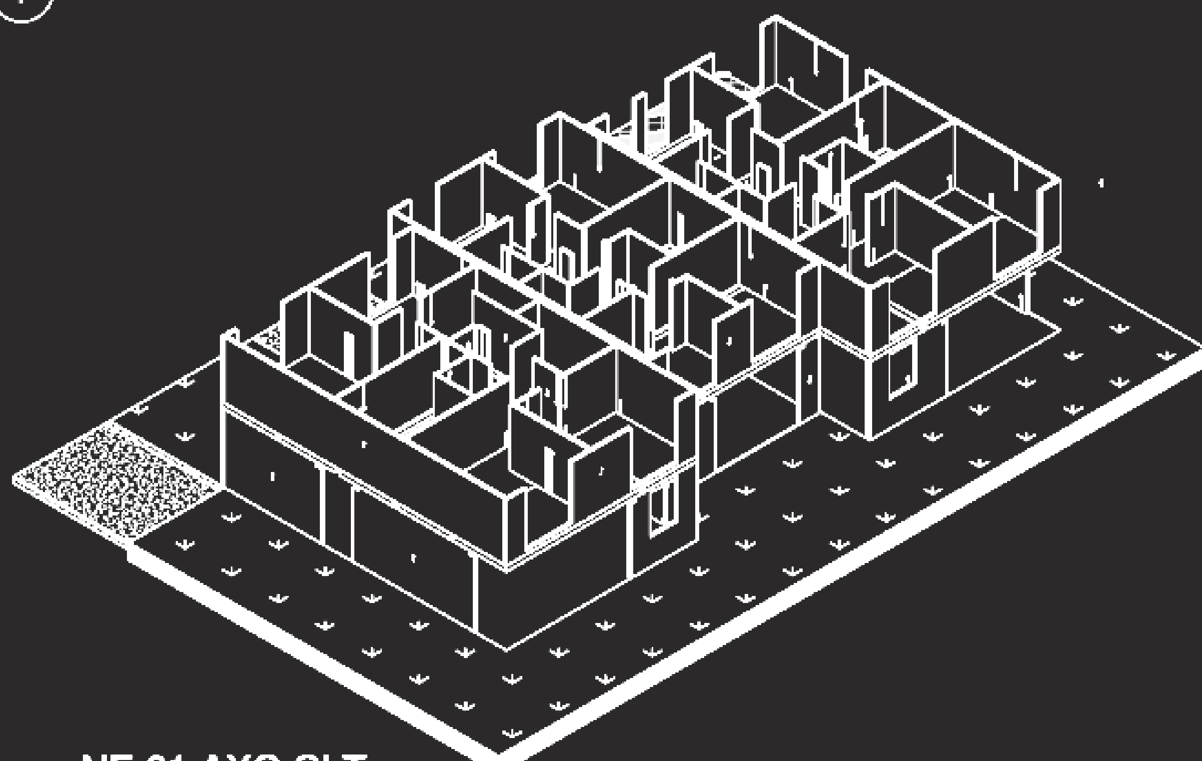
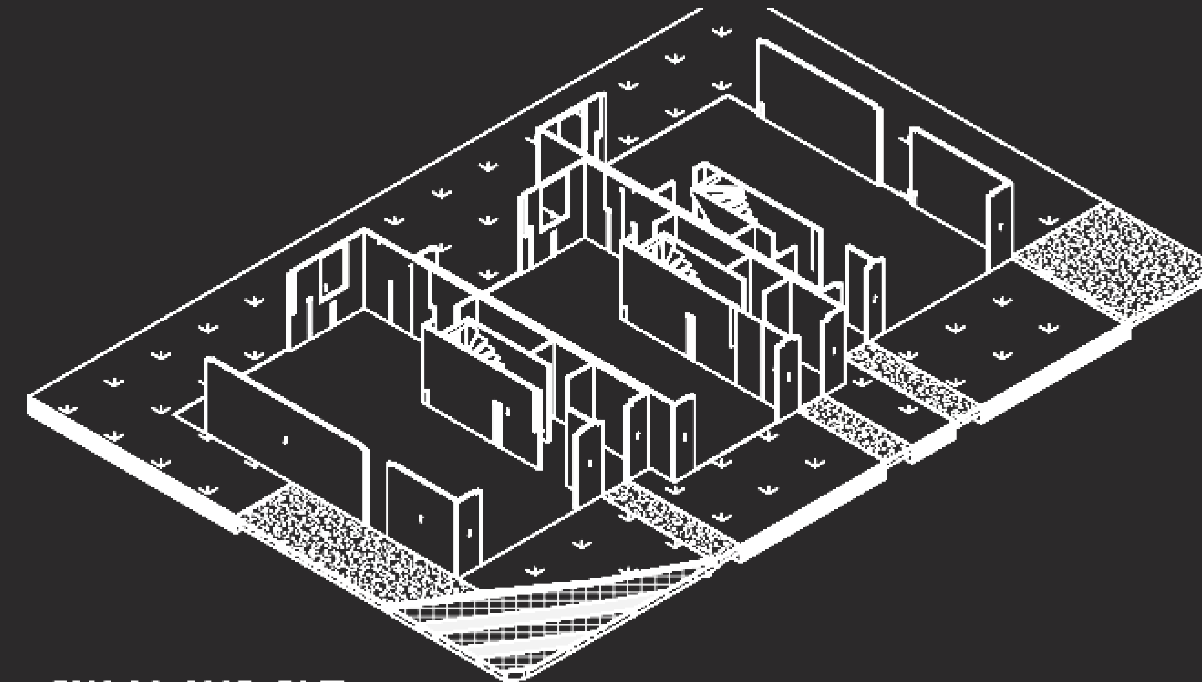


