OPTOPPEN PLAYBOOK

The world needs 230 billion m²
of new floor area by 2060
Our best option is up

What is Optoppen?

Optoppen — from the Dutch for ‘topping up’ — is the practice of adding lightweight, preferably timber, storeys to existing buildings unlocking their unused structural capacity.

COVER PHOTO : HOTEL VINCCI GALA — JOSÉ HEVIA BLACH
PHOTO ON FACING PAGE : THE CARTER, LONDON — TDUK

PHOTO : ROTHBLAAS

1 CONCEPT

This paper shares Hugo Bell’s design submission to the Rothoblaas Build the (IM)POSSIBLE competition. It is intended to provoke thought, and encourage building owners and designers to think ‘outside of the box’.

The competition set the brief for a hybrid design submission for mass timber. The submission focuses on tackling key barriers to mass timber construction.

The solution assumes an existing layout, adding commercial floors using a composite CLT and concrete flat slab approach with glulam columns.

The competition was organised by Rothoblaas, where they required their products to play a key role in the success of the design.

So, why not...

Unlock funding
for retrofitting existing buildings

Provide more space
with significantly less carbon emissions

Creates approximately 8% more floor area of the extent of each city

Flagship effective performance
to boost mass timber

Maximise the capacity
of existing foundations

CONCEPT

The problem

Across the globe, thousands of existing buildings are structurally capable of carrying more. Their foundations were sized conservatively. Their roof slabs were never designed to be the final word. And above them sits airspace that planners, developers and engineers have largely left untouched.

‘Optoppen’, from the Dutch for topping up, is a methodology for adding lightweight timber storeys to existing buildings, unlocking that latent structural capacity without demolition, without relocating occupants, and without the embodied carbon cost of starting from scratch.

The concept originated from our work in the UK, Netherlands and Spain where housing pressure and a mature mass timber industry have made vertical extension a mainstream development strategy. In cities around the world the same pressures exist. The same structural logic applies. The barriers are regulatory and cultural, not physical.

This playbook exists to dismantle those barriers.

What we set out to prove

Hugo Bell, Design Structural Engineer at Whitby Wood, submitted this scheme to the Rothoblaas Build the (IM)POSSIBLE competition in 2025 — a brief asking engineers and designers to demonstrate what hybrid timber construction could genuinely achieve.

The submission was not a theoretical exercise. It is a fully engineered structural proposal for a real building typology: a seven-storey Victorian commercial building, representative of tens of thousands of structures, extended upward by three storeys using a composite CLT and concrete flat slab system with glulam columns.

The jury called it “a strong story about timber potential.”

We think it’s more than a story.

Here’s the evidence...

40%

Additional floor area created on the same footprint, using existing foundations

65%

Structural timber content in the extension by volume

650tCO_2e

Stored carbon, sequestered over the building’s life

Equivalent to 250 average family cars running for a year (IstructE)

80 kgCO_2e/m^2

Structural embodied carbon across the whole building, including the existing RC frame. For context, a conventional new-build commercial structure typically runs at 200–400 kgCO_2e/m^2

Zero demolition

The existing structure stays intact—only the roof slab comes off, freeing foundation capacity for the extension above. It’s not a marginal gain; it’s a fundamentally different model for urban growth.

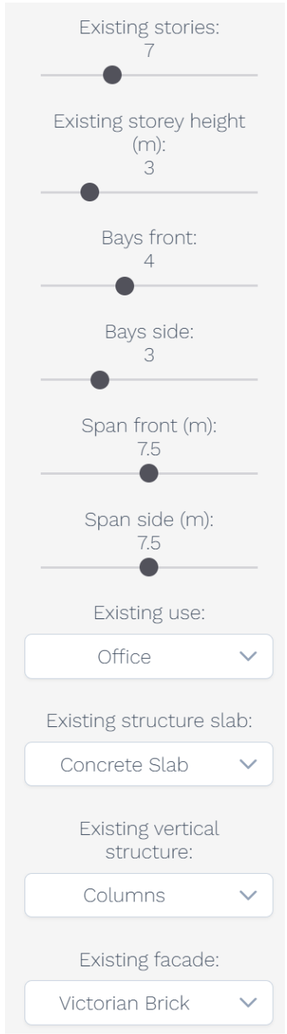
Existing Structures
BEFORE WE TOP UP

The structure is based on typical building stock following the options available in the Optoppen web app.

Commercial constraints are becoming increasingly common with international events putting strain on contractors. This solution offers an economic advantageous path to providing low-carbon commercial spaces at premium heights.

ASSUMPTIONS

— ‘Unknown ground’ was assumed when using the tool, which conservatively only allows 10% additional load under already consolidated foundations
— The roof slab is demolished as often these were not designed for the required loads, are the wrong geometry, and have undergone water damage over their lifetime
— *Existing vertical structure all assumed to be retained*



OUR EXAMPLE:

7 STOREY STRUCTURE
7.5M STRUCTURAL BAYS
MASONRY (VICTORIAN) FAÇADE
RC FLAT SLAB
RC COLUMNS
RC CORE WALLS

ACTIVATE OPTOPPEN, UNLOCK REFURBISHMENT FUNDING

CONCEPT

The Tool

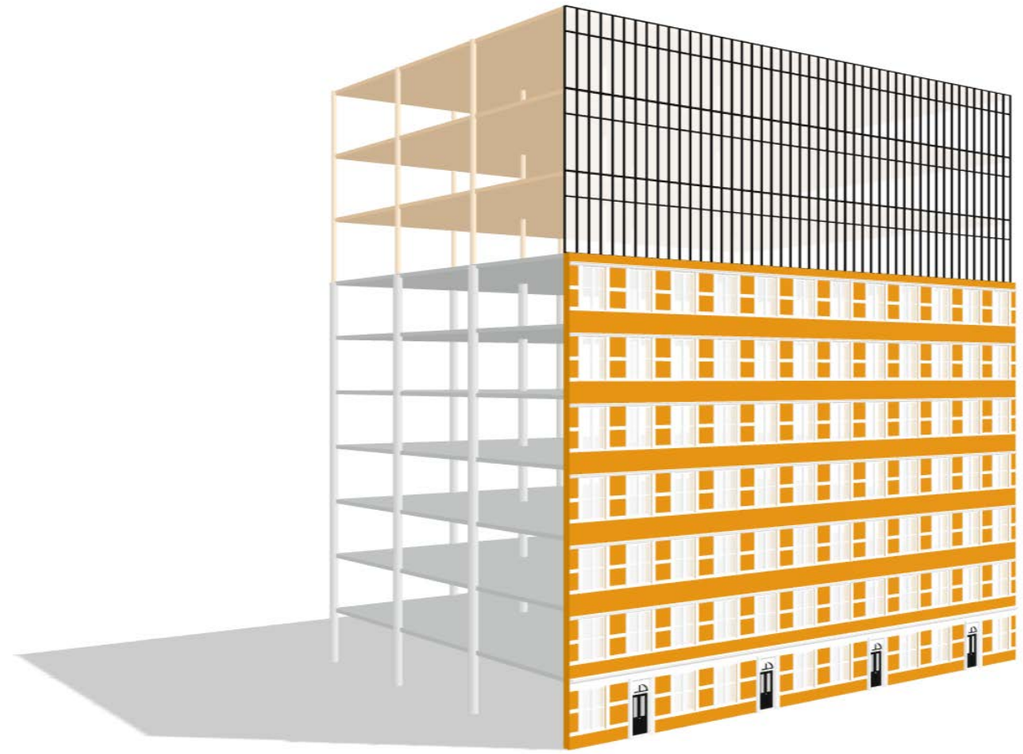
OPTOPPEN.APP
WHITBYWOOD.COM

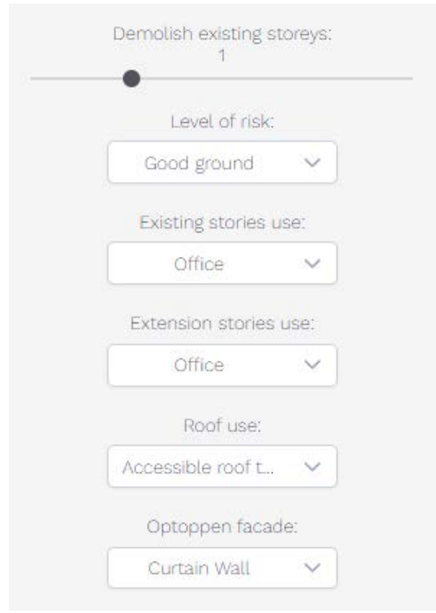
The Optoppen movement has sought to demonstrate the potential of lightweight vertical extensions.

