DIGITAL PILOT PROJECTS

BUILD IN WOOD

Co-funded by the European Union

INTRODUCTION

W H Y   B U I L D - I N - W O O D ?

In light of the urgency of the current climate crisis, the EU has committed, under the Paris Agreement, to becoming carbon neutral by 2050. In order to meet this target, serious disruption of 'business as usual' is required in many sectors, construction included.

With improvements in thermal fabric and operational energy having been the target of sustainability agendas in recent history, the significance of embodied carbon is increasing and subsequently moving to the forefront of political agendas.

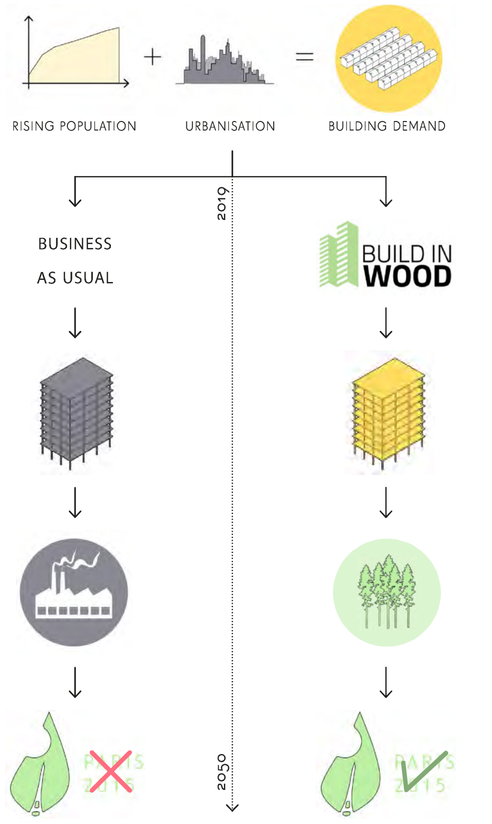
Building with wood not only provides embodied carbon benefits through the substitution of the highly carbon intensive conventional building materials we are familiar with, such as steel and concrete, but also stores biogenic carbon absorbed during the life of the trees.

Harvesting timber from sustainably managed forests, where replanting maintains, if not increases, timber volumes year on year, allows timber buildings to become a new carbon sink. This means building in wood not only reduces the direct carbon emissions of construction, but can actually reverse current carbon levels through increased sequestration into a 'new carbon store'.

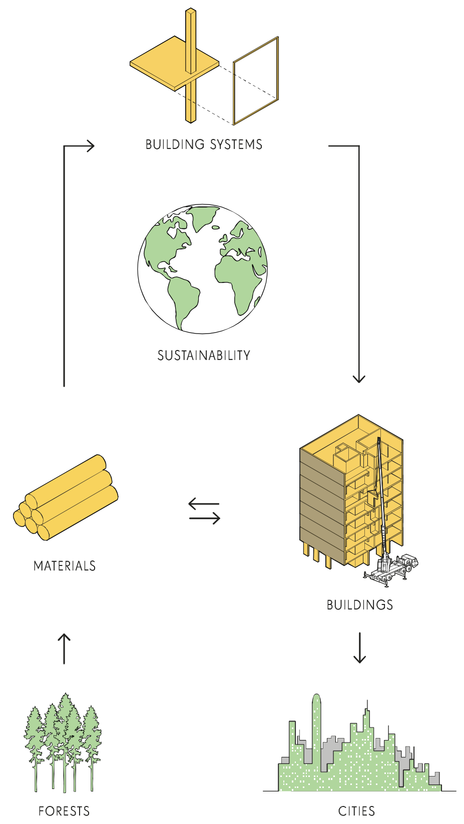
By engagement with stakeholders across all stages of the timber value chain, the system has been designed to optimise the use of the forest resources available to be used as efficiently as possible, thus enabling the greatest positive environmental impact.

The carefully designed and tested solutions of the Build-in-Wood system help to provide architects, engineers, clients and local authorities with the confidence that a given project can be built in timber, irrespective of project specific requirements, and the knowledge and expertise needed to do just that.

Embodied carbon data is provided, pre-empting the requirements of embodied carbon policies currently under development by governments across Europe, whilst also enabling stakeholders themselves to make responsible design decisions.



BUILD-IN-WOOD AND THE PARIS AGREEMENT
The Build-in-Wood system aims not only to minimise as far as possible the negative environmental impact of construction, but also to actively remove carbon from the atmosphere reducing current levels.



WOOD VALUE CHAIN
The Build-in-Wood systems have been designed with consideration of all stages of the timber value chain in order to address the needs and requirements of each stakeholder from forestry and manufacture through to planning policy.

WHAT IS BUILD-IN-WOOD?

Build-in-Wood comprises an optimised timber building system, designed for maximum adaptability to suit the often drastically different needs of any given project, without the inherent redundancy that can often result from a system designed for multiple scenarios.

The system incorporates a structural frame and a non-structural facade, which have been designed for use holistically as well as independently to encourage reuse, retrofitting and extensions of existing building stock.

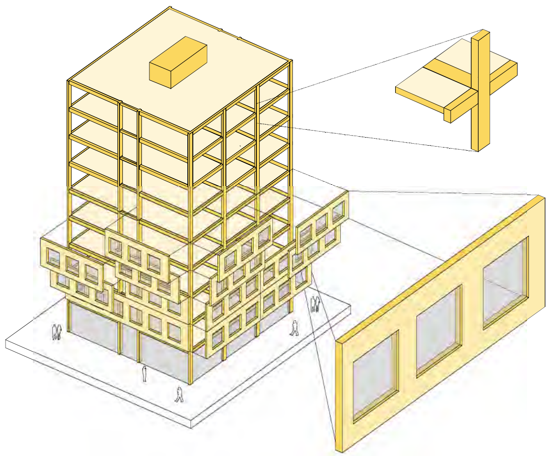
Different project specific requirements, such as building use, location, performance requirements and aesthetic aspirations are accommodated through selection from a refined spectrum of iterative components within the system kit-of-parts.

This focus on achieving the necessary adaptability through variable, rather than fixed components that are resilient to all requirements, ensures a tailored solution for each project that is materially, environmentally and financially viable and efficient.

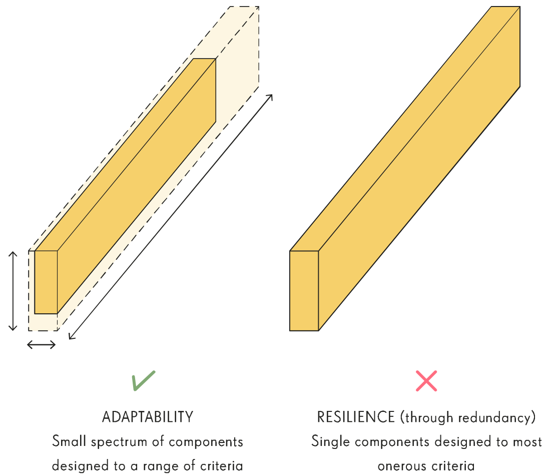
Design for longevity as well as consideration of disassembly and end of life, aims to maximise the life-cycle of each timber component, subsequently extending the period for which it can store its biogenic carbon.

The system aims to increase awareness and understanding of the significance that life-span has on the potential impact of timber products as carbon stores. It does this not only by designing to promote maximising the period before the timber is allowed to decay or burn, re-releasing its carbon, but also by quantifying a project's contribution to the new 'timber building carbon sink' as a product of its lifespan.

By establishing a method for quantifying the contribution of the biogenic stored carbon within bio-based products, Build-in-Wood begins to provide a mechanism and narrative for promoting and increasing the use of timber products through local policy.



The structural and façade systems are designed to work in harmony, however can also be used independently to further increase the applicability of the systems.



The need for the system to achieve the varying requirements of a broad spectrum of different project types and site locations whilst also using materials and resources efficiently has underpinned the system approach.
A refined spectrum of solutions for each component ensures different requirements can be achieved without over-engineering and redundancies.

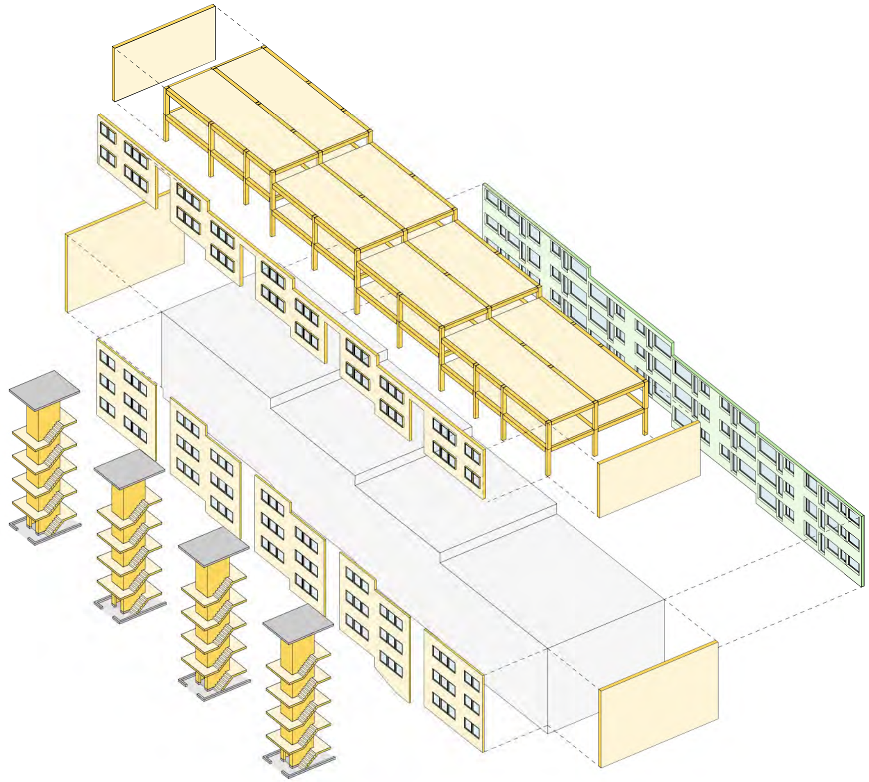
BUILD-IN-WOOD PILOT PROJECTS

The Build-in-Wood consortium aim is to increase the uptake of timber in the construction industry. We have identified a series of challenges which prevent wood from being exploited as a building material, including user attitudes, lack of know-how, building regulations as well as economic and regulatory concerns.
Our aim is to provide the support needed to overcome these perceived barriers. Pilot projects are a way to engage our partner cities, including Amsterdam, Copenhagen, Trento and Trondheim, in an ongoing discussion and together address key questions regarding the use of a wood-based building system and investigate how policy might influence the adoption of timber in construction.

The pilot projects of the Build-in-Wood structural and façade systems aim to identify the benefits and implications of adopting the system in the context of Haringey's local requirements.

Pilot projects will focus on specific areas of the design and construction process:

- construction process e.g., programme, site logistics, potential savings, quality, productivity
- sustainability LCA, embodied carbon, CO_2 reductions/ sequestration, energy use, recyclability, dis-assembly, circular economy etc.
- legislation – GLA and local planning policy and Building Regulations



VESTLIA TRONDHEIM (N)
The first completed pilot project is the Vestlia refurbishment: an holistic approach to energetic refurbishment, accessibility improvement and rooftop extension of a residential building erected in the late 1970.

THE STRUCTURAL SYSTEM

The Build-in-Wood structural system is designed as a post and beam frame, due both to the flexibility of internal configuration and uses offered by this approach and its material efficiency, allowing more buildings to be construction from the available timber.

Not only is flexibility of internal layout vital in order to design buildings with different functions, but this approach also offers the potential to reconfigure spaces in order to change or modify their function during or post construction.

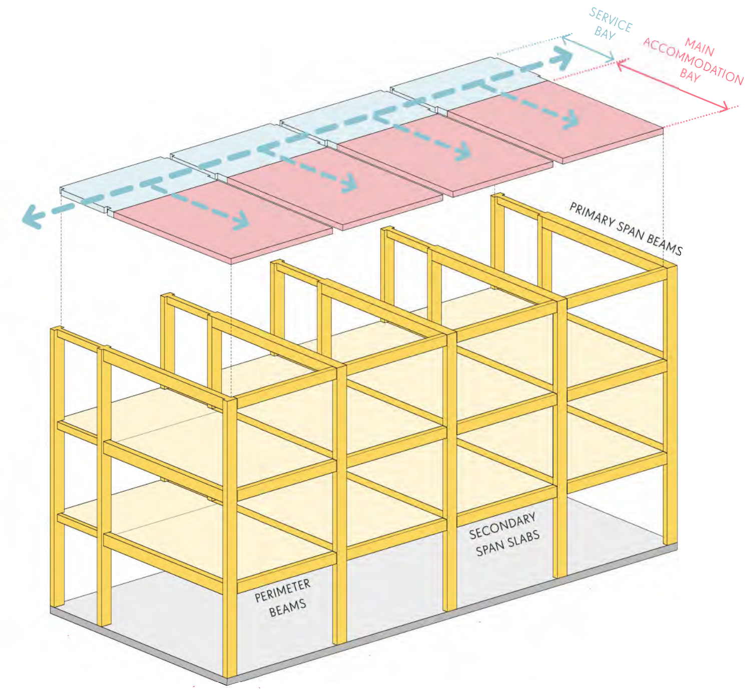
This future adaptability is particularly beneficial in the current post pandemic context, with uncertainty surrounding future work habits. This flexibility can help guarantee longevity from an environmental perspective and for a clients investment.

The main bay is designed as a flexible open space with perimeter columns only. The system is designed as a hierarchical grid; that is a primary span greater than the secondary span. This approach being most efficient structurally, typically offers both material and cost savings, with minimal impact on internal layout due to the flexibility already inherent within the 'column free' primary bay.

To maximise headroom, the system configuration has been developed with a clear servicing strategy. Primary beams are oriented perpendicular to the facade, spanning out from a central servicing corridor. The narrow width of this corridor reduces the beam depth in this location, enabling central service runs to be distributed across the length of the building without compromising headroom.

From this main spine, services are then distributed out into individual bays in between the primary beams, ensuring services can reach all areas of the building without needing to pass under the deep primary beams of the main bays.

This configuration allows rational distribution of high level services as well as creating a natural circulation and access zone, beneficial for both residential and office layouts.



BUILD-IN-WOOD STRUCTURAL SYSTEM REPRESENTATION

Primary bemas are oriented perpendicularly to the facade to maximise headroom and allowing a simple, effective servicing strategy. Facade panels are fixed to perimeter beams.

THE FAÇADE SYSTEM

The Build-in-Wood façade system is designed as a prefabricated panel comprising a substructure frame onto which variable layers are added, both internally and externally, that are tailored to suit each of the thermal, fire and acoustic performance levels required.

The element is non-loadbearing, thus only needing to take its own self weight and wind load to distribute back to the primary structure. As such, a framed solution is able to achieve the structural demands without the redundant material that would be used with a solid substrate, offering a more materially efficient solution.

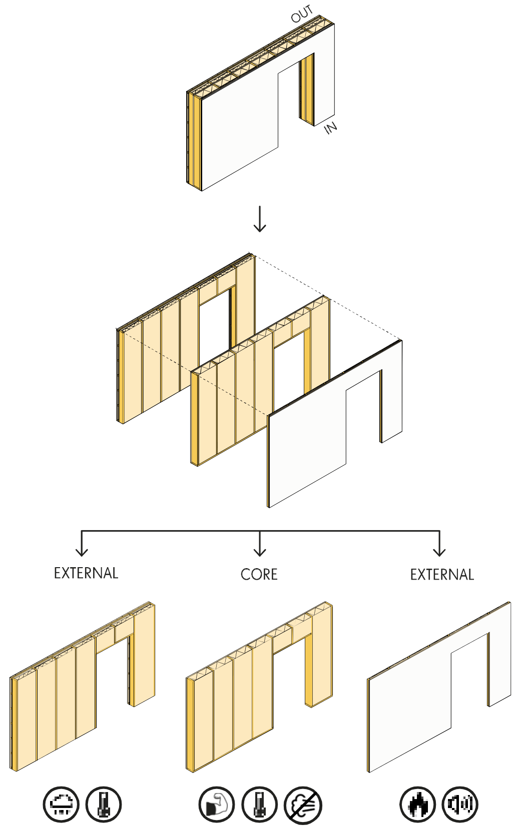
In addition, a frame allows for the space between posts to be filled with insulation contributing towards the panels thermal performance and subsequently decreasing its overall thickness.

The facade panels are 'single storey' horizontally oriented simplifying the connection back to the primary structure by using a single bracket type which has been specifically developed and allows for the panels to be installed without the need for scaffolding.

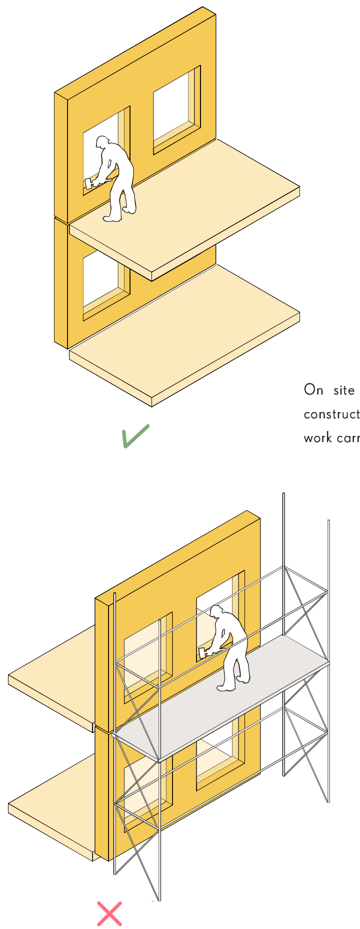
The panel size is adaptable to suit the floor to floor and bay width of any project using the Build-in-Wood structural system, and can also be used wholly, or in part, for refurbishment of an existing building.

A fixed depth for the facade panels structural frame allows for a consistent set of rules to design openings within the capacity of the panel, providing maximum flexibility in the buildings design. Full height openings for level threshold access onto balconies and terraces can also be accommodated, taking into account variations in floor build up for different building types.

The use of timber and other bio-based products has been prioritised for each layer to maximise their application where permitted by regulations; reaction to fire and durability of bio-based products has been interrogated with non-combustible alternatives provided where this is not permitted (e.g. UK).



FAÇADE PANEL LAYERS
The panel is composed of three layers, each dealing with a different aspect of the overall performance: structural, acoustic, thermal and fire. The structural core has a fixed depth whilst the thickness of the other layers are variable.



On site work carried out on the construction site, as opposed to work carried out in the factory.

INSTALLATION AND CONNECTIONS
The panel has been designed to be able to be installed from each floor plate, designing out the need for scaffolding. This potentially reduces installation time, as well as cost, and allows for a simple connection to the building frame.

SYSTEM ADAPTABILITY

The approach to achieving adaptability through the system has been fundamental to its development. With a broad variability in performance, geometric and aesthetic requirements, it is evident that a 'single' resilient solution would be over-engineered as well as both financially and architecturally unviable in most situations.

With this in mind, the concept of 'variable components' was developed and has become the backbone of the systems. To begin to design variable components it was first necessary to establish the project criteria which would influence each; from structural and dimensional requirements to fire, acoustic and thermal performance.

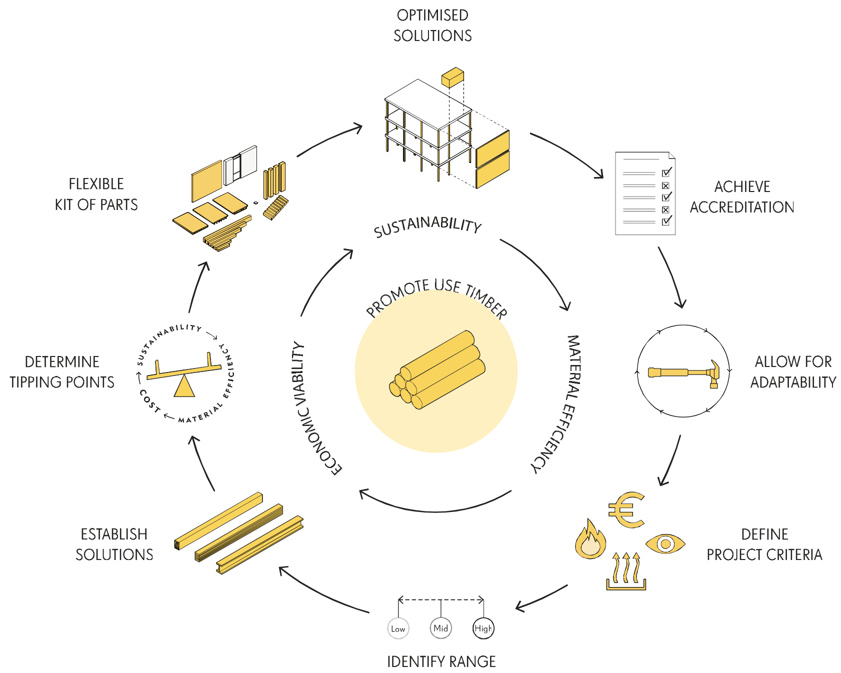
Once the project criteria were defined, extensive analysis was undertaken to establish the range of potential requirements for each criteria, be that performance levels, dimensions or materials.

The range of performance criteria addressed by Build-in-Wood is based on analysis of current regulations and market trends at the time of writing. Please note that the exact performance requirements for a certain criteria on any given project must be established by the design team using current local legislation and so specific values based on building use or location are not given.

From this range, key 'typical' scenarios (low, mid and high) were identified for which various detailed 'solutions' were developed and then critically assessed against their alignment with the project aims.

This process was used to establish the 'tipping points' at which the approach to addressing a given criteria needed to change in order for a given component to be as materially, environmentally and economically efficient as possible.

Combinations of solutions which resulted in the fewest 'tipping points', whilst not compromising on the project aims, were then selected in order to make the system as simple and understandable as possible with the fewest component variations.



DFMA ADVANTAGES

Aside from its environmental credentials, many of the frequently quoted benefits of working with mass timber stem from its prefabrication. The result being high quality, precise products that can be quicker, safer and easier to manufacture and assemble compared with conventional on site construction.

An understanding of design for manufacture and assembly (DFMA) is invaluable to ensure that these potential benefits can be realised and optimised for a specific project.

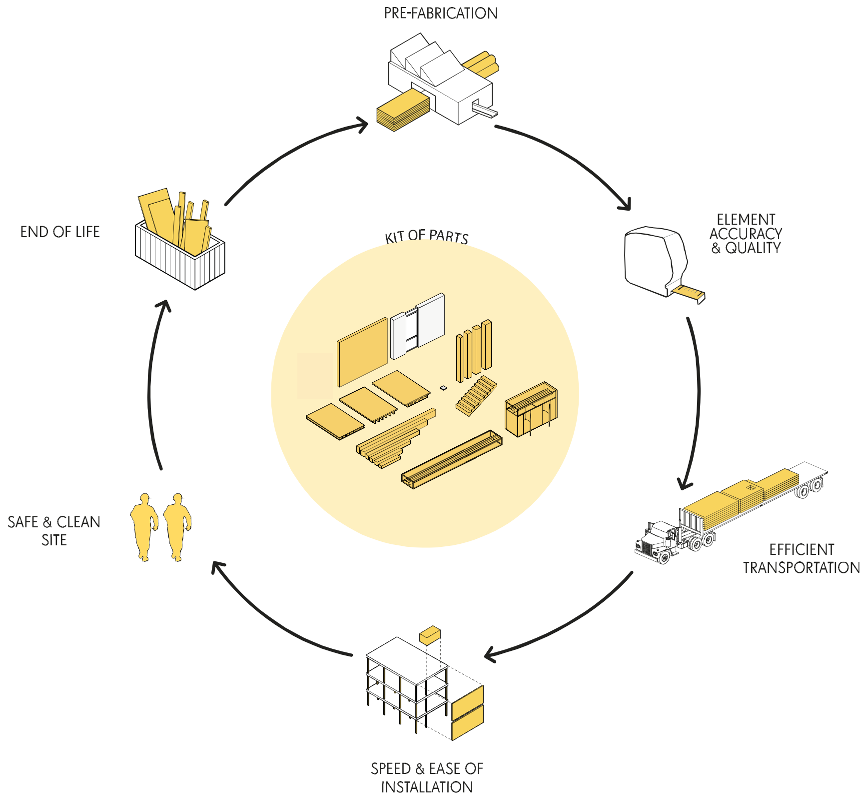
The Build-in-Wood systems have been developed as a kit of parts for DFMA construction taking into account factors such as efficient transportation and ease of installation.

It is also important for users of the system to understand the implications of their own design decisions on the manufacture and assembly of the prefabricated components.

Repetition is a key principle of DFMA construction which can offer cost and time savings during manufacture and simplify and save time during deliveries and assembly on site.

It is more likely that components will be reused at end of life if they are part of a DFMA kit of parts due to their increased relevance for other projects, simple identification and well documented performance.

Limiting the number of component types by reducing the number of grid variations or facade bay types can offer savings and should be kept in mind where time and budget savings are priorities.



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement no. 862820

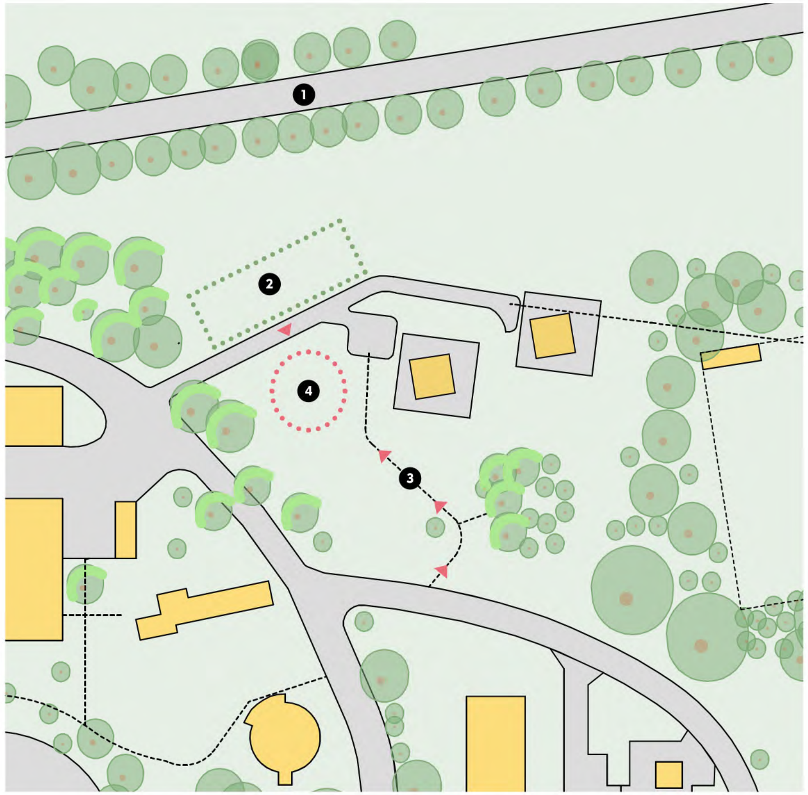
BUILD IN WOOD

BUILD-IN-WOOD DEMONSTRATOR

LARGE SCALE SITE PLAN

1. Identified general site location

2. DTI building



APPROXIMATE SITE PLAN

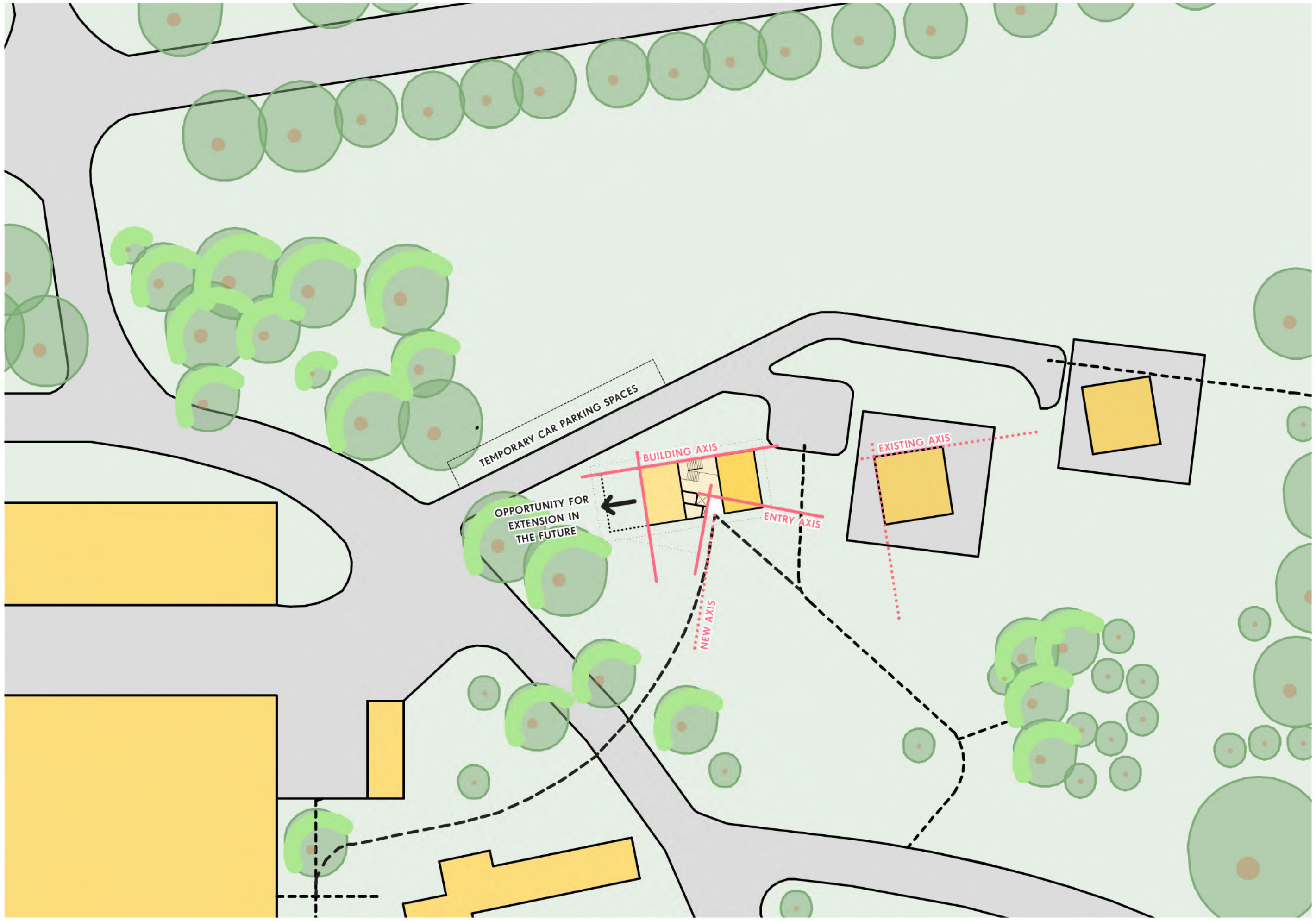
1. Main vehicular access road

2. Temporary car parking for events

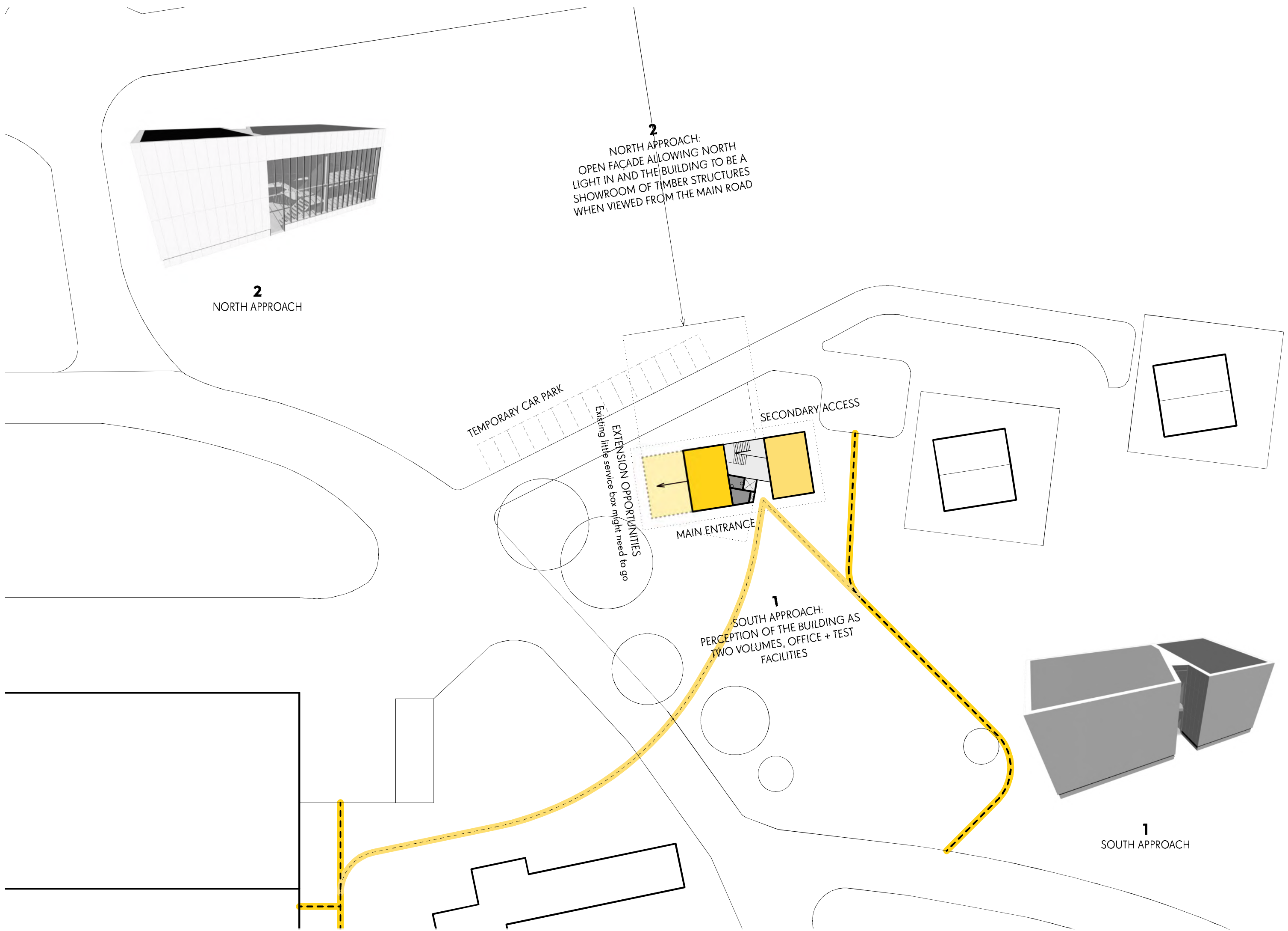
3. Main pedestrian access

4. Approximate site location

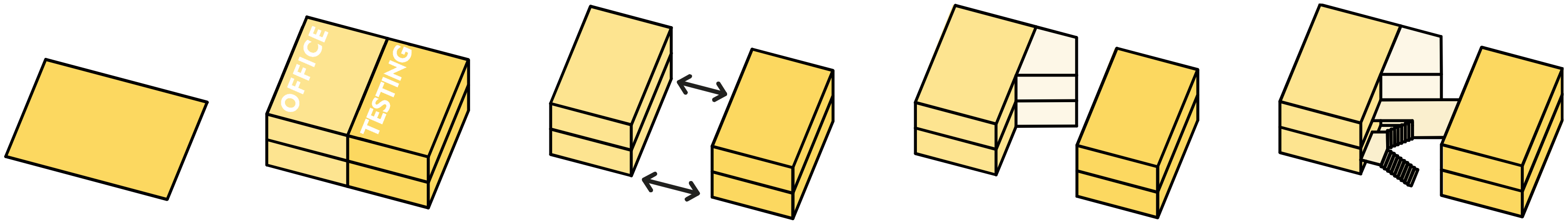
SITE LOCATION



SITE INSERTION



BUILDING IN CONTEXT



BUILDING FOOTPRINT

BUILDING USES

Office and testing facilities distributed into 2 parts of the building

BUILDING VOLUMES

Office and testing facilities separated into two independant volumes

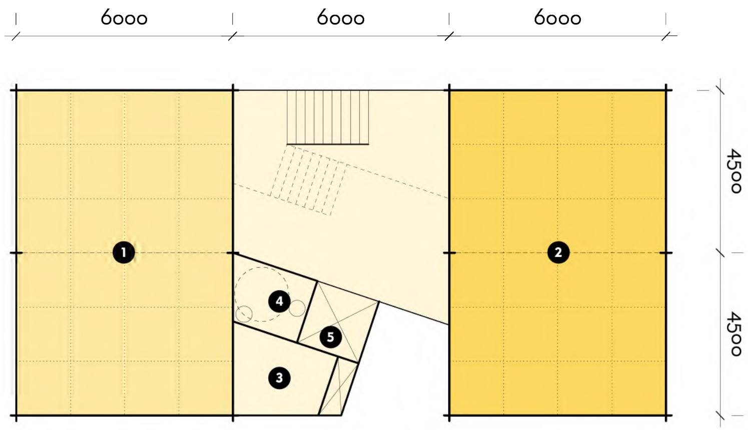
SUPPORT ZONES

Support facilities added in-between the 2 volumes

CIRCULATION

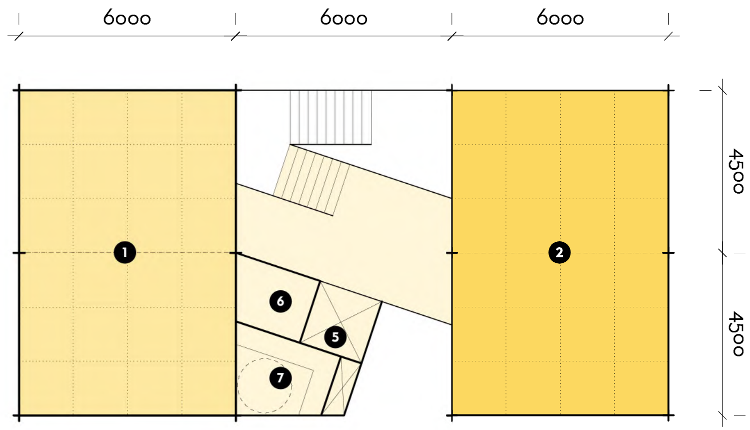
Feature staircase added in-betwen the volumes, alongside viewing deck

DESIGN CONCEPT



GROUND FLOOR PLAN

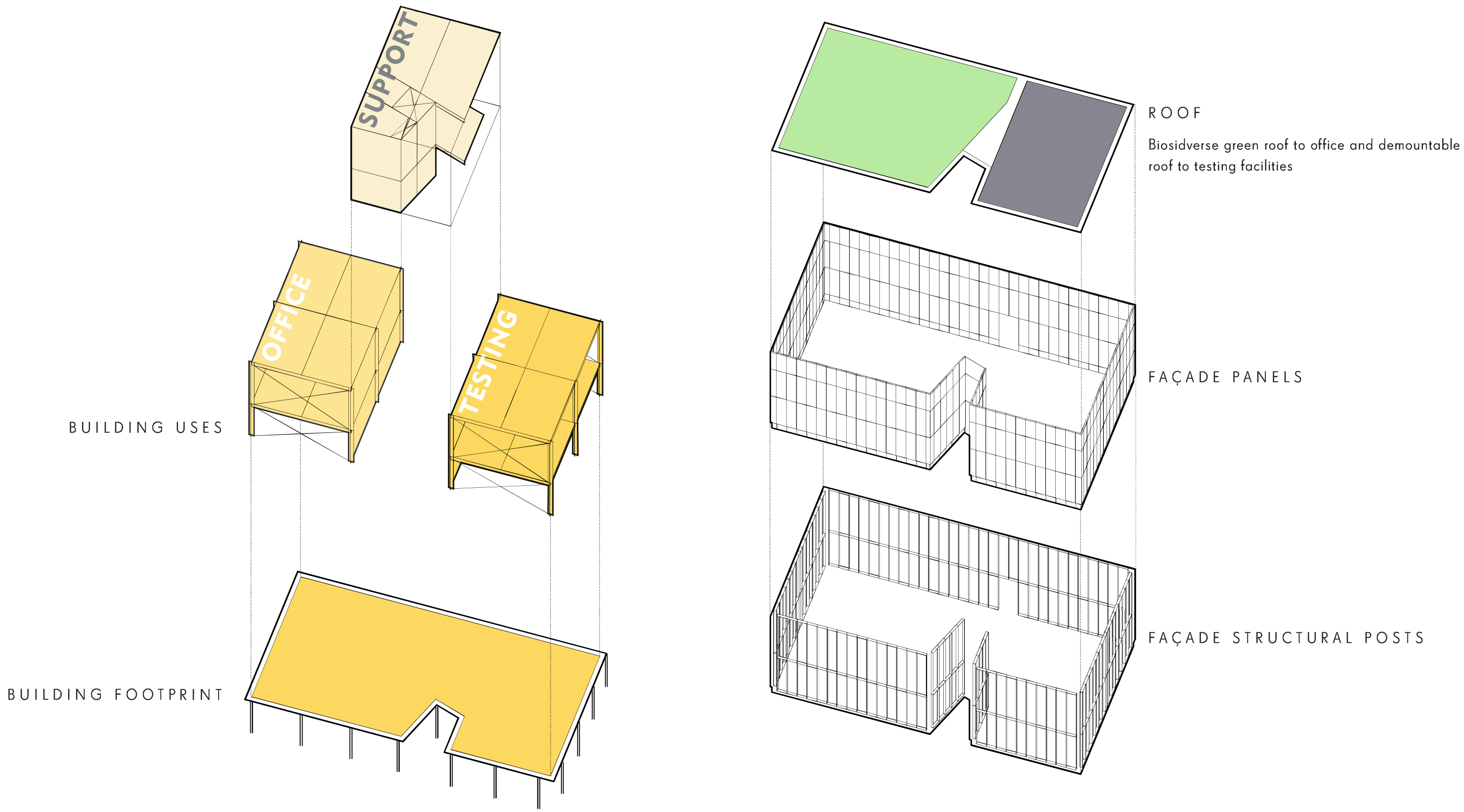
1. Office
2. Testing facility
3. Storage/ services
4. Disabled access toilet
5. Lift