2 NE 01 AXO CLT



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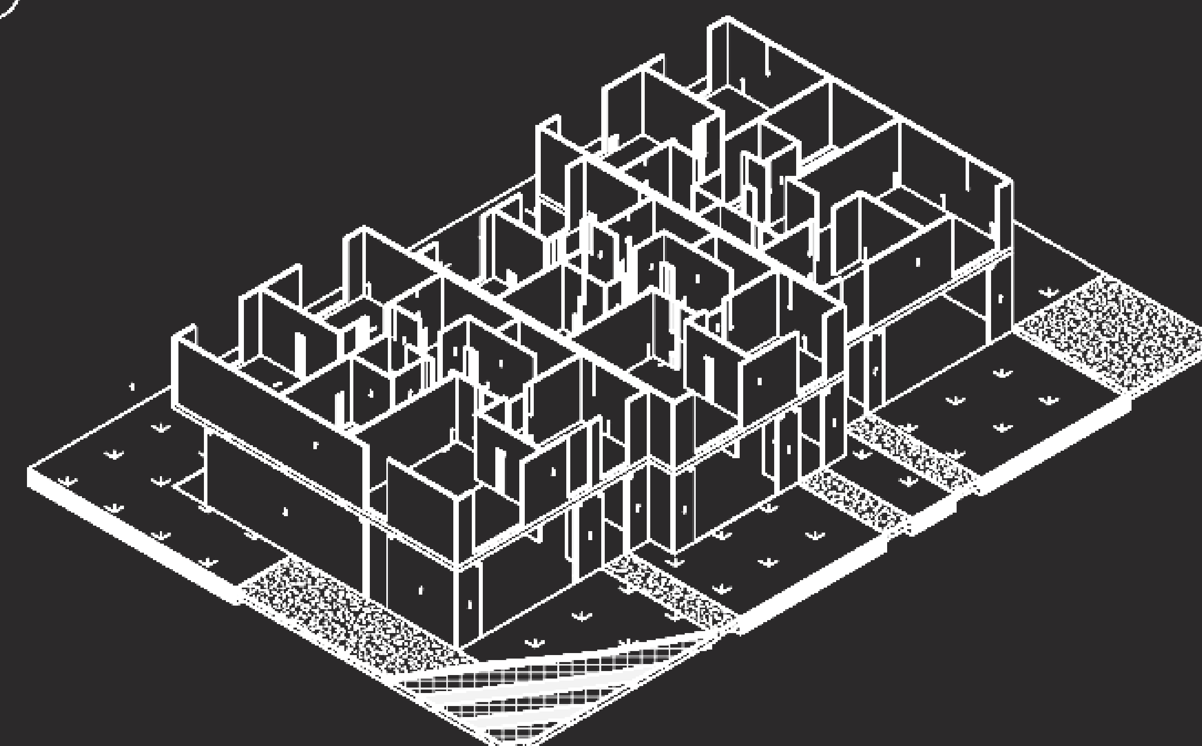