The Optoppen Playbook draws inspiration from this initiative, and the tool developed by Whitby Wood formed the basis of the concept. The relevant inputs provide insight into the clarity and simplicity of its interface:

whitby wood

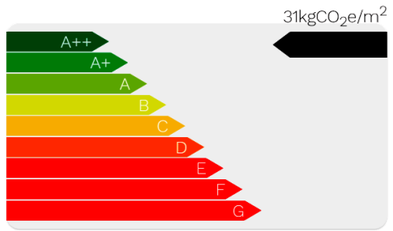
OPTOPPEN INPUTS





OPTOPPEN ANALYSIS

The tool assumes a pure timber solution which the reduced SCORS result reflects as opposed to the hybrid system that follows a metaldeck solution is also provided in the tool reducing the SCORS result to A+.



Additional stories:
3
Additional area:
2025m²
Additional area:
43%

SCORS rating:
A++
Extension embodied CO_2e:
213t
Sequestered CO_2e in timber extension:
650t

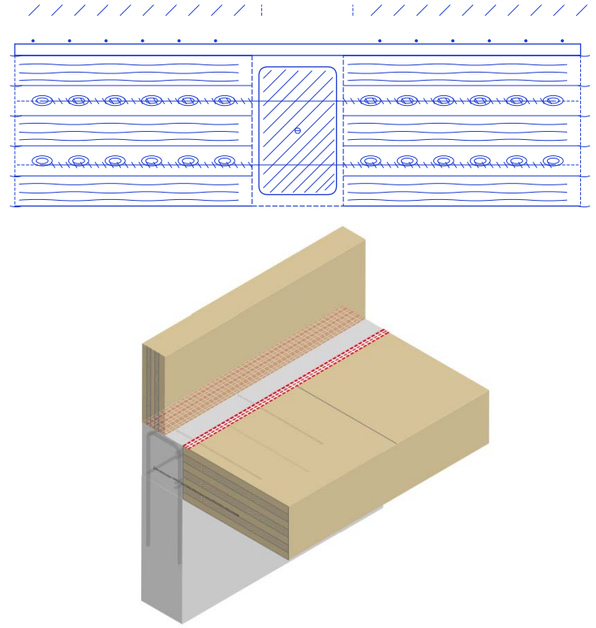
Metal deck extension comparison:
Additional stories:
3
SCORS rating:
A+

rothoblaas

Rothoblaas products are at the heart of this solution — this section explores how they perform within a hybrid structural system.

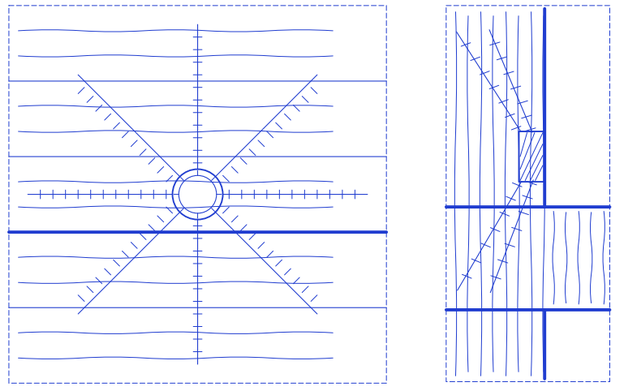
TC FUSION

A concrete interface between CLT slabs in conjunction with VGS screws offers improved moment continuity between the panels. It also provides a more seamless connection into vertical concrete elements for timber.



RING

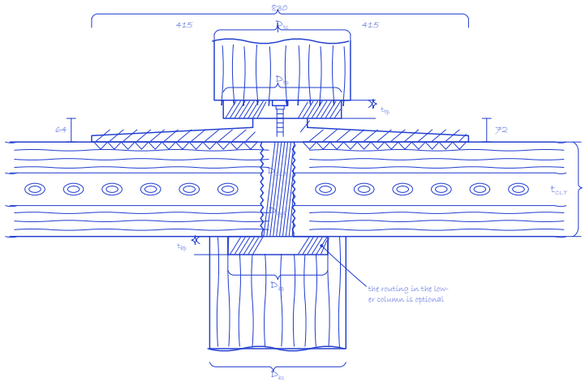
A removable connection to provide a flush interface at vertical and horizontal joints whilst improving continuity between elements through utilising double screw inclination. The connection is suitable for prefab or on site assembly.



CONCEPT

SPIDER

A column connection and reinforcement system allowing significant bearing to the floorplate to provide capacity for extensive mass timber grids offering open plan opportunities. Provides 7.0 x 8.0m structural bays with 5000kN transfer between pillars.

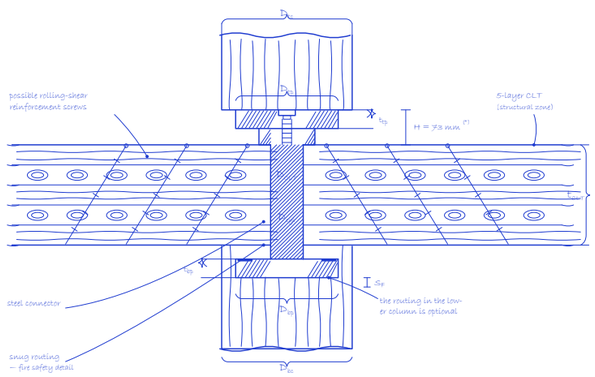


3

COLUMN TO COLUMN

PILLAR

A column connection and reinforcement with a thinner mechanism -valuable in column locations where the SPIDER extends out of the building envelope. Provides 3.5x7.0m structural bays with 5000kN transfer between pillars.

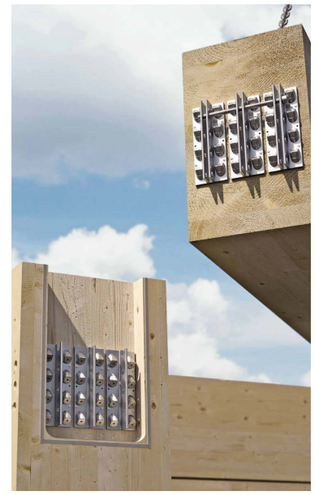


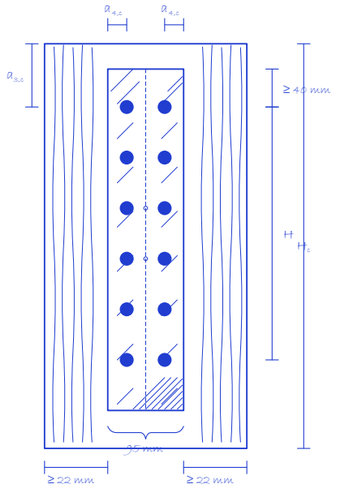
4

COLUMN TO COLUMN

ALUMEGA

A hidden connection for horizontal and vertical timber offering multiple capacities dependant on the approach required.





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BEAM TO COLUMN

The design can offer greater capacity for Rothoblaas implementation by introducing the following products:

— SLOT connector between CLT wall panels

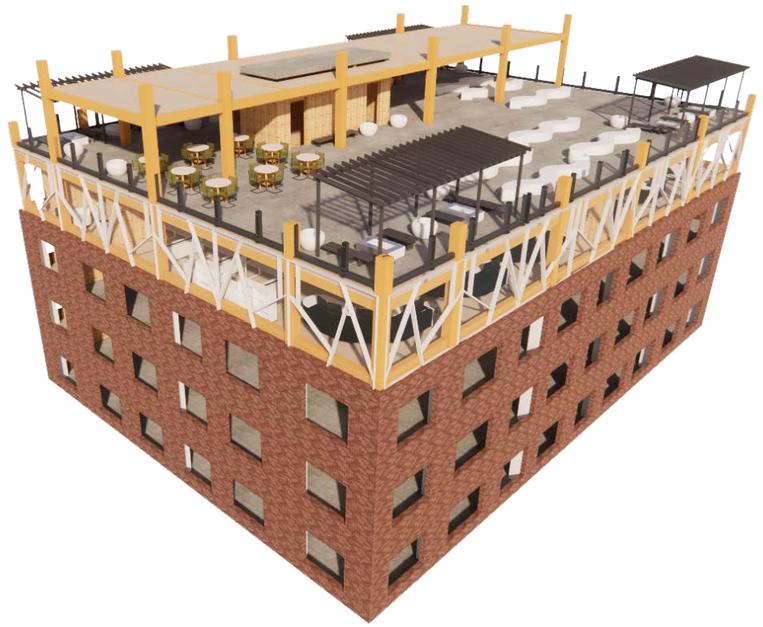
— SHARP METAL between Beam and CLT slab interface