FIRST FLOOR PLAN

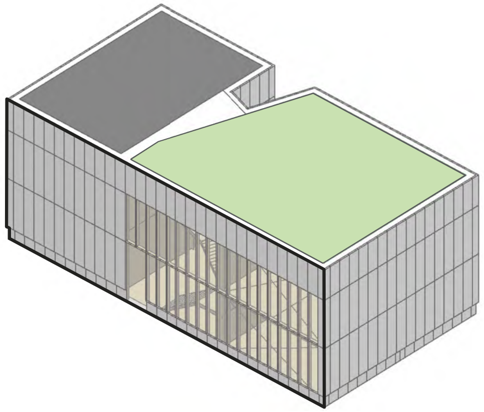
1. Office
2. Testing facility
5. Office kitchen
6. Server/ stationery point
7. Kitchen

LAYOUT



BUILDING TECTONICS

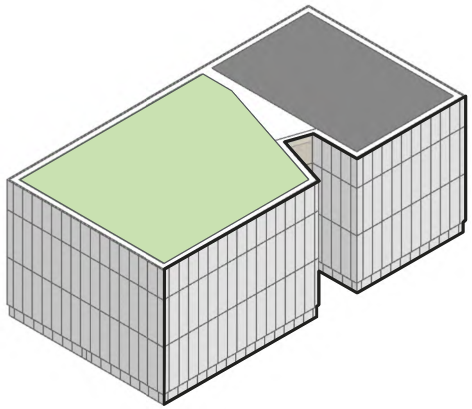




NORTH FAÇADE

- Open façade allows north light in
- Large amounts of glazing so that the building's interior can be perceived from the exterior
- The building can be perceived as a showroom of timber structures when viewed from the main road





SOUTH FAÇADE

- Solid façade with glazing to the volume connecting the two buildings
- The building is perceived as two volumes: the office and the testing facilities

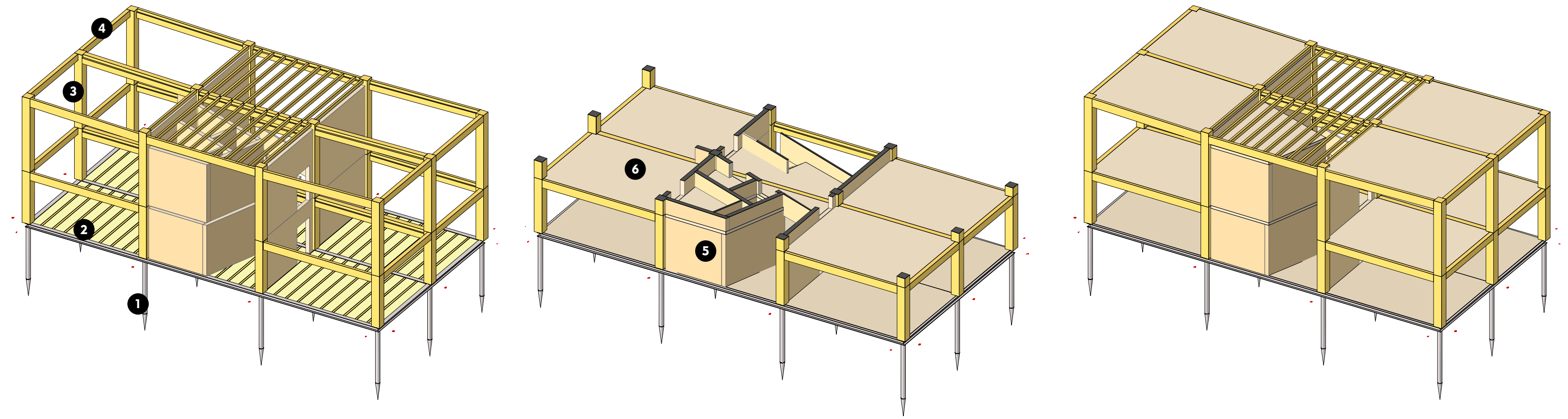
FAÇADE APPROACH

Transparent façade with surrounding landscaping

Modular façade with big openings

Modular façade solid/ openable modules

DESIGN PRECEDENTS



1. Steel pole foundations

2. Raised ground slab - assumption: Insulated ground floor slab; rib/composite floor system;

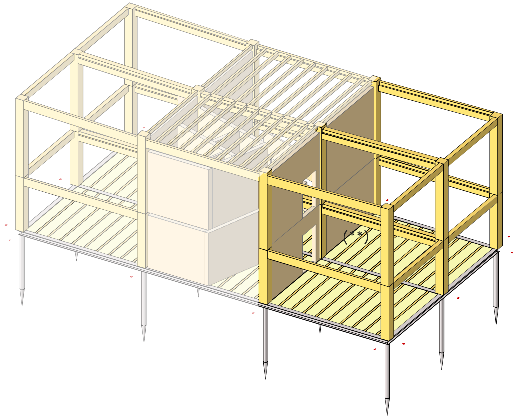
3. Glulam columns

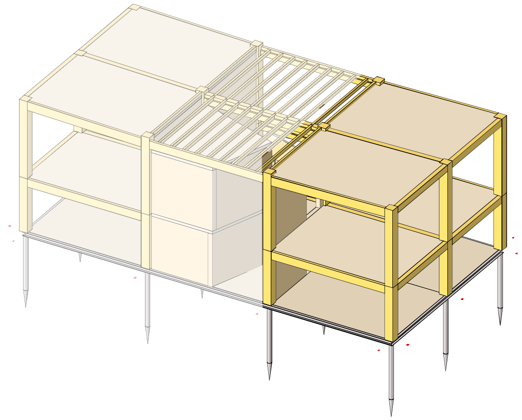
4. Glulam beams

5. Cross laminated timber (CLT) walls

6. Cross laminated timber (CLT) slabs

STRUCTURAL SYSTEM





FIXED STRUCTURAL ELEMENTS

Steel poles

Glulam columns

Glulam beams

(**) Note central beam to be demoutable

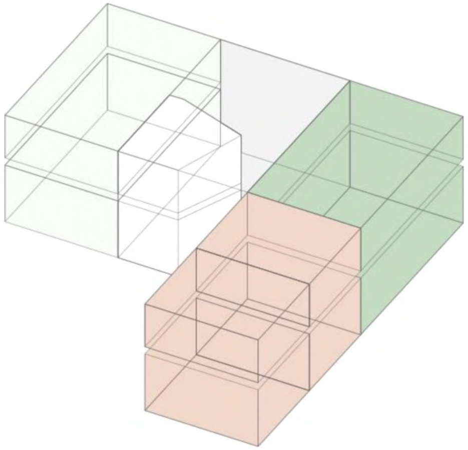
DEMOUNTABLE STRUCTURAL ELEMENTS

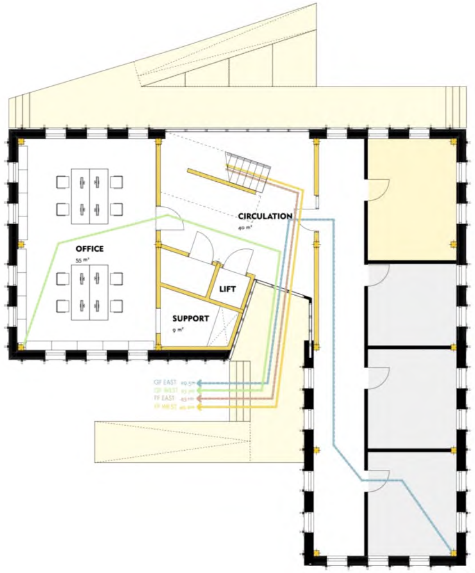
Ground floor slab

Roof slab

Facade panels (non structural)

DEMOUNTABILITY





EXTENDIBILITY

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BUILD IN WOOD

DUTCH PILOT PROJECTS

TWO SITES

LOCATION

NEW RESIDENTAIL DEVELOPMENT

SUBURBAN SITE

Coordinates : 52°47′N 4°48′E

EXISTING BUILDING EXTENSION

PERI-URBAN SITE

Coordinates: 52°25′N 4°53′E

THE CONTEXT

SCHAGEN - MUGGENBURG ZUID

KEY:

site boudaries

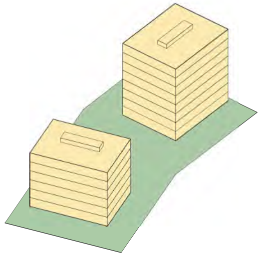
2020
2015
2000
1975
1950
1925
1900
1850
1800
1750
1700

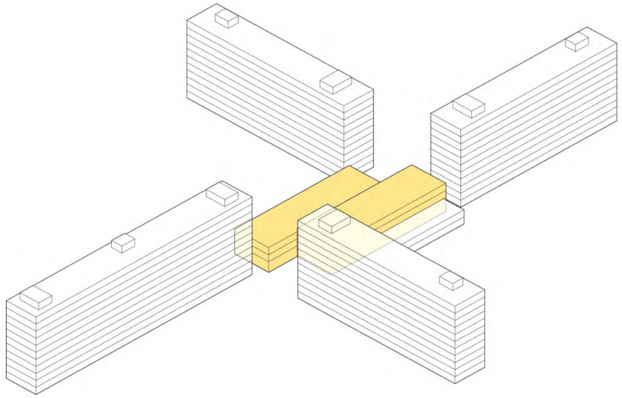
building ages

AMSTERDAM - MOLENWIJK

SOURCE: https://parallel.co.uk/netherlands

AT A GLANCE

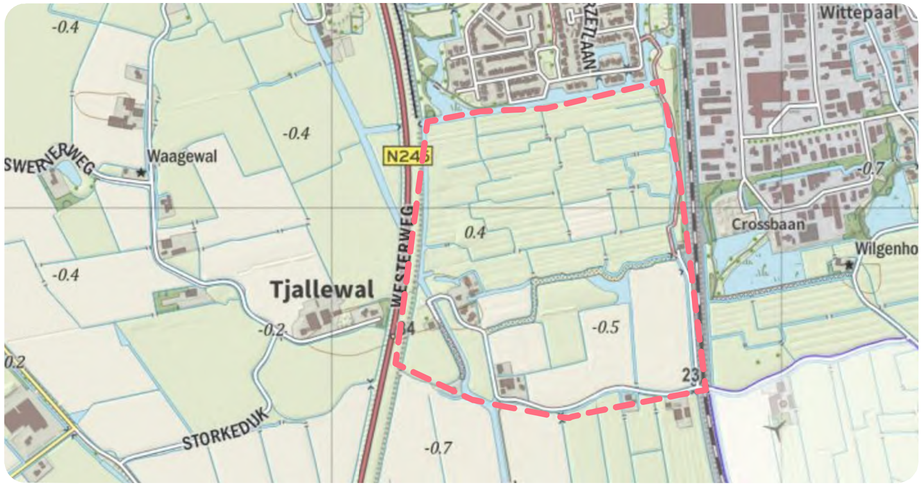




SCHAGEN MUGGENBURG ZUID	PARAMETERS	AMSTERDAM MOLENWIJK
4no.	Number of blocks	1 no. (exixtib build. extension)
Residential	Building Use	Residential
60 to 100 (depending on mix)	Number of houses	40
7000	GIA (m2)	6720 (resi. extension)
5 to 7 storey (3250 mm floor to floor)	Building Height (m)	4 exist.+ 3 extension (3000 mm floor to floor)
2.5+Self-weight	Assumed Dead Load (kN/m2)	2.5+Self-weight
2	Assumend Live Load (kN/m2)	2
6 floors/8 beams	Floor Vibration	6 floors/8 beams
55	Acoustic Performance (L'nTw, dB)	55
60	Fire Performance (mins.)	60
0.2 min.	U-Value (W/m2K)	0.2 min.

1. SCHAGEN - MUGGENBURG ZUID

SITE - MASTERPLAN



SCHAGEN MUGGENBRUG CURRENT SITUATION

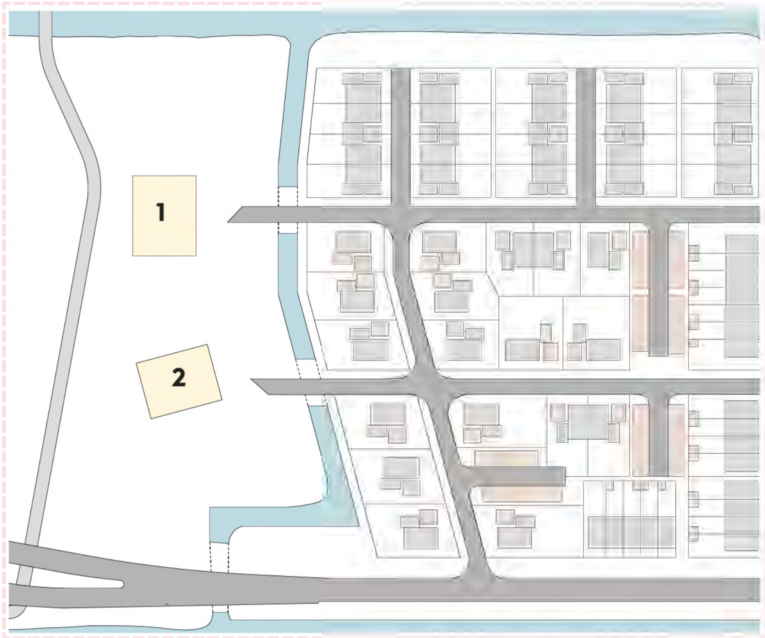
SITE A

SITE B

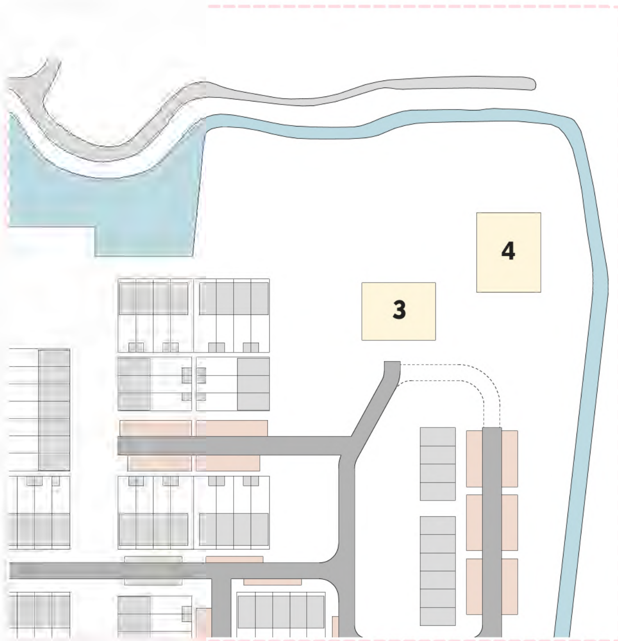
SCHAGEN MUGGENBURG MASTERPLAN

BUILD-IN-WOOD

SITE - MASTERPLAN



SITE A



SITE B

KEY:

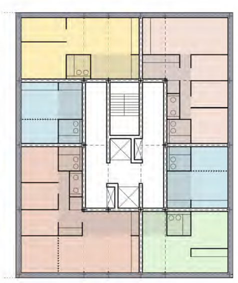
- Pilot projects / Blocks (5 to 7 storey)
- Buildings (2 to 3 storey)
- Primary /Secondary roads
- Parking spaces
- Canals

FOUR RESIDENTIAL BLOCKS

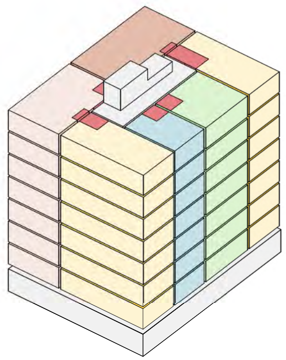
OUTLINE TARGET: 20 TO 40 HOUSES x BLOCK (final number depending on mix. and build. height)

BUILDING FOOTPRINTS SLIGHTLY DIFFERENTLY SIZED

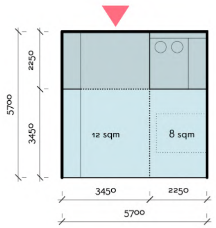
KEY HOUSE TYPES



TYPICAL FLOORPLAN (6 HOUSES X FLOOR CONFIGURATION)



48 HOUSES - TYPICAL 8 STOREY

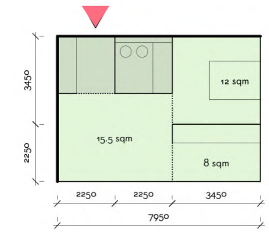


STUDIO

Single aspect unit

(never facing North)

33 sqm

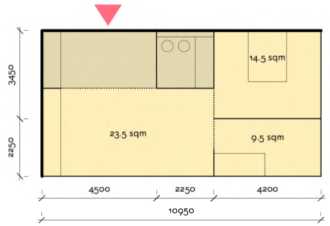


1 BED / 2 PERSON HOUSE

Dual aspect unit

(Corner unit)

46 sqm

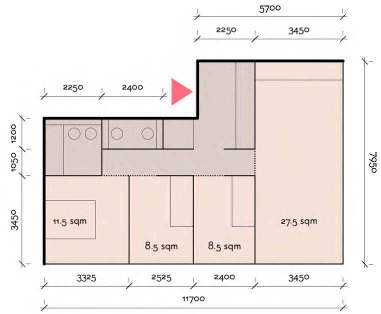


2 BED / 3 PERSON HOUSE

Dual aspect unit

(Corner unit)

63 sqm

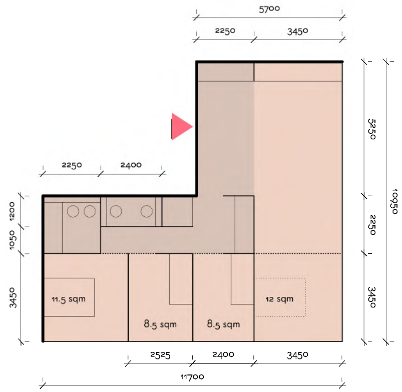


3 BED /4 PERSON HOUSE

Dual aspect unit

(Corner unit)

80 sqm



4 BED /6 PERSON HOUSE

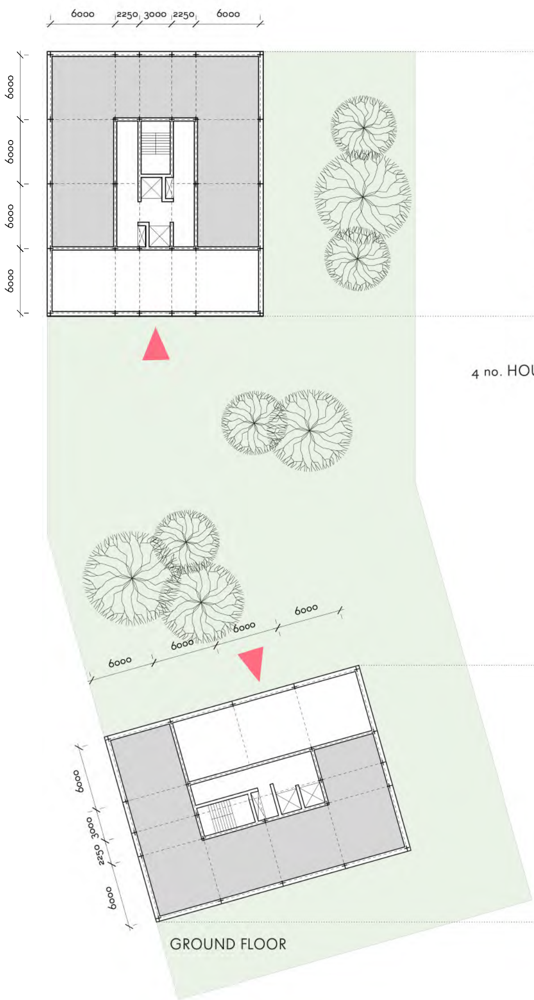
Dual aspect unit

(Corner unit)

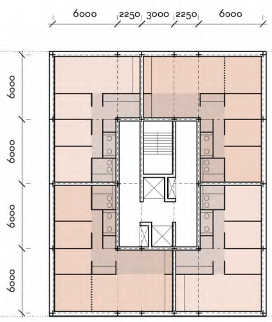
97 sqm

FIVE KEY HOUSE TYPES

MIX OF UNITS - ADAPTABILITY POTENTIAL



GROUND FLOOR



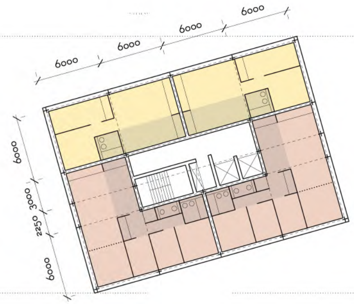
4 no. HOUSES x FLOOR - TYPICAL FLOOR CONFIGURATION A

6 no. HOUSES x FLOOR - TYPICAL FLOOR CONFIGURATION B

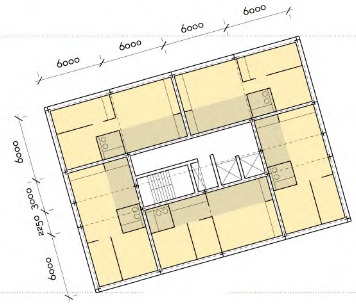
8 no. HOUSES x FLOOR - TYPICAL FLOOR CONFIGURATION C

KEY:

LOBBY / CIRCULATION · PLANT / CYCLES / STORAGE · STUDIO FLAT · 1 BEDROOM FLAT · 2 BEDROOM FLAT · 3 BEDROOM FLAT · 4 BEDROOM FLAT



4 no. UNITS x FLOOR - TYPICAL FLOOR CONFIGURATION A

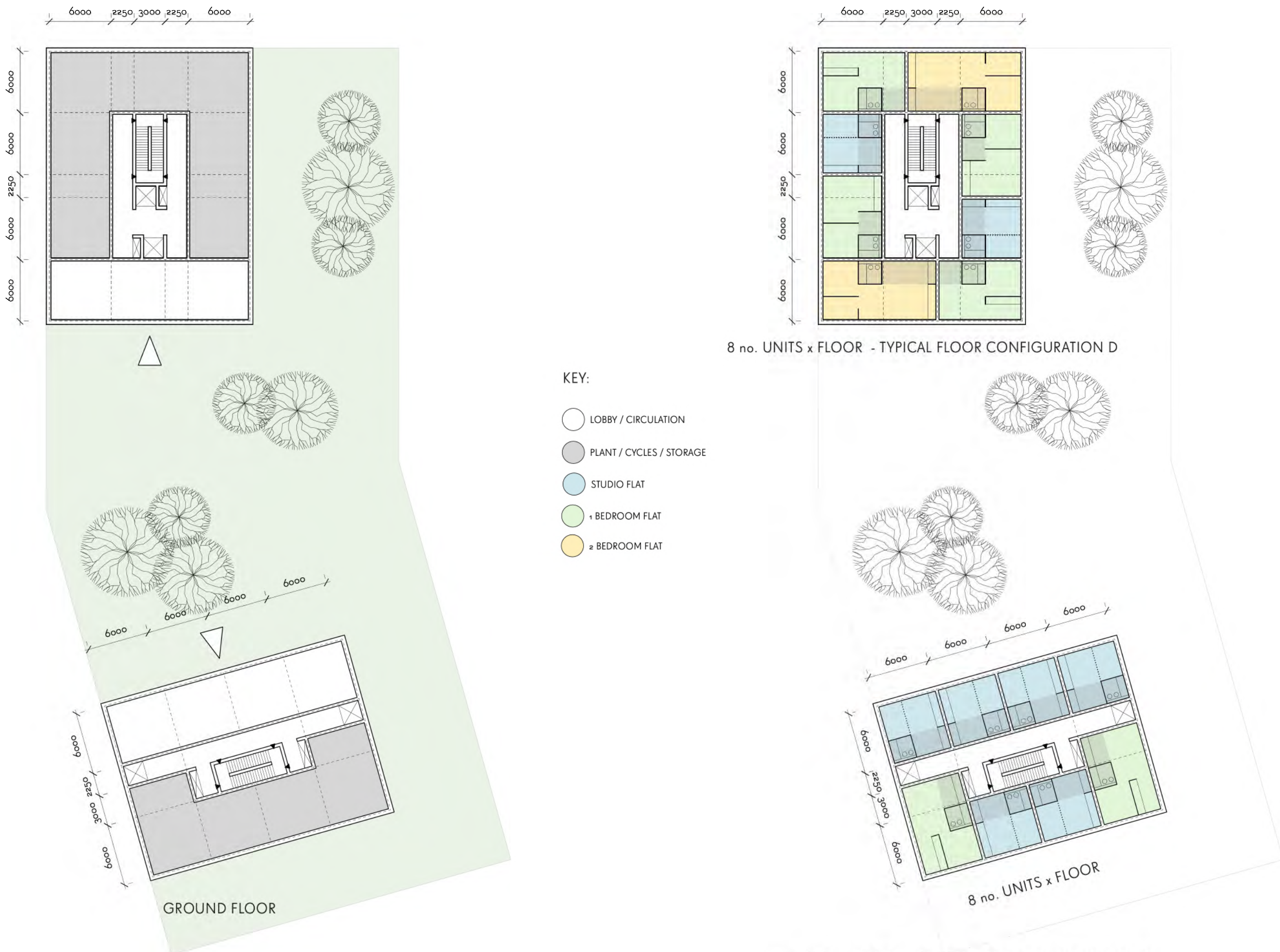


5no. UNITS x FLOOR - TYPICAL FLOOR CONFIGURATION B

7no. UNITS x FLOOR - TYPICAL FLOOR CONFIG. C

Note: To comply with dutch fire regulations the core could include "wokkel staricase" creating two escape routes; see also page 22 for alternative design with douple escape stairs.

MIX OF UNITS - ADAPTABILITY POTENTIAL (MAX. CAPACITY)



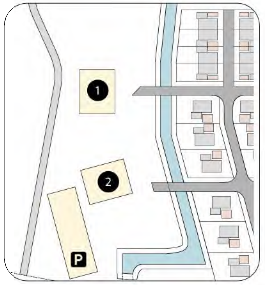
8 no. UNITS x FLOOR - TYPICAL FLOOR CONFIGURATION D

NOTE :

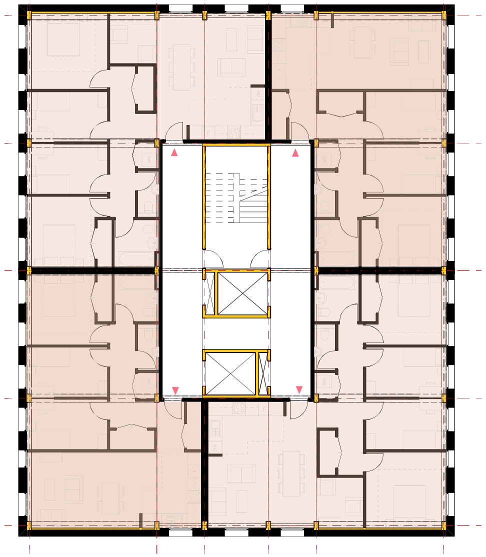
This additional plan configuration - that includes double escape stairs - maximises the number of units that are accessed per core (8 no.); we could design eight even smaller units and reduce the floorplan, but we do not recommend creating floor plans with more units.

"Development proposals should ensure that the number of dwellings accessed from a single core does exceed eight per floor. Deviation (by exception) from this requirement will need to be justified and mitigated by maximising corridor widths (beyond 1500mm) and introducing natural ventilation/daylight to corridors. (Excerpt from the London Housing Design Guide)

TYPICAL PLAN

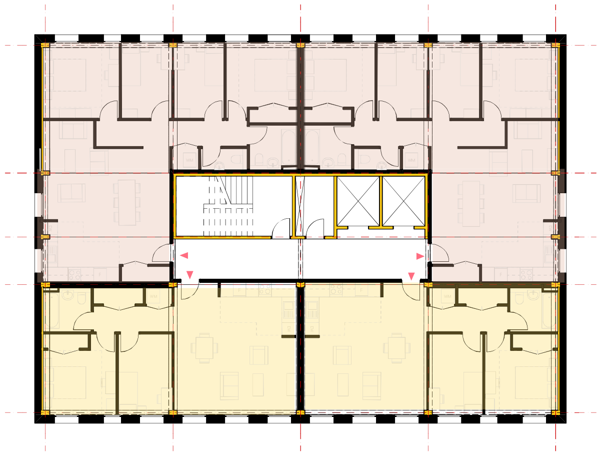


SITE A_PLAN



BUILDING 1 _ 4 no. UNITS x FLOOR

Note: see page 32 for layout with two escape stairs/routes; alternatively core could include "wokkel staricase" creating two escape routes



BUILDING 2 _ 4 no. UNITS x FLOOR

Note: see page 32 for layout with two escape stairs/routes

MASSING AND GRIDS

MASSING

The Build-in-Wood structural system has been designed for buildings between 5 and 10 stories in height.
If built with the system, projects of less than 5 stories could be over engineered, containing redundant material. However, an unique approach to using engineered timber can facilitate specific design aspirations in low rise schemes and so should be considered on a case by case basis. For buildings over 10 stories, consideration of a hybrid approach, using engineered timber alongside other materials such as concrete and steel, could be required in order to keep member sizes practical and to use each material to its advantage. From this point of view the Shagen residentail blocks falls within the "sweet spot" for maximum use of engineered timber.

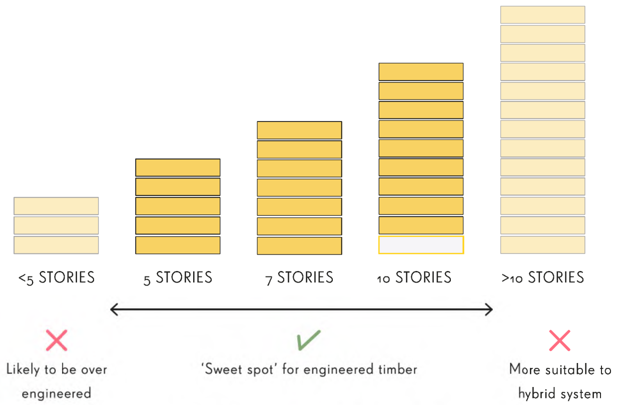
GRIDS

We must design a timber building as a timber building from the outset; in order to choose the most efficient span dimensions and structural solutions: trying to force it into structural grids conceived for traditional building materials such as concrete or steel will result in material and component size inefficiencies. Grids need to be defined trying foresee the best possible use of space and also to optimise the relative sizes of all structural components: efficiency is a multifaceted concept (belonging to the categories of material, cost, space) that does only depend on column spacing and area efficiencies.Two main grid types are commonly used for post&beam structures: the square and the rectangular one.

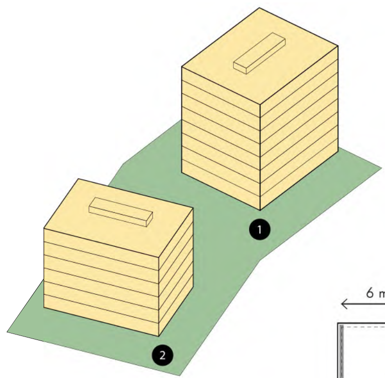
The choice between the two is influenced by the following considerations:
- span/dimensional ranges for floor panels
- max. allowable building height, floor to floor and internal/room heights
- material efficiency
- cost: e.g. thinner floor panels lower the overall material costs but this saving is often offset by a larger beam/columns number.

Square grids are moderately material efficient as this configuration makes the slabs work as hard as the beams.

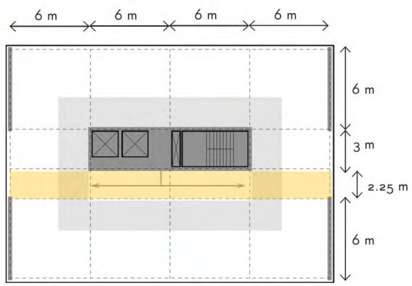
Rectangular grids are more material efficient: in this case the geometry of the primary structure (beams) means that slabs sizes can be optimised (the narrower grid dimension being determined by structural, vibrational and of the floor slab panels) whilst the larger grid dimension is based on layout needs.



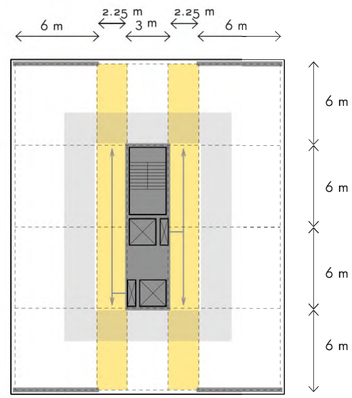
THE SHAGEN 5 to 7 STOREY DEVELOPMENT



FOCUS ON SITE A
BUILDING 1 AND 2
5 to 7 STOREY



BUILDING GRID 2

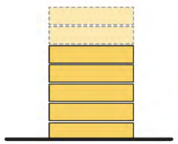


BUILDING GRID 1

KEY:

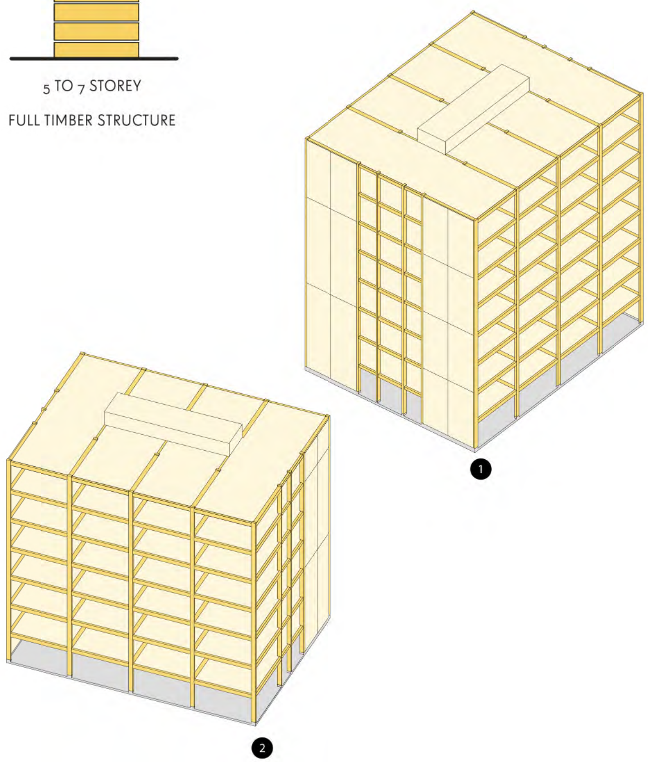
- Service bay /distribution corridor
- Wet areas

STRUCTURAL SYSTEM

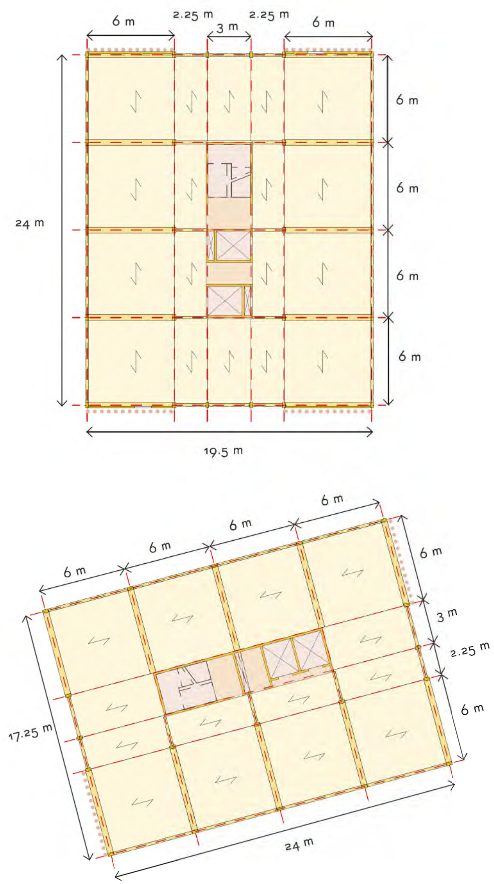


5 TO 7 STOREY

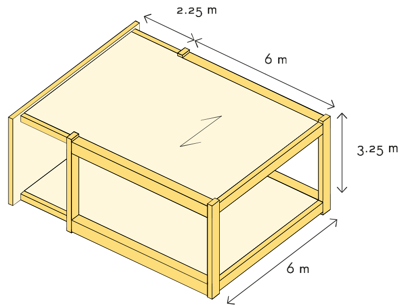
FULL TIMBER STRUCTURE



STRUCTURAL DESIGN CONCEPT - AXONOMETRIC VIEW



STRUCTURAL DESIGN CONCEPT - TYPICAL PLAN



TYPICAL STRUCTURAL BAY

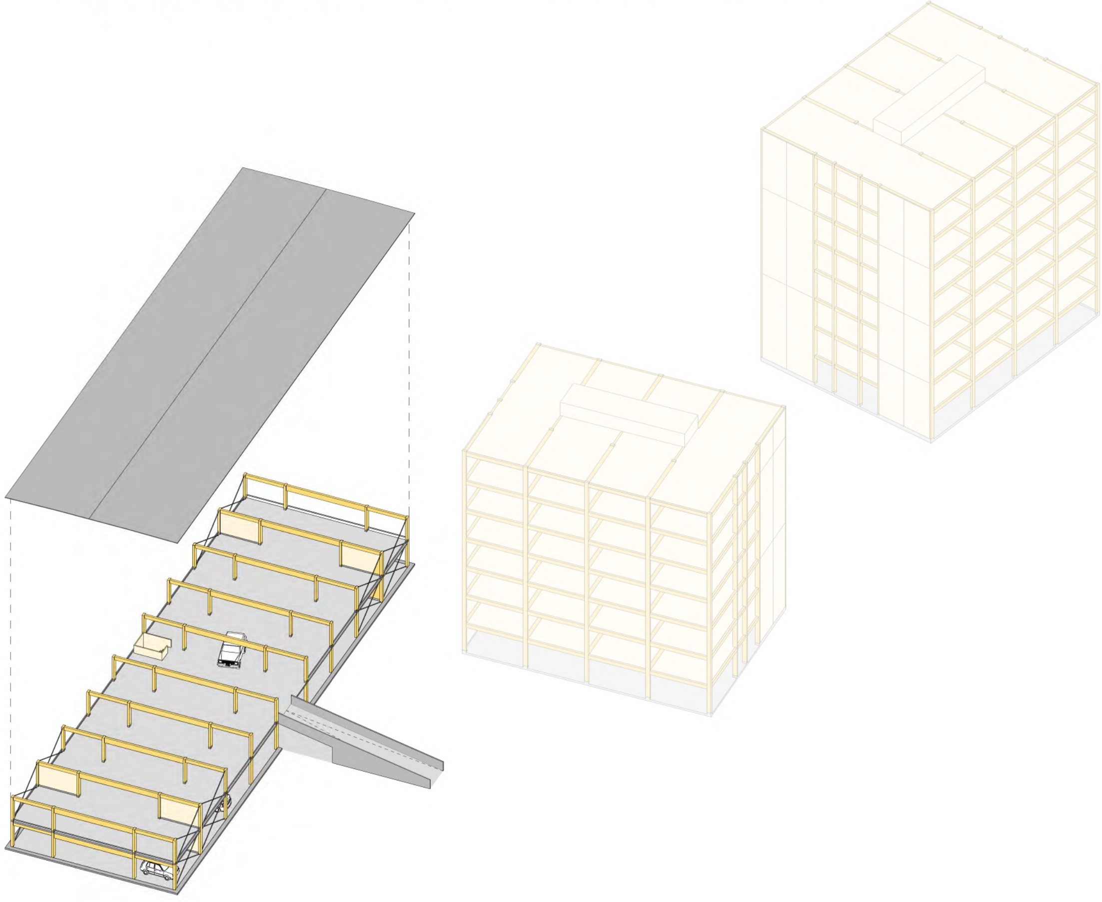
KEY

- CLT cores (stability structure)
- CLT shear walls (stability structure_ see plans) (*)
- Glulam beams
- Glulam Columns
- CLT slabs spanning direction
- Ground floor slab (see axonometry)

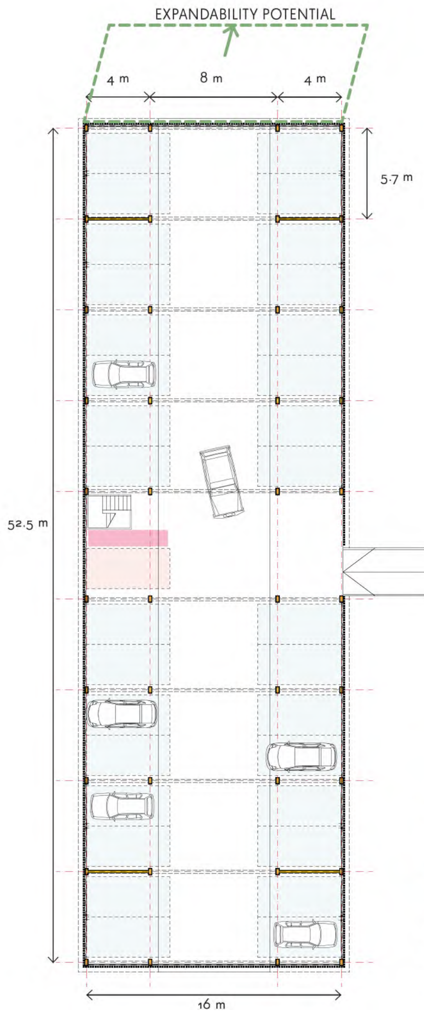
Note: (*) Shear-walls needed where indicated.
Openings, if needed, to be vertically aligned.