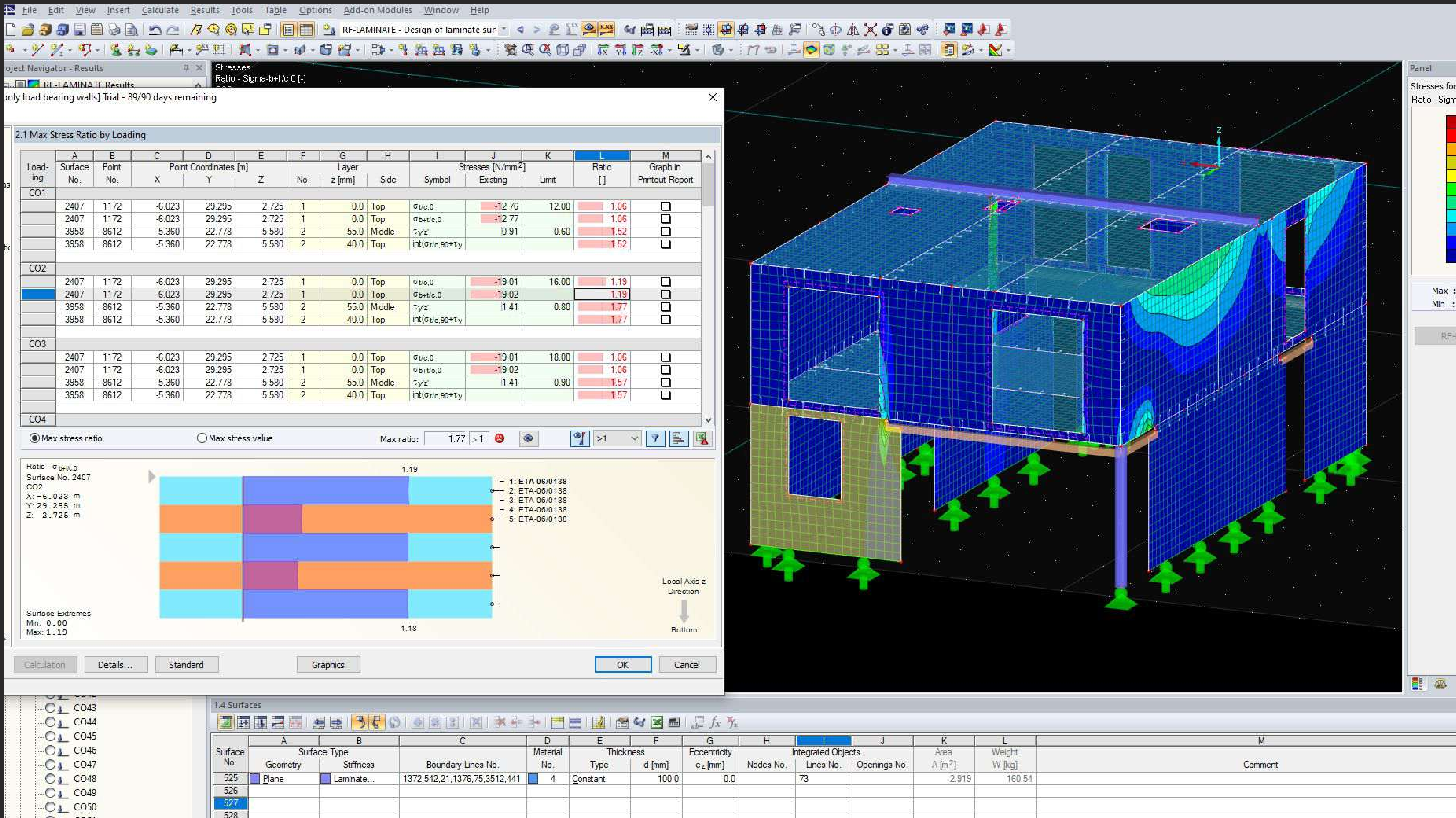
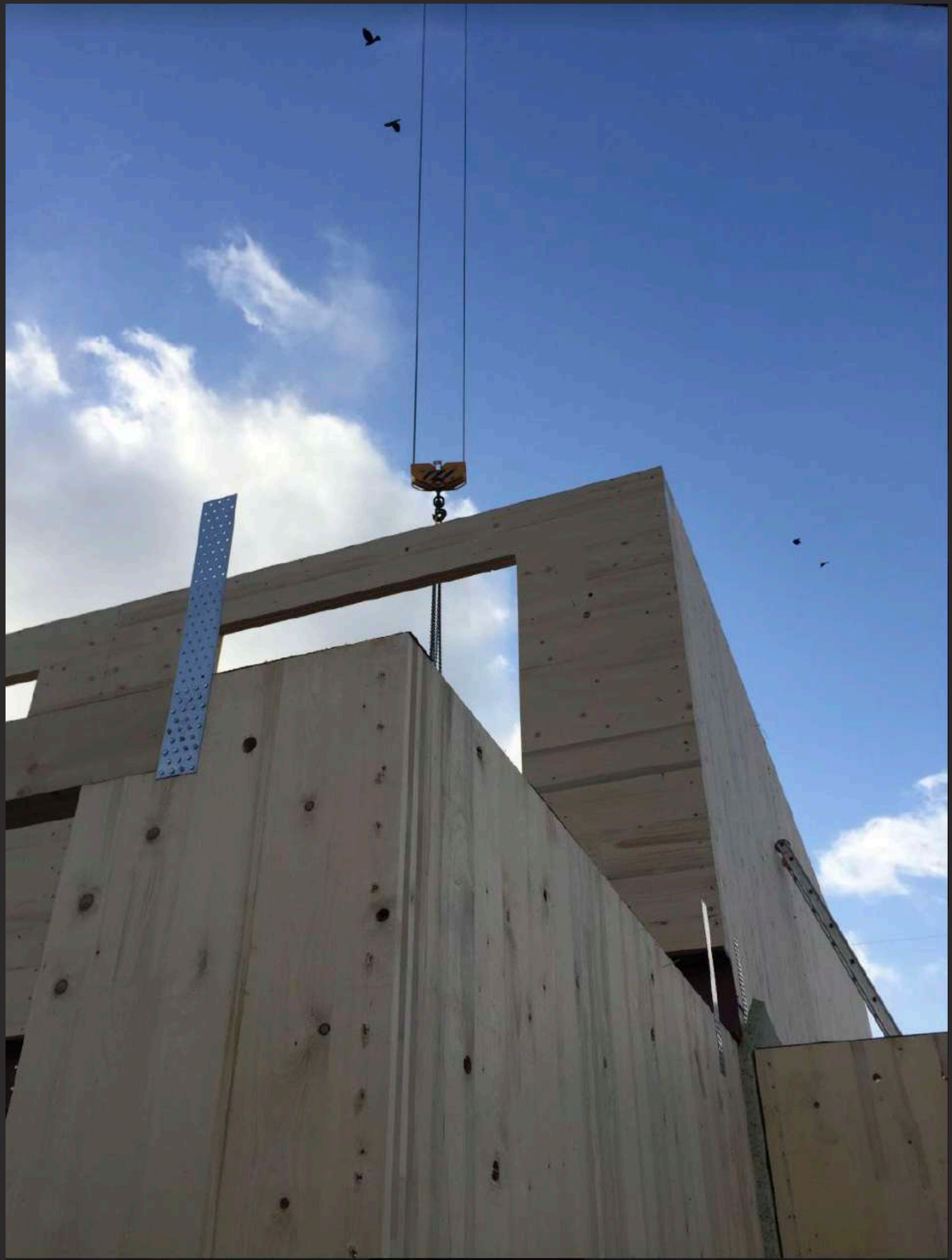