The Solution

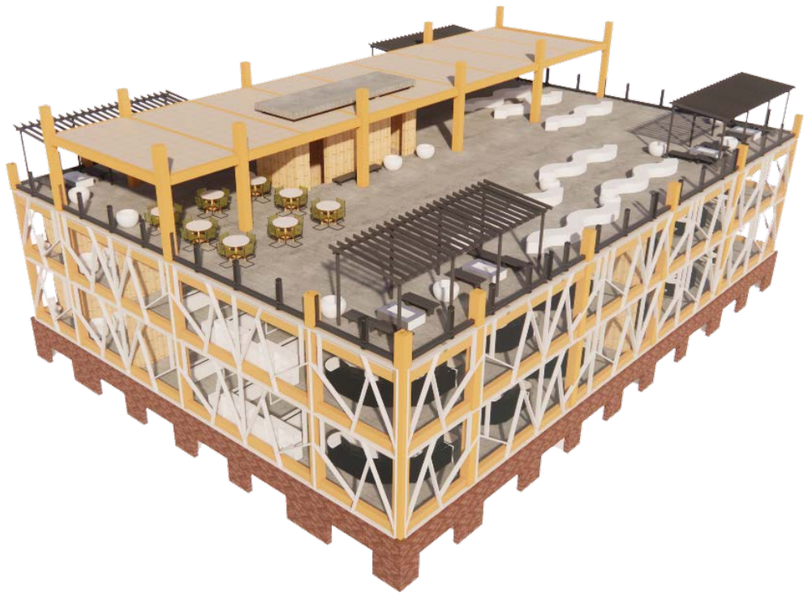
A concept to improve the capability awareness of timber hybrid design and provide stakeholders more OPPORTUNITIES

A flat slab CLT floor system, supported on Spider and Pillar connectors, forms the structural basis of the extension. TC Fusion connectors join CLT panels and — in a notable application — tie the shear wall extensions together in combination with Ring connectors. Where facade elements require beam support, Alumega connectors are adopted alongside the Pillar system.

The most significant innovations arise at the interface between the existing and new structure, where standard Rothoblaas products have been adapted to achieve structural continuity across the two systems.



3-STOREY EXISTING STRUCTURE - **SINGLE STOREY** OPTOPPEN



5-STOREY EXISTING STRUCTURE - **DOUBLE STOREY** OPTOPPEN

FUTURE PROOFING

The flat soffit inherent to the post-and-slab system provides the floor-to-ceiling clearance and soffit flexibility needed to accommodate residential retrofitting, should future demand require it.

The Timber Concrete Composite construction also delivers the acoustic performance necessary for residential and educational uses, in accordance with SCI P354 guidance on acceptable floor resonance.

SCALABILITY

The solution is deliberately kept simple — a design decision that makes it readily applicable across a range of massing configurations and building footprints. Given the diversity of urban building stock, the system is suited to both single- and double-storey extensions. The general arrangement and adapted product specification should nonetheless be reviewed and optimised against the specifics of each existing structure.

PHOTO : ROTHBLAAS

DESIGN 2

Basis of Structural Design

The concept is led by structural performance - an approach seldom prioritised at the concept design stage.

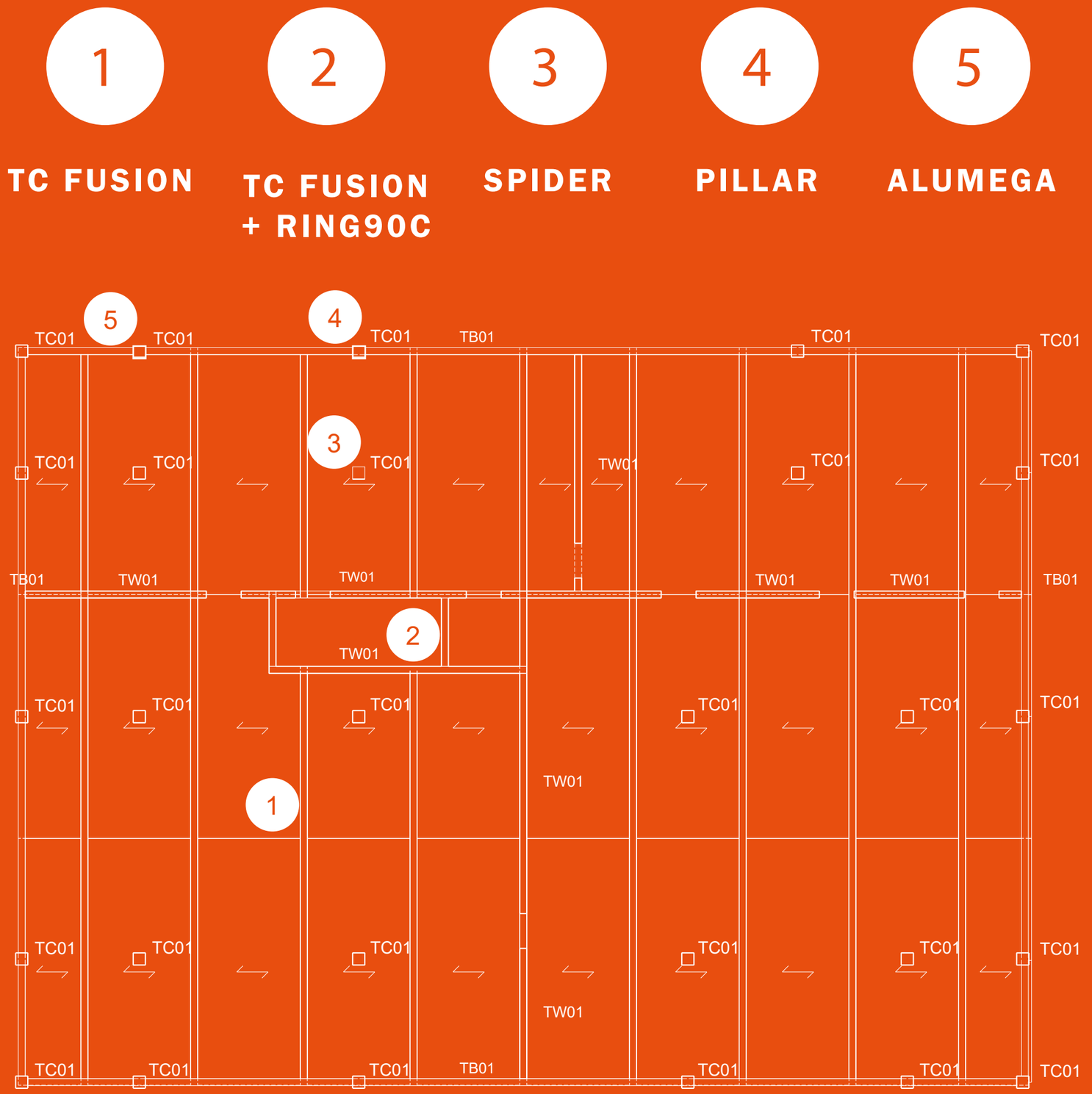
To maximise the potential of the extension space, the proposal aligns with EN1990: *Basis of Structural Design*, while investigating efficiencies within the structural floorplate detailed on this page.

The design conforms to the EN guidance found within the following:

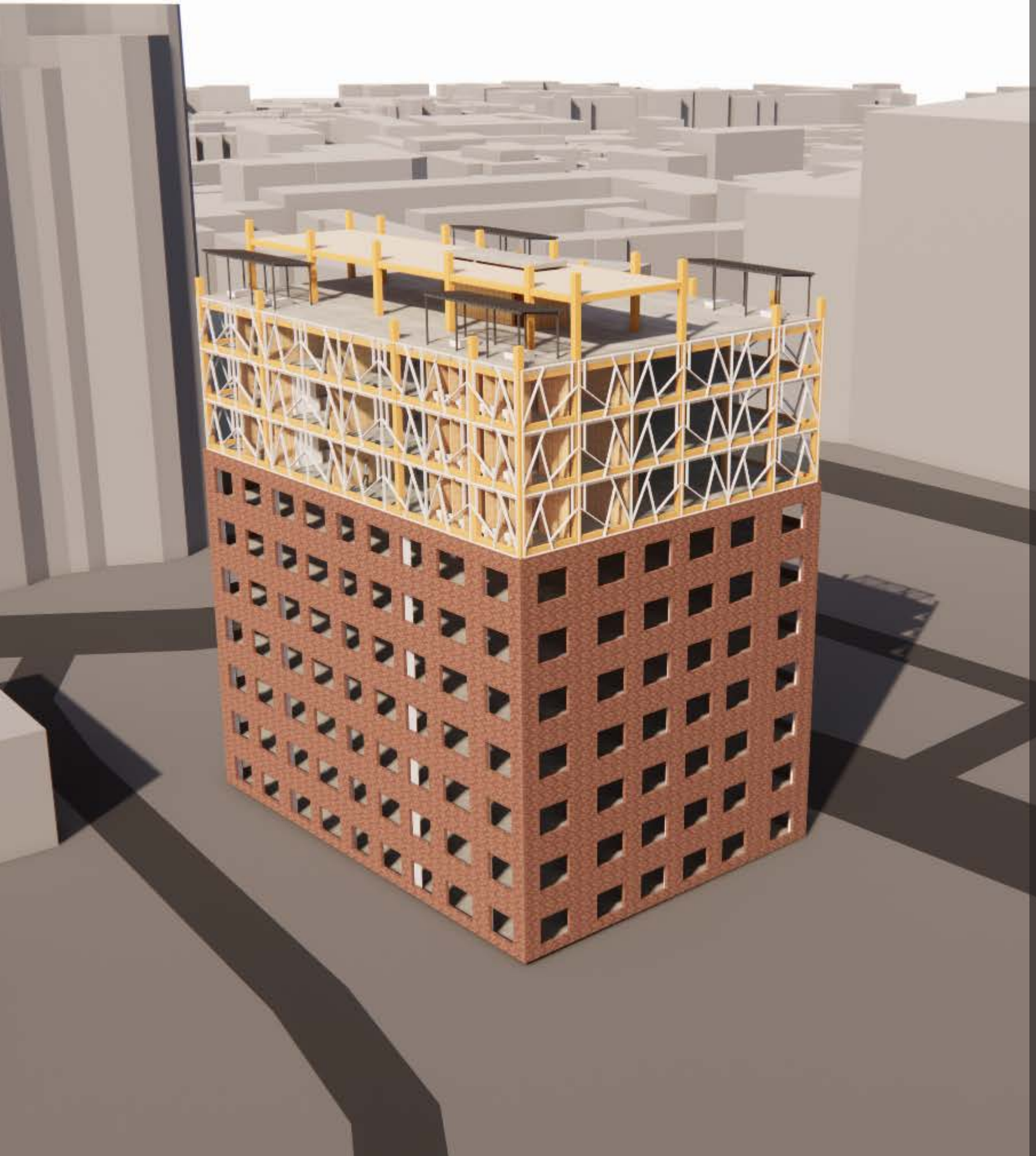
- EN1990 Basis of Structural Design
- EN1991 Actions on Structures
- EN1992 Design of Concrete Structures
- EN1995 Design of Timber Structures

SCHEDULE

TC01	350SQ GLULAM COLUMN
TW01	240dp CLT
TB01	350W x 200DP GLULAM BEAM
⟷	ONE WAY SPANNING 240DP CLT



TYPICAL ARRANGEMENT



FIRE DESIGN

The composite topping benefits the compartmentation design along with the TC fusion joints mitigating fire spread and fuel loads. The contribution of the timber char zone offers a positive fire design to achieve appropriate REI requirements.

TC Fusion junctions offer non-combustible fire junctions at key element nodes, slab to slab and slab to wall.

VERTICAL DESIGN

CLT Slab composite transmit permanent and imposed loads to the vertical elements through the detailed Rothoblaas connections. Glulam and CLT columns and walls respectively provide the vertical load path into the existing structure which takes load to the existing foundations.

LATERAL DESIGN

Lateral loading is taken through facade into columns and ring beams. Loads are then transferred to the main stabilising elements through a diaphragm that is built through the hybrid TCC. Composite behaviour is to be optioneered against cost and buildability. Columns to be designed only for vertical loading in the lateral analysis. Additional CLT shear walls in both axis are centred on a CLT core. These are all fixed in design as to be the main stabilising elements in lateral strength.

Robustness

PROVIDING CAPACITY

The following design principles outline the key robustness considerations in the structure:

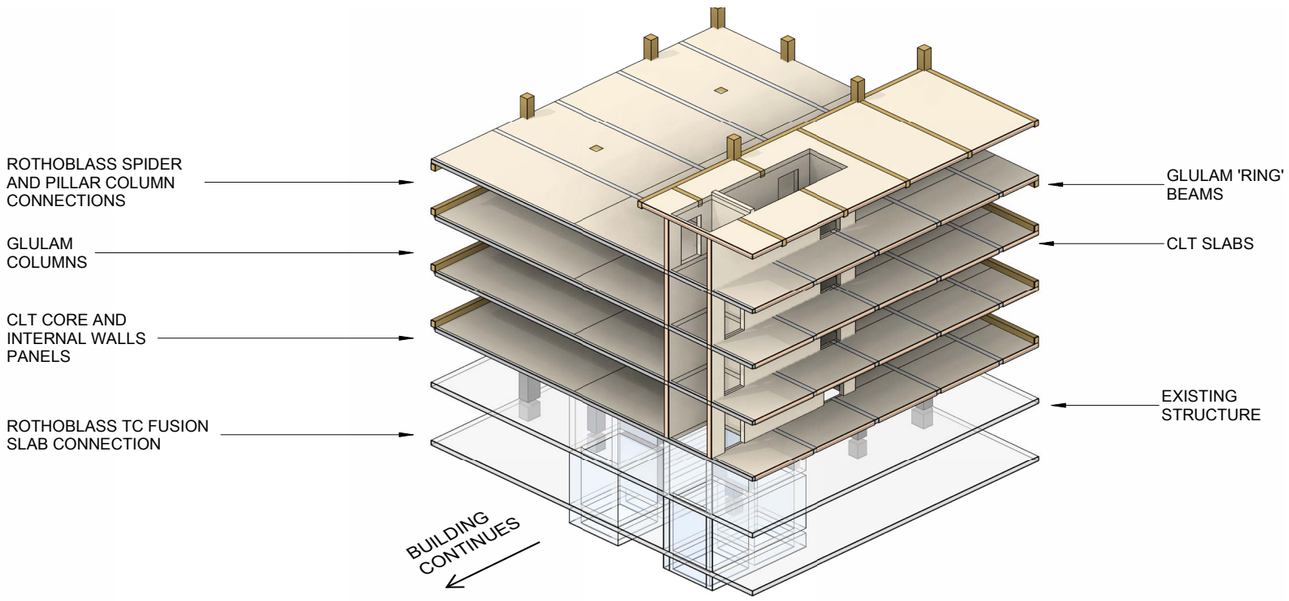
— Connections designed to a 80% shear capacity for neighbouring columns.

— To improve the connection, design columns have been thickened to improve the bearing face. This in turn increases the biaxial capacity providing mitigation against brittle failure.

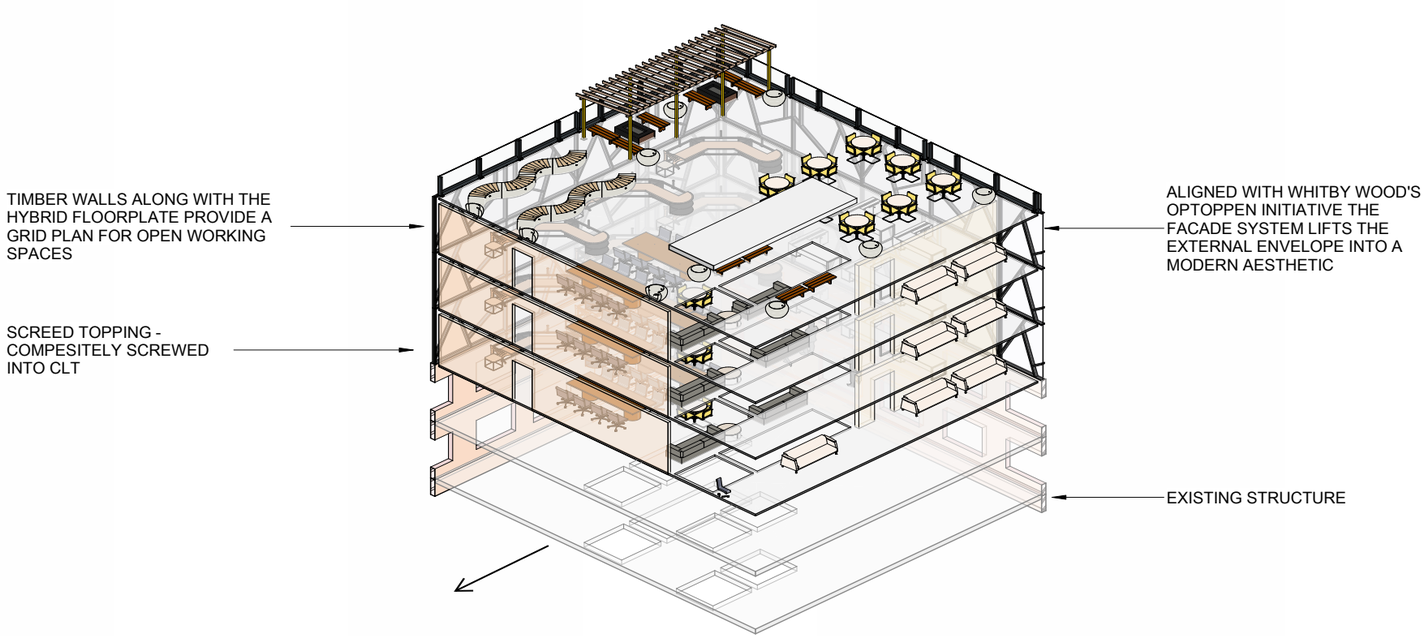
— Horizontally, TC Fusion connections tie the CLT panelling to mitigate brittle failure more common to a glued edge.