SYSTEM - CARPARK INTEGRATION

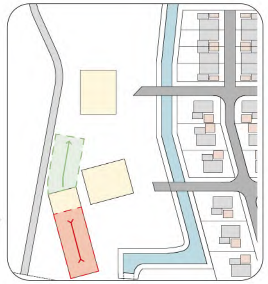
CARPARK INTEGRATION - ABOVE GROUND PARKING



STRUCTURAL DESIGN CONCEPT - AXONOMETRIC VIEW



FIRST FLOOR PLAN



KEY PLAN _ SITE A

TWO STOREY ADAPTABLE TIMBER CARPARK

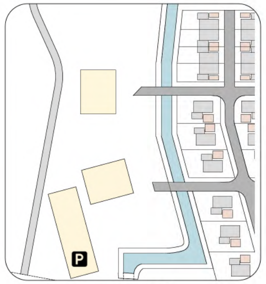
REF. TWO STOREY CAR PARK BAD-AIBLING (D)

H. KAUFMANN

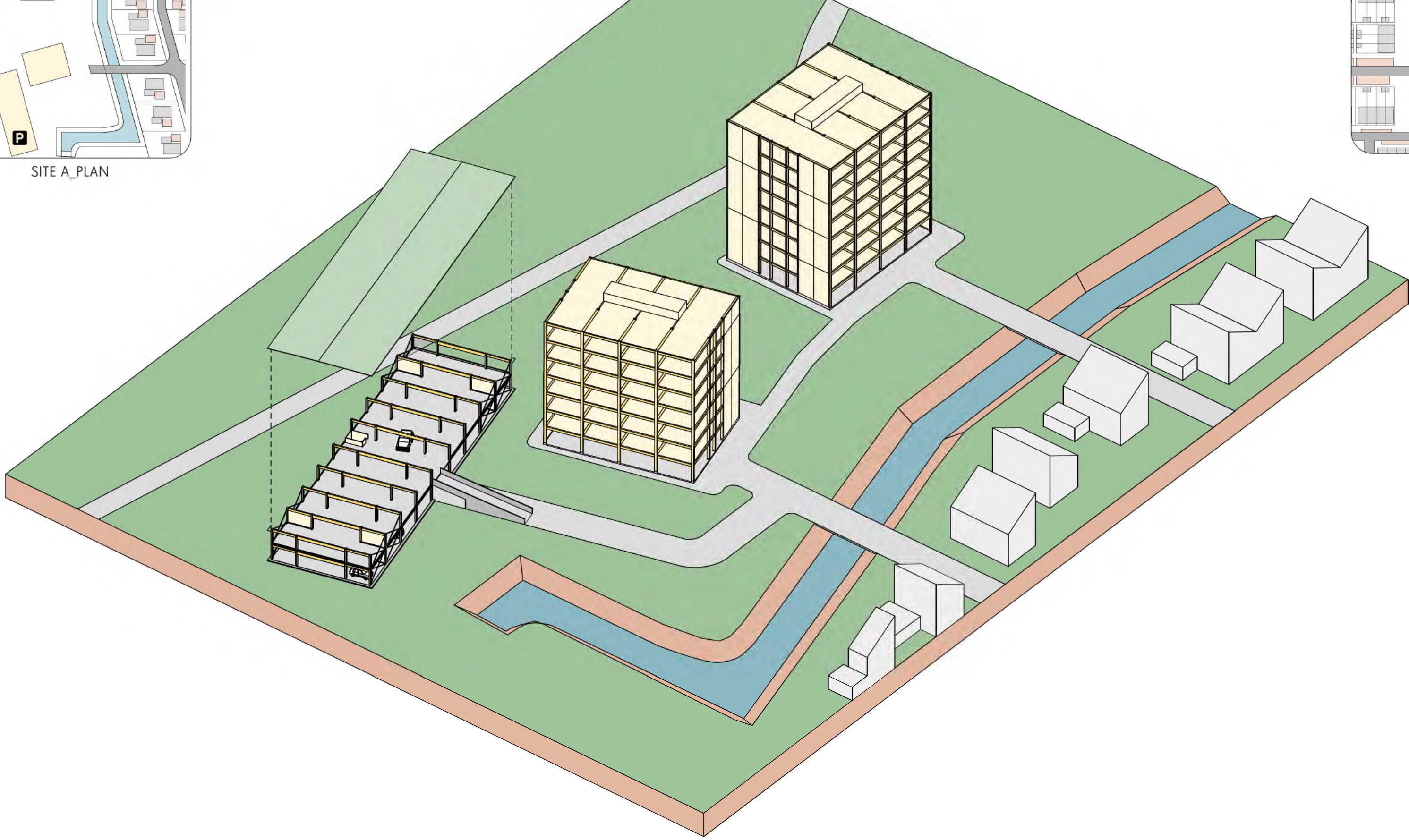
BUILD-IN-WOOD

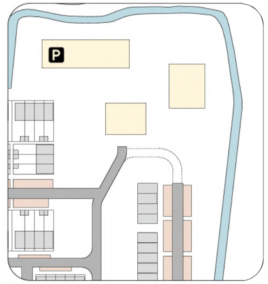
27

SITE OVERVIEW



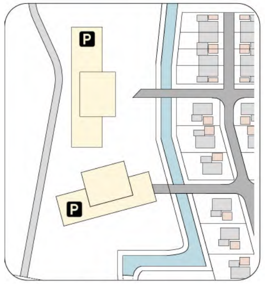
SITE A_PLAN



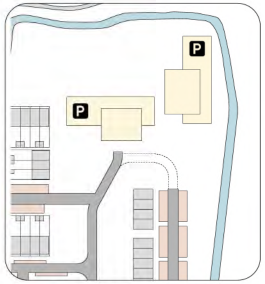


SITE B_PLAN

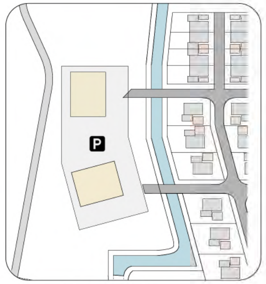
OTHER CARPARK INTEGRATION OPTIONS



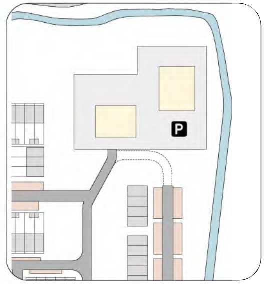
SITE A_ PLAN



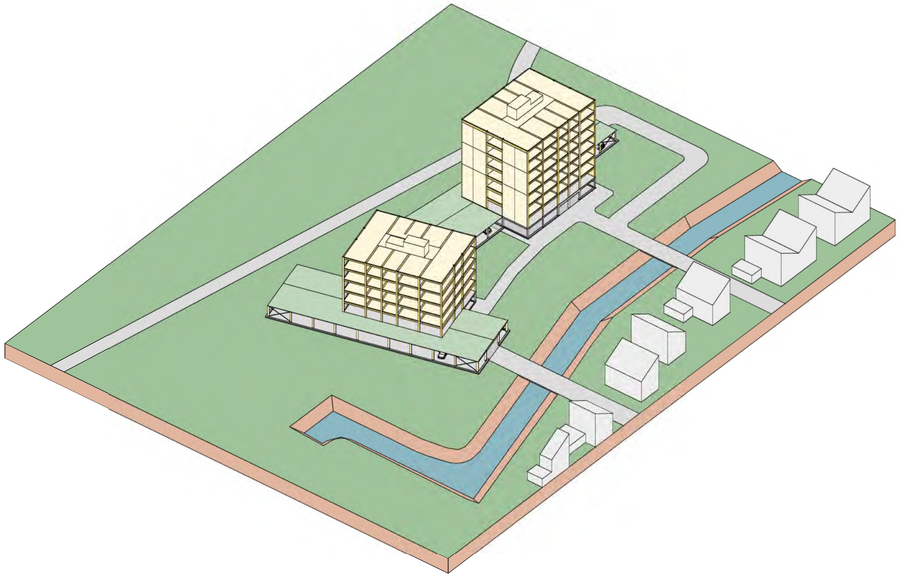
SITE B_ PLAN



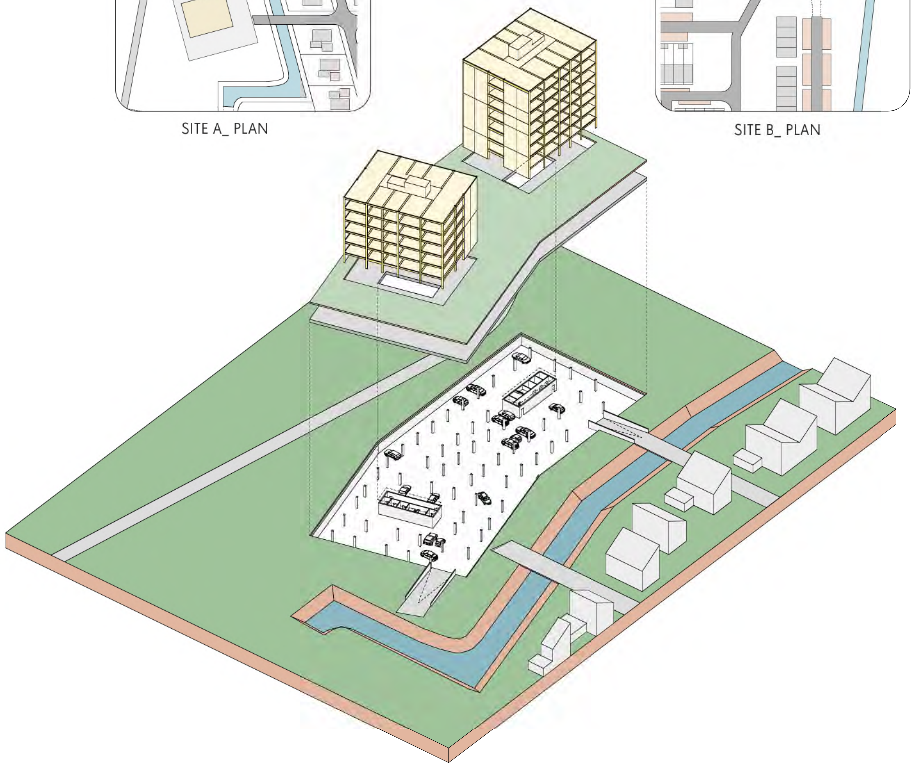
SITE A_ PLAN



SITE B_ PLAN



SITE A_ ABOVE GROUND - ONE STOREY CARPARK INTEGRATED WITH HOUSING BLOCK STRUCTURE



SITE A_ UNDERGROUND CARPARK INTEGRATED WITH HOUSING BLOCK STRUCTURE

STRUCTURE - UNDERGROUND/INTEGRATED CARPARK COORDINATION

The Build-in-Wood system can be adapted to coordinate with car park structures placed either under or over-ground.

Two options have been explored (both compliant with Dutch NEN 2443 regulation) for the Muggengurg buildings: a one drive aisle and a two drive aisle, which depends on the amount of the required car park spaces. Both options are based on the idea that continuity between timber and concrete structures allow for max. materila and cost efficiency.

Key considerations:

1 - A standard car park space is 2.500m x 5.130m

2 - The drive aisle for perpendicular parking must be> 5.660 m*

3 - The columns in line with the car park spaces must be recessed between 0.500m and 1.500m

4 - 5.700m span to allow for two cars, 8.100m span for 3 cars

5 - 4.800m span for the one drive aisle option, 9.000m span for the two drive aisles option

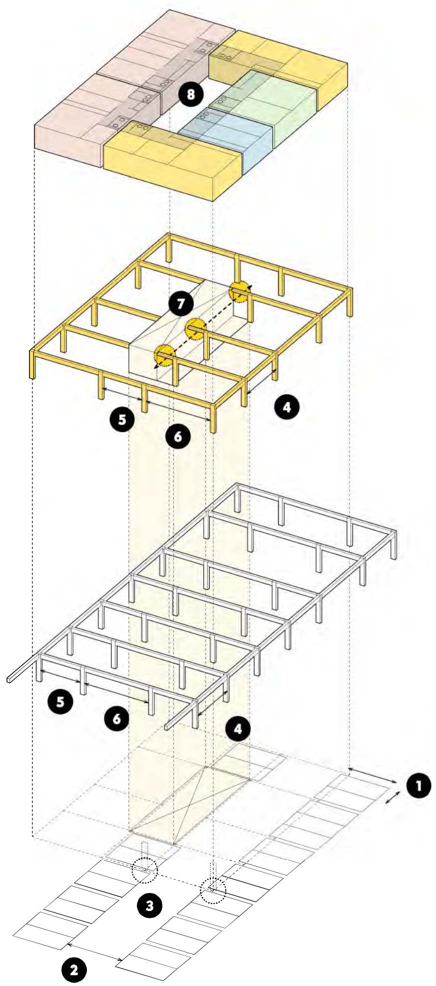
6 - 7.500m span for both options

7 - Shorter span shallower beams at the service area

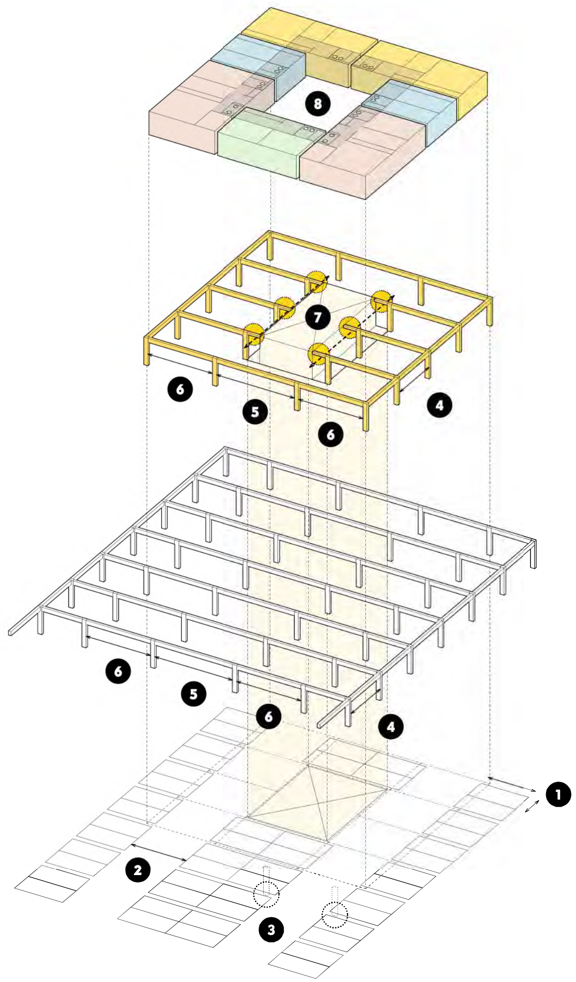
8 - Wet areas ring around the core

Alternatively we could design a transfer structure - e.g. concrete down-stand beams - at the interface between concrete and timber structure. This approach would allow for each structure (timber/concrete) to be independent: a flexibility that has important cost implications but might also be advantageous, especially when dealing with existing structures that are outdated in terms of min. parking spaces dimensions.

Note:
(*) in non-public car parks whilst in public carpark it need to be >6.00m

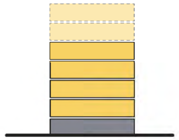


ONE DRIVE ISLE



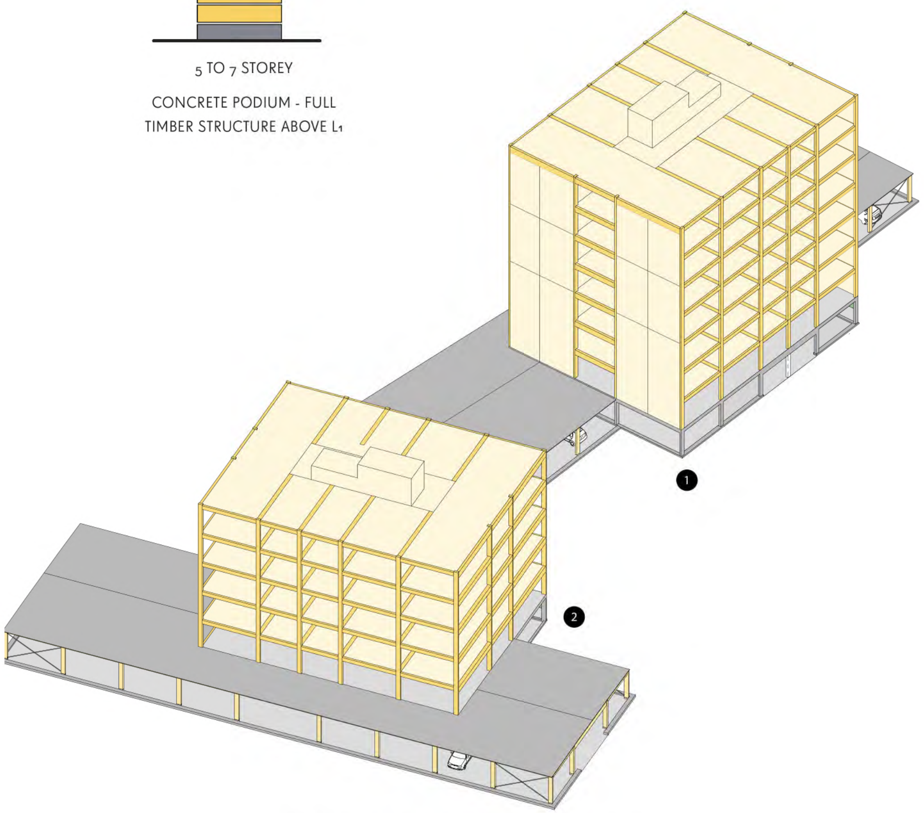
TWO DRIVE ISLE

STRUCTURE ADJUSTMENTS TO INTEGRATE ONE STOREY ABOVE-GROUND CARPARK



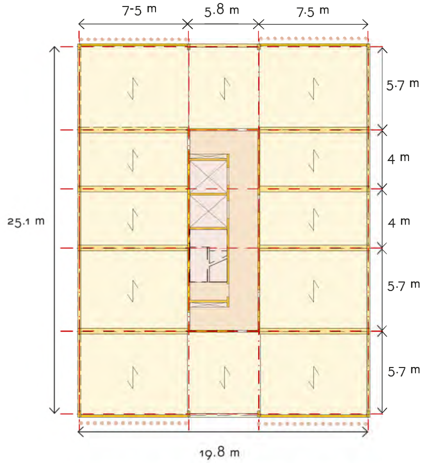
5 TO 7 STOREY

CONCRETE PODIUM - FULL TIMBER STRUCTURE ABOVE L1

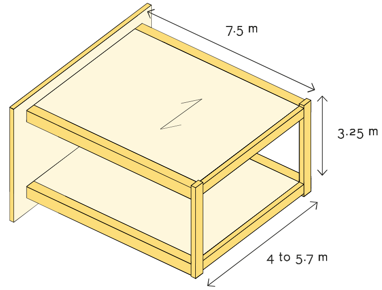


STRUCTURAL DESIGN CONCEPT - AXONOMETRIC VIEW

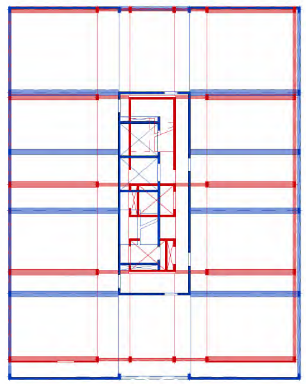
Note ground floor RC concrete podium to interface with car park and protect/elevate timber structure



STRUCTURAL DESIGN CONCEPT - TYPICAL PLAN



TYPICAL STRUCTURAL BAY



STRUCTURAL OF BIW "INITIIAL" AND

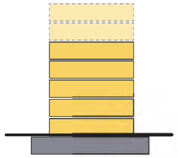
"ADJUSTED" STRUCTURES

KEY

- CLT cores (stability structure)
- CLT shear walls (stability structure_ see plans) (*)
- Glulam beams
- Glulam Columns
- CLT slabs spanning direction
- Ground floor slab (see axo. drawing)
- "Adjusted" structure (to cope with integrated GF carpark)
- BIW "initial" structure (see page 22)

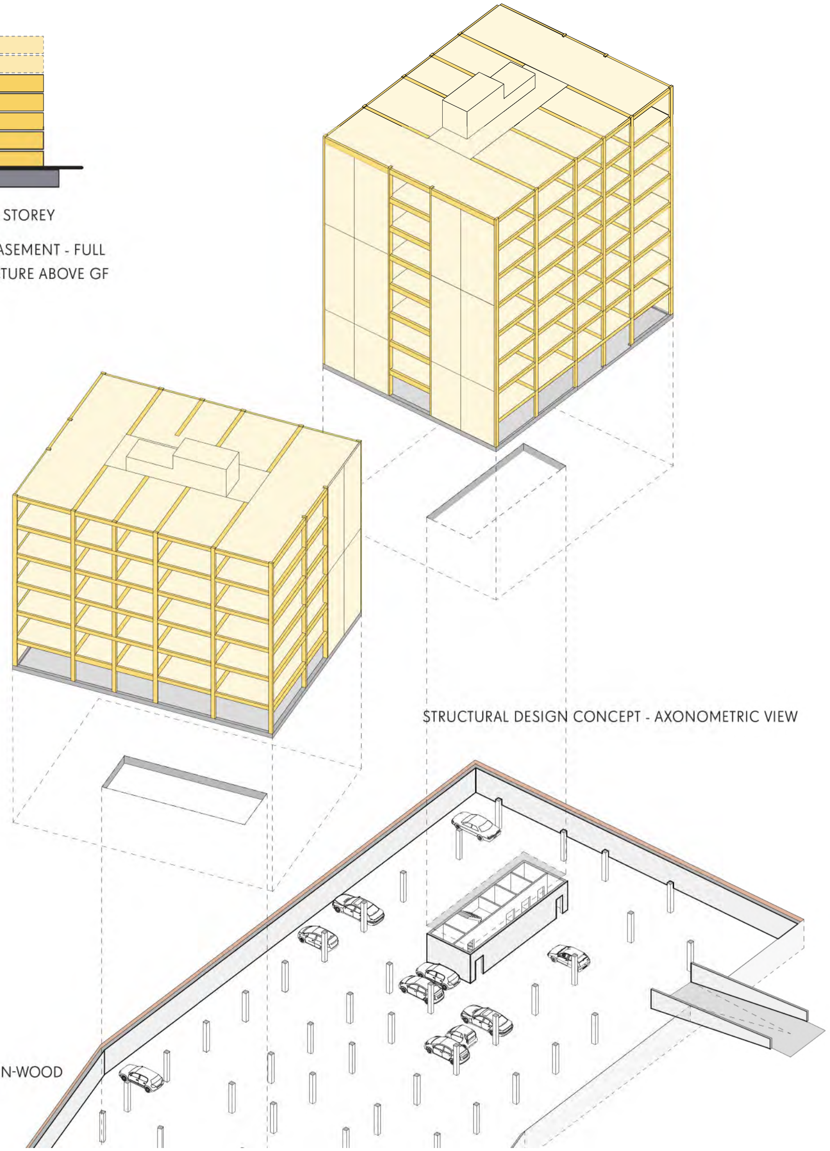
Note: (*) Shear-walls needed where indicated.
Openings, if needed, to be vertically aligned.

STRUCTURE ADJUSTMENTS TO COORDINATE WITH UNDERGROUND CARPARK



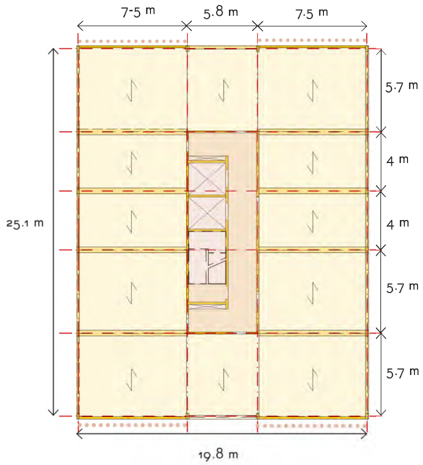
5 TO 7 STOREY

CONCRETE BASEMENT - FULL TIMBER STRUCTURE ABOVE GF

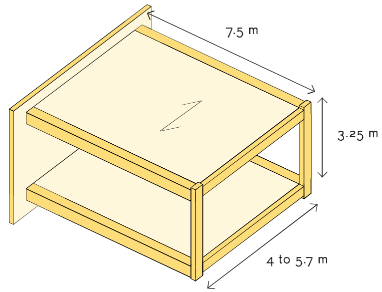


STRUCTURAL DESIGN CONCEPT - AXONOMETRIC VIEW

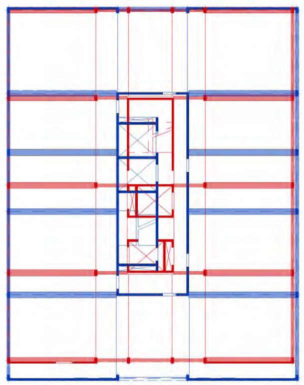
BUILD-IN-WOOD



STRUCTURAL DESIGN CONCEPT - TYPICAL PLAN



TYPICAL STRUCTURAL BAY



STRUCTURAL OF BIW "INITIIAL" AND "ADJUSTED" STRUCTURES

KEY

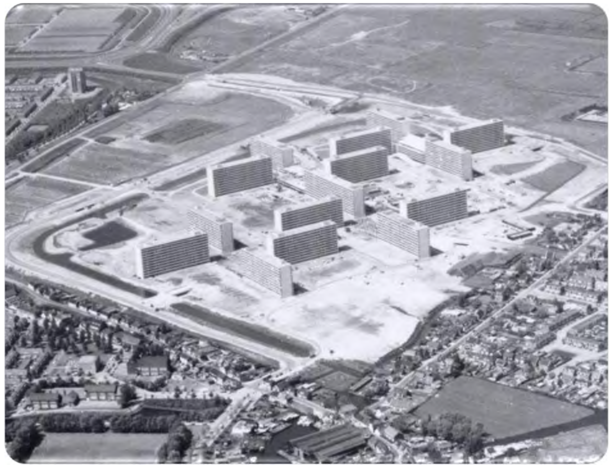
- CLT cores (stability structure)
- CLT shear walls (stability structure_ see plans) (*)
- Glulam beams
- Glulam Columns
- CLT slabs spanning direction
- Ground floor slab (see axo. drawing)
- "Adjusted" structure (to cope with integrated GF carpark)
- BIW "initial" structure (see page 22)

Note: (*) Shear-walls needed where indicated.
Openings, if needed, to be vertically aligned.

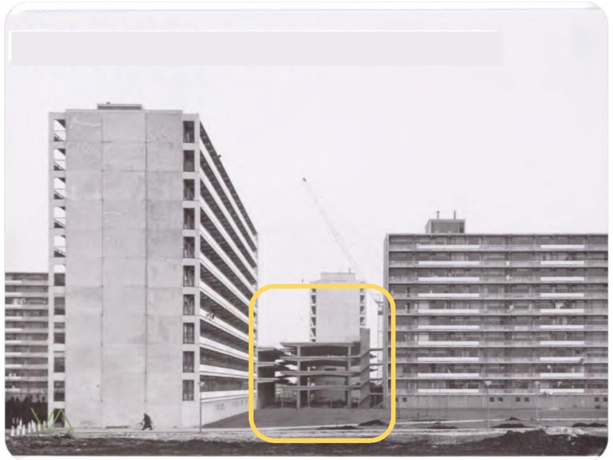
32

2. AMSTERDAM - MOLENWIJK

THE SITE IN TIME



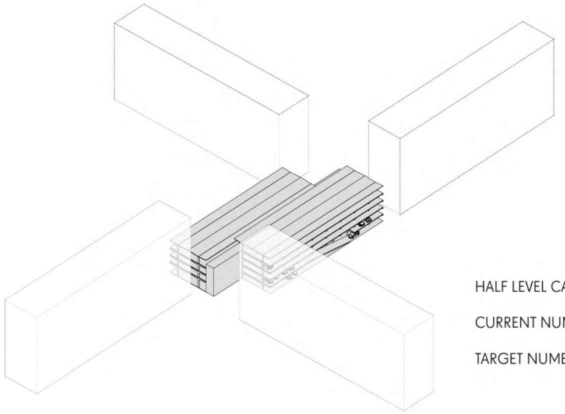
1968-70



NOW

THE SITE IN TIME

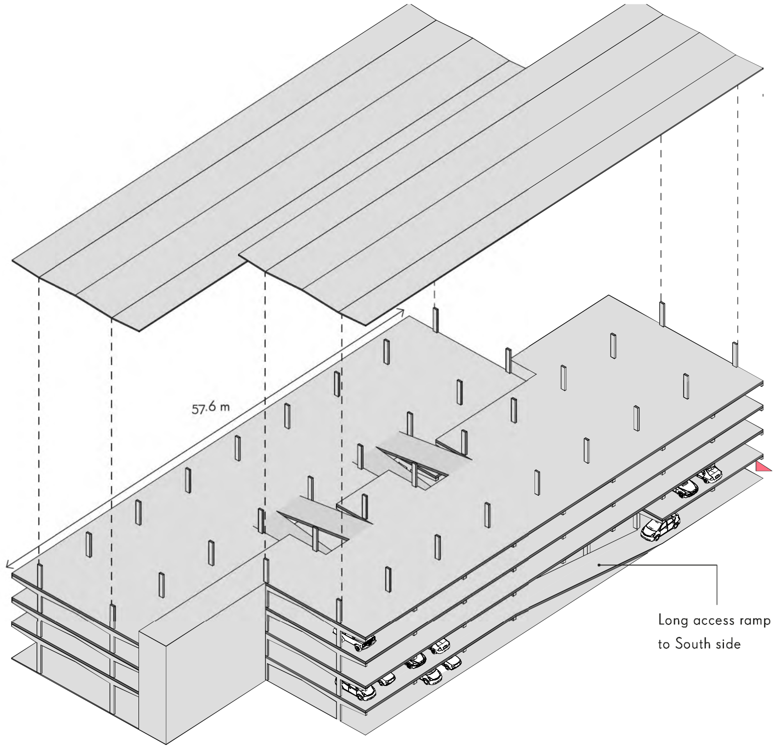
EXISTING CARPARK

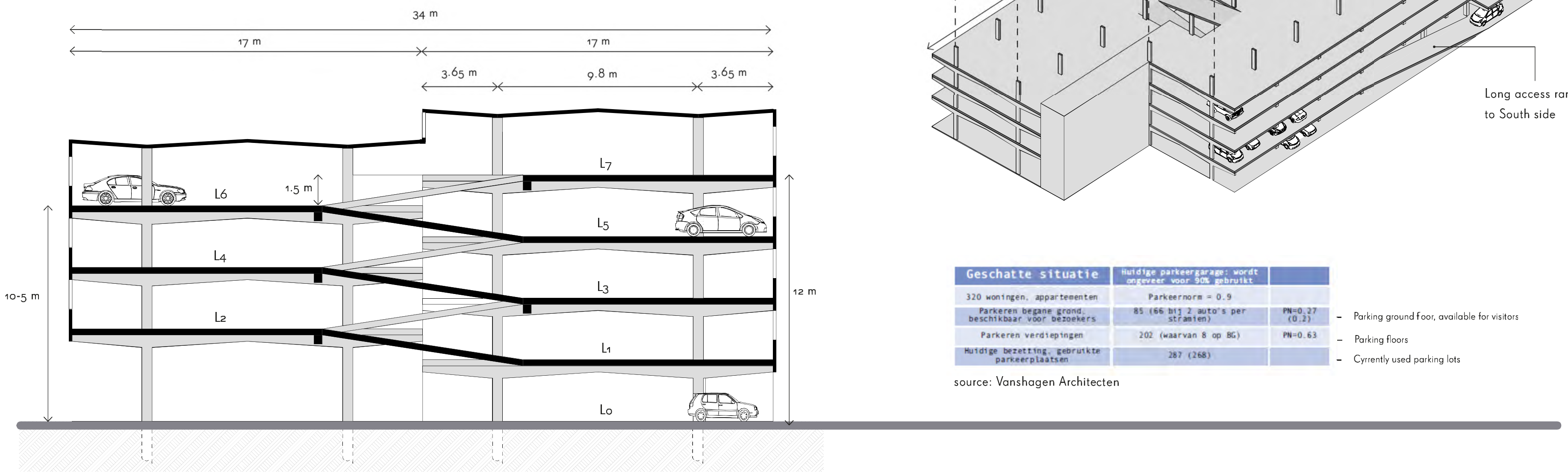


HALF LEVEL CAR PARK

CURRENT NUMBER OF PARKING SPACES: 264

TARGET NUMBER OF PARKING SPACES (AFTER REFURB.): 208 CAR

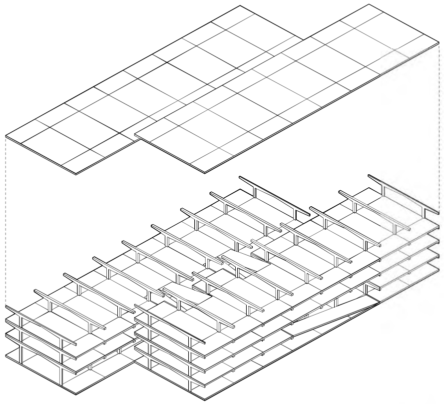




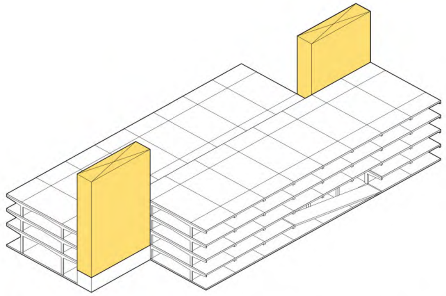
Geschatte situatie	Huidige parkeergarage: wordt ongeveer voor 90% gebruikt		
320 woningen, appartementen	Parkeernorm = 0.9		
Parkeren begane grond, beschikbaar voor bezoekers	85 (66 bij 2 auto's per stramien)	PN=0.27 (0.2)	– Parking ground foor, available for visitors
Parkeren verdiepingen	202 (waarvan 8 op BG)	PN=0.63	– Parking floors
Huidige bezetting, gebruikte parkeerplaatsen	287 (268)		– Cyrrently used parking lots

source: Vanshagen Architecten

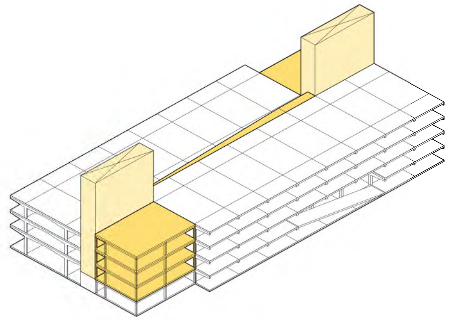
INITIAL, DISCARDED IDEA - EXTENDING THE EXISTING CARPARK



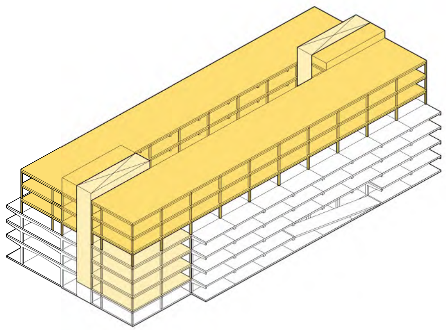
1 HALF LEVEL CAR PARK RETAINED EXCEPT FOR LIGHTWEIGHT ROOF



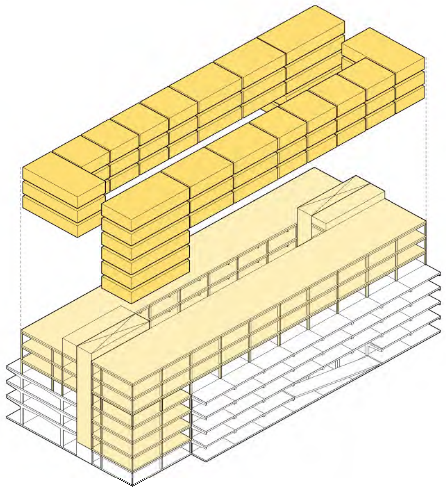
2 NEW WOODEN CORES ADJACENT TO EXIST. STRUCTURE TO LINK LEVELS ON BOTH ENDS OF THE EXISTING STRUCTURE



3 CORNERS FILLED WITH WOODEN EXTENSION. CENTRALLY LOCATED RAMP TO CONNENCT ALL CARPARK DECKS

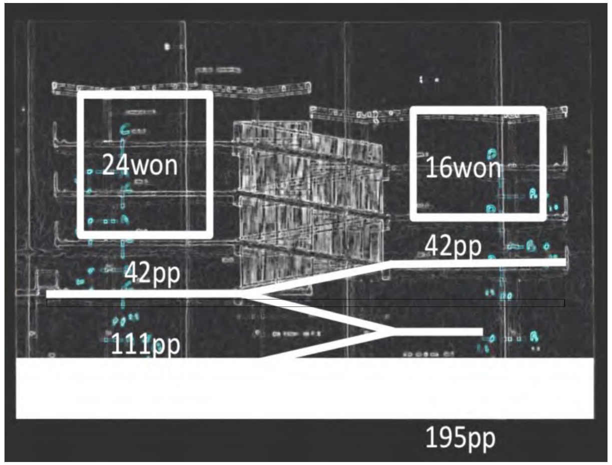


4 3 STOREY WOODEN EXTENSION TO OVER THE EXISTING CONCRETE STRUCTURE



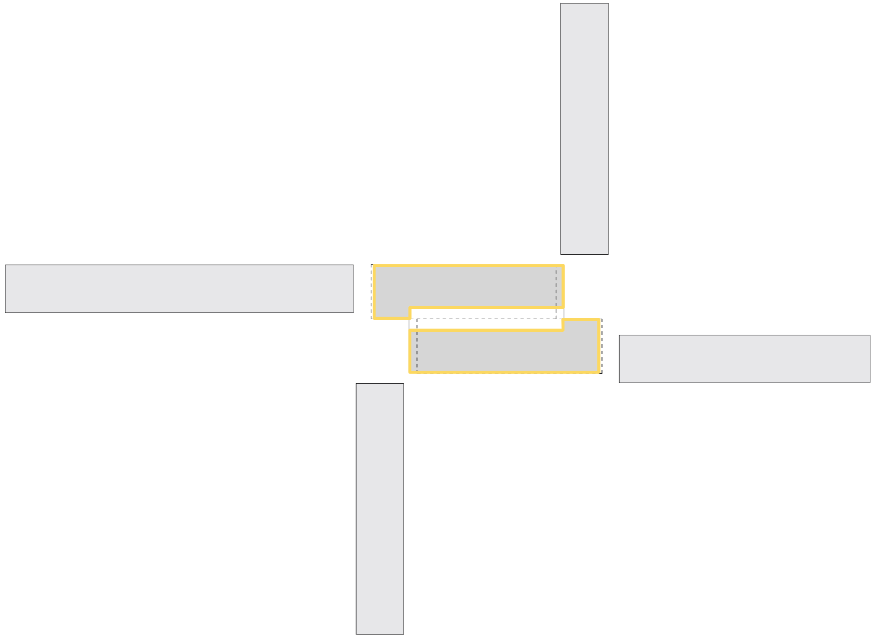
5 POTENTIAL TO CREATE 53 HOMES EXTENDING UPWARDS AND SIDEWAYS THE EXISITNG STRUCTURE

REVISED APPROACH: DEMOLITION OF EXISTING CARPARK - NEW CARPARK WITH SAME FOOTPRINT



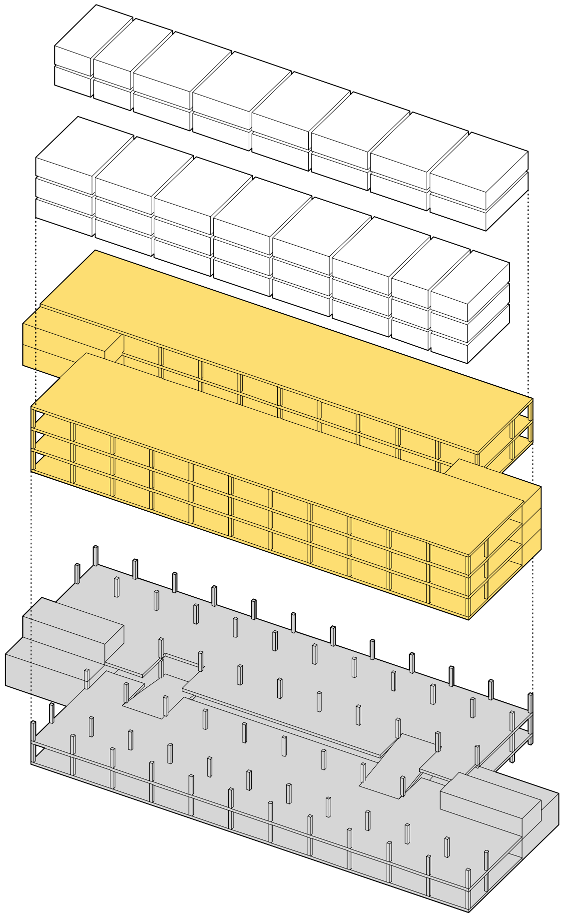
DEMOLISHING THE EXISTING CAR PARK AND BUILDING A SIMILAR ONE (HALF LEVEL FLOORS) WITHIN THE EXISTING FOOTPRINT