4 SW 01 AXO CLT

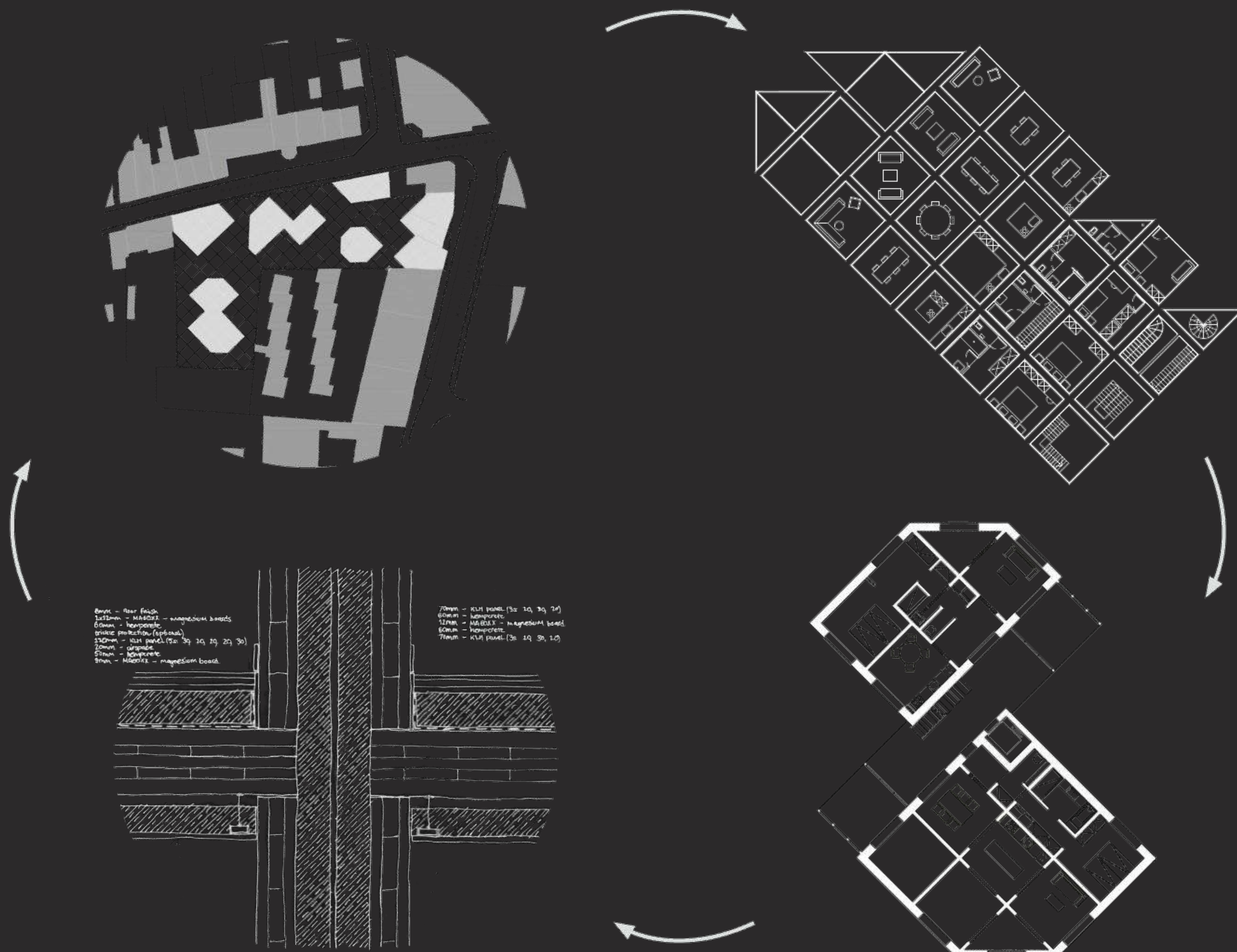
We are also working with a developer in Waasmunster to convert what was originally a timber-frame 6-home project to a CLT system.



We provided complete documentation for CLT module production using BIM and included a full statistical evaluation.



The project is currently under construction.



We are also working with a developer where we upscale these CLT systems to a masterplan scale.

This is a masterplan where the same principle was developed and applied to a project for 36 housing units. The masterplan and the module are optimized for prefabrication.

Employing the same module throughout the project allowed us to use the materials efficiently, reducing cost and increasing production speed.

Organizing the modules in a seemingly random way gives each housing unit a unique character.

For more information on these projects, or to hear the latest about our work with CLT, get in touch at:

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