— The external ring beam has enhanced capacity due to its size defined by architectural interface requirements and is used as a tie to the frame in the instance of slab failure.

— Vertically, uplift is designed for through rebar hooking into the existing structure where post-fixed anchors cannot purely be relied upon in tension.



PROPOSED STRUCTURE ONLY
3D STRUCTURE



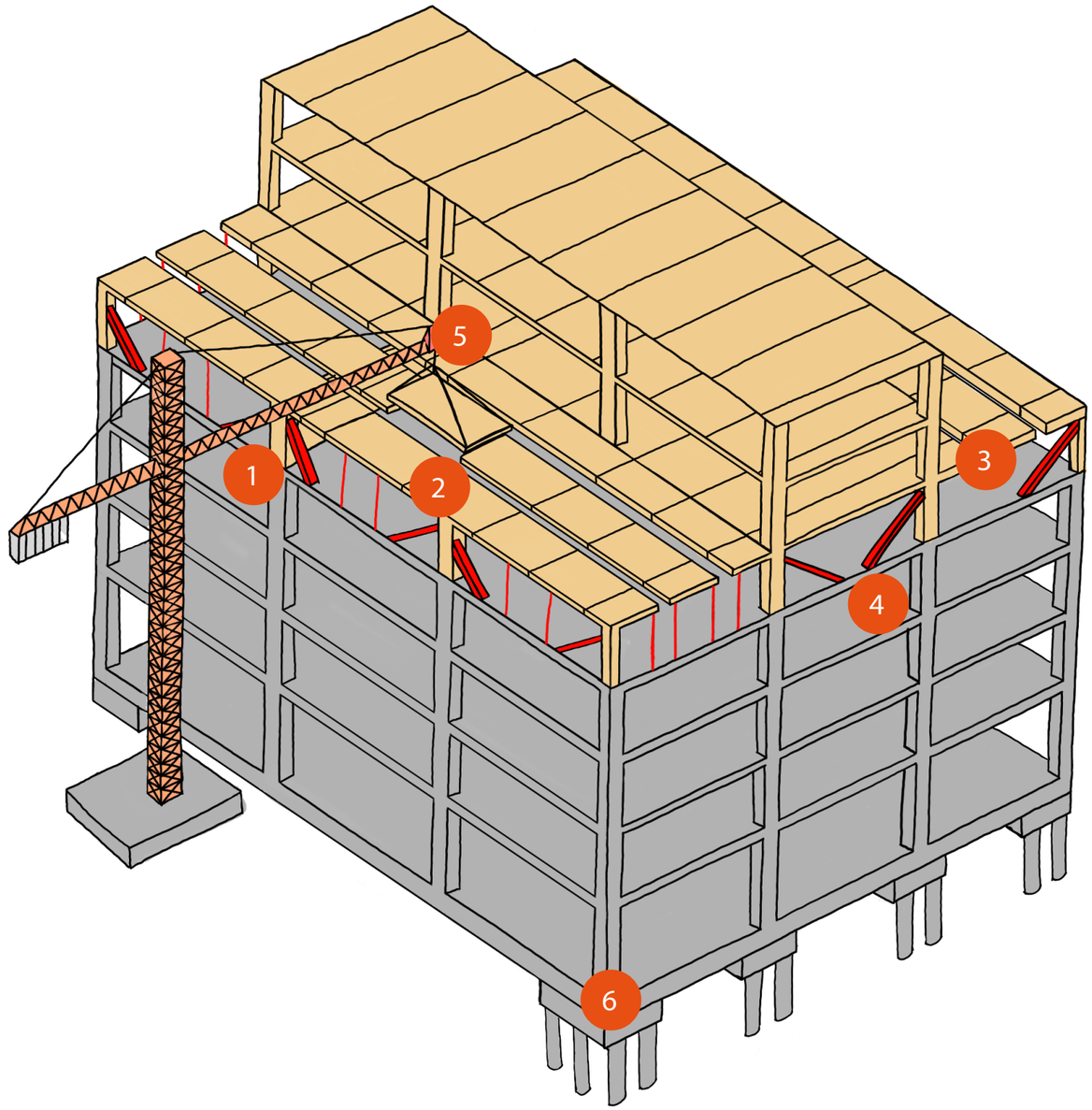
PROPOSED BUILDING LAYOUT
3D STRUCTURE

Buildability

TEMPORARY CONSIDERATION

Complexity in site condition variations will mean the structure will need to be designed to consider:

1. **Temporary works**
2. **Tensile forces in connections**
   (disproportionate collapse design considers in permanent condition)
3. **Formwork requirements**
4. **Timber tolerance**
   (use of Rothoblaas UPLIFT recommended)
5. **Access to existing structure summit**
6. **Foundation capacity**



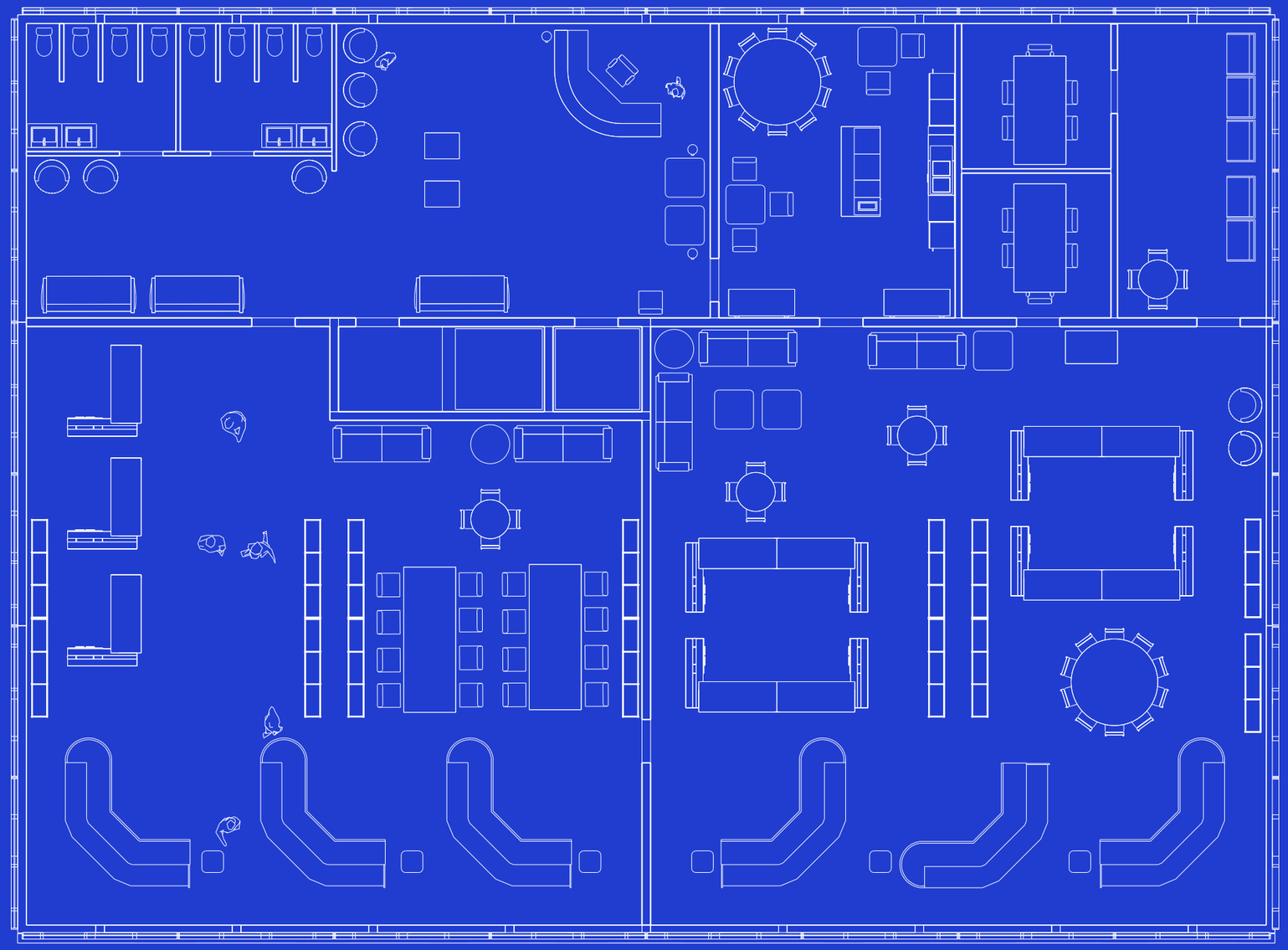
Commercial Development

PORTFOLIO SCALABILITY

The typology benefits from an effective structural grid providing improved open plan communal spaces with opportunities for collaborative working.