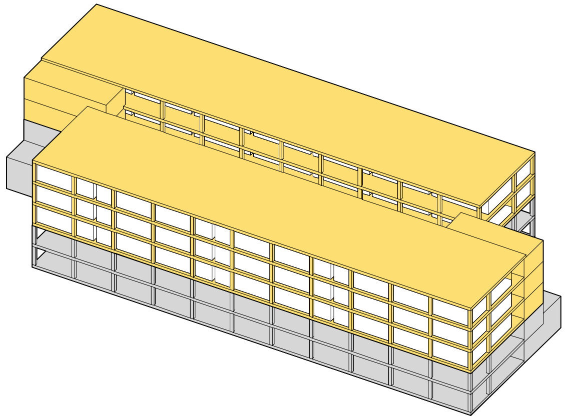
OPTIMISED CAR PARKING FLOORS + NEW RESIDENTIAL PROVISION ABOVE



SITE INSERTION

NEW CARPARK WITH SAME FOOTPRINT

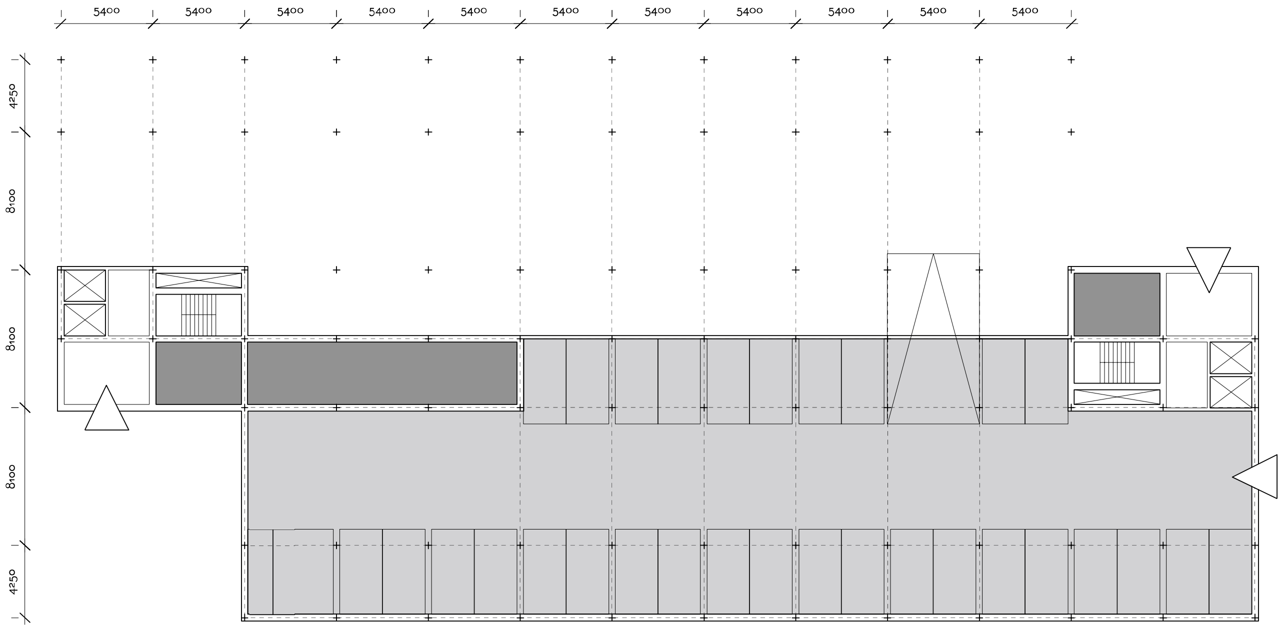




RE-BUILD RC CONCRETE CARPAK WITH UPPER TIMBER EXTENSION

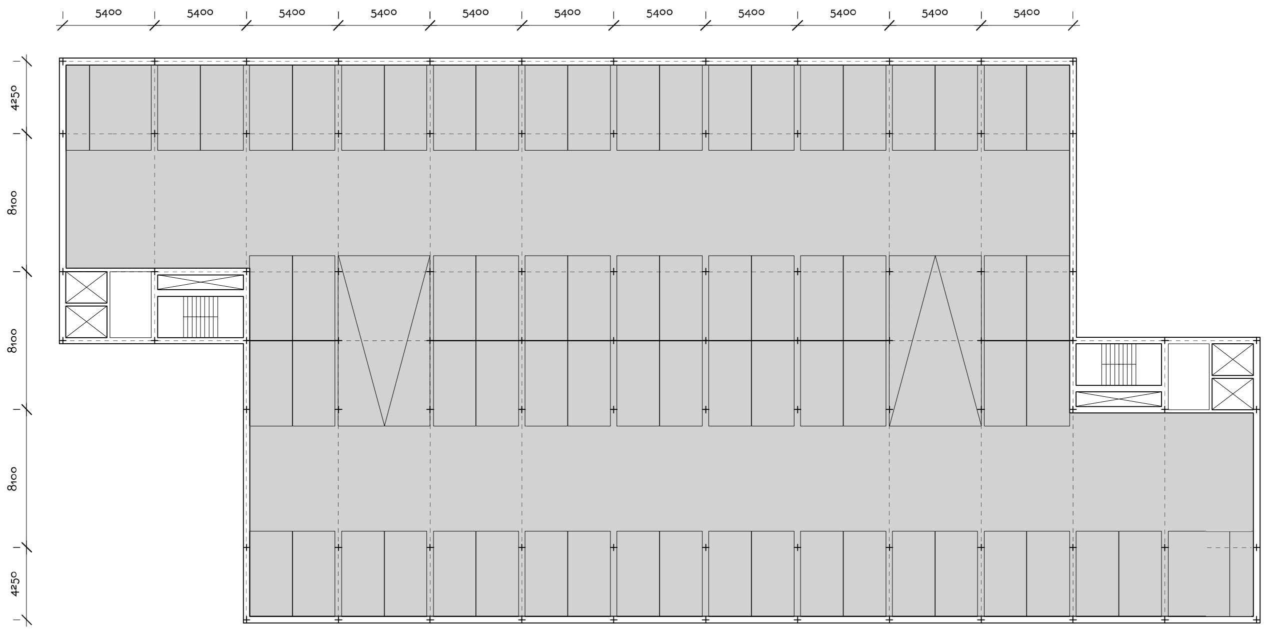
40 RESIDENTAIL UNITS - 190 CAR PARKING SPACES

CARPARK FLOOR (SINGLE)



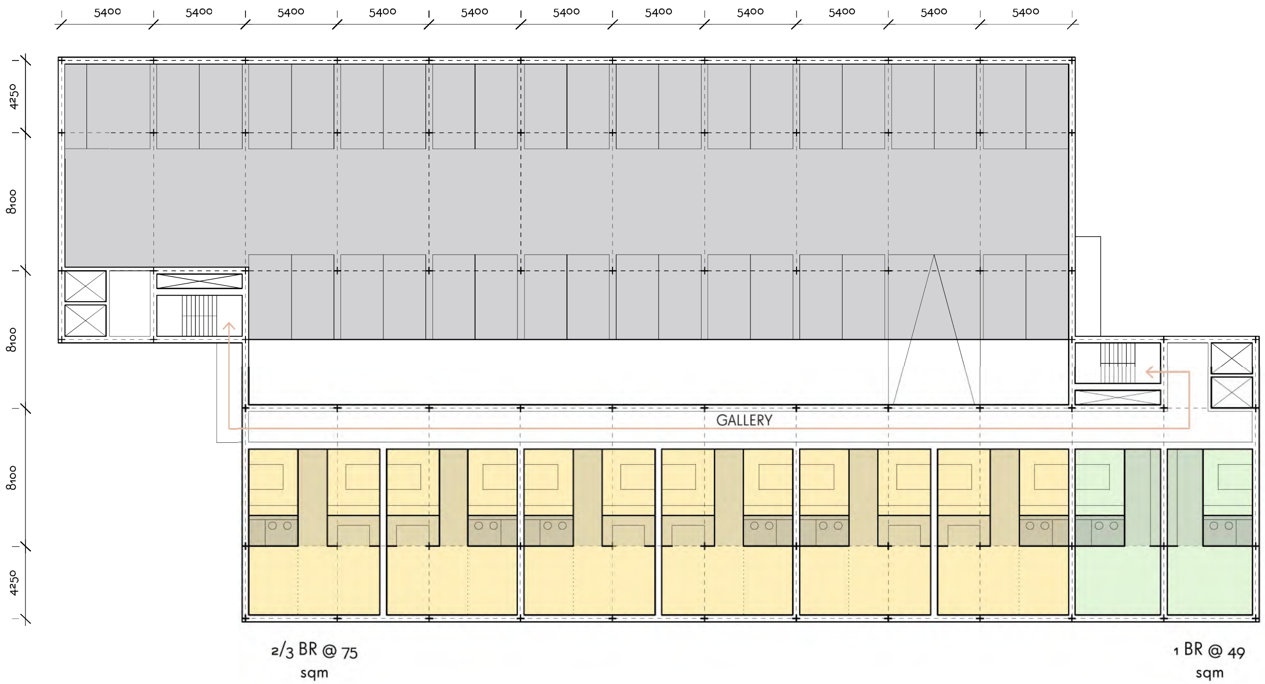
TYPICAL CARPARK FLOOR (32 PARKING SPACES)

CARPARK FLOOR (DOUBLE)



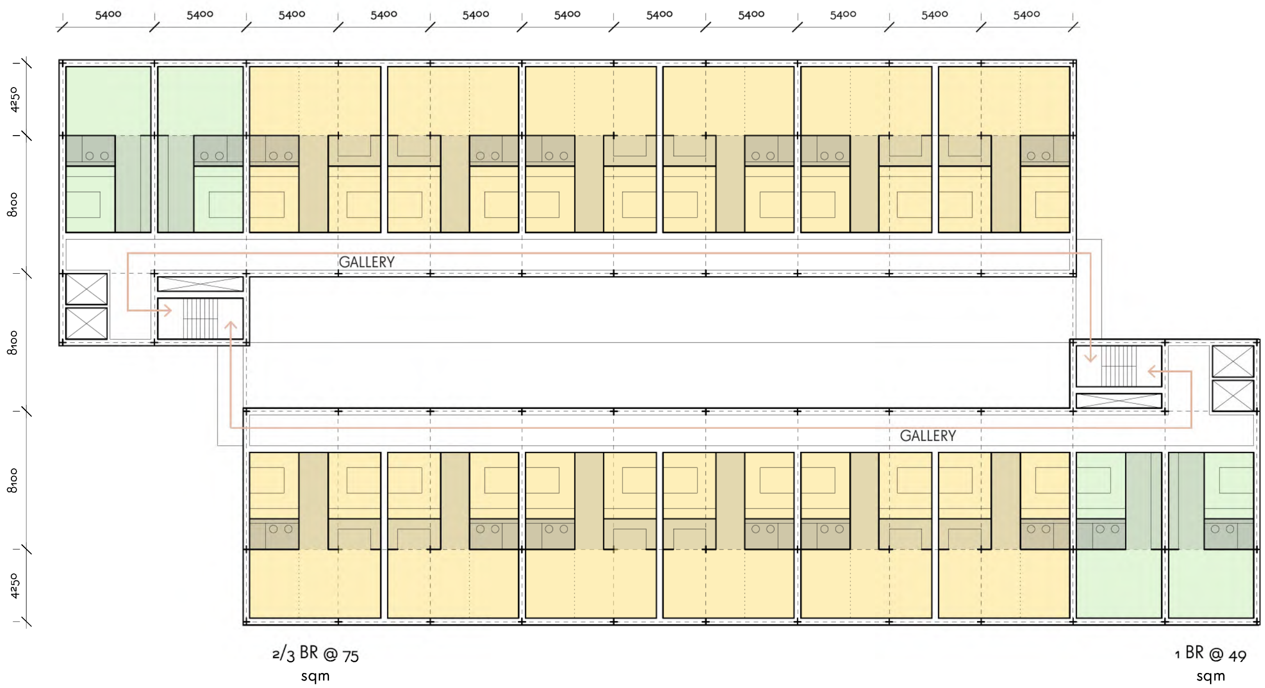
TYPICAL CARPARK FLOOR (72 PARKING SPACES)

MIXED USE FLOOR



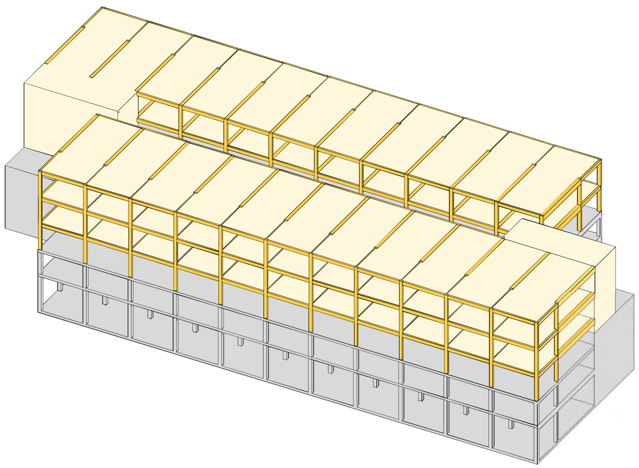
MIXED USE FLOOR - 8 HOMES AND 32 CARPARK SPACES

RESIDENTIAL FLOOR

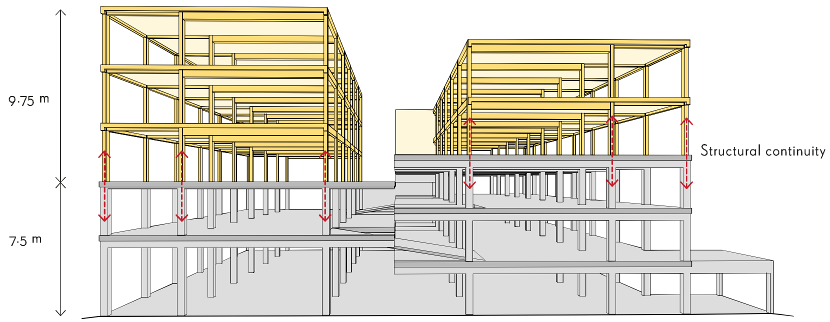


RESIDENTIAL FLOOR - 16 HOMES

TIMBER EXTENSION - STRUCTURE



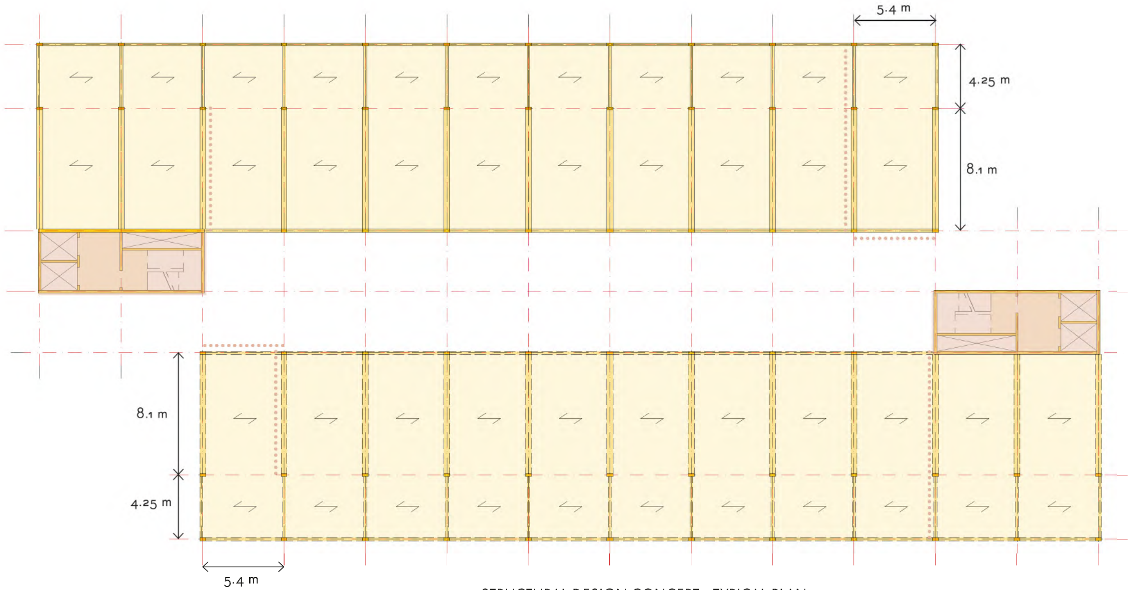
STRUCTURAL DESIGN CONCEPT - AXONOMETRIC VIEW



SECTION WITH HIGHLIGTED NEW RC CONCRETE CARPARK AND RESIDENTAIL EXTENSION

KEY

- CLT cores (stability structure)
- CLT shear walls (stability structure_ see plans)
- Glulam beams
- Glulam Columns
- CLT slabs spanning direction
- Ground floor slab (see axonometry)
- Structural continuity (Timber - RC)

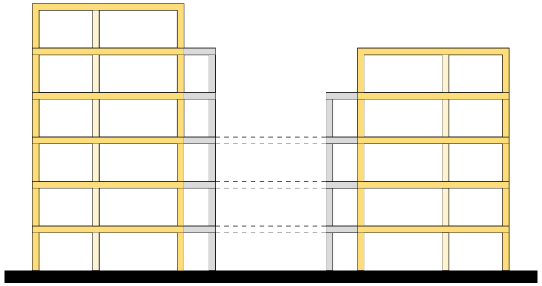


STRUCTURAL DESIGN CONCEPT - TYPICAL PLAN

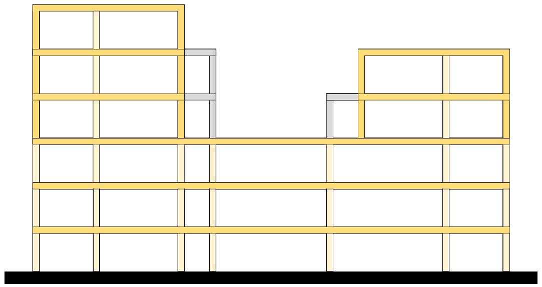
BUILD-IN-WOOD

44

REVISED APPROACH: DEMOLITION OF EXISTING CARPARK - NEW TIMBER CARPARK



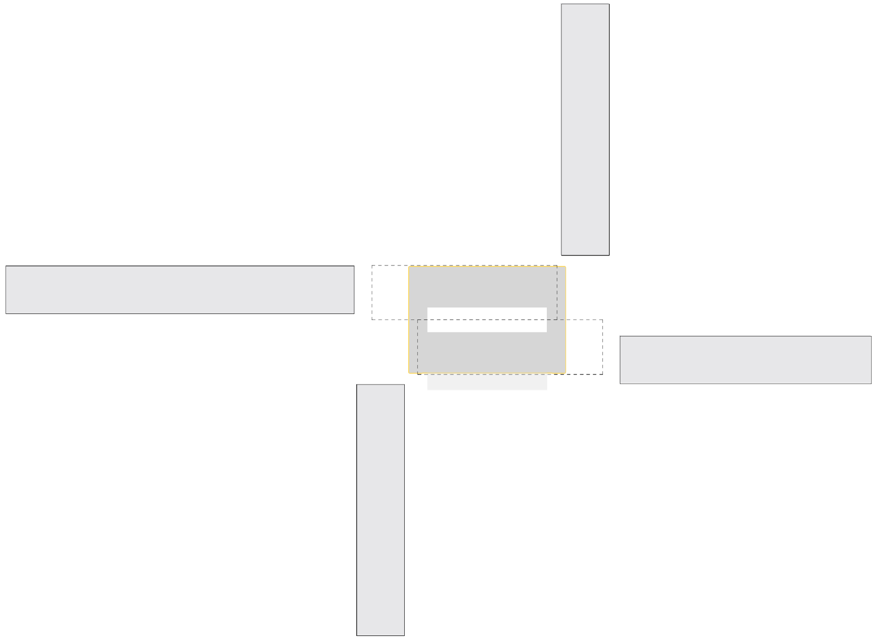
FUTURE (FULL RESIDENTIAL)



DAY ONE (MIXED USE)

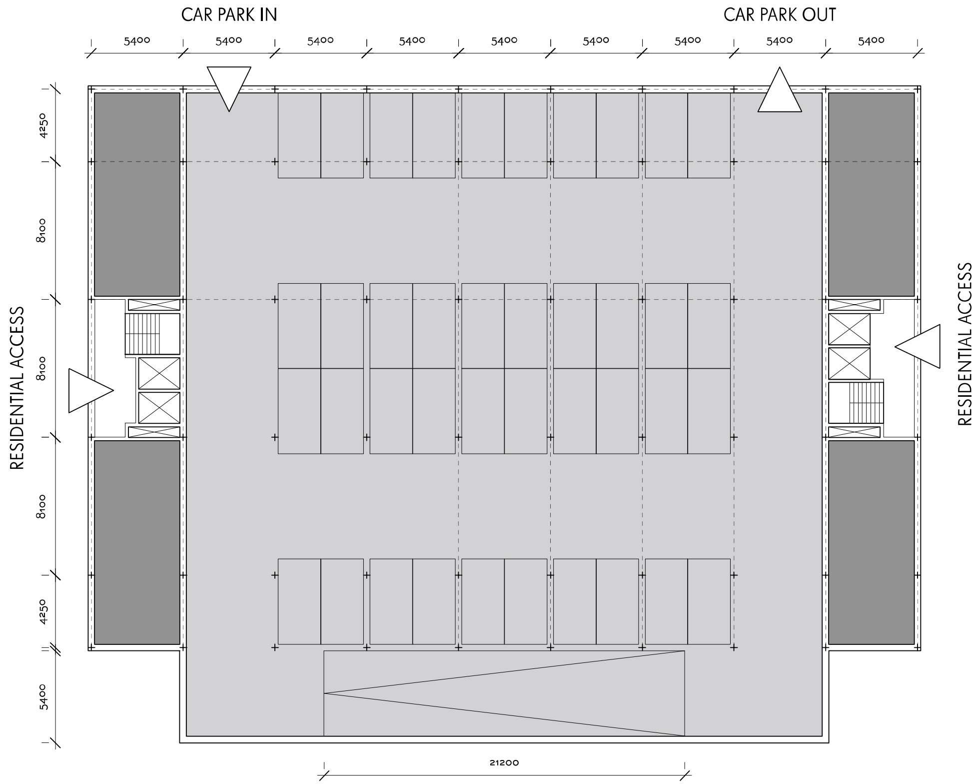
CONTINUOS CAR PARK FLOORS FOR + RESIDENTIAL ABOVE

FULL TIMBER STRUCTURE: REVERSIBLE / FUTURE PROOF ARCHITECTURE



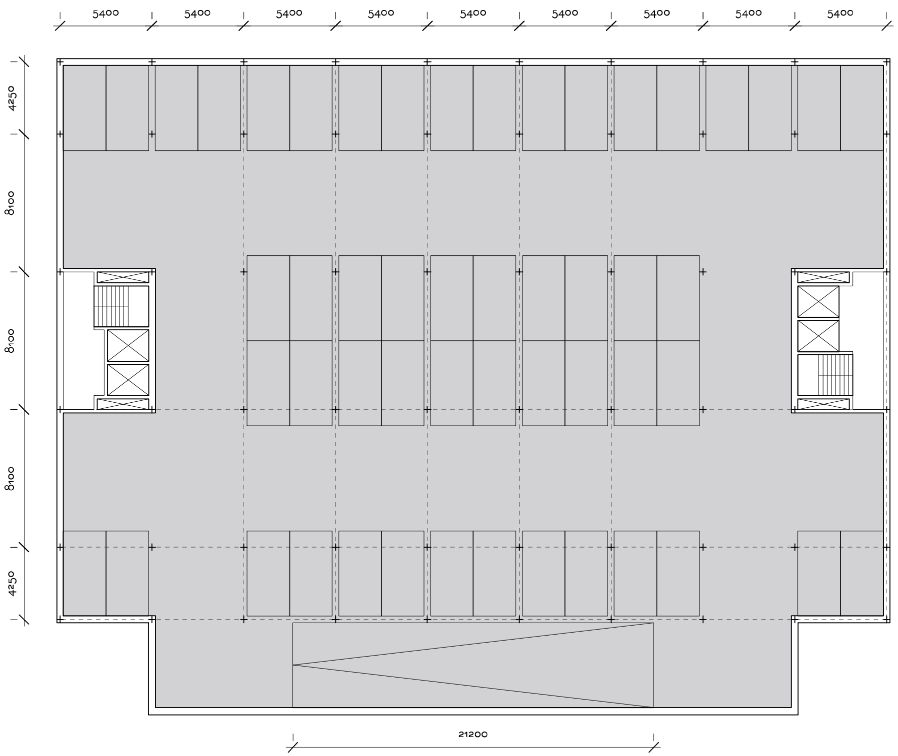
SITE INSERTION

GROUND FLOOR CARPARK



40 PARKING SPACES

TYPICAL CARPARK FLOOR

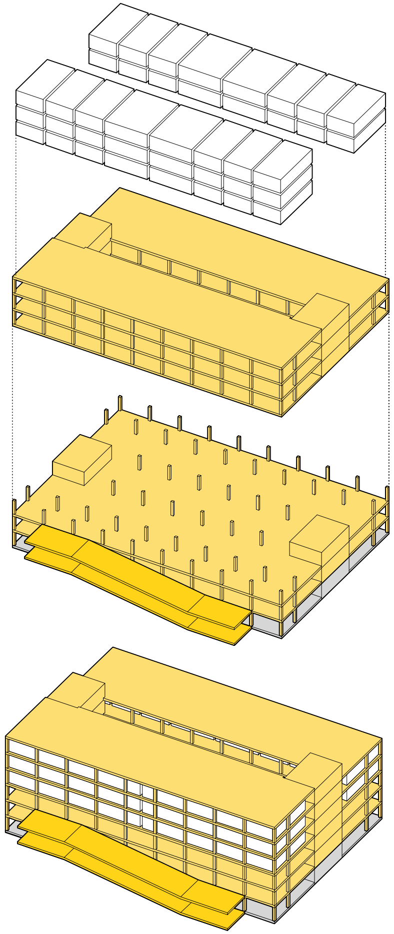


52 PARKING SPACES

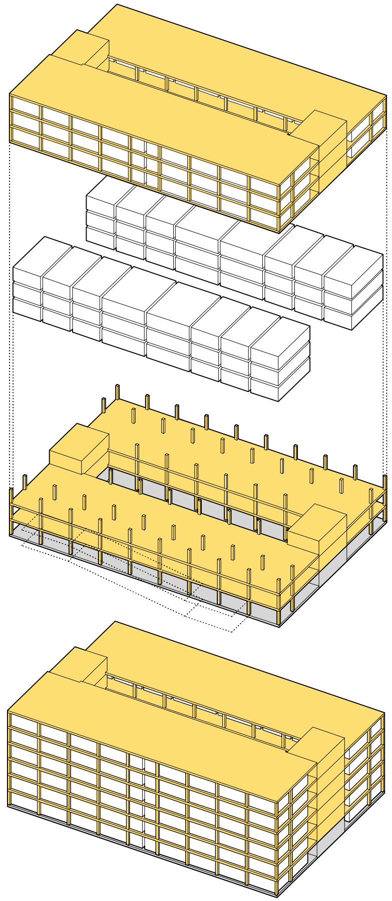
TYPICAL RESIDENTIAL FLOOR

16 HOUSED PER FLOOR

REVISED APPROACH: DEMOLITION OF EXISTING CARPARK - NEW MIXED USE STRUCTURE

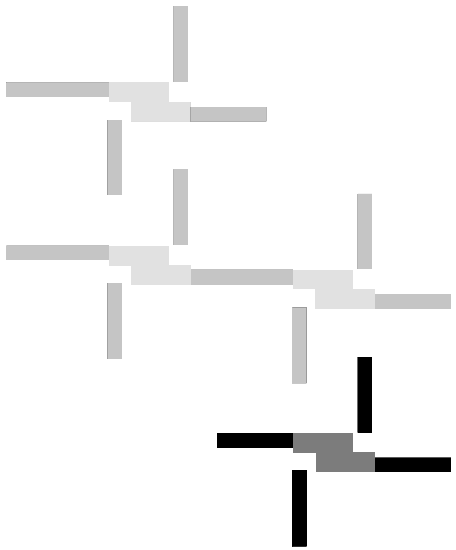


MIXED USE STRUCTURE (HOUSING + CARPARK)



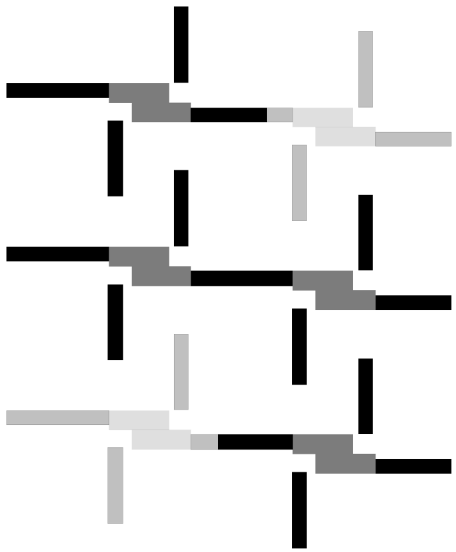
FURTURE FULL HOUSING CONVERSION

ANOTHER POSSIBLE APPROACH: EXTENDING THE SYSTEM RATHER THAN THE BUILDING



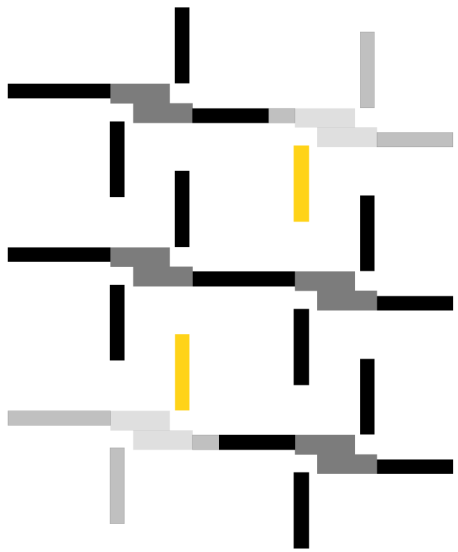
EXISTING ORGANISATION

Clusters of four linear blocks around a central car park space within the park



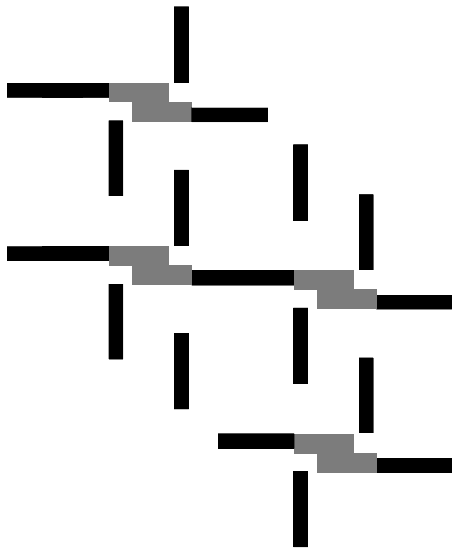
SYSTEMATIC LOGIC

Compositional approach understanding allows for infinite growing of the geometry



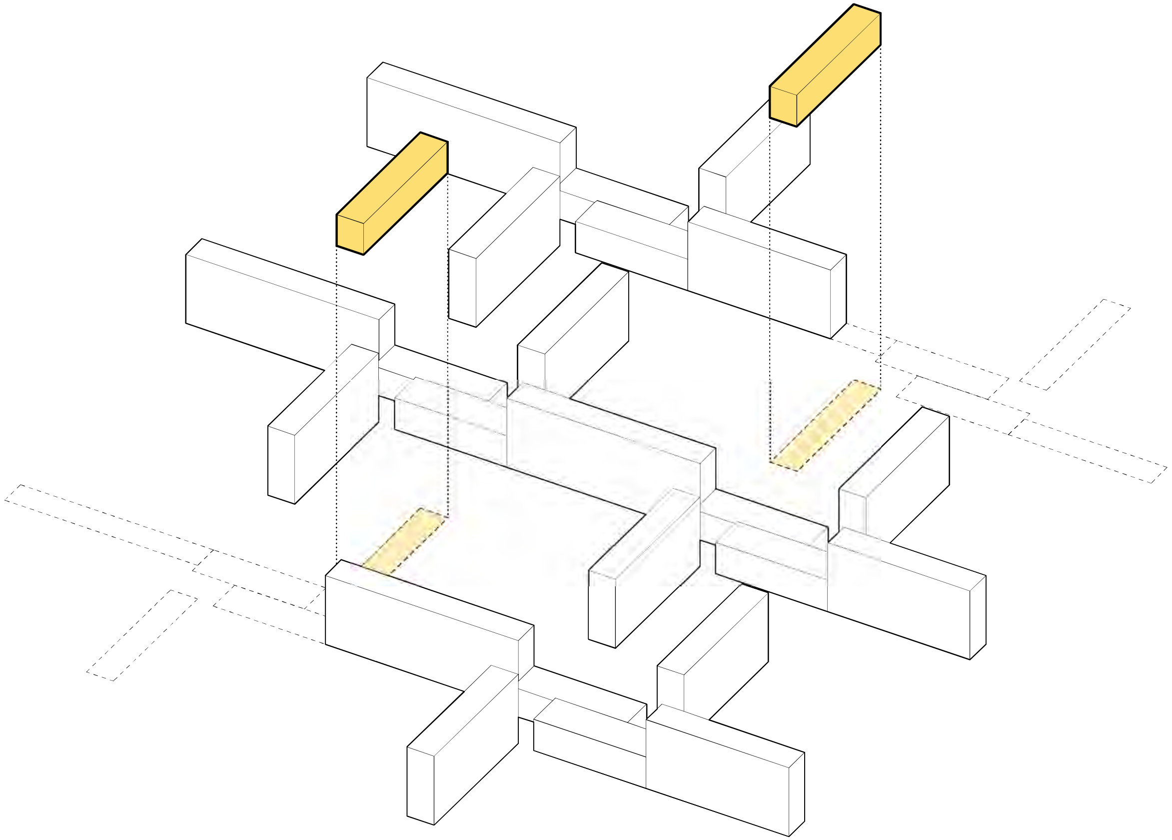
NEW BUILD

Retain the existing car park and propose new timber residential buildings within the park



INTEGRATION

An architectural dialogue between old a new systematic constructions approach can be established



NEW BULD TIMBER PAVILLIONS IN THE PARK

ANNEXES

ANNEX 01 - NL CONTEXT - HOUSING SHORTAGE AND CLIMATE POLICIES

HOUSING SHORTAGE

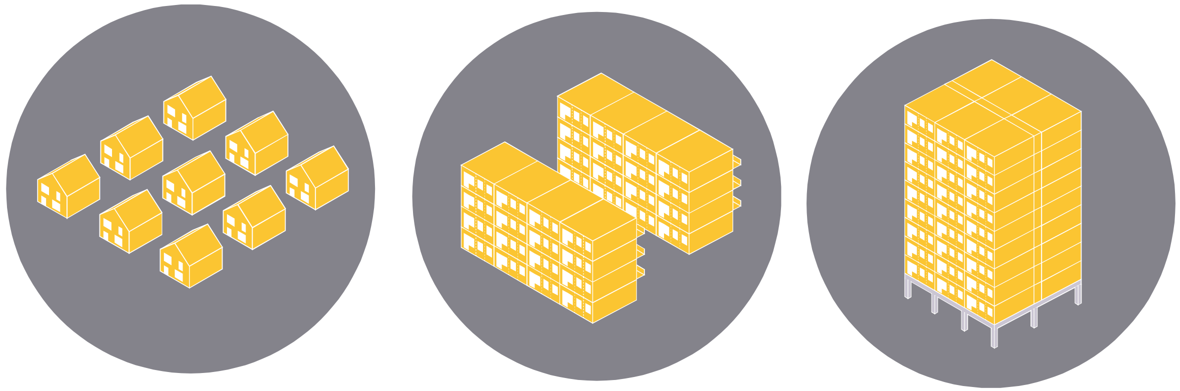
The Netherlands currently experiences a housing shortage of ca. 315,000 homes (3.2%), of which 64,160 in the Amsterdam Metropolitan Region (source).

According to estimations by ABN AMRO, taking into account population growth and an increasing percentage in single-person households, around 80,000 houses should be built every year for the next 10 years to respond to the projected demand, which is high in most parts of the country. Moreover, the Netherlands is expected to grow to 18.8 million inhabitants until 2035, translating into a demand for a total 845,000 additional homes for the 2020-2030 period.

CLIMATE POLICY

Through the Climate Act (May 28, 2019), the Dutch government aims to reach a 95% GhG emissions reduction by 2050 compared to the 1990s levels, with an interim goal of reacing a 49% reduction by 2030. The Climate Plan, the National Energy and Climate Plan (NECP) and the National Climate Agreement contain the policy and measures to achieve these climate goals. The latter includes targets for the reduction of 3.4 Mt of CO_2 in the built environment by 2030 compared to the reference scenario, as well as specific provisions for "enhancing carbon capture in the supply chain. The use of timber, cuttings and other natural products (cascading) in the supply chain that are produced as a result of the management of green spaces will increase carbon capture and will prevent carbon dioxide emissions as a result of the use of alternative building materials" (C4.5.2). The Dutch Government also has the ambition to be 50% circular by 2030, and fully circular by 2050. These plans were first released in 2016, after which concise reports were made on how to transition certain sectors of the economy towards circularity by 2030. These reports were called 'Transition Agendas', of which five have been written: Biomass & food, Plastics, Manufacturing industry, Built environment and Consumer goods.

(source: Urbasofia research)



NL: 80,000 HOUSES X YEAR FOR THE NEXT 10 YEARS TO RESPOND TO THE PROJECTED DEMAND

ANNEX 02 - NL CONTEXT - KEY DESIGN AND PERFORMANCE REQUIREMENTS

Space standards for new buildings:

Min. floor to ceiling height: 2600 mm (living/sleeping areas)
(2300 mm service spaces/bathrooms)

Min. floor area of 18 m2 x inhabitant.

Living and sleeping area to be > 55% of total accomodation surface (including sevice areas)

Min. living room area: 11 m2

Toilets/bathrooms min. spacial requirements:
-Toliet 0.9 m×1.2m (BB section 4.2)
- Bathroom: 1,6m^2, min. 0.8m wide (BB section 4.3)
- Bathroom with toilet: 2,2 m^2, min. 0.9m wide

Min. required storage space:
- Min. required storage space (BB section 4.5)
min. 5m^2 and 1,8m wide accessible from the site
- Min. required outdoor space (BB section 4.6)
min. 4m^2 and 1,5m wide
accessible from living/sleeping area

Note: the case of a residential unit with a usable area of not more than 50 m^2, the outdoor space may be communal if the floor area of outdoor space is at least 1 m^2 per residential function designated on that outdoor space, with a minimum of 4 m^2 and a width of at least 1.3 m. The outdoor space needs to be accessible directly from the house or via communal areas.

souce: Conix

Fire resistance requirements for residential buildings:

Fire resistance requirements mins:
5/8 storey = 90
> 8 = 120

Max number of storey/height = no limit

souce: www.bouwbesluitonline.nl

Parking spaces:

Car park provision ranges between 1 and 1.5 car park spaces per home depending on several factors.
A grid of 8.1 x 8.1 m is a standard option for organising car parks. It is good practice for the access ramps to be located within the volume of the buildings when the car park footprint is larger than the building.

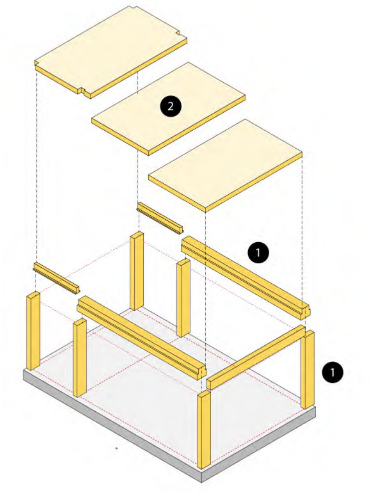
Minimum acoustic requirements for residential buildings:

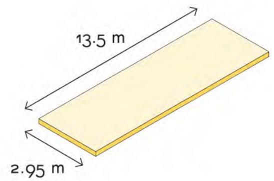
Impact sound: $L'_{nT,w}+C_I$ = ≤ 54 dB

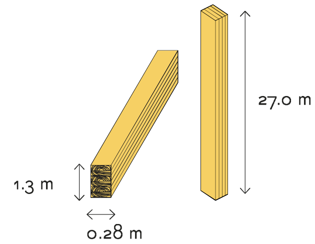
Airborne sound: R'_w+C = ≥ 52 dB

souce: www.bouwbesluitonline.nl

ANNEX 03 - BUILD-IN-WOOD STRUCTURE - KEY MATERIALS





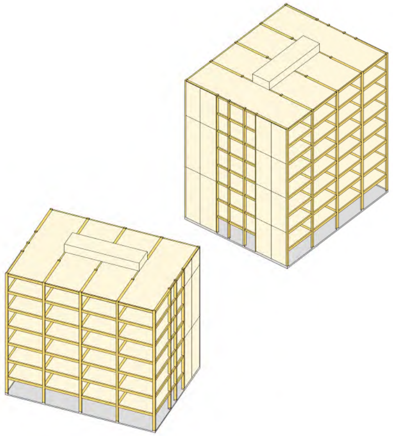


Cross laminated timber (CLT) panels are made from finger jointed sawn timber lengths that are combined to form composite layers arranged perpendicularly to each other to provide structural strength in two directions. CLT panels are available in a range of standard sizes that can be cut down to suit project specific parameters. Most manufacturers suggest designing to 2.95m x 13.5m as these are the most common stock sizes available, and most easy to transport. However, longer, wider lengths are available on request at a higher cost (the largest size panel currelty available on the market is 24.0m x 4.2m wide).

Glulam (GLT) beams and columns manufactured from layers of parallel timber lamellas bonded together with strong, moisture resistant adhesives (relatively small pieces of wood are graded for strength, and then their ends are finger-jointed into lamellas of the required length). Widths and depths of standard sized GLT elements are based on multiples of a lamella thickness (20 to 45mm); manufacturers tend to offer a quite wide range of standard sizes based on these multiples.