Commercial development has been recently constrained by political and economic factors, placing more financial pressure on contractors forcing traditional material reliance.

Extended structural bays provide flexibility to adapt to th evariety of existing column grids in a portfolio. Scalability with a combination of the tool and the solution’s typicla detailing offers a great opportunity commercially.



TYPICAL COMMERCIAL LAYOUT

Provision of valuable spaces can be achieved through innovative design methods.

“Timber is celebrated, being visible both inside and out on the façade. Even if the building isn’t built, it tells a strong story about timber’s potential.”

BUILD THE (IM)POSSIBLE JURY, 2025

MASS TIMBER SEMINAR, BUILD THE (IM)POSSIBLE FINALIST PRESENTATION

REINSTATING TIMBER

Commercial development has been recently constrained by political and economic events, placing increased financial pressure on contractors and reinforcing a reliance on traditional materials. Timber designers now have the opportunity to respond with agility - engaging early to demonstrate that mass timber is not only structurally viable but commercially competitive, reframing it as the pragmatic choice rather than the ambitious one.

Early integration between disciplines is key to realising this. By onboarding fire engineering design from the outset, a holistic design approach reduces engineering judgement requirements and in turn shortens programme and gives clients greater cost certainty throughout delivery.

DETAILS

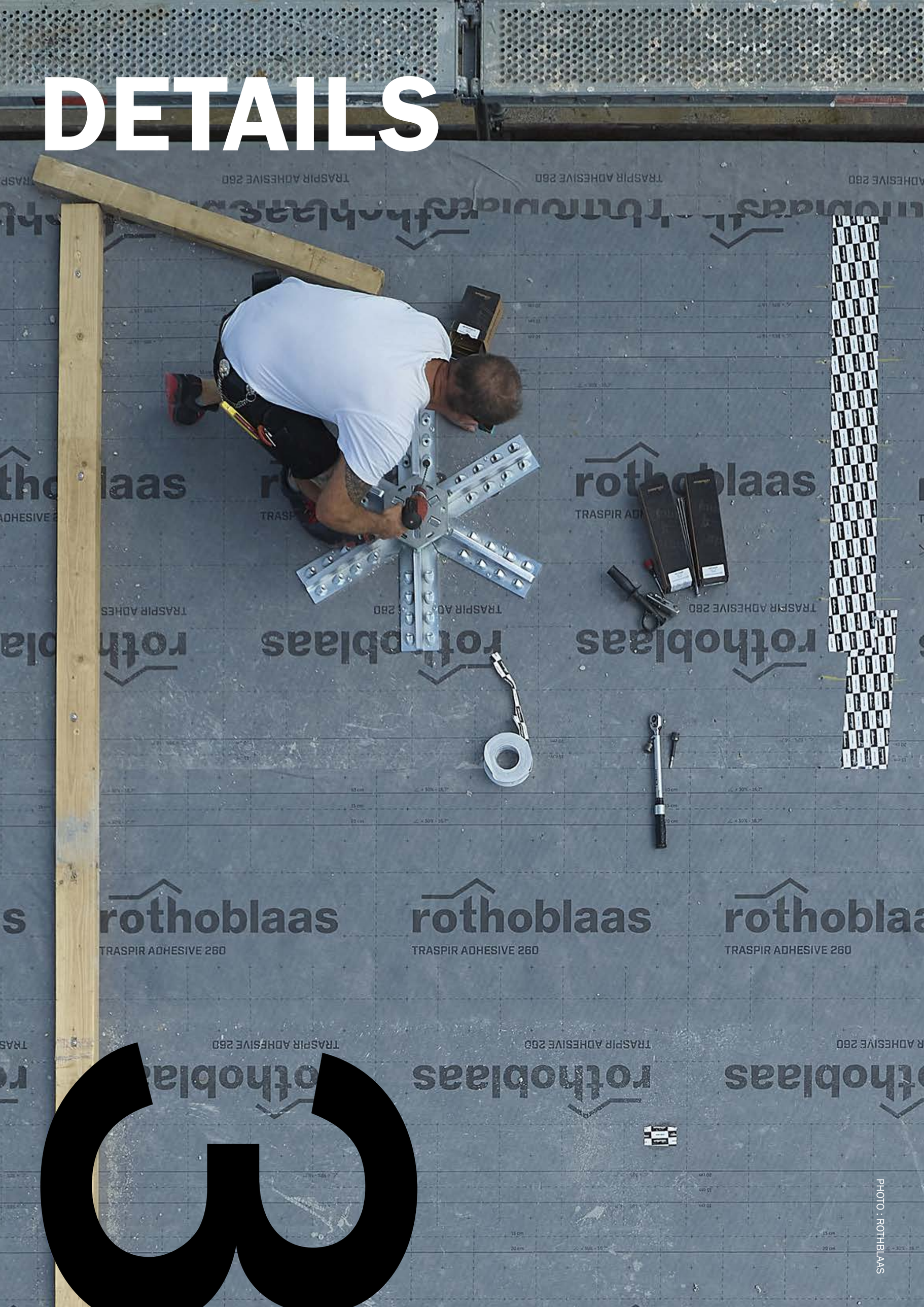


PHOTO : ROTHBLAAS

DETAILS

TC FUSION

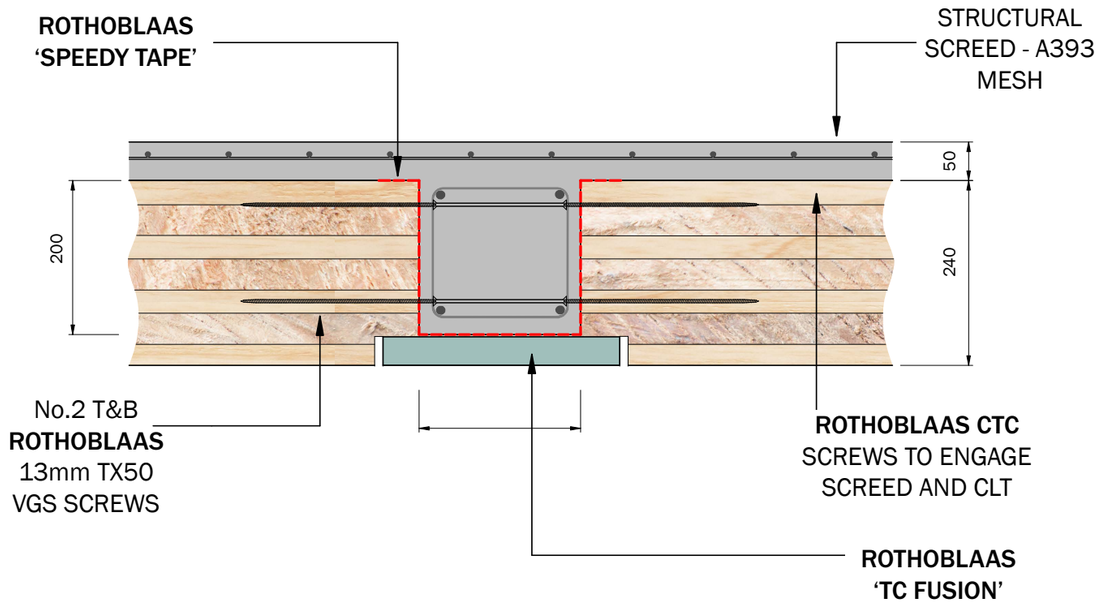
Hybrid connection providing improved moment continuity between CLT panels

Post and slab system made possible in conjunction with spider and pillar connectors

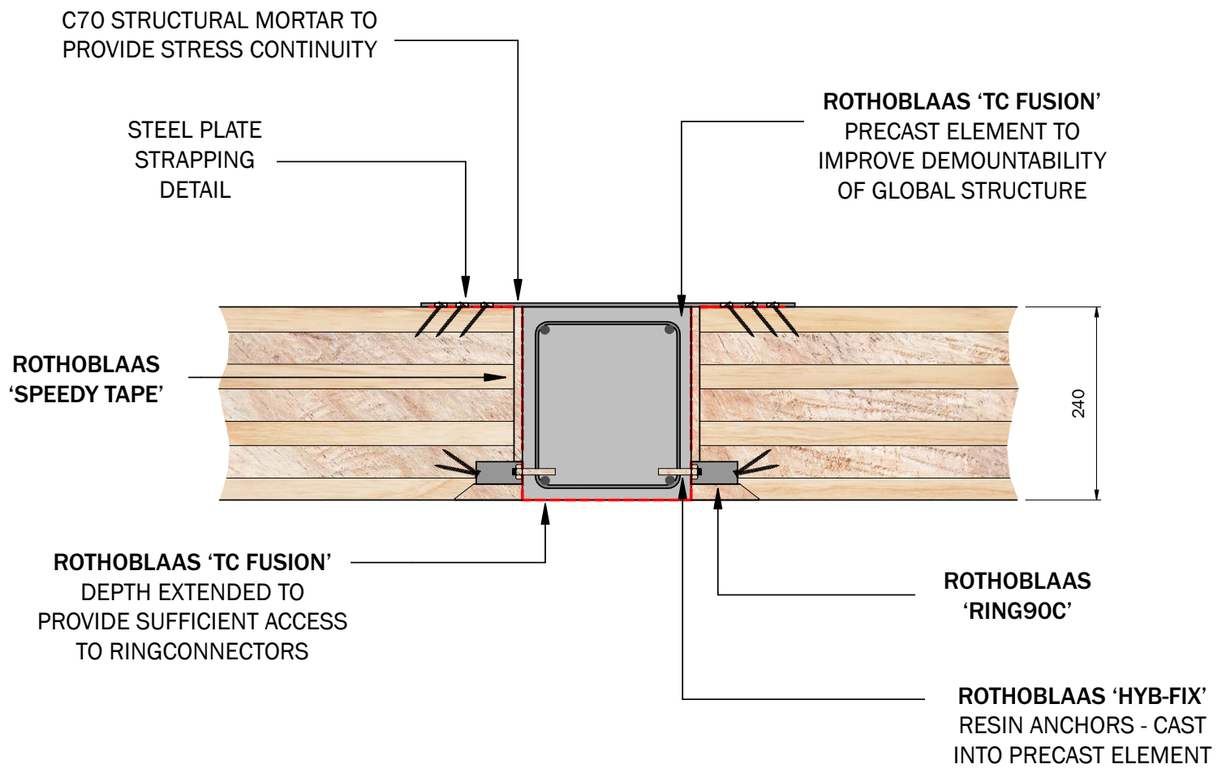
Reinforced screed tied into the CLT

1

IN-SITU



PRECAST



Optoppen Innovation

240dp CLT - panel size on plan governed by transport limits. A 7.5m structural bay is governed by flexural capacity of floorplate and column connection shear capacity. Composite connection with reinforced screed via optioneering of:

— Rothoblaas CTC Screws
— Rothoblaas Ring Connector
— Notched CLT panelling

To offer full demountability, a precast connection is possible for shorter spanning structure where a composite in situ floorplate can not be specified.
Note, this connection is not fully detailed. However, awareness of its potential is important.

DETAILS

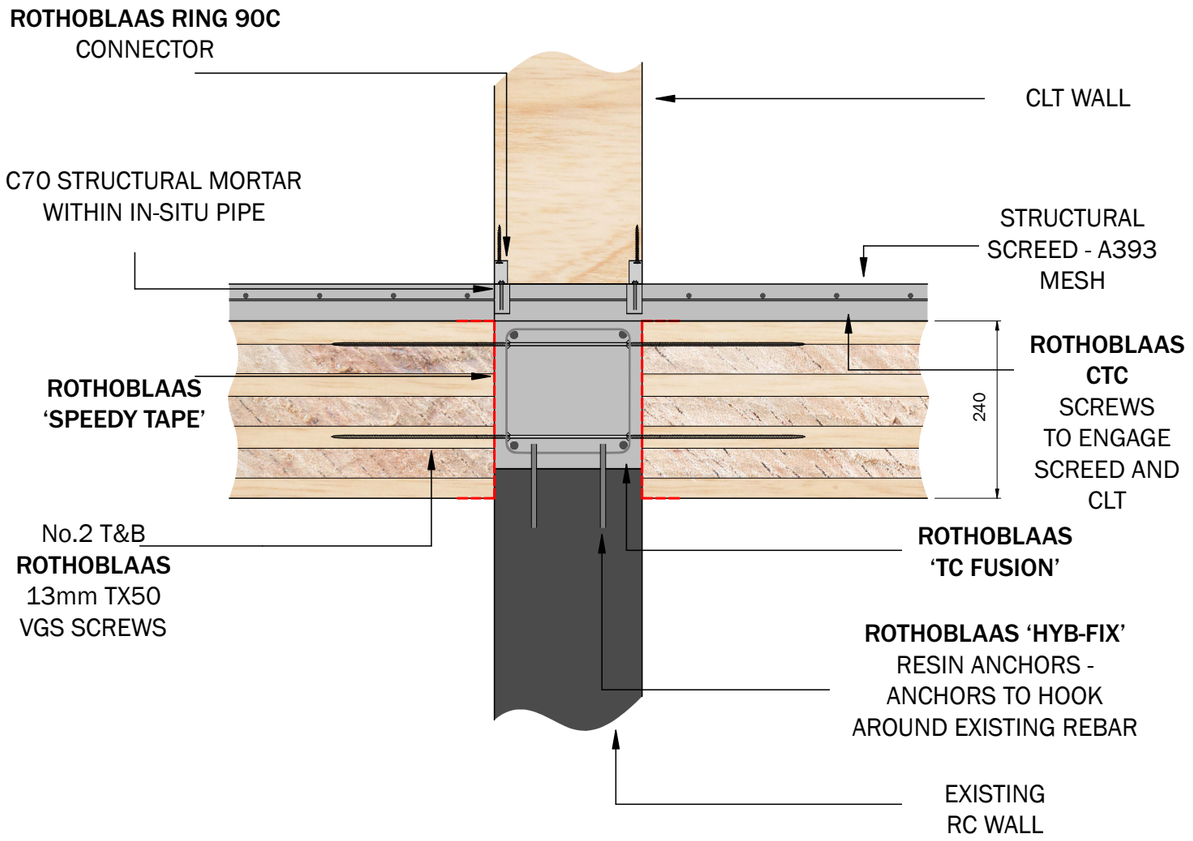
TC FUSION + RING90C

TC Fusion+ RING to provide continuity into existing stability system

Stability elements tied into the composite floorplate

Ring connectors to provide demountability

2



TC Fusion and extended vertical structure should align with stability elements in the existing structure, scabbling and post-fixed resin anchors to provide continuity. Ring connectors used at SSL ensure tolerance for sufficient continuity is provided to tie CLT panelling into the TCC connection.

Fire boarding is required for the ring connector to prevent internal heating of panelling in the fire condition.