MATERIAL		COMPONENTS				FIRE	DURABILITY	
MATERIAL TYPE	BiW APPLICATION	TIMBER SPECIES AND STRENGHT	ADHESIVE TYPE (Kg/m2)	ADHESIVE PROPORTION (g/m2)	DENSITY (Kg/m3)	REACTION TO FIRE (untreated)	SERVICE CLASS	USE CLASSES
1 GLT (Glue Laminated Timber)	Beams and columns	Spruce, fir or pine. Occasionally larch, Douglas fir or even hardwoods GL24 to GL30 strength	MUF (preferred)* or PUR; rarely EPI and PRF (*) Preventing delamination	MUF between 250 and 300	Between 380 kg/m^3 and 500 kg/m^3 depending on type of wood and strenght class	D-s2, d0	Suitable for Service Classes SC1 (heated internal) SC2 (unheated internal) and SC3 (exterior condition)	Suitable for Use Classes UC2 or 3
2 CLT (Cross Laminated Timber)	Cores, shearwalls and floorplates	Spruce, fir; rarely pine, larch, Douglas fir C16 to C24 strength	PUR or MUF (preferred); rarely EPI	MUF btw. 250 and 300 PUR btw. 110 and 150 Note: Some products have glued board edges, and thereof contain more glue	Between 470 kg/m^3 (spruce) to 590 kg/m^3 (larch) at 12% MC (moisture content)	D-s2, d0	Suitable for Service Classes SC1 (heated internal) and SC2 (unheated internal)	Suitable for Use Classes UC1 or 2

ANNEX 04 - BUILD-IN-WOOD STRUCTURE - KIT OF PARTS COMPONENTS



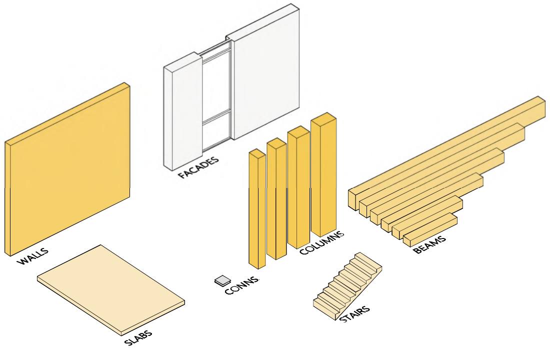
SCHAGEN - MUGGENBRUG ZUID

KIT OF PARTS FOR COMPONENTS COUNT (Site A)

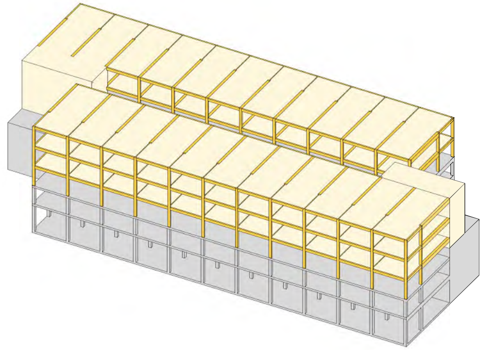
Approx 1950 m³ of CLT and glulam

Approx 133 m³ of timber per floor (for each building)

(full timber configuration)



KIT OF PARTS



AMSTERDAM - MOLENWIJK

KIT OF PARTS FOR COMPONENTS COUNT

Approx 980 m³ of CLT and glulam

Approx. 200 m³ of timber per floor

(full timber upwards extension 3+2 storey)

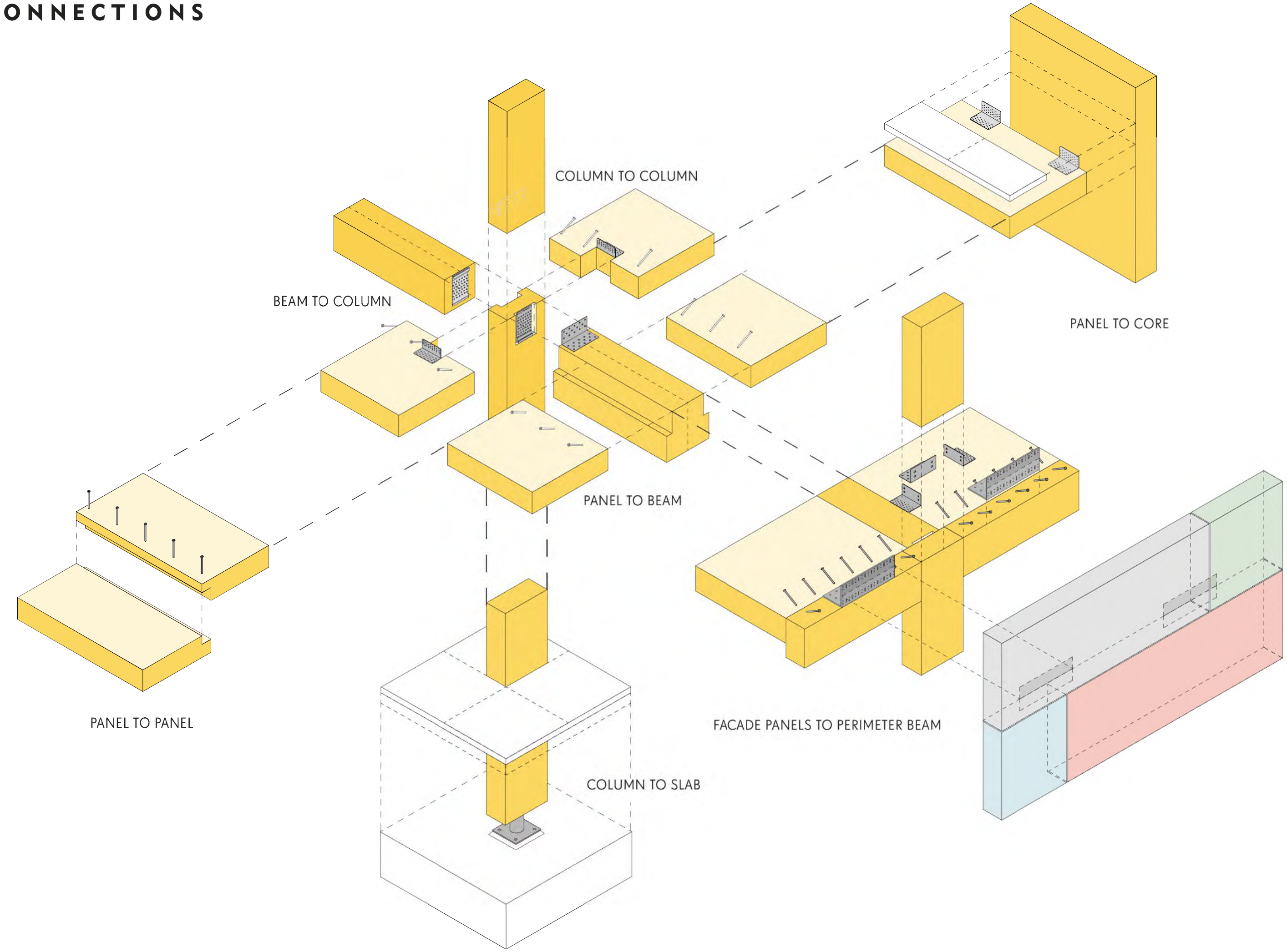
ANNEX 05 - COMPONENT CONNECTIONS

The Build-in-Wood consortium studied assembly details for key interfaces which predominantly use connectors and products that are widely available on the market from various different manufacturers.

The use of steel connections is unavoidable in timber buildings, but understanding how to simplify the approach to these connections has the potential to offer not only carbon but also cost savings on an engineered timber project and overall optimisation of building performance through the design of well detailed interfces. Aside from the development of this particularly complex connections node, the project aim has been to focus on the use of a minimal number of pre-existing certified connectors, and to clarify and illustrate how these products can be used.

COST AND ASSEMBLY PROCESS OPTIMISATION

Most of the connections are "off the shelf" products (nails, bolts, screws as well as brackets or specialist connections).
With regards to connections, specialist suppliers suggest allowing between 8%/12% (non-seismic areas) and 18 to 20% (seismic areas) of the timber supply price; furthermore, the price complex connections can range between 15% and 35% of timber volumetric costs.
Other possible optimisation areas for the timber assembly process are:
- dry jointing of components on site (if wet trades are avoided)
- making use of fewer and stronger joints (if time-consuming screw installation is kept off the critical path) to simplify and speed up the overall programme.



OVERVIEW OF THE KEY CONNECTIONS THAT ARE BEING USED THROUGHOUT THE SYSTEM

BUILD-IN-WOOD

ANNEX 06 - STABILITY STRUCTURE -CORES AND SHEAR WALLS

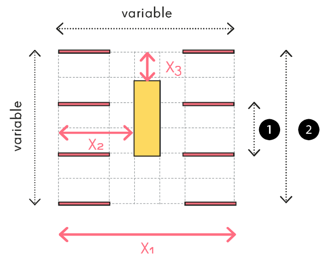
The extent of, and demands on, the stability structure of a given project are largely influenced by the buildings size, geometry and location, as each site will have different wind and seismic conditions.
In addition, fire regulations in several European countries specifically prohibit the use of combustible materials for the primary evacuation & egress routes in the event of a fire, meaning the stair cores cannot have an engineered timber structure. With this in mind the Build-in-Wood system is designed to allow for two material options for the cores; CLT or concrete.

CLT shear walls are usually deployed in conjunction with CLT cores (wherre possible) in 5 to 7 storey tall buildings providing a simple and cost-effective stability solution, however this solution is suitable only for buildings uses that do not require flexible, open-spaces e.g. residential, hotel type buildings.

Key design considerations: attention to placement of the core to avoid wind/seismic induced torsional forces. For the same reason shear walls must be place symmetrically in relation to the core or in a position that remove/reduce torsional loads to the core. Wall penetrations within the shear walls are restricted in size and position.

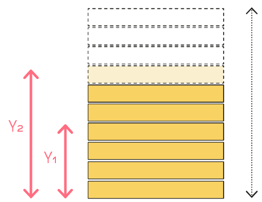
Advantages: maximise use of timber, cost effective and simple connections

Disadvantages: deployable only for building with many internal wall locations (residential, hotels etc.)



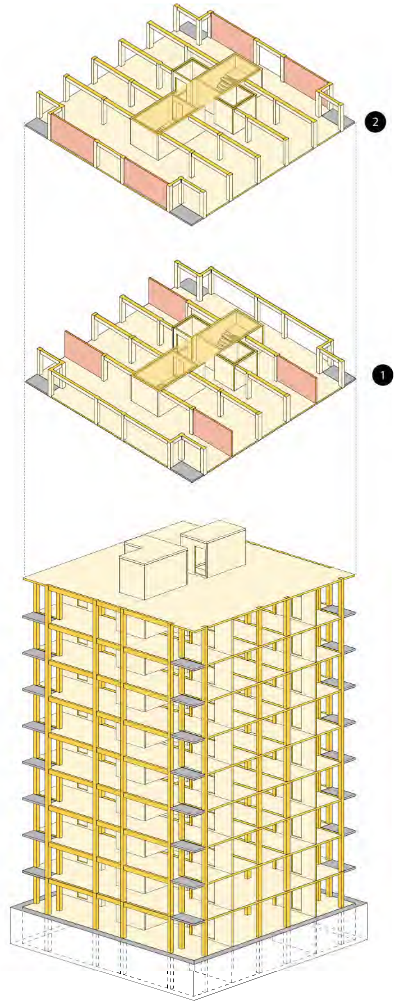
Note: X indicates critial dimension/s

TYPICAL PLAN WITH DIAGONALS POSITION HIGHLIGHTED SHEAR WALL POSITION IN RELATION TO CORE/S



Note: Y indicates critial dimension/s

TYPICAL BUILDING SECTION



TYPICAL RESIDENTAIL TOWER BLOCK WITH HIGHLIGHTED CORE AND SHEAR WALL CONFIGUHATIONS

ANNEX 07 - ACOUSTICS: FLOOR BUILDUPS

The principles for mitigating sound transmission are well tested and documented for concrete buildings, however these same principles and calculation methods are not appropriate to mass timber buildings. In fact, a consequence of the lightweight nature of timber is that it performs quite differently to conventional heavy masonry structures in terms of sound transmission.

This acoustic uncertainty is most relevant to the impact sound insulative performance of floors, which has consequently been a key focus of the consortiums attention.

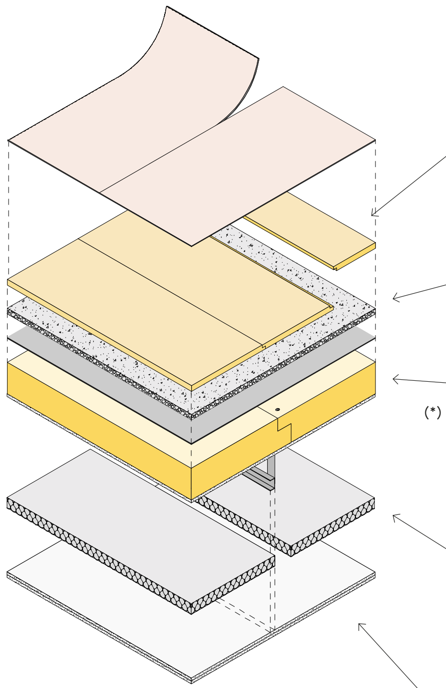
Build-in-Wood has developed solutions to achieve various levels of acoustic performance; these solutions achieve the necessary performance by also prioritising:
- use of 'dry' products which remove the need for wet trades
- de-mountability for better end of life prospects, e.g. preference for mechanical fixings which can be taken apart over the use of adhesives
- use of nature-based materials and products or those with the lowest embodied carbon
- use of lightweight solutions where possible to allow for material efficiency of the structure.

NL minimum acoustic requirements for residential buildings:

Impact sound: $L'_{nT,w}+C_I$ = ≤ 54 dB

Airborne sound: R'_w+C = ≥ 52 dB

souce: www.bouwbesluitonline.nl



EXPODED VIEW OF A TYPICAL RESIDENTIAL FLOOR BUILDUP WITH HIGLIGTED COMPONETS AND ACOUSTIC IMPROVEMENT X COMPONENT

DRY SCREED BOARDS (MECH. FIXED)

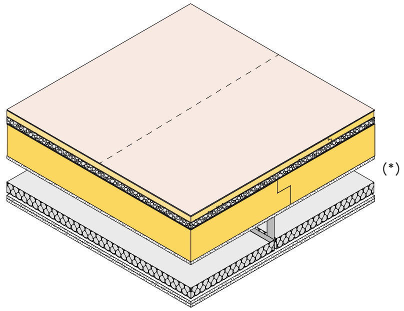
GRAVEL/ GRIT OVER DECOUPLING MAT

CLT FLOOR SLABS

MINERAL WOOL INSULATION

SUSPENDED CEILINGS

TYPICAL BUILD-IN-WOOD FLOOR BUILDUP ACHIEVING REQUIRED PERFORMANCE



54 dB IMPACT / 52 dB AIRBORNE

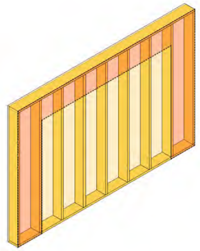
floor finish varies
20 mm dry screed
40 (min.) mm grit
trickle protection sheet
140 mm (min.) CLT slab
void
2x80 (min.) mineral wool insulation
20 mm (min.) plasterboard ceiling system

(*) Additonal Plasterboard panel only for fire protection, no acoustic performance

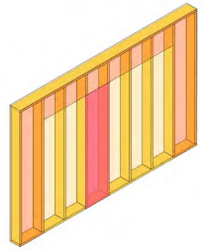
ANNEX 08 - NON STRUCTURAL FACADE PANELS

The Build-in-Wood facade system has been designed for use in conjunction with a Build-in-Wood structural frame. The core of the facade system comprises an LVL frame designed to distribute wind load and the panels own self weight back to the buildings primary structure, without excessive material use.
The panel sizes proposed correlate to the bay width and floor to floor heights of the Build-in-Wood structural system. Structural calculations for the different panel sizes and different wind loads, showed minimal variation in the required post sizes. These findings led to the systems use of a fixed post size suitable for all scenarios. By Fixing the post size and setting out for the sub-structural frame irrespective of wind load or panel size,a single set of detailed rules for the location and size of openings has been established for any situation.
Posts are set out at, or slightly below, 600mm centres so that they are equally spaced across the panels width; full flexibility is provided for the horizontal location of openings as long as a solid portion of panel is maintained either side of the opening containing two regularly spaced posts. There is also no limit on the number of openings across the width of any given panel as long as an additional equivalent solid piece of panel (approximately 600mm) is maintained in between each subsequent opening.

THE USE OF NON STRUCTURAL FACADE PANELS ALLOWS TO EASILY ACTIVATE THE STREET FRONTAGE OF RESIDENTAIL OR MIXED USED BUILDINGS



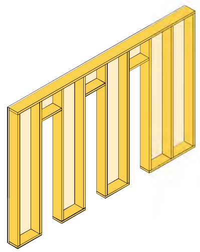
MINUMUM OPENING SURROUND



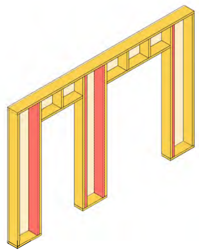
MINUMUM OPENING SPACING

LOCATION OF OPENINGS

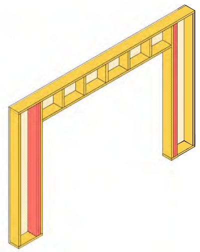
There is full flexibility for the location of openings so long as a solid portion of panel, min 500mm deep, is maintained across the top of the opening and a solid portion of panel, as a minimum correlating to the width of two typically spaced vertical posts (circa. 600mm), is maintained on either side of the optening.



OPENINGS < / = POST SPACING
no additional posts needed



OPENINGS 2 or 3 x POST SPACING
+ 1 post either side of opening



OPENINGS > / = 4 x POST SPACING
+ 2 posts either side of opening

SIZE & NUMBER OF OPENINGS

There is also full flexibility as to the number and size of openings possible within the constraints outlined above however large openings have additional requirements.

ANNEX 09 - CONSIDERATIONS ON CLADDING

The choice of material and setting out of cladding is a unique aspect of every building, consequently the Build-in-Wood facade system aims to offer as much flexibility with regards to cladding as is possible.

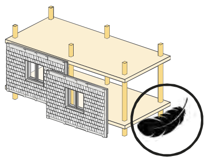
However, the focus of the research has been to incorporate cladding materials whose properties align with the requirements for off-site installation.

The Build-in-Wood facade system aims to mitigate the need for scaffolding on site, meaning the panels would ideally arrive to site fully externally finished, and are connected back to the main structure from inside the building.

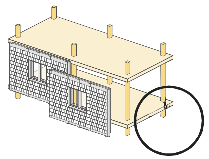
This means the cladding materials chosen must have certain qualities which lend themselves to prefabrication, transportation and installation on site. The cladding materials recommended for the Build-in-Wood system are therefore light weight and robust at the same time (see cladding solutions to the right).

Consideration of the cladding support system is also required to ensure it can withstand the movements and deflections of the panels during transportation and installation, and similarly the fixings must also tolerate these movements without causing damage. The setting out and detailing of the cladding elements is particularly critical at panel interfaces where consideration should be given as to how to allow movement between panels whilst also achieving the cladding alignment required from a design perspective.

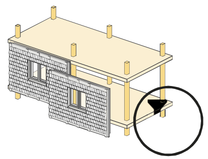
It is also possible to use any traditional site installed cladding system, such as brickwork, however it must be understood that in these situations scaffolding will still be required.
The Build-in-Wood facade system can still offer advantages in these scenarios such as quickly making the building watertight through installation of the panels themselves allowing internal fit out and first fix to commence alongside the brickwork erection.



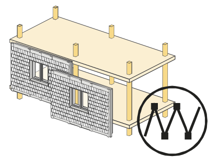
WEIGHT
- The weight of the material affects whether it can be installed in the factory, light weight materials are considered for Build-in-Wood to facilitate fully factory finished panels
- The weight of the panels for transport and lifting on site must also be considered



ROBUSTNESS
- Robust materials are require to allow for offsite construction and transportation of the panels without damage
- Installation of the panels on site also requires a robust material to prevent damage

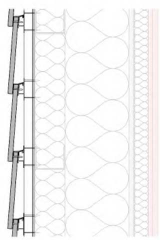


FIXINGS
- The cladding support system can affect whether it can be installed on site, robust battens provide better security than some brackets
- The fixings themselves must be robust for transport and installation, the use of glue as a fixing should be avoided

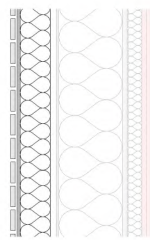


MOVEMENT ALLOWANCE
- It is important to install sufficient movement joints or leave gaps in the cladding which allow for differential movement at the joints between panels

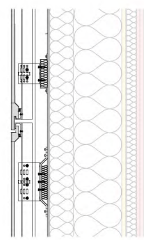
CLADDING AND DFMA - KEY JUDGMENT CRITERIA



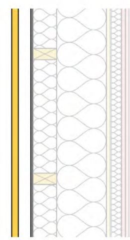
OPTION A:
CLAY TILES CLADDING



OPTION B:
BRICK SLIPS



OPTION C:
GRC SHEETS



OPTION D:
TIMBER CLADDING

CLADDING SOLUTIONS

ANNEX 10A - CONSIDERATION ON FIRE: CHARRING AND DELAMINATION

A thorough understanding of fire engineering is fundamental in achieving fire safety and asset retention on any project, irrespective of the materials used.

Large format pieces of mass timber do not easily catch fire, and so are unlikely to be the source of a fire. However, timber will burn when exposed to a fire of sufficient intensity, which must be acknowledged within the design. Timber begins to char at around 300 degrees celsius, this process is predictable, converting approximately 0.7mm of timber mass into char for each minute of sustained exposure to this level of heat. This means that designing an element to achieve a set period of resistance to fire can be accommodated through oversizing the component by the amount that it is calculated to be affected by the fire within the timeframe.

Widely accepted methods for calculating the thickness of charring layers are available in Eurocode 5 which also take into account the initial accelerated burning at first ignition of a mass timber element. These methods have been used to size the Build-in-Wood component char layers for different fire resistant periods.

When calculating the thickness of char layers it is also essential to understand how many, if any, glue lines will be located within the layer which is set to char as well as the type of glue that will be used to bond the layers. There are broadly speaking two types of glue used in the manufacture of engineered timber products; thermosetting and non-thermosetting glues. Testing within the industry has identified instances of failure of the glue bonding between lamellas on exposure to heat where non-thermosetting glues have been used in the manufacture of the product. This is reffered to as delamination or fall off and results in the residual portion of the outer lamella falling away and exposing the lamella beneath. The layer of char that forms as timber burns insulates the timber beneath slowing the rate of combustion. Delamination removes this insulative layer exposing the 'fresh' timber beneath and temporarily accelerating the burn rate.

This means that where a charring layer is calculated to include one or more glue lines of a product manufactured using non-thermosetting glue, the thickness of the layer must be increased to take this into account; accelerated burning following delamination can increase a fire's intensity and in some instances has been shown to result in a second 'flashover'.

Given that the heat from a fire can travel deeper into the thickness of a mass timber element than the portion which is visibly charring, a glue line behind the charring layer also has the potential to be influenced by the heat from a fire.

Complete failure or de-bonding of a glue line resulting in detachment is unlikely within the residual section. However, heat radiating into the timber could lead to a partial reduction of bonding strength with consequent structural implications. This phenomenon is currently difficult to predict.

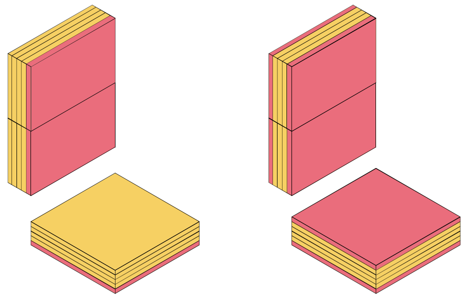
Build-in-Wood recommends the specification and use of mass timber products manufactured only using thermosetting glues as a robust approch to mitigate each of these issues. Not all manufacturers currently use thermosetting glues, but in time this is anticipated to become the industry standard.

Fire resistance requirements for residential buildings:

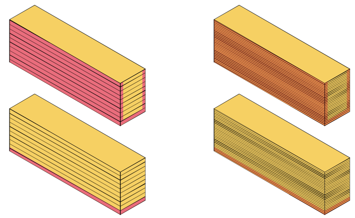
Fire resistance requirements mins:
5/8 storey = 90
> 8 = 120

Max number of storey/height = no limit

souce: www.bouwbesluitonline.nl



CLT SLABS AND WALLS



BEAMS

CHARRING LAYERS

The char layer is the added thickness of a timber component which exceeds the required structural dimensions, designed to protect the timber components in case of fire.

ANNEX 10B - CONSIDERATIONS ON FIRE: COMPARTMENTATION

It is important to understand and take into account that when timber burns it contributes to a fire, this makes timber different from concrete and steel which although far less predictable in a fire, do not contribute to a fires intensity or burn-time. The intensity and period for which a fire burns is influenced by the combustible elements available for it to use as fuel, referred to as the fire load.

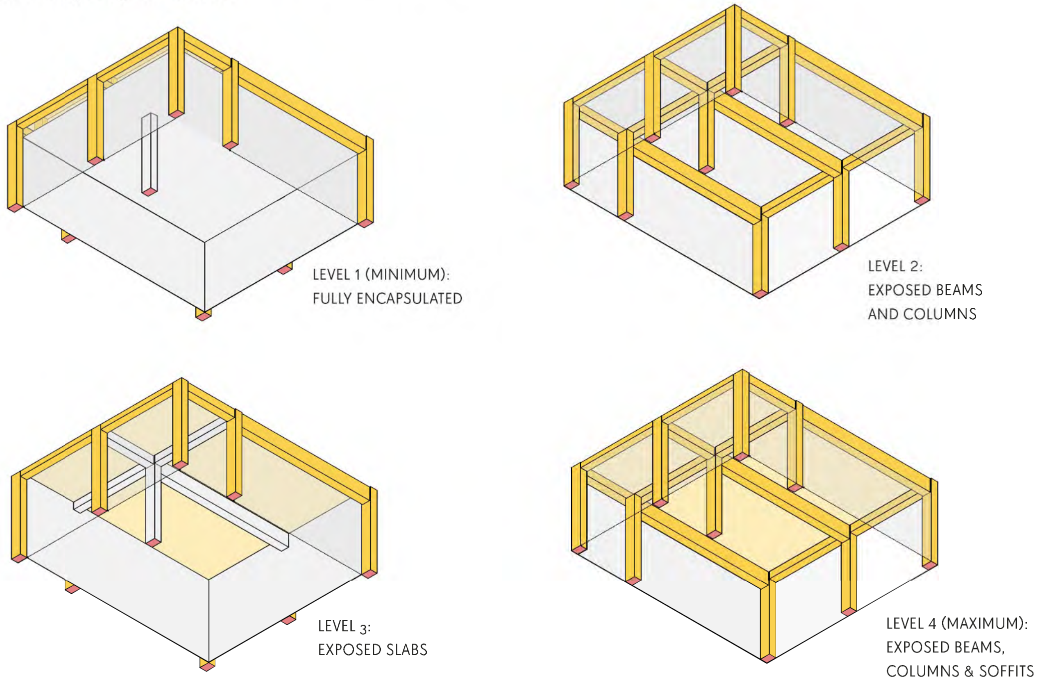
Buildings are designed as a series of fire compartments which are spaces whose surrounding walls and floors are of fire resisting construction to prevent the spread of fire to or from adjacent compartments within a set time period. The size, configuration and contents of the compartment where a fire originates governs the development and intensity of the fire for the duration of the resistance period. An understanding of the typical contents of residential and commercial buildings, has informed accepted standard fire loads which vary by compartment size and building use.

Build-in-Wood has undertaken analysis comparing this assumed baseline fire load with the additional load provided by different exposed timber surfaces. Compartment sizes between 90 and 700 m2, as well as residential and commercial use scenarios have been explored.
Four different exposure levels, increasing in fire load contribution, have also been considered as follows:

- Level 1 - fully encapsulated
- Level 2 - exposed beams and columns
- Level 3 - exposed soffits
- Level 4 - fully exposed

The longer the fire resistance period the greater the volume of timber that contributes to the fire load will be, as such different resistance periods have also been considered.

The additional fire-load from the exposed structure is calculated both as an absolute value and as a percentage of the baseline assumed fire-load for the compartment.
Given the high degree of variability in compartment configurations, as well as factors which can influence both the fire risk and user profiles, it is not appropriate to explicitly advise the amount of timber that it is safe to expose within the Build-in-Wood system.
Instead the scenarios outlined here should be used to begin a discussion within the project design team, in order for the fire engineer (the involvement of this expertise is fundamental form early stage of any timber project) to determine a safe approach in the specific project circumstances, that aligns with the design aspirations for exposing the material.



ENCAPSULATION LEVELS

ANNEX 11 - DESIGN FOR DURABILITY

Historic timber buildings illustrate the potential for timber to match, if not exceed, the life span of conventional construction materials. However, the key to ensuring longevity of timber is in preventing the moisture content from exceeding the factory level of around 12% for any extended period. If the timber has been exposed to a leak or water damage it must be dried - by exposure to adequate ventilation - and assessed for repair; this can typically be done using locally sourced timber products.

GROUND INTERFACES

Timber elements must not have contact with the ground and should be raised on upstands or other structural elements to a minimum of 150mm above the final finished floor level.

WATER MANAGEMENT DURING CONSTRUCTION

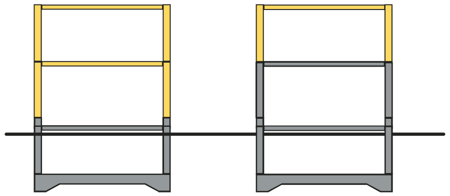
Particular attention needs to be invested to ensure the timber is not wet when the building is made weather tight. Prior to this, design must also be used to keep the timber away from moisture sources, and to ensure that any defects or damage which might expose the structure to water can be quickly and easily identified and rectified.

ROOFS

Roofs must be designed to prevent water sitting on the timber during construction or on failure of a waterproofing membrane, meaning the structure itself must be sloped. The greater the fall/pitch the lower the risk of water pooling when determining the direction of falls/ pitches, consideration needs to be given to avoid draining towards key timber structural elements such as the core, to further prevent water damage to such structurally vital areas.

WET AREAS

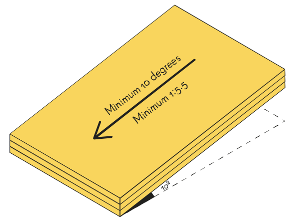
Kitchens and bathrooms should be lined with a wet room tanking membrane; applied to all low level areas, this prevents possible damage from dripping taps or leaks. Full height tanking should be applied to areas of heavy exposure such as showers and baths. Extra protection can be added to areas such as bathrooms by designing them as wet rooms and providing them with moisture sensors that allow to detect water-leaks in real time.

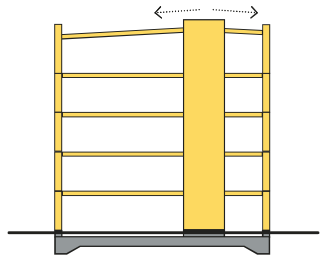


Upstands
Ground floor slab
Basement walls
Basement floor slab
Foundations

Ground floor columns (PODIUM)
Ground floor slab
Basement walls
Basement floor slab
Foundations

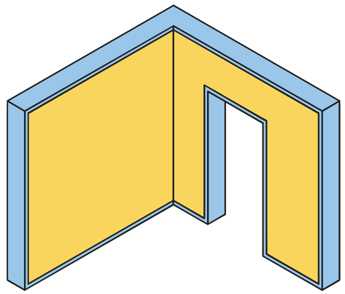
DESIGN PRINCIPLE FOR GROUD INTERFACES





'Flat' roofs should be laid to minimal falls with the water encouraged away from vital timber structural elements. Temporary drains through parapet are required during construction.

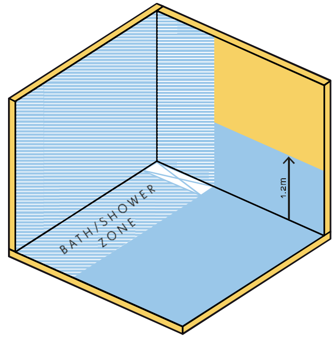
DESIGN PRINCIPLE FOR CLT ROOF PANELS



Area of CLT to be covered with coloured end grain sealer

WATER MANAGEMENT DURING CONSTRUCTION

The use of grain sealant and waterproof grouts is particularly important where the end grain is exposed (e.g. edges/ends of elements and connections) as this is where the material has the greatest hygroscopic action.



Area of CLT to be covered with robust waterproofing layer
Bath/shower zone
Gullies are recommended for additional protection

WET AREAS WATER MANAGEMENT (IN USE)

In addition to the above outlined de-risking strategies moisture sensors could be in-built in crritical areas to allow real-time monitoring of the wet areas and detect leaks early.

ANNEX 12 - THE WET AREAS CONCEPT

WET AREAS

The Build-in-Wood structural system has been designed to accommodate the integration of proprietary volumetric modular wet boxes for bathrooms and kitchens. These spaces often require a substantial amount of time to complete on site due to the complexity and the extent of services and finishes. This also means that the potential for defects and poor quality workmanship increases. As do the risks associated with the presence of plumbing which, if defective can lead to a risk of moisture damage which is of particular concern in a timber building.

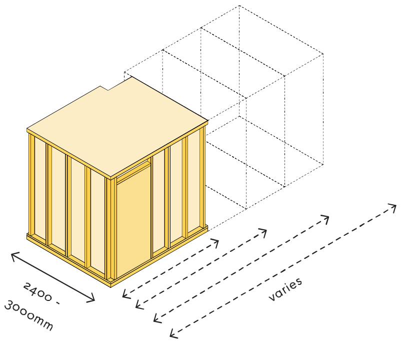
By using off-site assembled modular wet boxes for these spaces, a more accurate and higher quality can be achieved whilst also having the potential to drastically reduce the time and number of trades people on site. There are various manufacturers of such modular products however the Build-in-Wood system focuses on the integration of modules which use a timber frame and CLT structure that aligns with the aims of the project.

See also the "Design for Durability" annex: Design Principles for Wet Areas in particular.

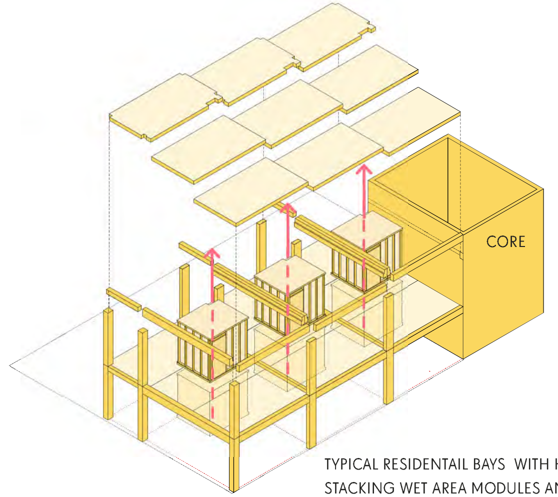
VERTICAL SERVICES DISTRIBUTION

In residential type buildings services are distributed vertically through risers which are usually part of the building cores. These services distribution routes must be designed in the correct number and size and identified at an early design stage to avoid clashes with the main structure; it is advisable to slightly oversize them to future-proof the building allowing it to cope with refurbishments or extensions to come.

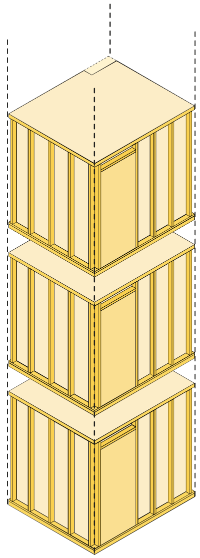
Attention needs also to be given to the positioning of riser access points which should ideally be placed in common/easily accessible areas. Furthermore, if foreseen as part of the fire strategy, smoke extraction shafts are very important in the planning of vertical pipe zones as they usually require a large amount of space (size increases proportionally to building footprint and height) and cannot host anything else.



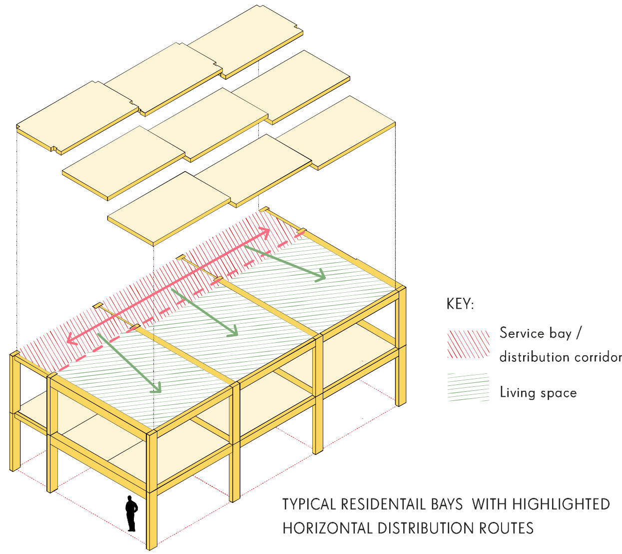
TYPICAL BATHROOM POD DIMENSIONS



TYPICAL RESIDENTAIL BAYS WITH HIGHLIGHTED STACKING WET AREA MODULES AND VERTICAL DRAINAGE RUNS

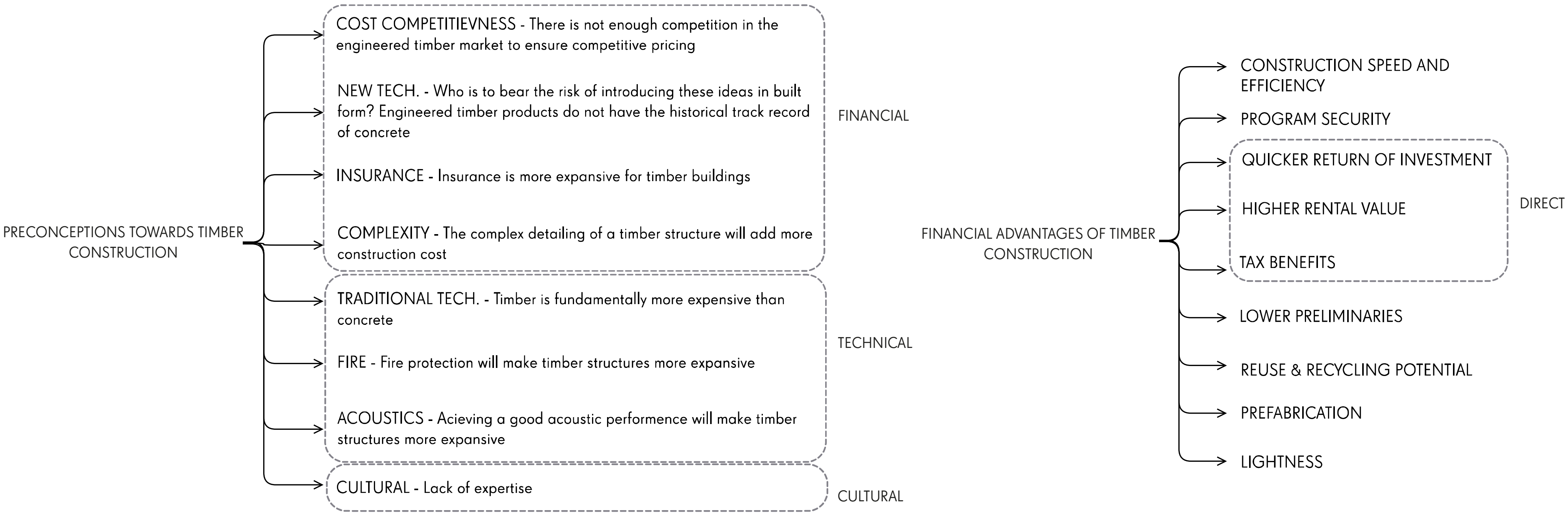


STACKING PRINCIPLE



TYPICAL RESIDENTAIL BAYS WITH HIGHLIGHTED HORIZONTAL DISTRIBUTION ROUTES

ANNEX 13 - ECONOMIC SUSTAINABILITY OVERVIEW



ANNEX 13A - ECONOMIC SUSTAINABILITY - DETAIL VIEW

TAX CREDITS
- Potential of future carbon tax avoidance
- CO_2 storage tax credits (carbon sink) potentially applicable
- Renewable material tax credits potentially applicable

CONSTRUCTION SPEED AND EFFICIENCY
- Earlier completion enables earlier sales, consequent earlier loan repayment saving larger interest payments (ref. to ROI)
- High installation rate (install. speeds depends on design complexity, component sizes, building type, climactic conditions, number of cranes and prefab. level)
- Follow-on trades can start immediately (no props or curing time) floors are readily stable and load-bearing (ref. to in-situ concrete scenario)
- Less on-site time means: lower overall wages, lower insurance premiumm, lower hiring times for crenes and equipment
- Efficiency form this point of view means using less manpower x sqm of construction

PREFABRICATION
- Fast building assembly
- Design fully coordinated upfront
- No site adjustments needed
- Less on-site deliveries
- Less material storage areas needed (on-time delivery)
- Less waste production on-site
- Less infrastructure on-site needed
- Offsite quality control - better component performance and precision, min. interfaces tolerance

LOWER PRELIMINARIES
- Potentail to avoid use of scaffolding
- Smaller site accomodation (smaller crew)
- Material storage agreas can be reduced thanks to high level of prefabrication and on-time delivery
- Smaller/less cranes (moveable cranes mean site logistics optimisation)
- Quick lifting of light, fully prefab. components
- Potentailly pre-installed/formed edge protections

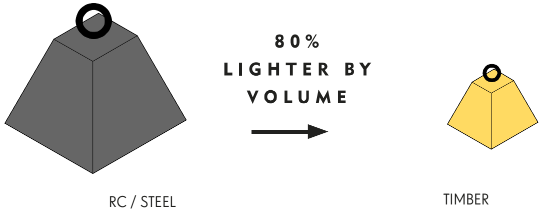
ANNEX 13B - FOCUS ON LIGHTNESS

Timber is 1/5 of the weight of reinforced concrete (average density of timber is approximately 500kg/m3 for Glulam and CLT LVL whilst RC has an approximate density of 2500kg/m3).
The bulk density (gross building volume divided by its dead load) of a typical concrete multi-storey building is approximately 300 kg/m3 (Yang et al., 2004); a conventional steel building with concrete decking has a bulk density of approx. 160 kg/m3 (Huang et al., 2007) whilst a timber building would have a bulk density of between 110kg/m3 and ~79 kg/m3 (structure only, not counting the conc. toppings)

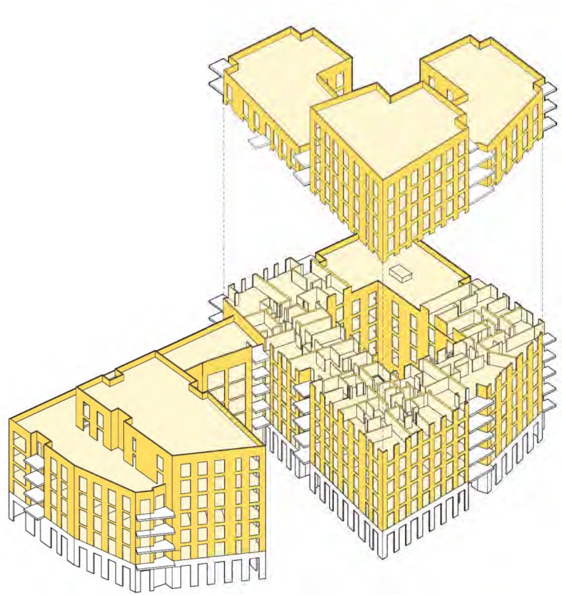
LESS WEIGHT - MORE BUILDING
When it comes to reusing existing structures, if new capacity is to be added by partial demolition and extension, without finding additional capacity in the underlying structure, then the new construction/extension must be significantly lighter than the original. In simple words, in the case of extension without previous demolition, where excess strength in the existing structure is found or engineered, a lighter construction form allows for larger extension within that margin of capacity.