DETAILS

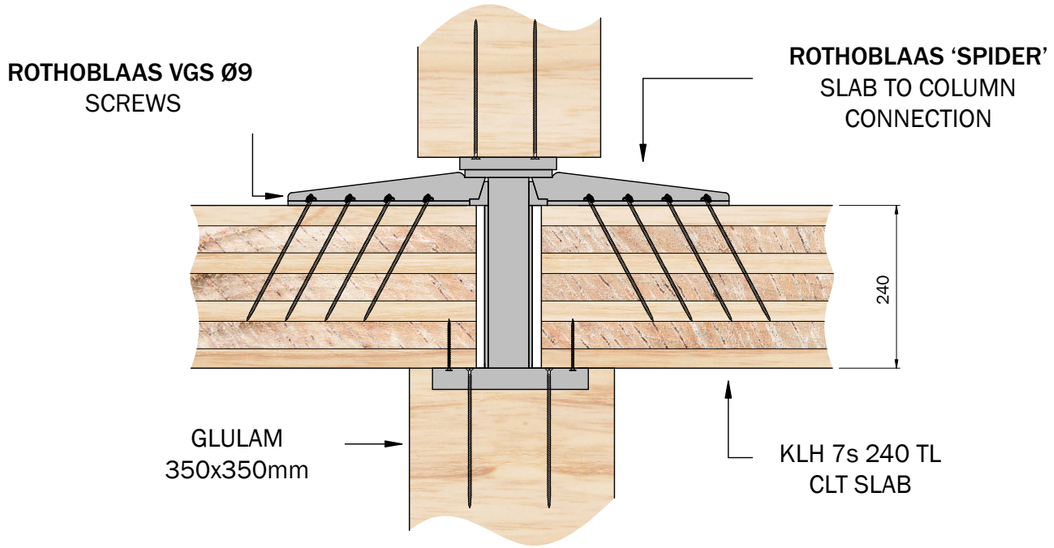
SPIDER

Column connection tying into the internal floorplate

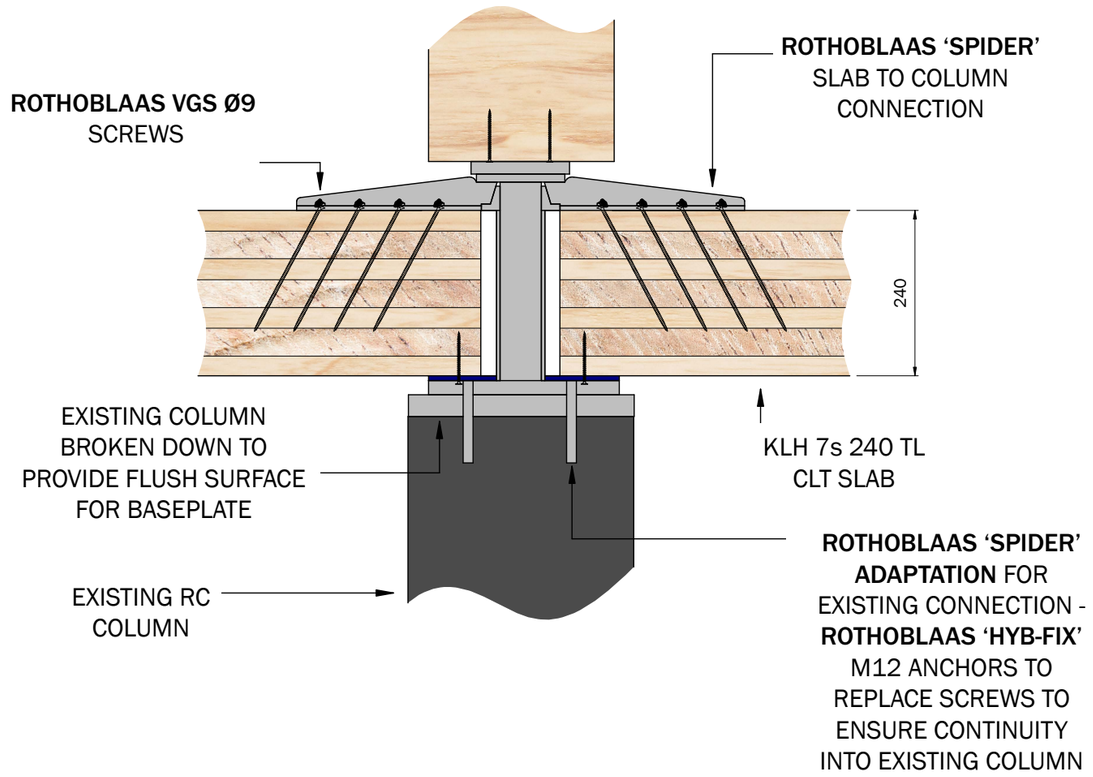
High shear capacity allowing extended spans and alignment with structure below

3

NEW TO NEW



NEW TO EXISTING



Connection Design

Max Shear Capacity: 791kN (240DP CLT)

LOCAL FIRE STRATEGY

— Embed connector into timber where possible
— Screws protected by reinforced screed
— Fire boarding below CLT for wider baseplate (above)

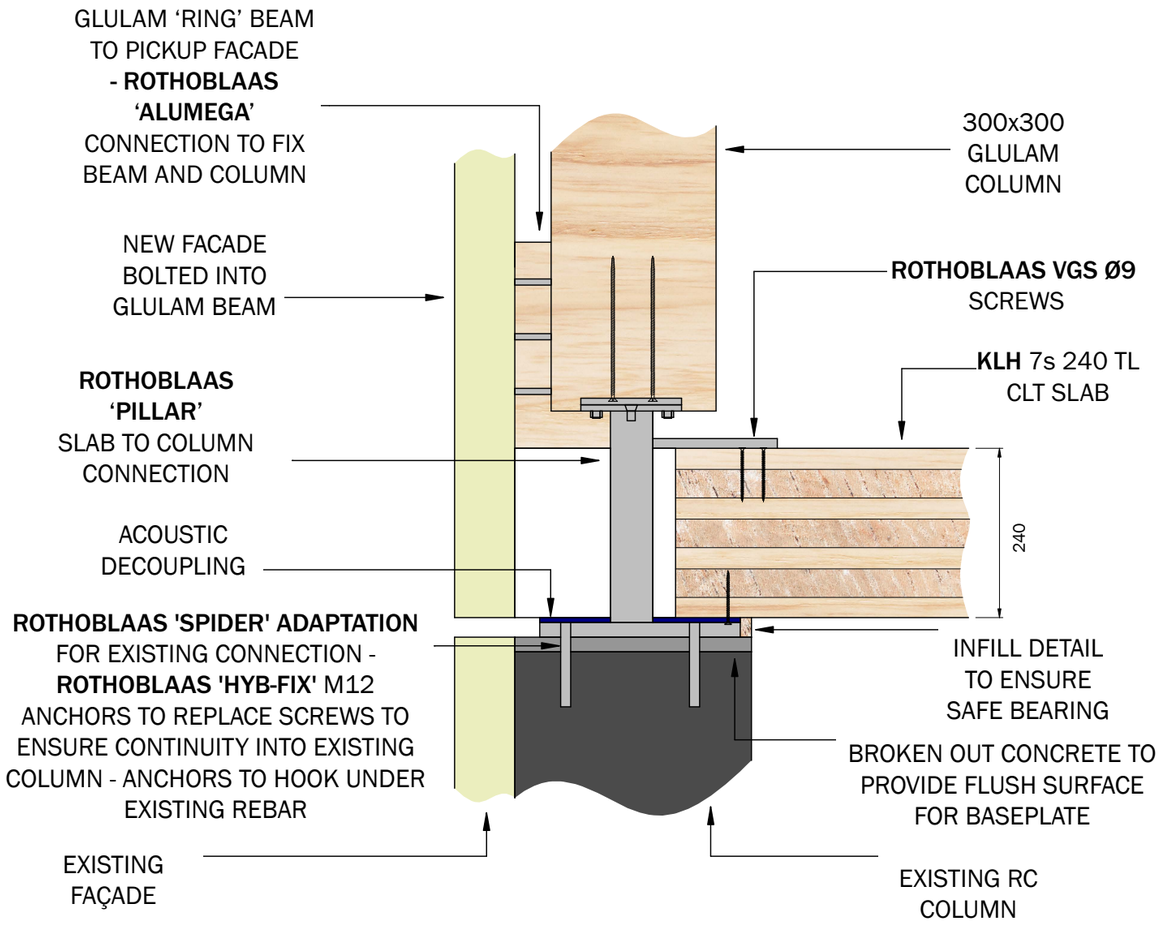
INNOVATION

— Wider baseplate:
  • To provide sufficient anchor space
  • Improved axial continuity and shear resistance
  • Sufficient bearing space for CLT
— Scabbled back existing column for buildability
— Hook onto existing rebar for disproportionate collapse design
— Resin anchors post fixed into existing structures for axial continuity

PILLAR + ALUMEGA

Column connection located at the external perimeter of the CLT

Thinner connection resulting in reduced shear loading therefore increased columns along perimeter



Connection Design

Max Shear Capacity: 125kN
(240DP CLT located at panel edge)

LOCAL FIRE STRATEGY

- Embed connector into timber where possible
- Internal screws protected by reinforced screed
- Fire boarding behind thermal line external to connector (above)

INNOVATION

- Wider baseplate:
  - To provide sufficient anchor space
  - Sufficient axial continuity and shear resistance
  - Sufficient bearing space for CLT
- Scabbled back existing column for buildability
- Hook onto existing rebar for disproportionate collapse design
- Resin anchors post fixed into existing structures for axial continuity

Hybrid construction making timber a reality

Whitby Wood and Rothoblaas synergy demonstrated the structural feasibility of timber vertical extension.

Opportunities to expose and celebrate timber will only improve the appreciation and enjoyment of the building.

ABOUT THE AUTHOR

Hugo Bell, a Structural Design Engineer at Whitby Wood, posed the Optoppen Playbook to the Rothoblaas community sparking great discussion on the future of the green urban environment.

Optoppen provides a ‘win win win’ solution to retrofitting sustainably.

Hugo’s ‘Build the (IM)POSSIBLE’ submission offers a real solution to hybrid timber which faces significant obstructions.

The jury of the competition stated
‘Timber is celebrated.. even if the building isn’t built, it tells a strong story about timber potential’.
But why can it not be built?..

PHOTO : ROTHOBLAAS

Technical win.
Economic win.
Sustainability win.

GRAPHIC DESIGN Isabelle Kushner