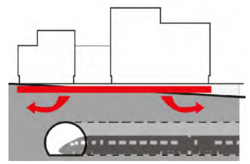
In some cases, there are obstacles to building developments such as limitations on loading due to underlying infrastructure (e.g., tunnels or sewers etc.) or buried structures that must remain undisturbed for archaeological reasons; the mere proximity to sensitive infrastructure or buildings that have low tolerance to ground movements can make a project unviable. In all these cases, lightweight timber buildings and extensions can enable development where heavier conventional building constructions would not.

LESS WEIGHT - SMALLER FOUNDATIONS
Projects making use of an engineered timber structure are 30-50% lighter than the same design in concrete (WS TDG 51,2020); this may result in significant reductions in the size and depth of the foundations (depending on the soil conditions on site).

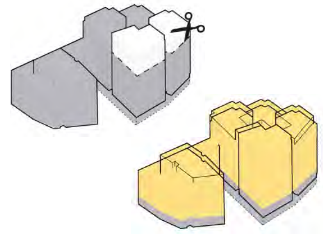


LIGTNESS OF TIMBER COMPARED WITH TRADITIONAL MATERIALS





USE OF RAFT FOUNDATIONS: SITE UNLOCKING

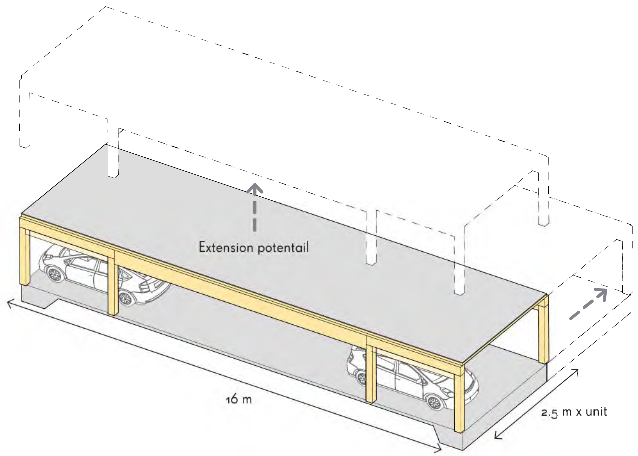


25% MORE HOMES

DALSTON WORKS: THE ADVANTAGES OF LIGHTNESS
Dalston Works is the world's largest cross laminated timber building: 121 nomes over 5-10 storeys

ANNEX 14 -ENGINEERED TIMBER CARPARKS

Overground, open multi-storey car parks are generally built using a kit of parts based on a hybrid set if component: posts and beams made in Glulam or LVL, and either prefab. RC or CLT/mastic asphalt floor panels.
To meet the needs of the car park users, each parking bay measures 2.5 x 5/5.2 m (base parking module) whilst the driveways are min. 5 to 6 m wide. Parking modules can be arranged next to each other to form parking decks of any length. These simple, modular, highly repetitive structures allows for the future additions of levels (depending on structural member sizes) and horizontal extensions or size reductions.
The relatively narrow depth of rectilinear carpark configurations (approx. 16 m) might allow to re-use the structure to host residential or commercial spaces (provided a floor to ceiling compatible with residential standards is provided).



TYPICAL PARKING BAY - EXTENSION POTENTIAL

ENGINEERED TIMBER CARPARKS - KEY PROJECTS IN EUROPE

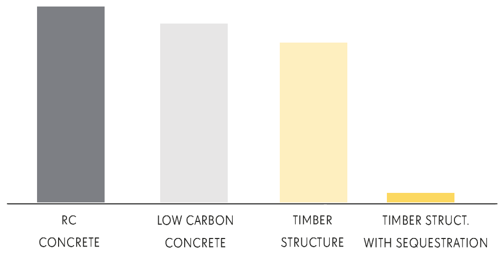
ANNEX 15 -EARLY STAGE LCA : DATA DRIVEN CHOICE

As awareness of the significance of embodied carbon raises, the ability to undertake high level life cycle analysis at early stages to inform design decisions is becoming relevant and essential, in the same way that passive design principles and building regulations have been informing the design process to reduce future operational carbon emissions for years.

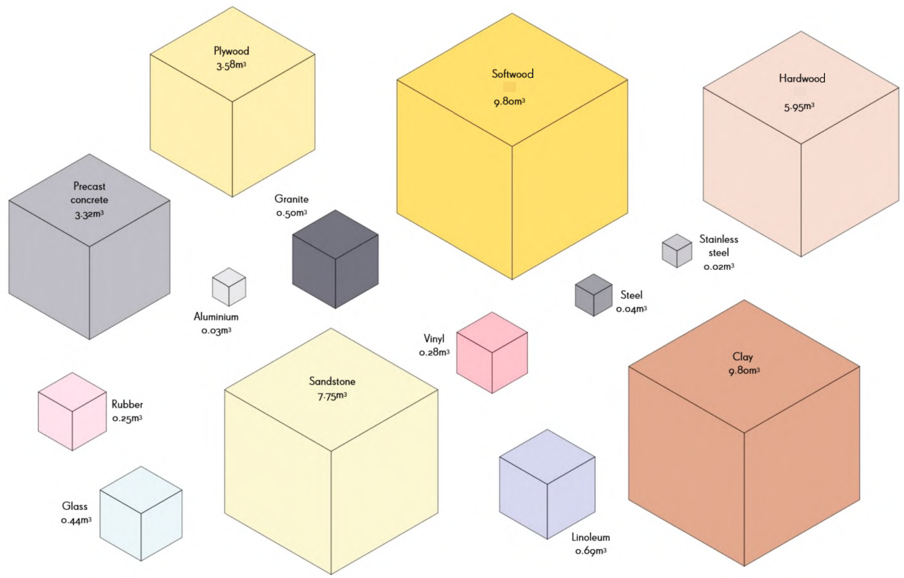
Understanding that all virgin materials have a carbon cost associated with their extraction/harvesting, processing and then delivery/installation is the starting point to understanding how we can reduce the embodied carbon of our buildings. Re-using existing buildings, through retrofit, and following that re-using materials/components in new projects will keep emissions at their lowest practical level, but at present the availability of materials for re-use is minimal. As such an understanding of the carbon cost of different material options, understanding whether recycled materials are available for each and how their embodied carbon compares, whilst also considering the quantity of material and its respective maintenance and lifespan can ensure that a holistically low embodied carbon solution is selected.

In the Build-in-Wood project our primary focus has been on substituting the material for the buildings primary structure, from carbon intensive concrete and steel to low carbon wood. Given the volume of material in the primary structure this is a logical place to start but also does not negate the requirement for consideration of material choices in other areas of the buildings design, which must also be considered through early stage LCA of the full building or specific aspects (such as the façade).

Using a lightweight material such as timber and striving for material efficiency also allows other knock on embodied carbon savings due to reductions in material volumes particularly for carbon intensive aspects such as foundations. Whilst timber stores carbon which contributes towards a new urban carbon store, this should never be used to justify unnecessary and redundant material use to offset other carbon intensive materials elsewhere in the building. For this reason we advocate following an embodied carbon target approach like that of LETI, which excludes the consideration of sequestration for the initial embodied carbon target, instead considering and quoting this separately as an additional benefit once the embodied carbon has been driven to the lowest practically achievable amount.



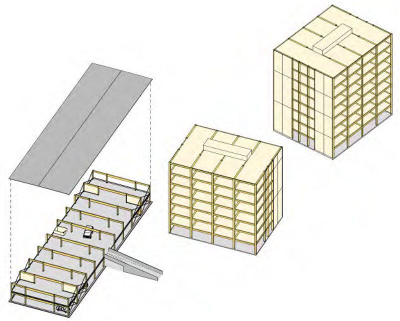
EMBODIED CARBON OF BUILDINGS WITH DIFFERENT STRUCTURES (GENERIC DATA)

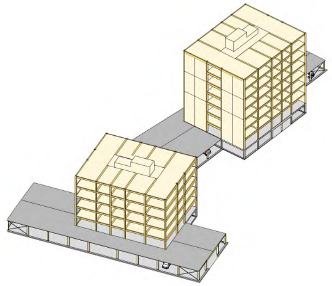


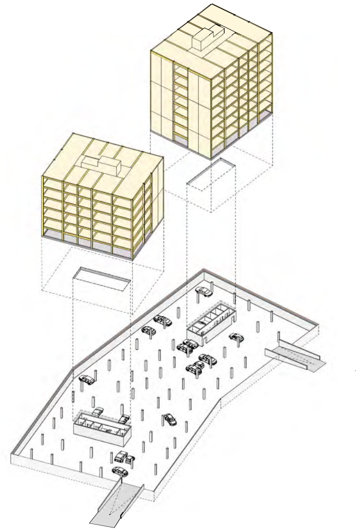
VOLUME OF MATERIAL THAT CAN BE PRODUCED FOR 1 TONNE CO_2E

(Source: In the Scale of Carbon Poster – Materials Council, 2013)

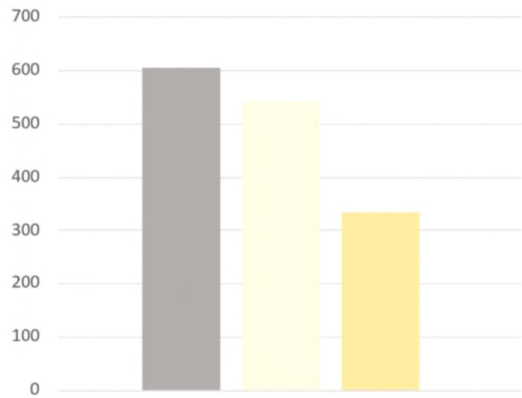
ANNEX 15A -SCHAGEN - MUGGENBURG - EARLY STAGE LCA



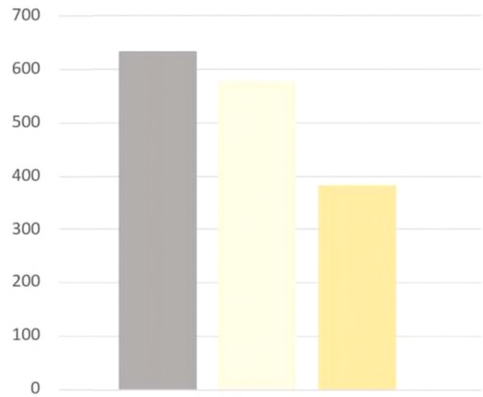




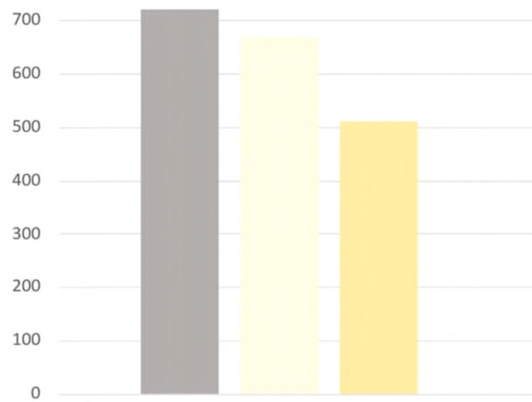
SCENARIO A: TIMBER RESIDENTIAL BLOCKS AND INDEPENDENT TIMBER CARPARK



SCENARIO B: TIMBER RESIDENTIAL BLOCKS AND INTEGRATED TIMBER CARPARK



SCENARIO C: TIMBER RESIDENTIAL BLOCKS OVER UNDERGROUND RC CARPARK

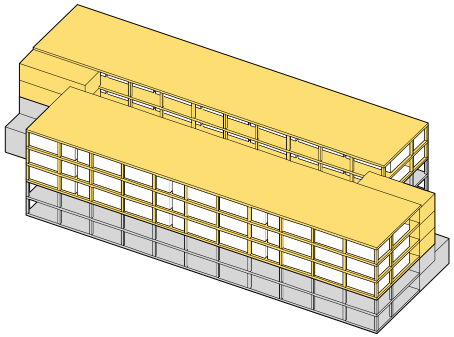


EMBODIED CARBON A1-C4 KGCO2e/m2

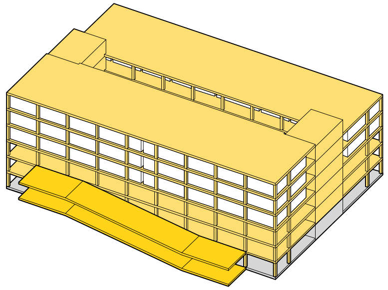
KEY:

RC Structure Timber Structure With Sequestered

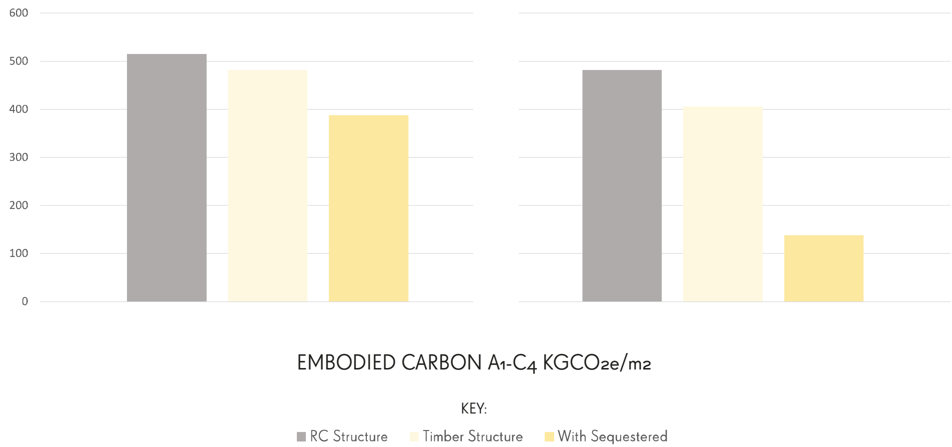
ANNEX 15B - AMSTERDAM - MOLENWIJK - EARLY STAGE LCA



SCENARIO A: TIMBER RESIDENTIAL EXTENSION OF NEW RC CARPARK STRUCTURE



SCENARIO B: FULL TIMBER CARPARK AND RESIDENTIAL DEVELOPMENT



ANNEX 16 -SYSTEM DISASSEMBLY

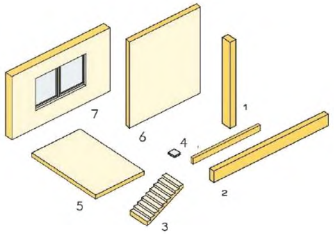
Almost all buildings built up to the early 2000s, were not designed for deconstruction: their life-cycle was conceived as linear (design - construction -demolition-disposal of construction waste), designers conceived buildings as permanent artefacts.

Design for deconstruction (DfD) is not a mainstream concept yet research and thinking into this concept has been increasing for some time, however clear guidelines and standard practices about how to achieve this are only now emerging despite the many, clear benefits that such a design approach generates such as:
- Reduction of construction waste plus the related pollution and carbon emissions
- Saving embodied carbon of materials / components that are going to be re-used or further used ideally for multiple life cycles
- Huge savings in raw materials consumption

All these benefits become evident at the "end of life phase" of buildings but need to be considered as goals from the early design phases when strategic decisions are made about materials, build-ups, connections, interfaces detailing etc. Ideally outline disassembly strategy plans should be drafted by the design team at the outset of a project.

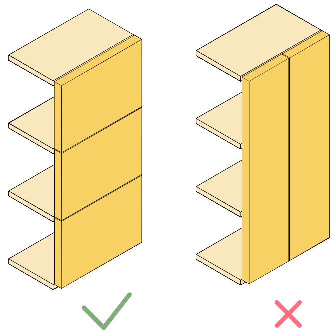
For the Build-in-Wood system we have focused on the six disassembly strategies which are visualised here. Our goal is to enable the timber building to act as "material banks" in the future.

This system is characterised by the repetition of a common module with sub-modules/increments that allow for dimensional flexibility. An intuitively simple structure with clearly defined primary (posts, beams etc.) and secondary components (floor-plates, shear walls, cores and façade panels) is formed by a kit of parts the components of which have standardised dimensions and are optimised in terms of structural performance, material efficiency and transportability (max. Dimension and weight). Connections are repeatable and demountable; they can be accessed relatively easily and rely on screws rather than adhesives or nails. All components are IDd and consequently traceable in future.



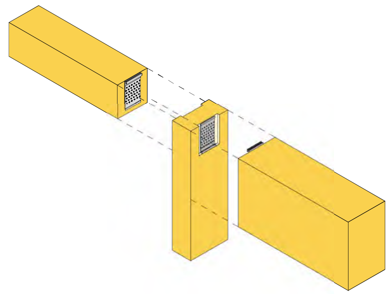
MINIMAL REPEATED COMPONENTS

System is easily legible and components easier to reuse due to 'standard' sizes.



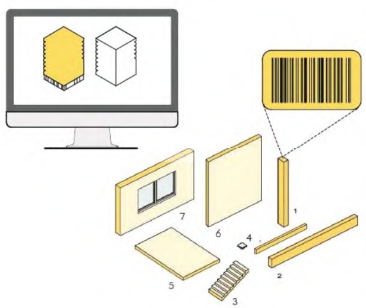
MODEST, LIGHT COMPONENT SIZES

Relatively small light components facilitate de-mounting, reducing the likelihood of damage and easing transportation for further processing or re-use.



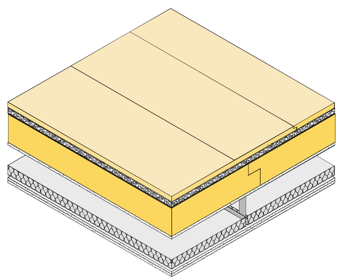
INTERFACES DESIGNED TO BE EASILY TAKEN APART AND POSSIBLY WITHSTAND MORE THAN ONE USE

We foresee the use of connections which allow for more than one use (where possible) to facilitate re-assembly of disassembled components with minimal processing.



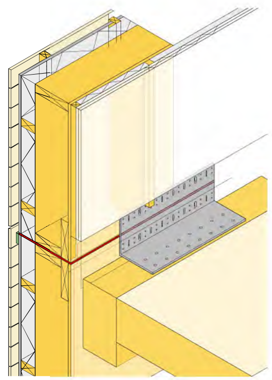
COMPONENT ID AND DATA

Components must be easily identifiable with quantitative and qualitative data made available for future users (e.g. through DIGITAL TWIN) as well as clear documentation describing method of deconstruction and component interdependencies.



USE OF DRY PRODUCTS AND MECHANICAL FIXINGS

Dry products and mechanical fixings in lieu of adhesives, makes it easy to separate different materials and elements without damage to components



EASY ACCESS TO CONNECTIONS

Connections made at low level from the building interior allow for easy and safe installation and straightforward access for demounting.

GLOSSARY

- Adaptability
"the quality of being able to adjust to varying or changes in conditions and requirements"

- Buildability
Pre-construction exercise that looks at a design from the perspective of those that will manufacture, install components, and carry out the construction works.

- Carbon footprint
Used as a collective term for greenhouse gases. Often measured in Carbon dioxide equivalents (CO_2e).

- Circular economy
CE aims to keep materials, components, products and assets at their highest utility and value at all times; material goods are designed and produced to be more durable, and to be repaired, refurbished, disassembled and reused endlessly.

- CLT
Cross-laminated timber.

- Decibel (db)
Measurement for the intensity of sound.

- DfMA(D)
Design for Manufacture and Assembly and Disassembly. Design for the ease of manufacture of parts and for the ease of assembly and disassembly.

- Disassembly
A non-destructive taking apart of an assembled product into constituent materials or components (BS8887-2:2009,3.11)

- Dynamic amplification
Multiplication of stress caused on a static load when a dynamic load is applied.

- Durability
Expectation that the structure or component will perform adequately in the context of the specified Design Working Life, Service Life and Use Class.

- Ease of disassembly
Assessment methods developed to measure the disassembly level/ potential of building components.

- Employer's requirements
Document produced by the client setting out their brief in terms of requirements and specification.

- Embodied carbon
Carbon dioxide (CO_2e) emissions generated from the formation of buildings, their refurbishment and subsequent maintenance.

- Encapsulation
The approach of protecting building elements by the application of fire lining.

- End of life
The end of life stage of a building starts when the building is decommissioned and not intended to have any further use. At this point, the building's demolition/deconstruction may be considered as a multi-output process that provides a source of materials, products and building elements that are to be discarded, recovered, recycled or reused.

- Eurocodes
Ten European standards specifying how structural design should be conducted within the EU.

- GLT (Glulam)
Glue Laminated Timber.

- Installation
On site works.

- Design Working Life
Assumed period for which a structure or part of it is to be used for its intended purpose with anticipated maintenance but without major repair being necessary.

- Life - Service life
Period of time from handover to First Maintenance Activity.

- LVL
Laminated veneered lumber.

- Manufacturing
Building the building system components within a factory environment.

- Material efficiency
Process of undertaking a building project enabling the most efficient use of materials over the life cycle of the building and its components e.g. using fewer materials.

- NIA (Net Internal Area)
The net internal area (NIA) of a building is the usable area measured to the internal finish of the perimeter or party walls at each floor level. Net internal area covers all areas that can be used for a particular purpose. NIA excludes internal structural walls (columns, piers etc.), walls enclosing excluded areas, lifts, stairwells including landings and Corridors and other circulation areas used in common.

- GIA (Gross Internal area)
the area of a building measured to the internal face of the perimeter walls at each floor level. The GIA excludes perimeter wall thickness's, canopies, external open-sided balconies, covered ways and fire escapes as well as voids over or under structural raked or stepped floors.

- Off-site
Term for assembly and fabrication of items for construction away from the building site.

- On site fire strategy
A required strategy outlining measures to prevent and manage fire during the construction phase both on-site and off-site.

- On site
Work carried out on the construction site, as opposed to work carried out in the factory/off-site (see prefabrication).

- On site waterproofing strategy
A required strategy outlining how water will be managed on site during the construction phase both on-site and offsite.

- System
Systems are a giant 'kit of parts': a set of pre-engineered components that go together in defined ways to produce structures very efficiently. Flexibility is designed in, so that a single platform can produce an almost infinite range of different structures.

- Plug and play
MEP services that are intended to work immediately when first used or connected, without reconfiguration or adjustment by the user.

- Prefabrication
Prefabricate describes assemblies/components that are manufactured under factory conditions and then transported to construction sites for incorporation into a building.

- PSI value
The linear thermal transmittance of an element, which is used to calculate the heat loss or gain through a thermal bridge.

- Redundancy
The over-scaling of a system or component to enable back-up in the case of failure or system scale / weight increase or different potential unknown scenarios.

- Sequestered Carbon
Trees absorb CO_2 from the atmosphere while they grow. This CO_2 remains locked in the timber until the end of its life.

- Thermal (cold) bridging
A path of least resistance for heat transfer, created by a component or area which has a higher thermal conductivity than its surrounding materials.

- Tipping point
The point at which a series of small changes or incidents becomes significant enough to cause a larger, more important change. In the context of Build-in-Wood, this is the point at which incremental increase/decrease in a given performance of a particular component becomes inappropriate to achieve in the current configuration or material and so a significant alteration is proposed to the component for performance levels beyond this point.

- U-Value
Measurement of the transmission of heat through a building element.

- Use Class
The environment to which the structure or Component will be exposed, as defined in BS EN 335

- LFA = Lettable Floor Area (in Dutch: V.V.O., verhuurbaar vloeroppervlak)
- GFA = Gross Floor Area (in Dutch: BVO or Bruto Vloeroppervlakte)
According to the NBN B06-002 and DIN 277 BVO needs to be calculated on all levels, also levels that are located partially or entirely underground, technical levels, roof terraces and attics where activities are foreseen to take place.
BVO is measured to he the outer face of the facade on just above the floor finishing; staircases, lift shafts and risers all belong to BVO.
BVO does not include:
- smaller parts with a section < 0,5m² on the outside of the facade
- free standing columns outside the facade with a section < 0,5m²
- voids > 4m²
- basements with a free height < 1,50m
- roof surfaces who are not used as a terrace
- open staircases outside the building
- non covered area's such as patio's with a surface > 4m²
- maintenance gangways positioned along the facade

ISO 9836 defined BVO as "total floor area". This standard makes a distinction between spaces who are totally surrounded by walls and spaces who are partially open to the surrounding area.
NEN 2580 makes even a further distinction between covered outside spaces and non-covered outside spaces, both when adjacent to the building. We don't look at gardens or sitting areas which are detached from the building.
(source: http://www.bouwdata.net)

- NFA = Net Floor Area (in Dutch: NVO or Netto Vloeroppervlakte in DIN 277 also indicated as NGF)
Net floor area is the GFA minus solid construction elements.
The following items are to be left out of the measurement:
- walls (net floor area is obtained when all walls are subtracted from the measurement whilst used floor area is obtained when only bearing walls are subtracted; in the Netherlands the latter one is called GO: gebruiksoppervlakte
- voids with a surface > 4m²
- parts of the room where the free height is < 1,5m
- shafts for technical ducts when the groundsurface > 0,5m²

(source: http://www.bouwdata.net)

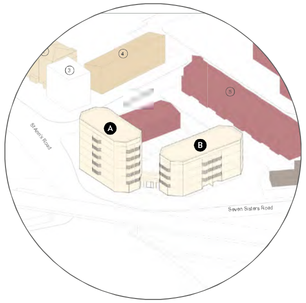
This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement no. 862820

BUILD IN WOOD

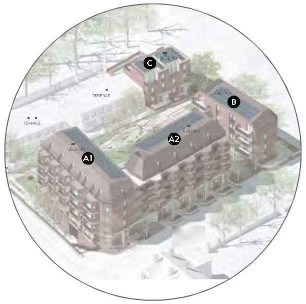
HARINGEY PILOT PROJECTS

TWO SITES

LOCATION

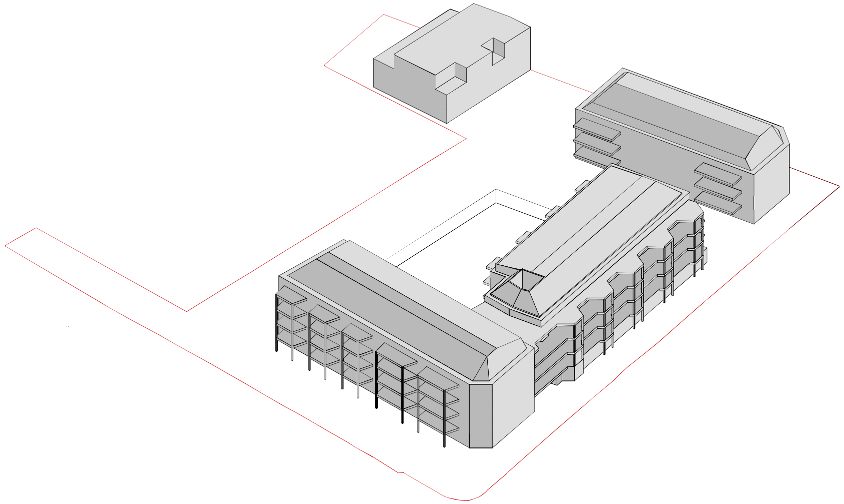


KC KERSWELL CLOSE



WA WOODSIDE AVENUE

AT A GLANCE



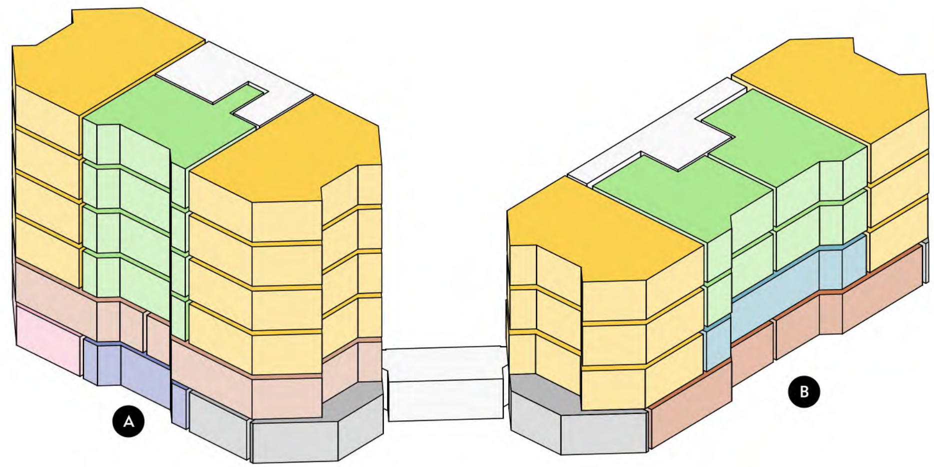
KERSWELL CLOSE	PARAMETERS	WOODSIDE AVENUE
2no.	Number of blocks	4 no.
Residential (Active front to GF)	Building Use	Residential
24 to 27	Number of residentail units	41
2881	GIA (m2)	4255
4 to 5 storey (3250 mm floor to floor)	Building Height (m)	2 to 5 storey (3250 mm floor to floor)
2.5+Self-weight	Assumed Dead Load (kN/m2)	2.5+Self-weight
2	Assumend Live Load (kN/m2)	2
6 floors/8 beams	Floor Vibration	6 floors/8 beams
55	Acoustic Performance (L'nTw, dB)	55
60	Fire Performance (mins.)	60
0.16 min.	U-Value (W/m2K)	0.16 min.

1. KERSWELL CLOSE

KERSWELL CLOSE DEVELOPMENT

The Kerswell Close development comprises 4 and 5 storey apartment blocks providing:
- 24 to 27 residential units (1 bed / 2 bed / 3 bed /4 bed) as part of mixed use development surrounding a private courtyard garden
- Community hub and workplace located at ground floor
- Vehicle service access gained from a close branching off St. Ann's road

The existing building is characterised by:
- A massing broken down into two blocks of different heights (A and B)
- A centrally located, prominent access point
- Street edges activated along all key frontages



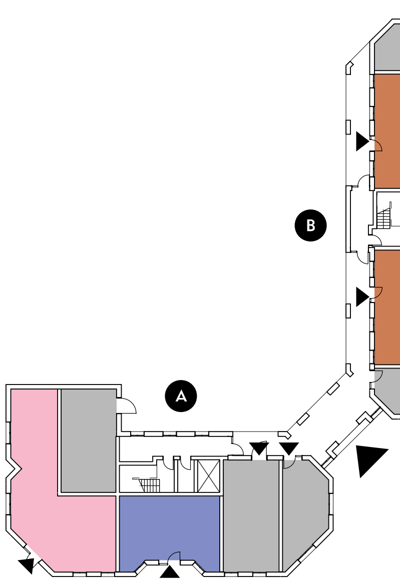
HOUSE TYPES - AXONOMETRIC VIEW

KEY

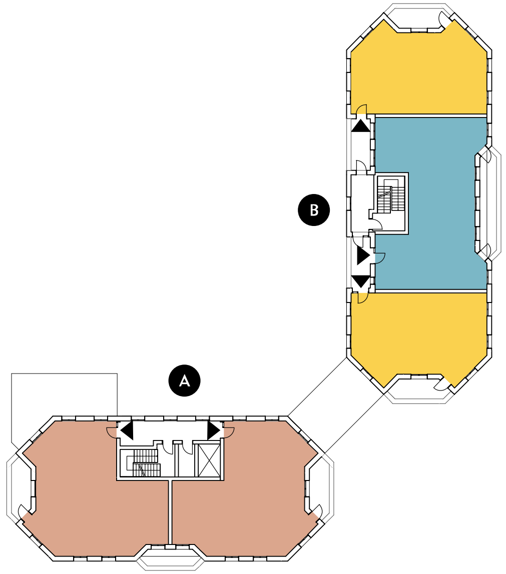
1B2P	4B6P
2B4P	Community Hub
3B5P	Workspace
3B5P WCH	Plant / Service

BUILD-IN-WOOD

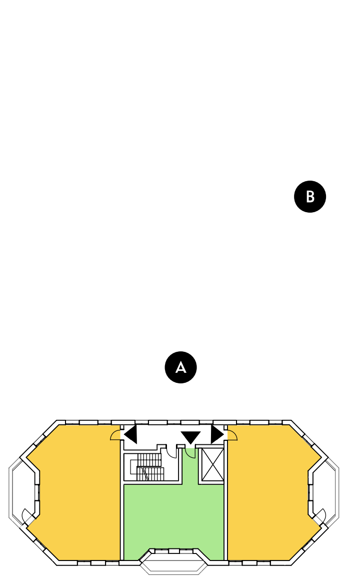
KERSWELL CLOSE DEVELOPMENT



GROUND FLOOR



FIRST FLOOR



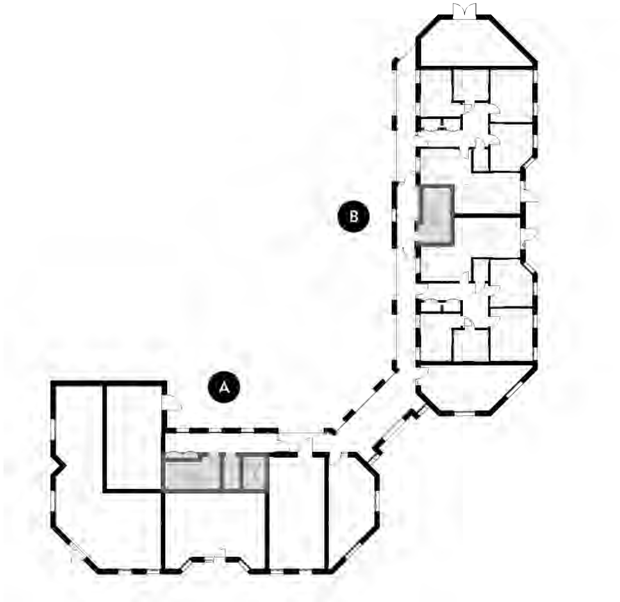
SECOND TO THIRD/FIFTH FLOORS

HOUSE TYPES - PLAN VIEW (NTS)

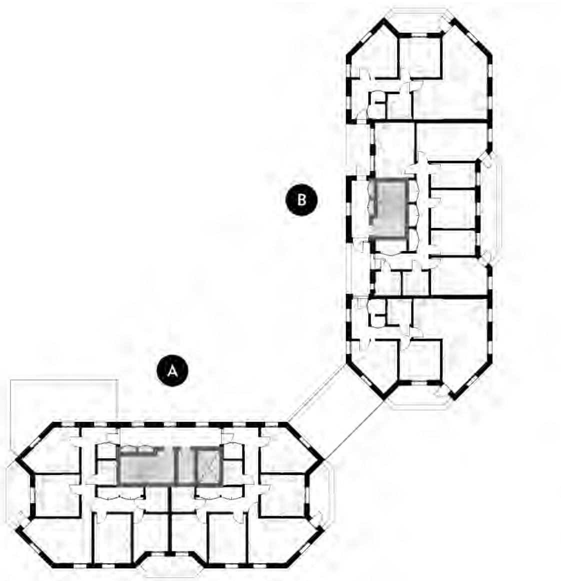
KEY

1B2P	4B6P
2B4P	Community Hub
3B5P	Workspace
3B5P WCH	Plant / Service

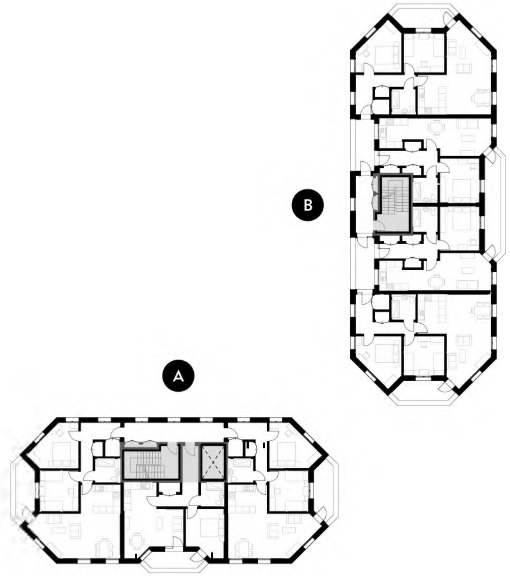
KERSWELL CLOSE - PLANS



GROUND FLOOR



FIRST FLOOR



SECOND TO THIRD/FIFTH FLOORS

KEY

Cores: vertical circulation and services distribution

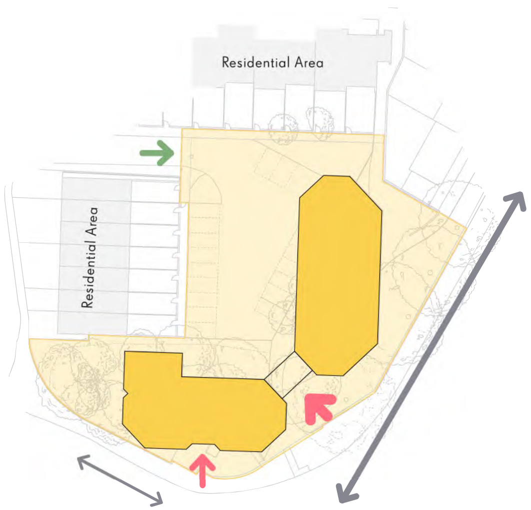
SITE OVERVIEW

The existing site is bound on 1 side by an adjacent building, and restricted on the remaining 3 sides by roads of differing importance.

Seven Sisters Road to the North-East of the site would appear to be the busiest road, into which St Ann's Road merges. Kerswell Close provides access to the rear of the site, but large lifting equipment (mobile cranes) would have to be carefully manoeuvred within this relatively tight alley.

Access to the site seems to be currently not restricted, but would need to be well managed during construction in order to avoid unnecessary closures or suspensions, particularly along Seven Sisters and St. Ann's Rd.

The use the Build-in-Wood system would help to reduce the number of daily deliveries as well as the requirement for site storage, given it's kit of parts components would be largely prefabricated and could be delivered to site just-in-time. Furthermore, the use of a mobile crane rather than a fixed tower crane - usual arrangement with timber construction - might be an advantage with respect to traditional construction methods.



KERSWELL CLOSE SITE PLANS OVERLAY (NTS)

KEY

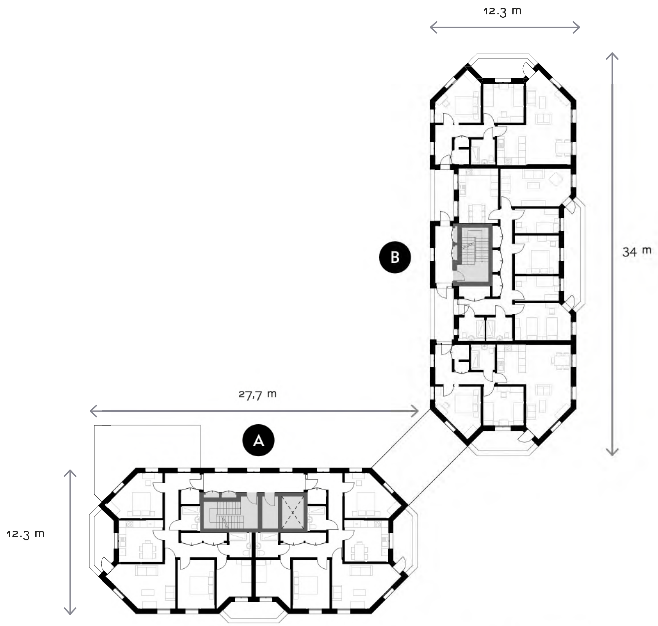
- Primary Route
- Secondary Route
- Adjacent Buildings
- Site Access Points
- Vehicle Access

AERIAL VIEW OF THE KERSWELL SITE

CURRENT DESIGN - DIMENSIONS

The current design comprises two urban blocks of different heights, incorporating several, repeatable single and double aspect, 1 ,2 ,3 and 4 bedroom flats that overlook a centrally located amenity space and the tree-lined roads surrounding the blocks.

This configuration could utilise the Build-in-Wood system without major adjustments because:
- it's generally orthogonal (except for the peculiar chamfered corners and balconies)
- the flats create a cellular type floor layout that can be created making use of non structural walls
- the structural spans are modest; floor to ceiling heights will not be affected by down-stand beams
- the layout is generally repetitive consequently allowing for repeatabilty of structural componets
- given the structural spans and the modest height of the building, vertical distribution cores might act as stability structure for the entire building but in this initial feasibility we foresee the use of additional internal or perimeter structural shear walls/diagonals.



FIRST FLOOR PLAN

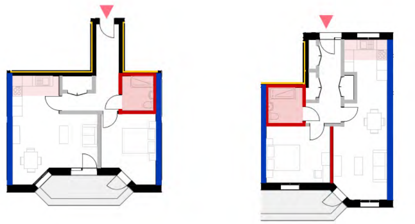
AXONOMETRIC VIEW (CURRENT DESIGN)

Height from GF to RFL FFL (*)

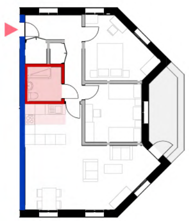
BUILD-IN-WOOD

22

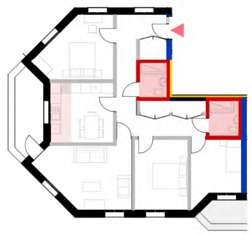
CURRENT DESIGN - HOUSE TYPES



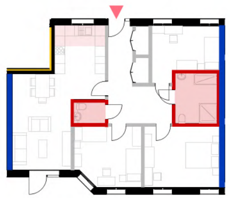
1Bed 2Person X8



2Bed 4Person X14



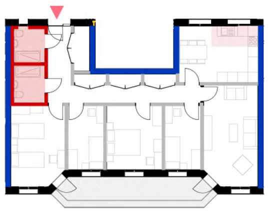
3Bed 5Person X2



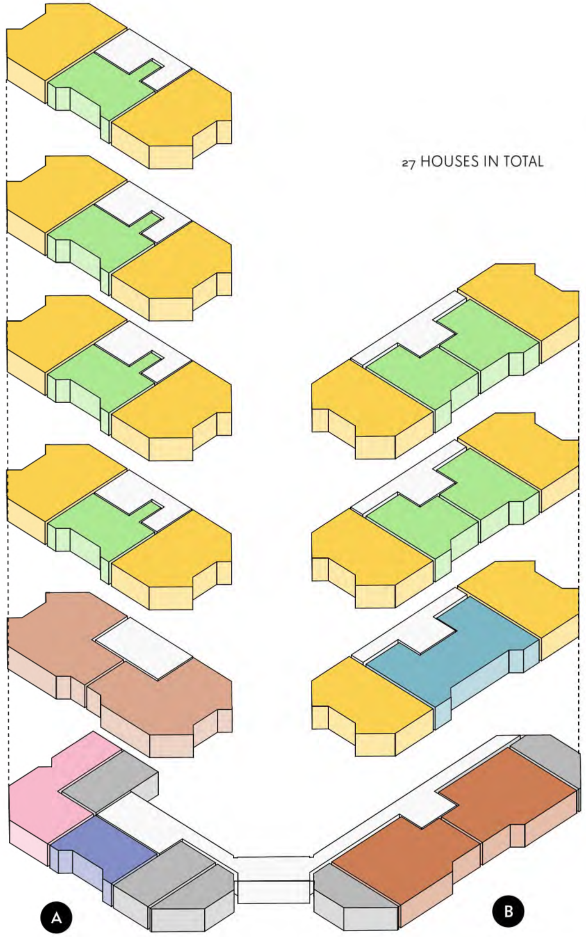
3Bed 5Person Weelchair Access. X2

KEY:

- Main Access Point
- Wet Areas (Bathrooms/Kitchens) - Prefab Pods
- Non-structural /internal walls
- Walls surrounding wet areas (potential Pods)
- Party-walls (non structural with enhanced performance)
- Facade Panels +Ext. in-situ brick leaf



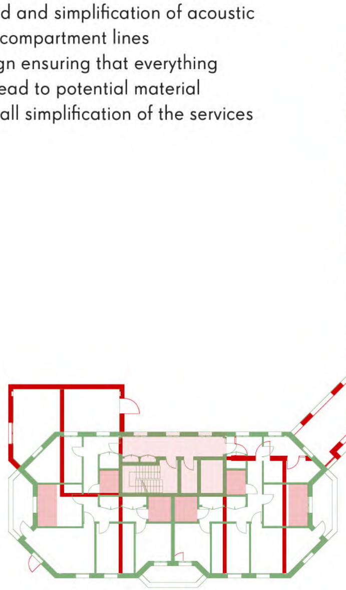
4Bed 6Person X1



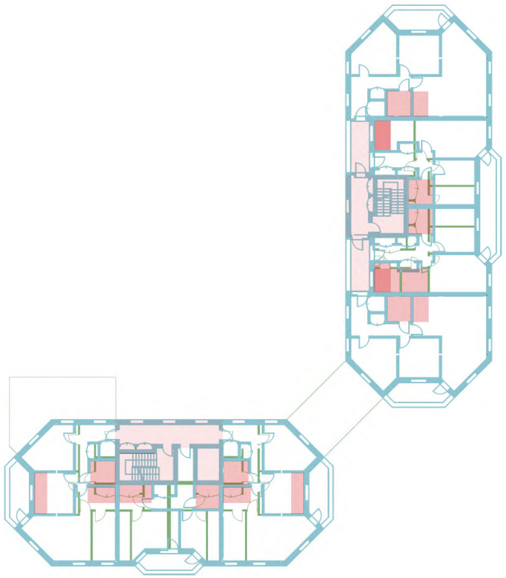
HOUSE TYPES - EXPLODED AXONOMETRIC VIEW

CURRENT DESIGN - THE IMPORTANCE OF STACKING

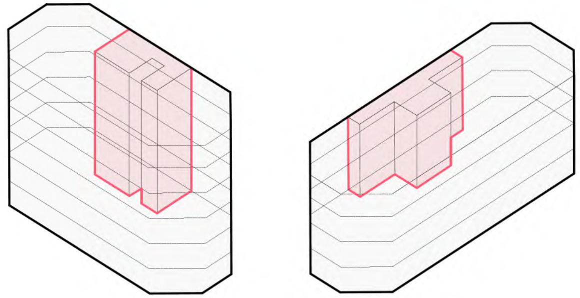
Deductions from the plan overlay exercise:
- the stacking of wet areas would allow for efficient service distribution and stacks
- the stacking of party walls would allow a shared grid to be established and simplification of acoustic and fire detailing at compartment lines
- a rationalised design ensuring that everything lines through could lead to potential material efficiencies and overall simplification of the services system.



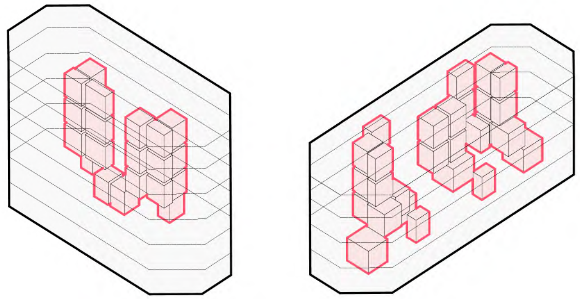
GROUND FLOOR - FIRST FLOOR OVERLAY



FIRST FLOOR - SECOND FLOOR OVERLAY



CORES - VERTICAL DISTIBUTION

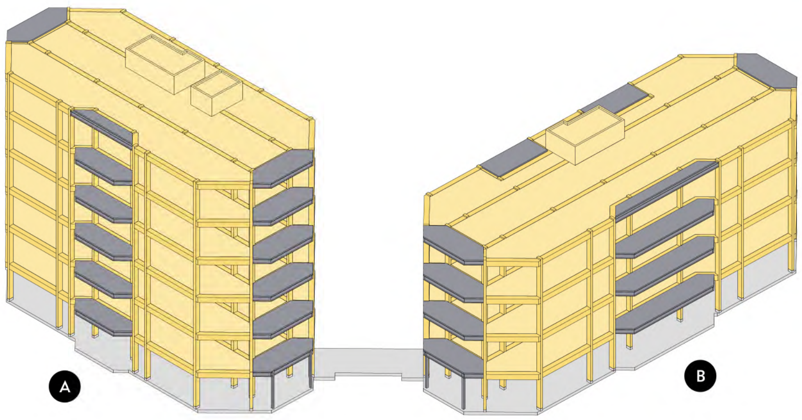


WET AREAS (BATHROOMS-KITCHENS)

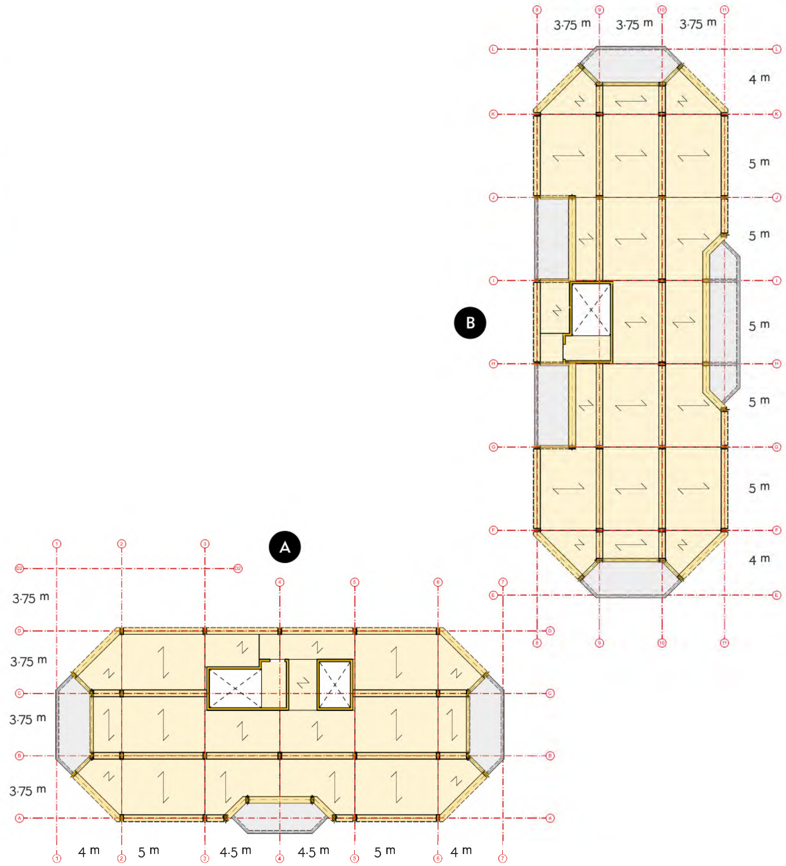
KEY

- Ground Floor Plan
- First Floor Plan
- Second Floor Plan
- Building Core (Vertical/Horizontal circulation)
- Wet Areas (Bathrooms/Kitchens)

BUILD-IN-WOOD SYSTEM DESIGN



STRUCTURAL DESIGN CONCEPT - AXONOMETRIC VIEW

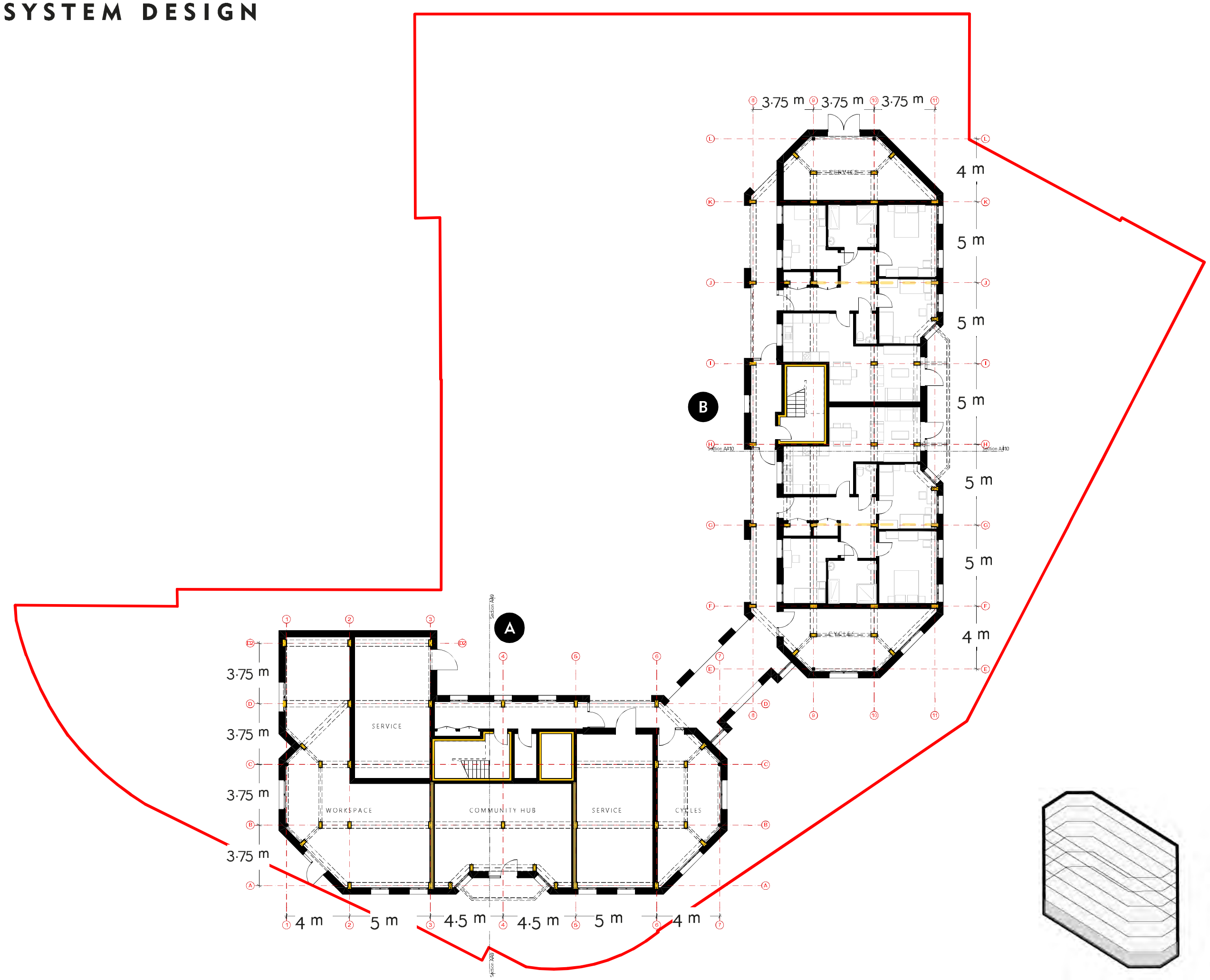


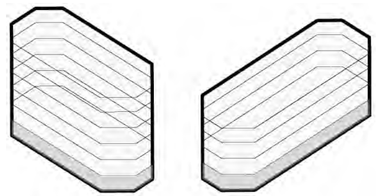
STRUCTURAL DESIGN CONCEPT - TYPICAL PLAN

KEY

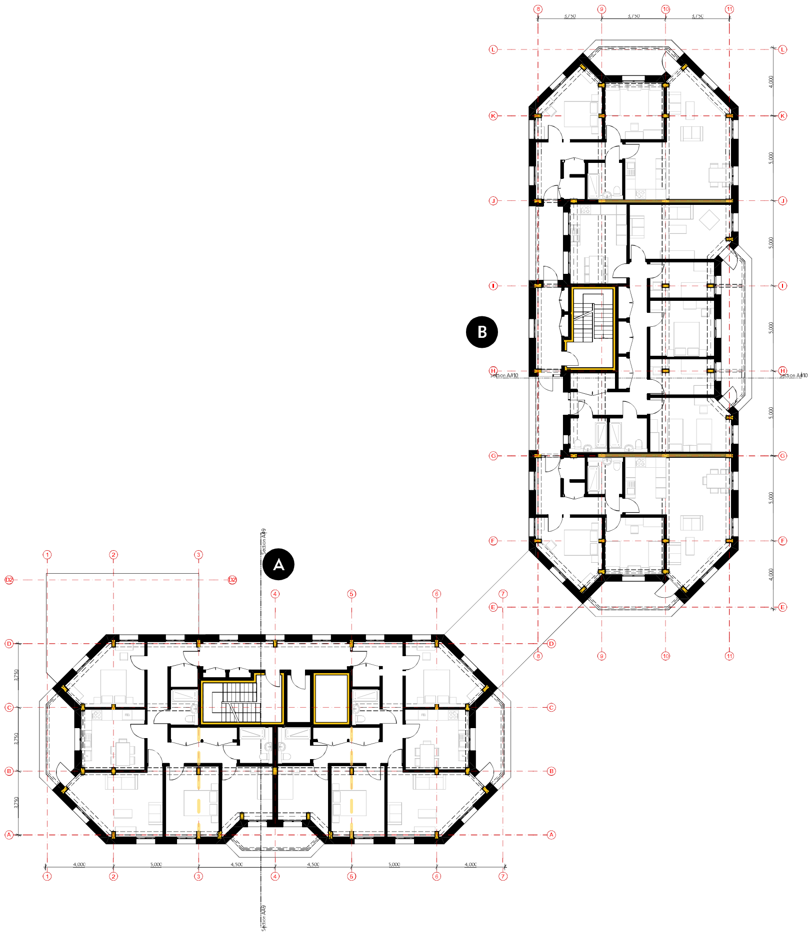
- CLT cores acting as stability structure
- Glulam beams
- Glulam Columns
- CLT slabs spanning direction
- Ground floor slab (see axonometry)
- Steel columns/beams (balconies)
- Steel deck to balconies

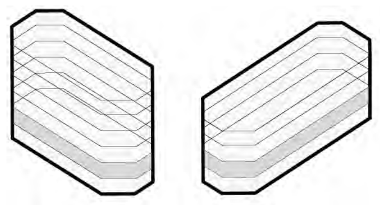
BUILD-IN-WOOD SYSTEM DESIGN





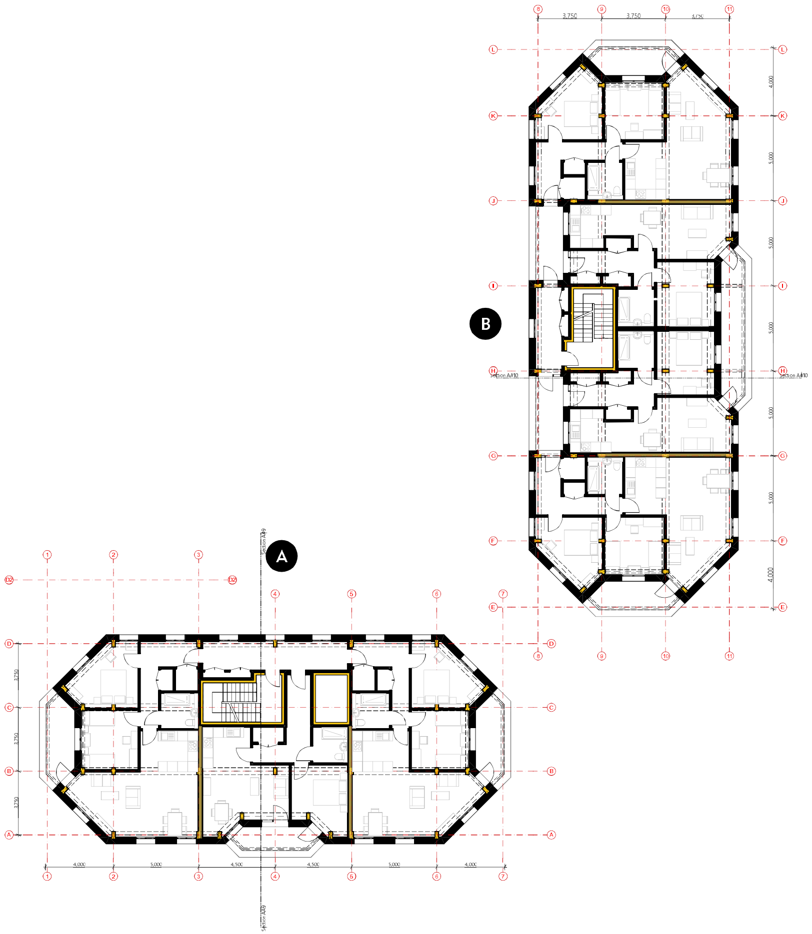
GROUND FLOOR PLAN WITH OVERLAID BUILD-IN-WOOD STRUCTURAL SYSTEM

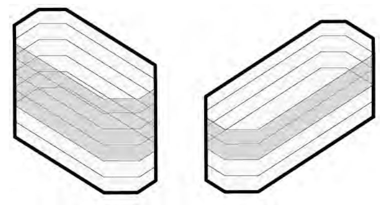




FIRST FLOOR PLAN WITH OVERLAID BUILD-IN-WOOD STRUCTURAL SYSTEM

BUILD-IN-WOOD SYSTEM DESIGN





SECOND TO FIFTH FLOOR PLAN WITH OVERLAID BUILD-IN-WOOD STRUCTURAL SYSTEM

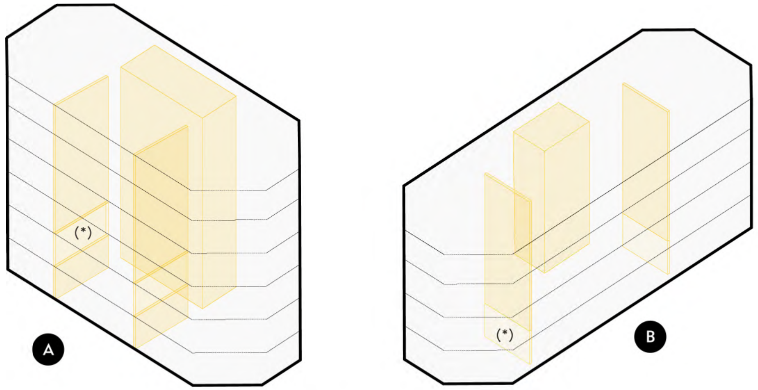
STABILITY STRUCTURE DESIGN

The extent of, and demands on, the stability structure of a wooden building are influenced by it's size, geometry and location (e.g. site specific wind and seismic conditions).

With this in mind the Build-in-Wood system is designed to allow for two material options for the cores which play a key role in terms of stability: CLT or concrete.

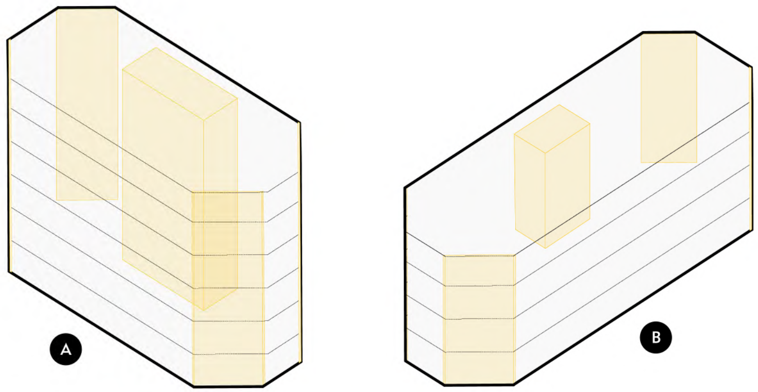
In this scenario the cores of the two blocks can be designed in CLT; as they are of relative modest height and size.
This rectilinear typology with one, centrally positioned core and distribution corridors radiating from it, is relatively common; the drawing on this page show potential options on how core and shear walls could be combined to deal with horizontal forces.

Generally speaking shear walls are positioned perpendicular to the core with full flexibility of their location for buildings at the lower end of the Build-in-Wood height range (4 to 6 storeys) whilst for taller buildings (9 to 10 stories), they are generally integrated into the facade zone.



STABILITY SYSTEM - OPTION A
Circulation core works in conjunction with internal shear walls. Configuration preferable in the UK as it avoids placing CLT panels (combustible material) on the facade.

(*) Note: transfer structure needed where indicated



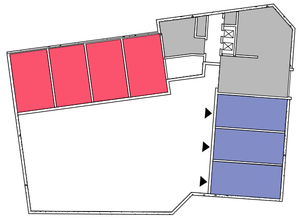
STABILITY SYSTEM - OPTION B
Circulation core works in conjunction with perimeter shear walls. Allows to minimise the impact of having to integrate a shear wall -with only one opening, aligned on all floors- in the design of interior spaces and might complicate the current balcony design.

2 - WOODSIDE AVENUE

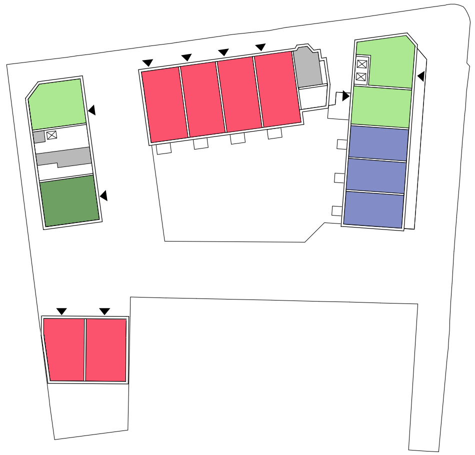
THE WOODSIDE AVENUE DEVELOPMENT

The Woodside Avenue development comprises of four 3 to 5 storey apartment blocks providing:
- 41 residential units (1 bed / 2 bed / 3 bed) as part of a mixed use development surrounding a private courtyard garden
- Vehicle service access gained from a private road branching off Woodside Avenue.

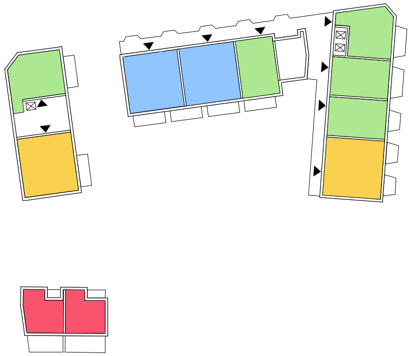
The existing building is characterised by:
- A massing broken down into four blocks of different heights, and size
- Two, centrally located, prominent access points
- A variety of generously sized house types (including 2 houses, 16 maisonettes and 23 apartments) overlooking a private courtyard garden.



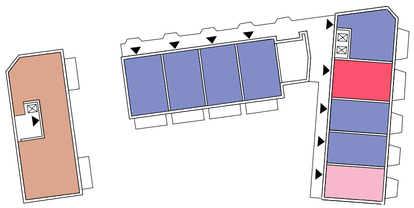
LOWER GROUND



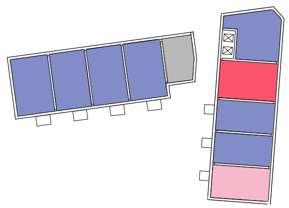
GROUND FLOOR



FIRST AND SECOND FLOOR



THIRD FLOOR



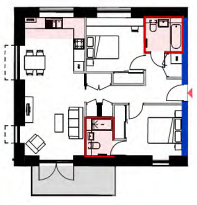
FOURTH FLOOR

KEY

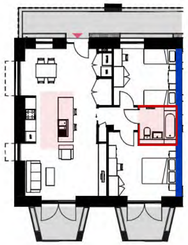
HOUSE TYPES -PLAN VIEW:

- 1B2P Flat
- 1B2P WC Accessible Flat
- 2B3P WC Accessible Flat
- 2B3P Maisonette
- 2B4P Flat
- 2B4P Maisonette
- 3B5P Flat

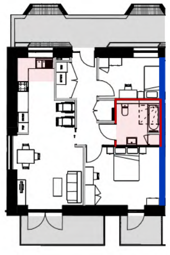
CURRENT DESIGN - KEY HOUSE TYPES



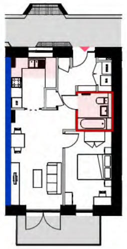
2B/4P Type S1 x2



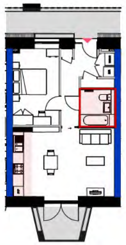
2B/4P Type S2 x2



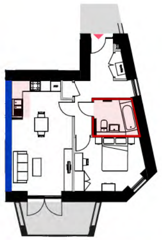
2B/3P x4



1B/2P Type Q1 x2



1B/2P Type Q2 x5

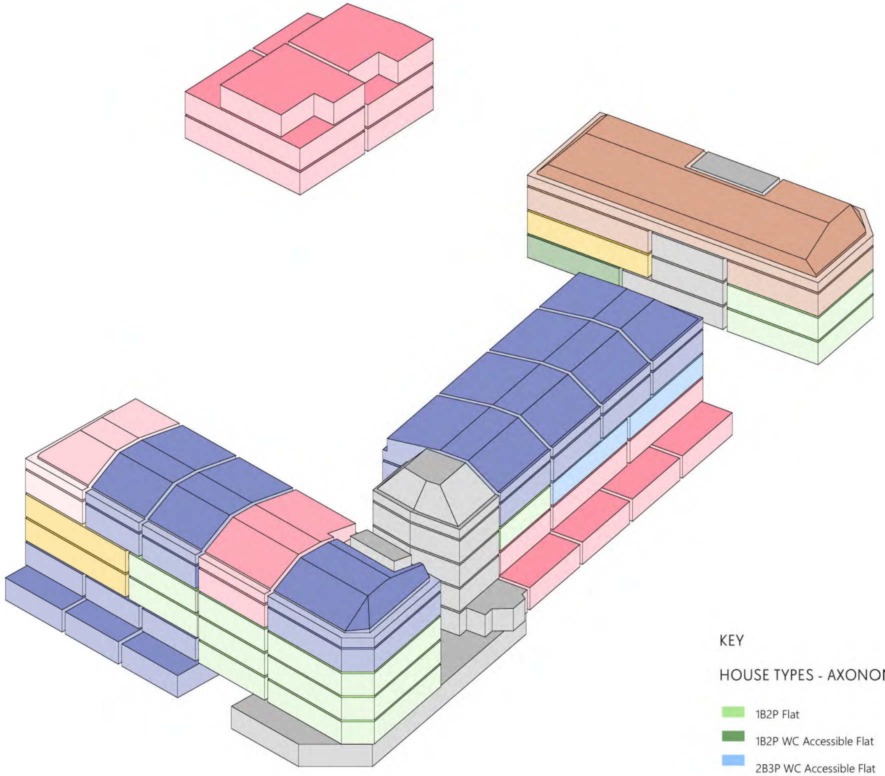


1B/2P Type Q3 x3

1B/2P Type Q4 x2

KEY:

- Main Access Point
- Wet Areas (Bathrooms/Kitchens) - Prefab Pods
- Non-structural /internal walls
- Walls surrounding wet areas (potential Pods)
- Party-walls (non structural with enhanced performance)
- Facade Panels +Ext. in-situ brick leaf

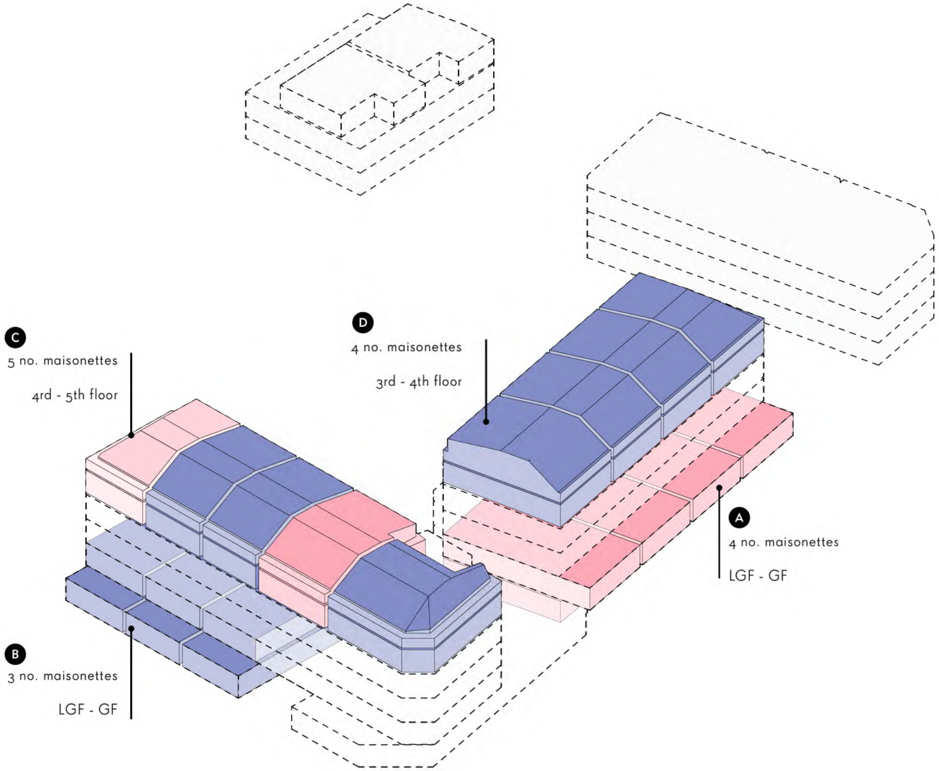


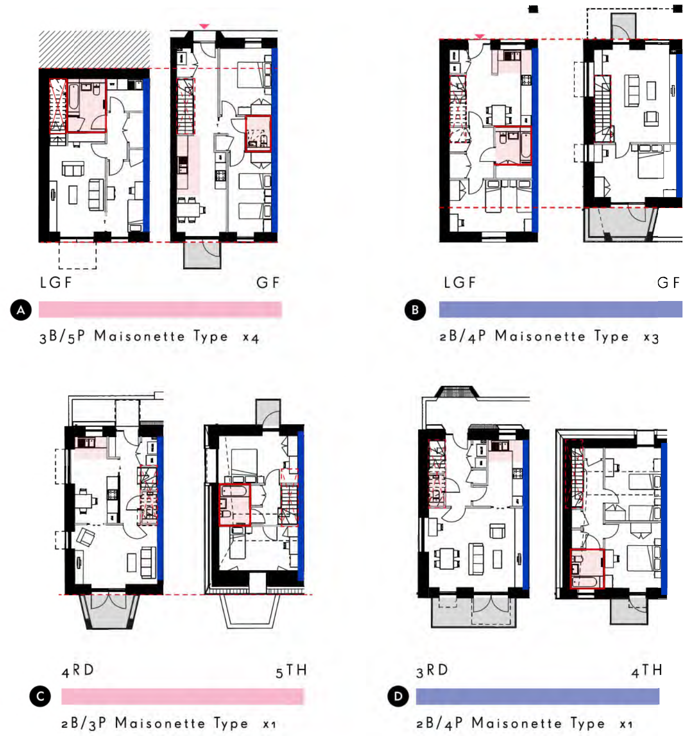
KEY

HOUSE TYPES - AXONOMETRIC VIEW:

- 1B2P Flat
- 1B2P WC Accessible Flat
- 2B3P WC Accessible Flat
- 2B3P Maisonette
- 2B4P Flat
- 2B4P Flat
- 2B4P Maisonette
- 3B5P Flat

CURRENT DESIGN - KEY MAISONETTES TYPES





KEY:

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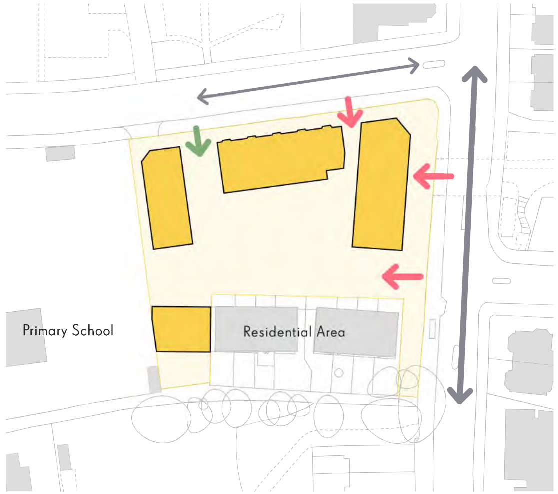
- Wet Areas (Bathrooms/Kitchens) - Prefab Pods
- Non-structural /internal walls
- Walls surrounding wet areas (potential Pods)
- Party-walls (non structural with enhanced performance)
- Facade Panels +Ext. in-situ brick leaf

SITE OVERVIEW

The Woodside Avenue site, located on Woodside Avenue at its junction with Muswell Hill Road, is set within the Muswell Hill district: a mainly Edwardian suburb and positioned close to the green spaces of Highgate Wood, Queen's Wood and Alexandra Park.

Access to the site, currently occupied by a vacant 2/3 storey care home that was built in the 1970s, seems to be unrestricted.

The presence around the site of:
- a Primary School (West)
- a housing development (North)
- 2/3 storey residential houses (East and North)
suggests that this is a quite sensitive context where the use of the Build-in-Wood timber system might help minimising the intrusion in the surrounding community by:
- making less use of noisy and dust producing equipment during the construction phase
- minimising the site traffic and speeding up an assembly process largely based on the use of prefabricated components that are delivered just in time.



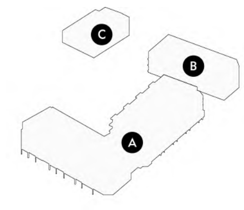
WOODSIDE AVE. SITE PLANS OVERLAY (NTS)

KEY

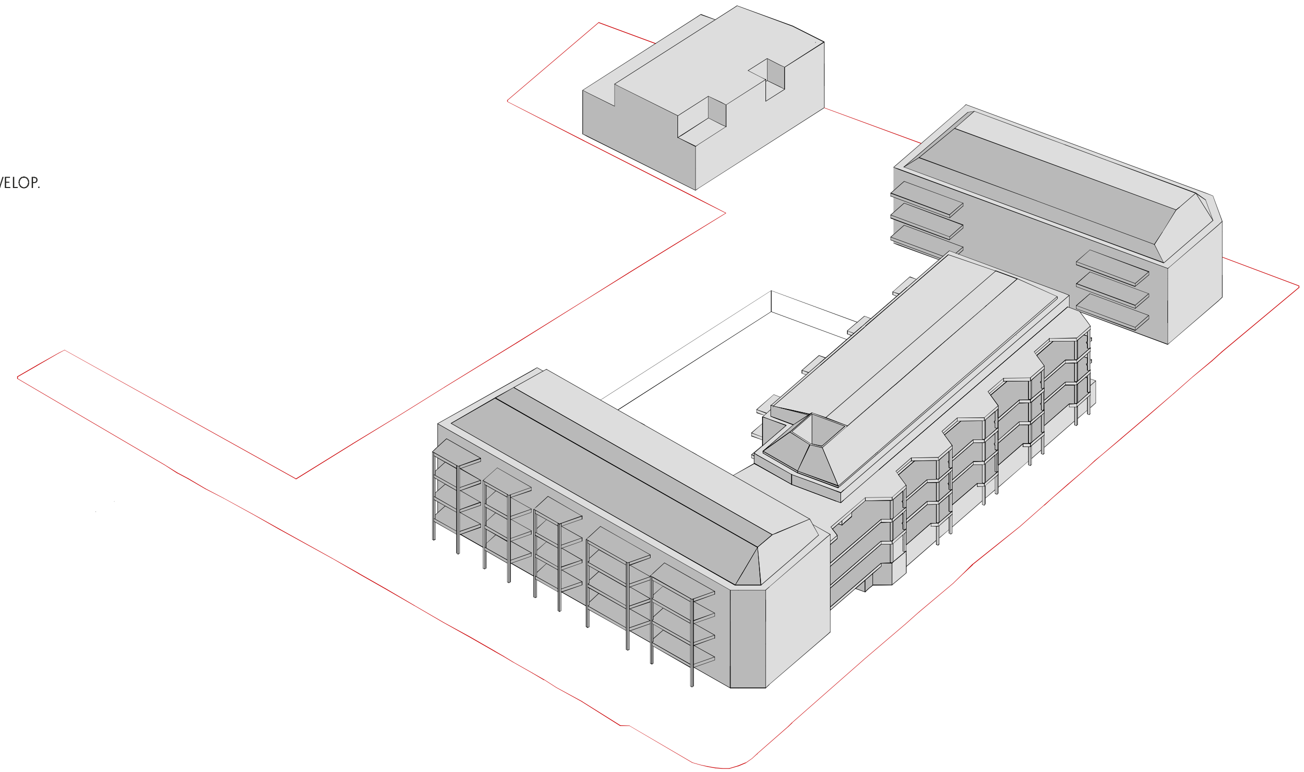
- Primary Route
- Secondary Route
- Adjacent Buildings
- Site Access Points
- Vehicle Access

AERIAL VIEW OF THE CRANWOOD SITE

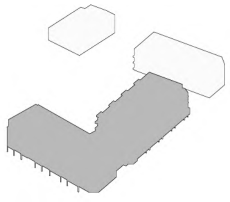
CURRENT DESIGN - THREE BLOCKS



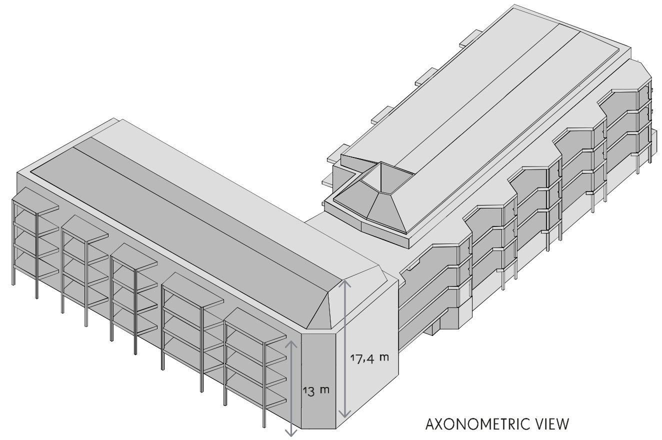
3 BUILDINGS FORMING THE WOODSIDE AVE. DEVELOP.



CURRENT DESIGN - BLOCK A - DIMENSIONS



BUILDING A



AXONOMETRIC VIEW

LOWER GROUND FLOOR

GROUND FLOOR

BUILD-IN-WOOD

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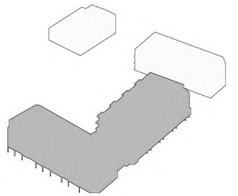
CURRENT DESIGN - BLOCK A

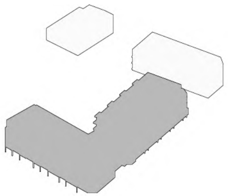


BUILDING A

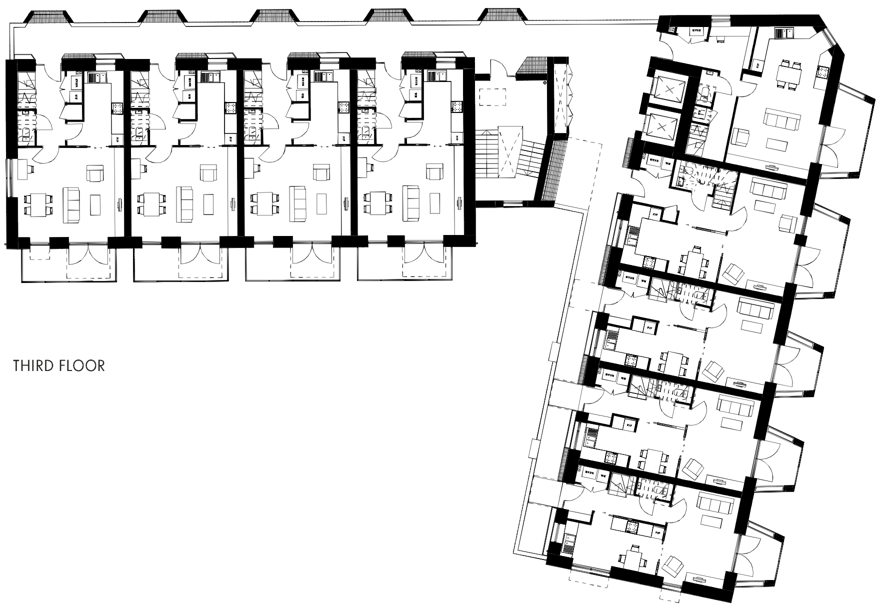
FIRST FLOOR

SECOND FLOOR

CURRENT DESIGN - BLOCK A



BUILDING A



THIRD FLOOR

FOURTH FLOOR

BUILD-IN-WOOD

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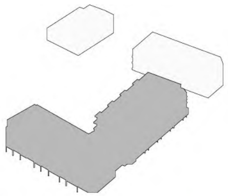
CURRENT DESIGN - BLOCK A - OVERLAYS

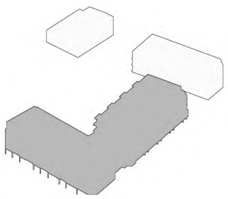


Deductions from the plan overlay exercise:
- the stacking of wet areas would allow for efficient service distribution and stacks
- the stacking of party walls would allow a shared grid to be established and simplification of acoustic and fire detailing at compartment lines
- a rationalised design ensuring that everything lines through could lead to larger material efficiencies.

KEY

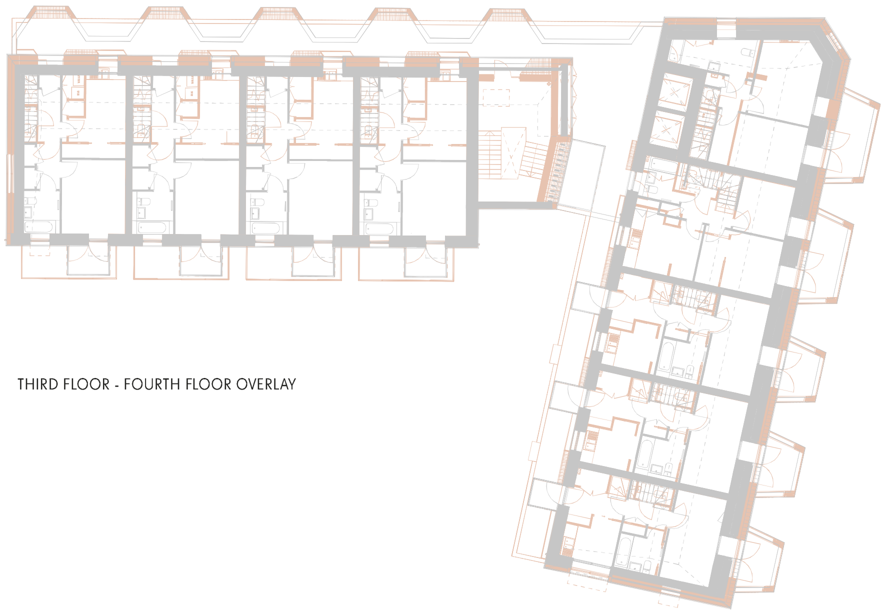
- Ground Floor Plan
- First Floor Plan
- Second Floor Plan
- Vertical circulation
- Wet Areas (Bathrooms/Kitchens)
- Balconies

CURRENT DESIGN - BLOCK A - OVERLAYS



BUILDING A

FIRST/SECOND FLOOR - THIRD FLOOR OVERLAY



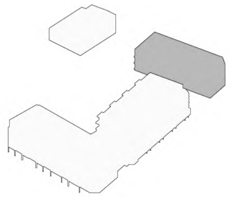
THIRD FLOOR - FOURTH FLOOR OVERLAY

KEY

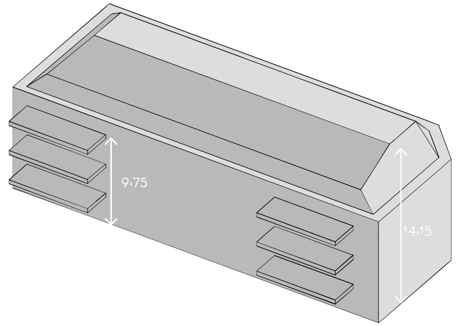
- Ground Floor Plan
- First Floor Plan
- Second Floor Plan
- Third Floor Plan
- Fourth Floor Plan
- Vertical circulation
- Wet Areas (Bathrooms/Kitchens)

BUILD-IN-WOOD

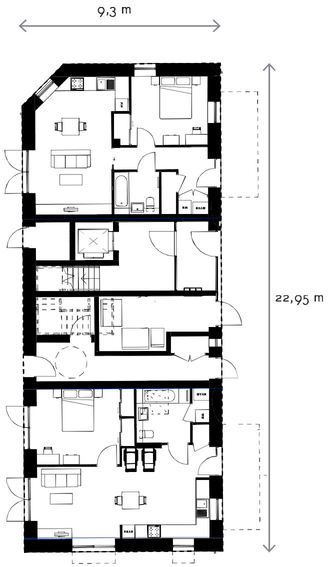
CURRENT DESIGN - BLOCK B - DIMENSIONS



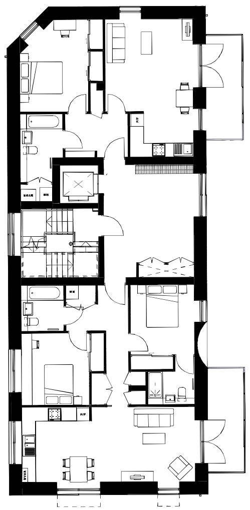
BUILDING B



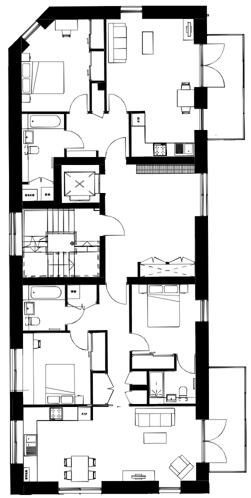
AXONOMETRIC VIEW



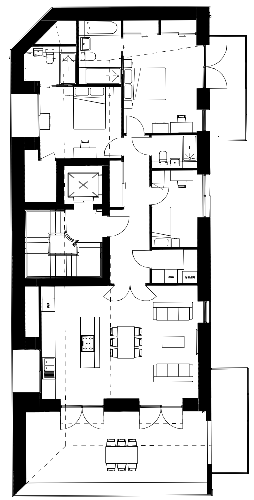
GROUND FLOOR



FIRST FLOOR

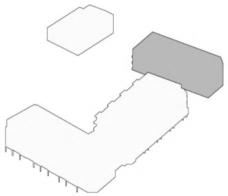


SECOND FLOOR



THIRD FLOOR

CURRENT DESIGN - BLOCK B - OVERLAYS



BUILDING B

Deductions from the plan overlay exercise:
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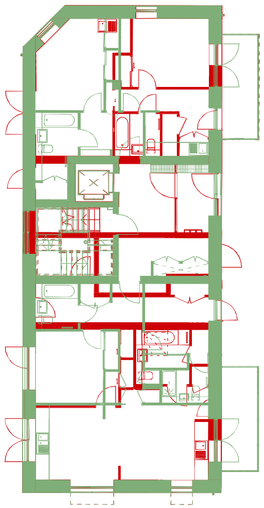
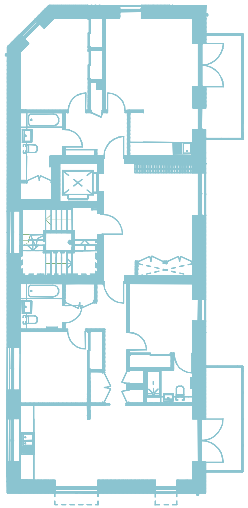
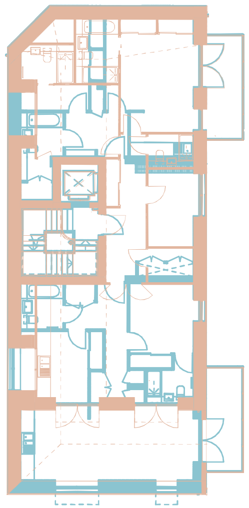
- the stacking of party walls would allow a shared grid to be established and simplification of acoustic and fire detailing at compartment lines
- a rationalised design ensuring that everything lines through could lead to larger material efficiencies.



GROUND FLOOR - FIRST FLOOR OVERLAY



FIRST FLOOR - SECOND FLOOR OVERLAY

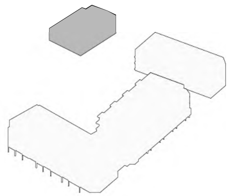


SECOND - THIRD FLOOR OVERLAY

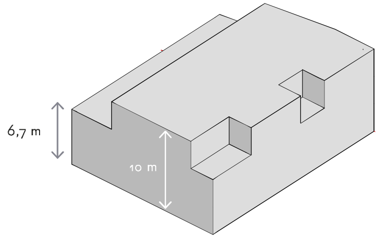
KEY

- Ground Floor Plan
- First Floor Plan
- Second Floor Plan
- Vertical circulation
- Wet Areas (Bathrooms/Kitchens)

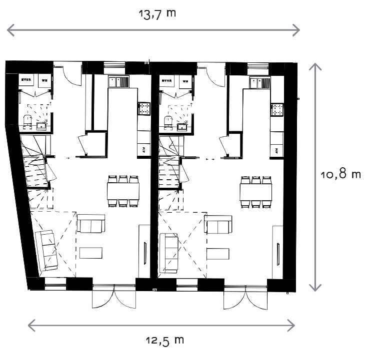
CURRENT DESIGN - BLOCK C - DIMENSIONS



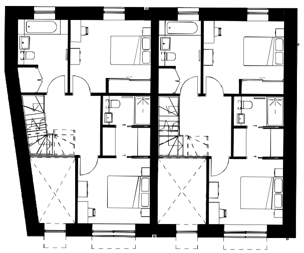
BUILDING C



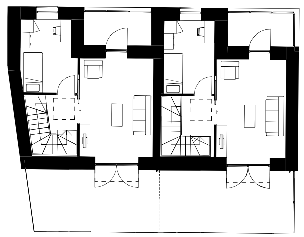
AXONOMETRIC VIEW



GROUND FLOOR

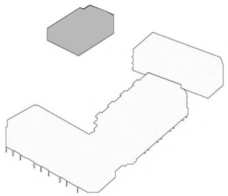


FIRST FLOOR

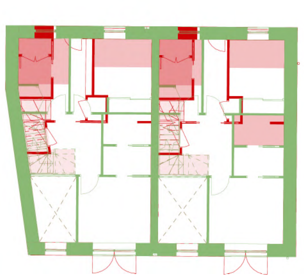


SECOND FLOOR

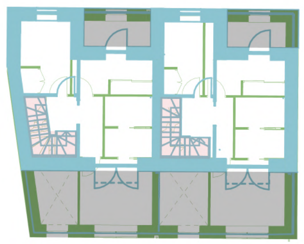
CURRENT DESIGN - BLOCK C - OVERLAYS



BUILDING C



GROUND FLOOR - FIRST FLOOR OVERLAY

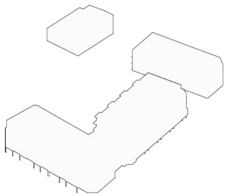


FIRST FLOOR - SECOND FLOOR OVERLAY

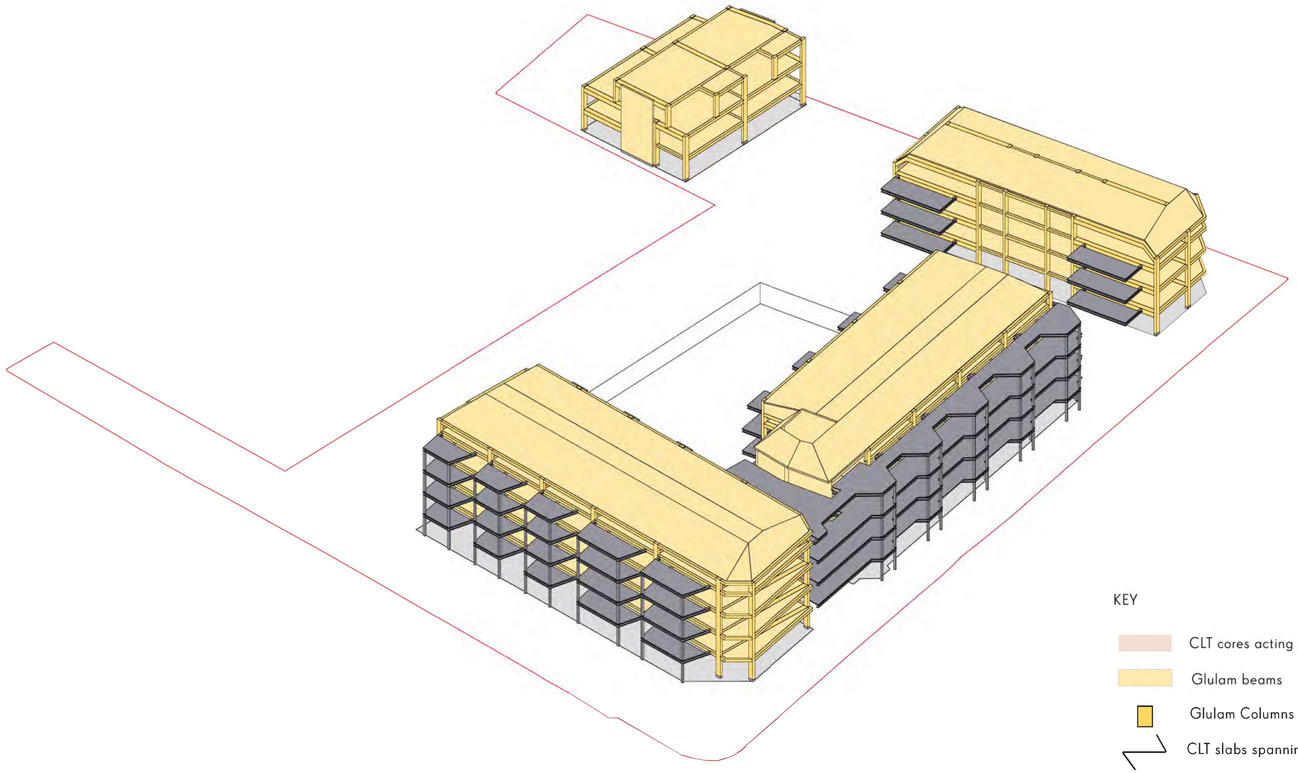
KEY

- Ground Floor Plan
- First Floor Plan
- Second Floor Plan
- Vertical circulation
- Wet Areas (Bathrooms/Kitchens)
- Balconies

BUILD-IN-WOOD SYSTEM DESIGN



BUILDINGS A - B - C

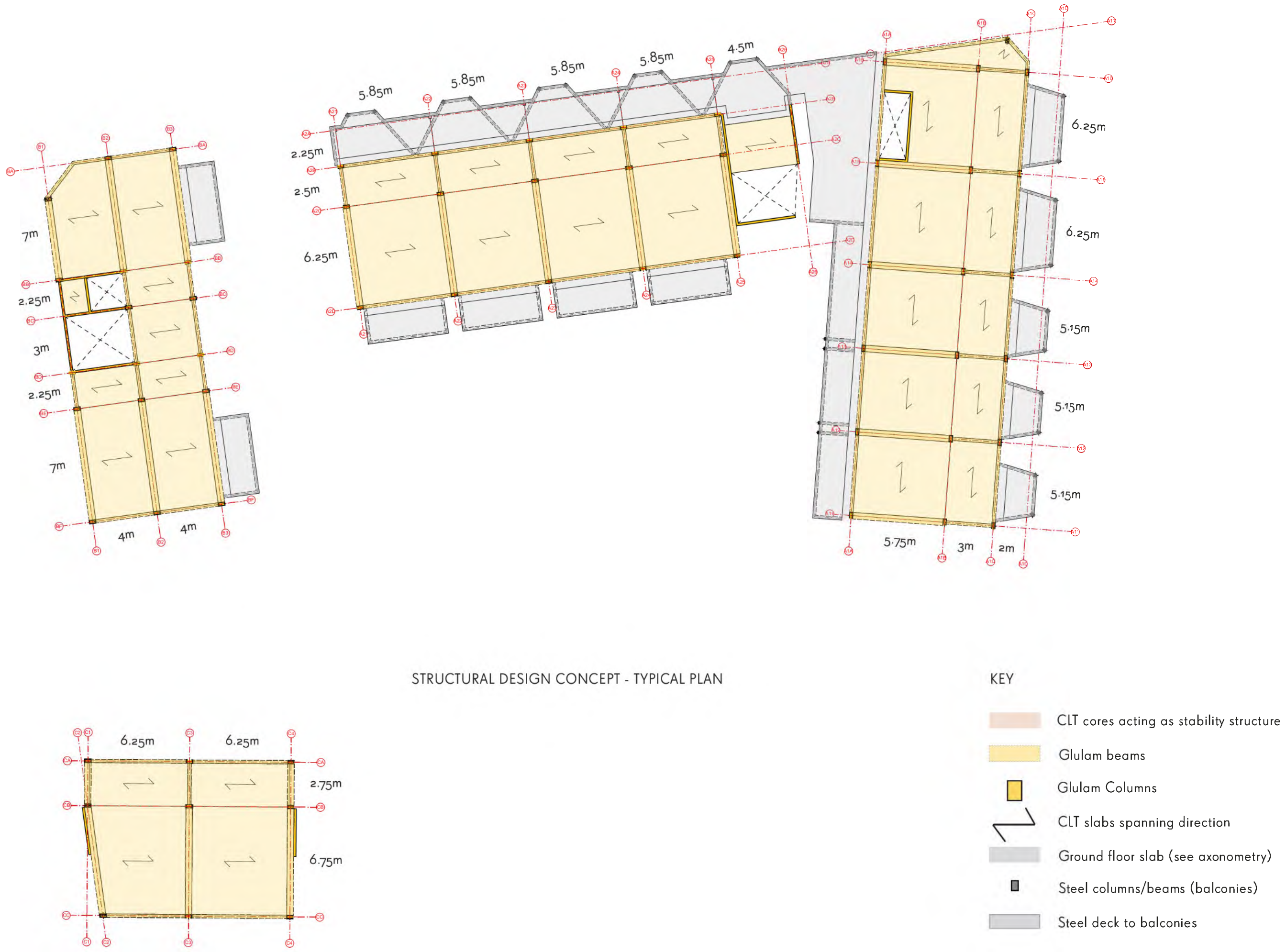


STRUCTURAL DESIGN CONCEPT - AXONOMETRIC VIEW

KEY

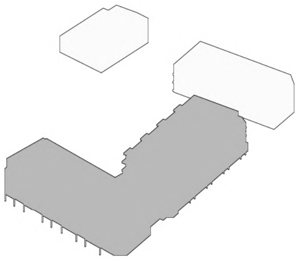
- CLT cores acting as stability structure
- Glulam beams
- Glulam Columns
- CLT slabs spanning direction
- Ground floor slab (see axonometry)
- Steel columns/beams (balconies)
- Steel deck to baclconies

BUILD-IN-WOOD SYSTEM DESIGN

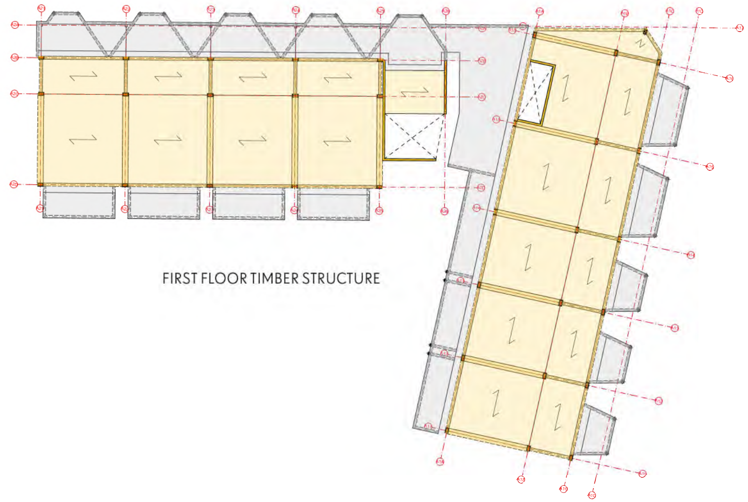


STRUCTURAL DESIGN CONCEPT - TYPICAL PLAN

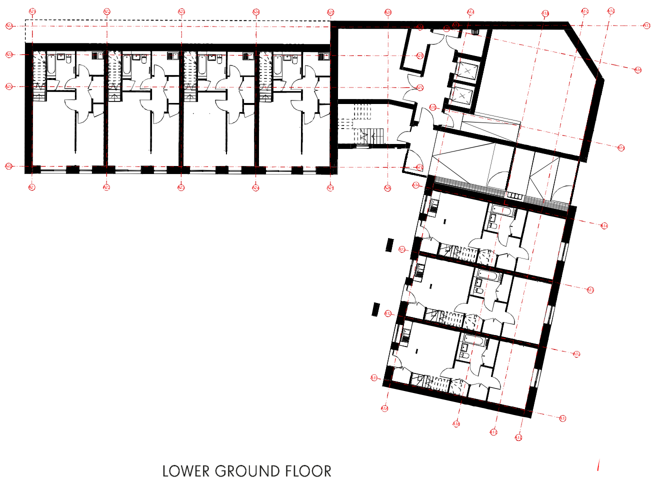
BUILD-IN-WOOD SYSTEM DESIGN



BUILDING A



FIRST FLOOR TIMBER STRUCTURE



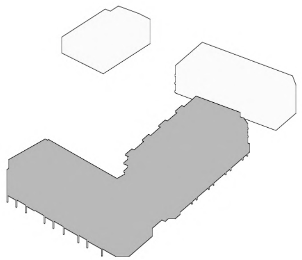
LOWER GROUND FLOOR

GROUND FLOOR

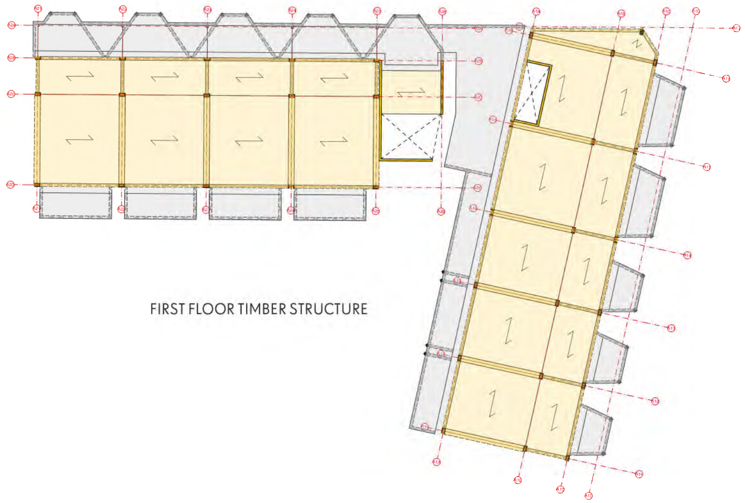
FIRST FLOOR

BUILD-IN-WOOD

BUILD-IN-WOOD SYSTEM DESIGN

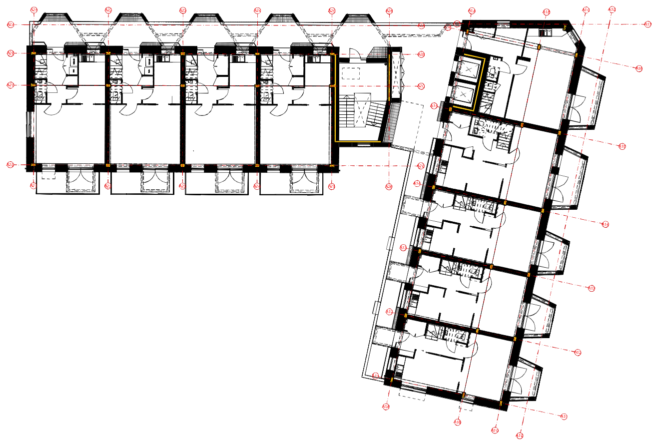


BUILDING A



FIRST FLOOR TIMBER STRUCTURE

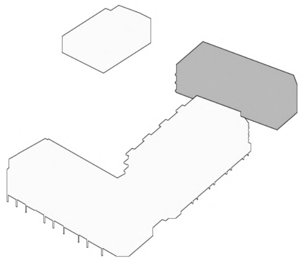
SECOND FLOOR



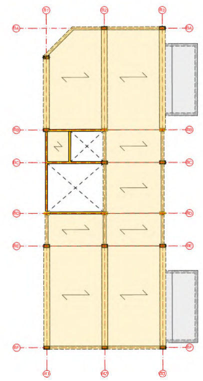
THIRD FLOOR

FOURTH FLOOR

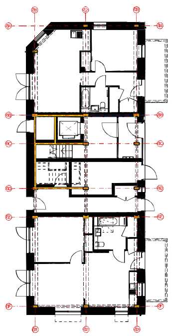
BUILD-IN-WOOD SYSTEM DESIGN



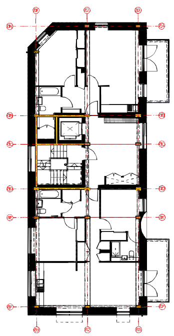
BUILDING B



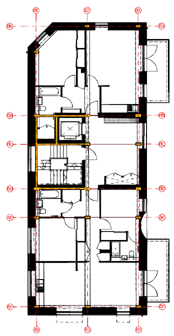
FIRST FLOOR TIMBER STRUCTURE



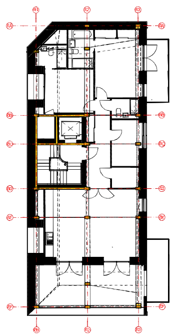
GROUND FLOOR



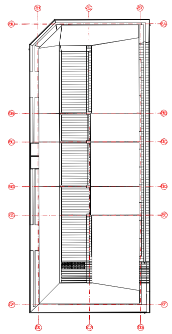
FIRST FLOOR



SECOND FLOOR

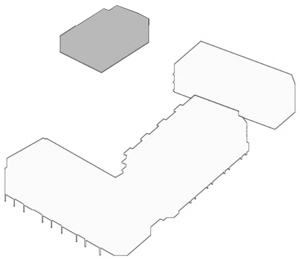


THIRD FLOOR

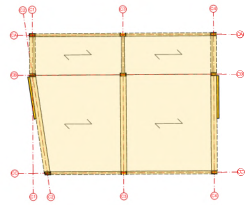


ROOF LEVEL

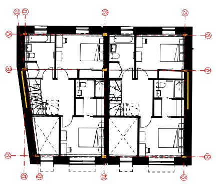
BUILD-IN-WOOD SYSTEM DESIGN



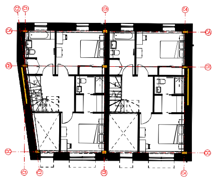
BUILDING C



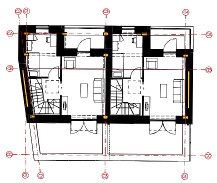
FIRST FLOOR TIMBER STRUCTURE



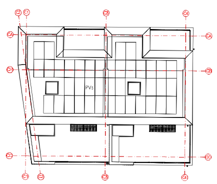
GROUND FLOOR



FIRST FLOOR



SECOND FLOOR



THIRD FLOOR

STABILITY STRUCTURE DESIGN

The extent of, and demands on, the stability structure of a wooden building are influenced by it's size, geometry and location (e.g. site specific wind and seismic conditions).

With this in mind the Build-in-Wood system is designed to allow for two material options for the cores which play a key role in terms of stability: CLT or concrete.

In this particular configuration cores of block A and B can be designed in CLT; as they are of modest height and size; the drawing on this page shows relative position of core and shear walls collaborating in dealing with horizontal forces.

Generally speaking shear walls are positioned perpendicular to the core with full flexibility of their location for buildings at the lower end of the Build-in-Wood height range (4 to 6 storeys) whilst for taller buildings (9 to 10 stories), they are generally integrated into the facade zone. In this instance, for block A in particular, it was necessary to positon shear elements at the maximum possible distance from the cores to allow them to stabilise the relatively long structures with the cores located towards the end of each block.

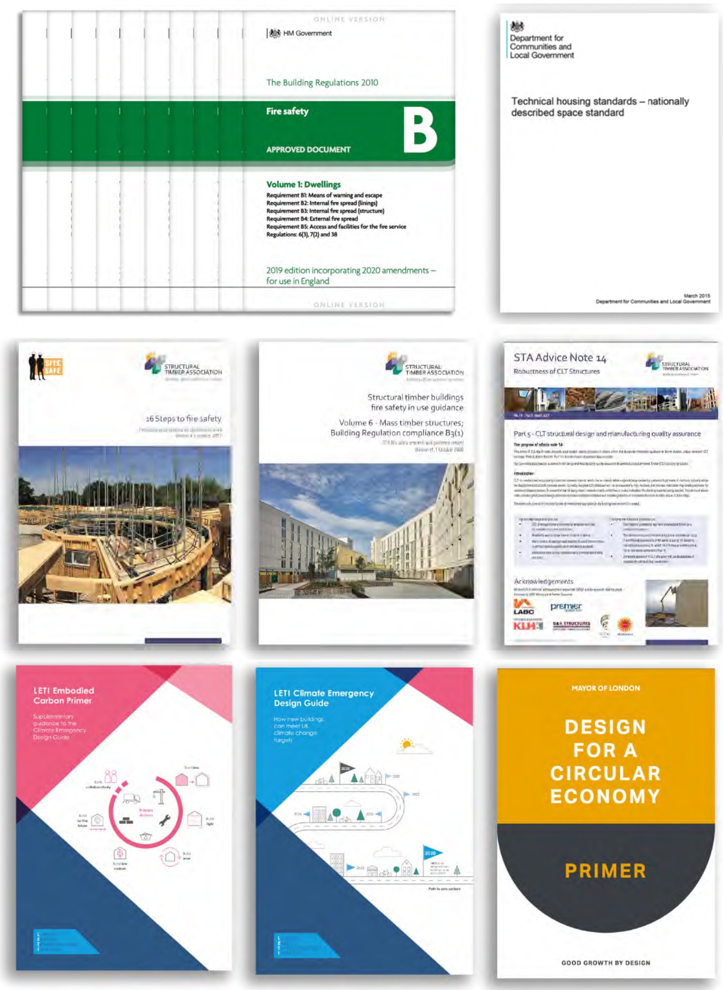
ANNEXES

UK SPECIFIC DESIGN AND PERFORMANCE REQUIREMENTS

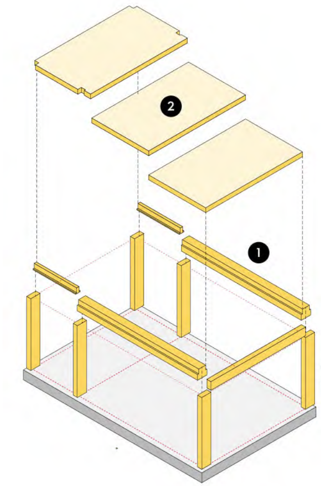
As outlined, the range of performance requirements that the Build-in-Wood structure and façade systems has been designed to adapt to was designed following an extensive review of Building Regulations across Europe at the outset of the project. Whilst individual regulations adapt and change over time, given the spread of performance that is required across the countries studied it is anticipated that the variable solutions developed will be capable of achieving the majority of project specific requirements in any European country for the foreseeable future.

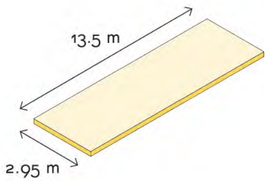
Due to the potential for regulations to be changed over time and due to the subtle nuances in regulations dependent on use, form, height and various other factors, the Build-in-Wood system does not propose a solution for the UK or Denmark or Italy, instead providing solutions for different performance targets and requirements, such as non-combustible materials in certain locations.

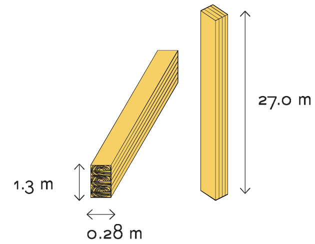
This initial review of regulations across Europe included a review of UK building regulations, space standards and other relevant local guidance such as that provided by the STA and LETI for carbon emissions. This research was expanded upon and looked at in greater detail as part of our 'New Model Building' project (explained in more detail in some of the following annexes) which ensures full compliance with all UK requirements.



BUILD-IN-WOOD STRUCTURE - KEY MATERIALS





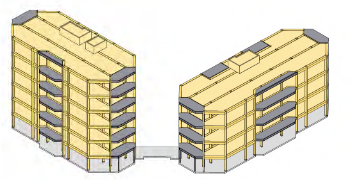


Cross laminated timber (CLT) panels are made from finger jointed sawn timber lengths that are combined to form composite layers arranged perpendicularly to each other to provide structural strength in two directions. CLT panels are available in a range of standard sizes that can be cut down to suit project specific parameters. Most manufacturers suggest designing to 2.95m x 13.5m as these are the most common stock sizes available, and most easy to transport. However, longer, wider lengths are available on request at a higher cost (the largest size panel currelty available on the market is 24.0m x 4.2m wide).

Glulam (GLT) beams and columns manufactured from layers of parallel timber lamellas bonded together with strong, moisture resistant adhesives (relatively small pieces of wood are graded for strength, and then their ends are finger-jointed into lamellas of the required length). Widths and depths of standard sized GLT elements are based on multiples of a lamella thickness (20 to 45mm); manufacturers tend to offer a quite wide range of standard sizes based on these multiples.

MATERIAL		COMPONENTS				FIRE	DURABILITY	
MATERIAL TYPE	BiW APPLICATION	TIMBER SPECIES AND STRENGHT	ADHESIVE TYPE (Kg/m2)	ADHESIVE PROPORTION (g/m2)	DENSITY (Kg/m3)	REACTION TO FIRE (untreated)	SERVICE CLASS	USE CLASSES
1 GLT (Glue Laminated Timber)	Beams and columns	Spruce, fir or pine. Occasionally larch, Douglas fir or even hardwoods GL24 to GL30 strength	MUF (preferred)* or PUR; rarely EPI and PRF (*) Preventing delamination	MUF between 250 and 300	Between 380 kg/m^3 and 500 kg/m^3 depending on type of wood and strenght class	D-s2, d0	Suitable for Service Classes SC1 (heated internal) SC2 (unheated internal) and SC3 (exterior condition)	Suitable for Use Classes UC2 or 3
2 CLT (Cross Laminated Timber)	Cores, shearwalls and floorplates	Spruce, fir; rarely pine, larch, Douglas fir C16 to C24 strength	PUR or MUF (preferred); rarely EPI	MUF btw. 250 and 300 PUR btw. 110 and 150 Note: Some products have glued board edges, and thereof contain more glue	Between 470 kg/m^3 (spruce) to 590 kg/m^3 (larch) at 12% MC (moisture content)	D-s2, d0	Suitable for Service Classes SC1 (heated internal) and SC2 (unheated internal)	Suitable for Use Classes UC1 or 2

BUILD-IN-WOOD STRUCTURE - KIT OF PARTS / QUANTITIES



KERSWELL CLOSE

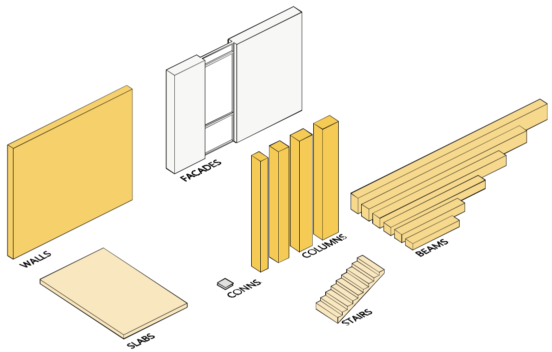
KIT OF PARTS FOR COMPONENTS COUNT

No of columns = 308
0.26m^3 glulam per column = 308 x 0.26 = 80 m^3 glulam

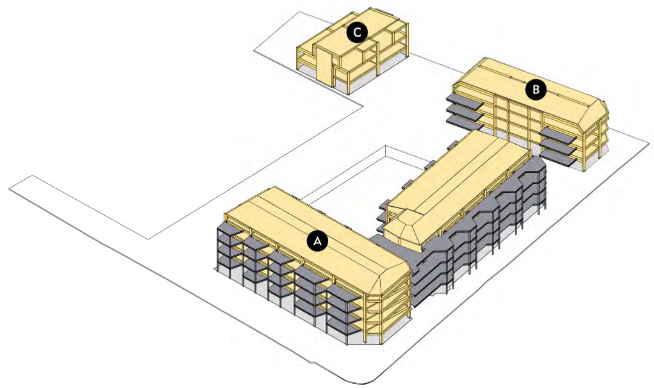
No of beams = 322
181 m^3 glulam

Area of floor slabs = 2,173 m^2
0.2m^3 per m^2 floor slab = 2,173 x 0.2 = 435 m^3 CLT

Length of CLT core / shear walls = 362 m
0.455 m^3 per linear m core/shear wall =
326 x 0.455 = 165 m^3 CLT



KIT OF PARTS



WOODSIDE AVENUE

KIT OF PARTS FOR COMPONENTS COUNT

BLOCK A

No of columns = 170
0.26 m^3 glulam per column = 170 x 0.26 = 44 m^3 glulam

No of beams = 210
121 m^3 glulam

Area of floor slabs = 2,128 m^2
0.2 m^3 per m^2 floor slab = 2,128 x 0.2 = 426 m^3 CLT

Length of CLT core / shear walls = 217 m
0.455 m^3 per linear m core/shear wall = 99 m^3 CLT

BLOCK B

No of columns = 68
0.26 m^3 glulam per column = 68 x 0.26 = 18 m^3 glulam

No of beams = 72
46 m^3 glulam

Area of floor slabs = 559 m^2
0.2 m^3 per m^2 floor slab = 559 x 0.2 = 112 m^3 CLT

Length of CLT core / shear walls = 95 m
0.455 m^3 per linear m core/shear wall = 43 m^3 CLT

BLOCK C

No of columns = 28
0.26 m^3 glulam per column = 28 x 0.26 = 7 m^3 glulam

No of beams = 33
21 m^3 glulam

Area of floor slabs = 276 m^2
0.2 m^3 per m^2 floor slab = 276 x 0.2 = 55 m^3 CLT

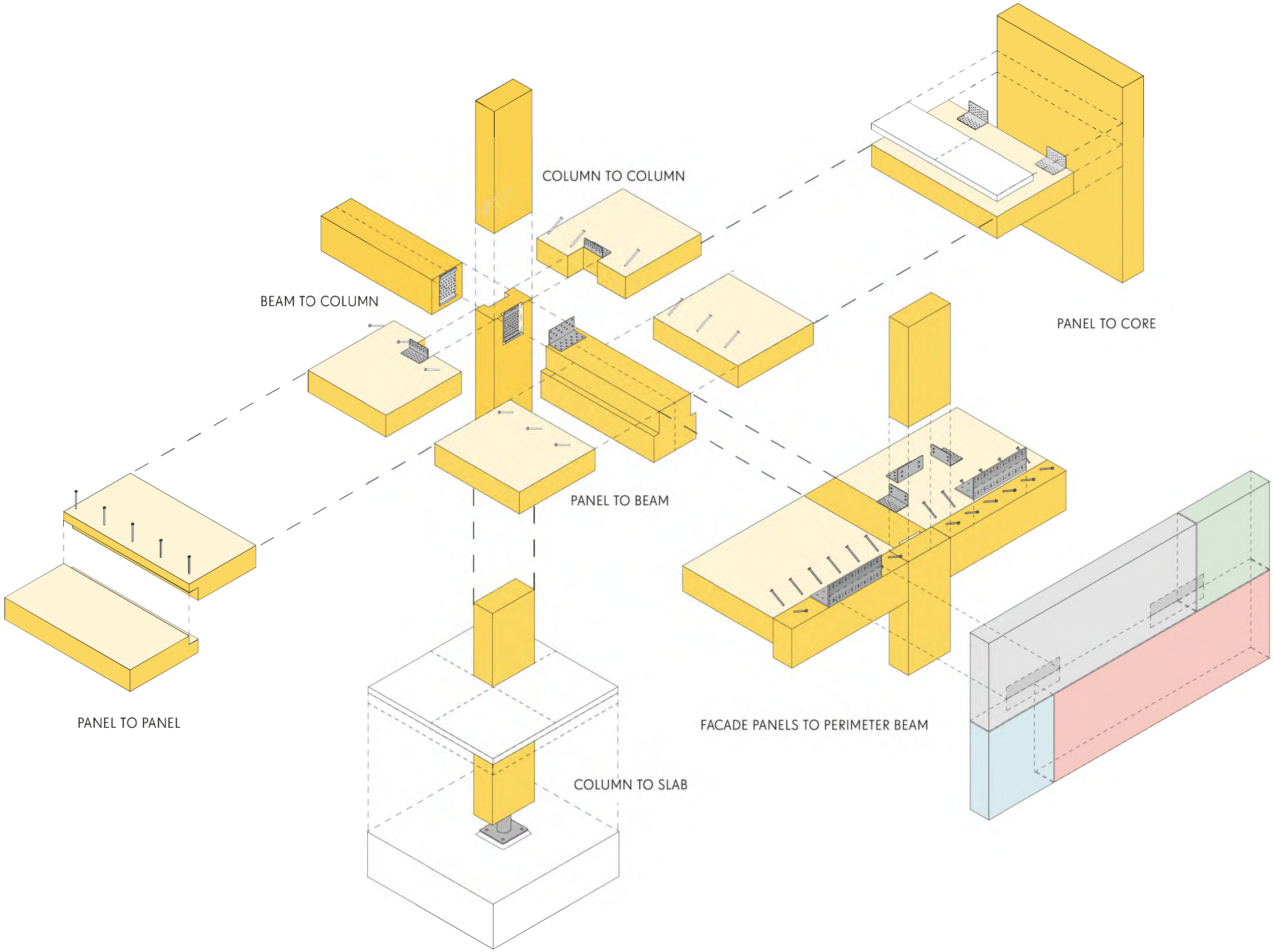
Length of CLT core / shear walls = 18 m
0.455 m^3 per linear m core/shear wall = 18 x 0.455 = 8 m^3 CLT

COMPONENT CONNECTIONS

The Build-in-Wood consortium studied assembly details for key interfaces which predominantly use connectors and products that are widely available on the market from various different manufacturers.

The use of steel connections is unavoidable in timber buildings, but understanding how to simplify the approach to these connections has the potential to offer not only carbon but also cost savings on an engineered timber project and overall optimisation of building performance through the design of well detailed interfces.

Aside from the development of this particularly complex connections node, the project aim has been to focus on the use of a minimal number of pre-existing certified connectors, and to clarify and illustrate how these products can be used.



OVERVIEW OF THE KEY CONNECTIONS THAT ARE BEING USED THROUGHOUT THE SYSTEM

DESIGN FOR DURABILITY

Historic timber buildings illustrate the potential for timber to match, if not exceed, the life span of conventional construction materials. However, the key to ensuring longevity of timber is in preventing the moisture content from exceeding the factory level of around 12% for any extended period. If the timber has been exposed to a leak or water damage it must be dried - by exposure to adequate ventilation - and assessed for repair; this can typically be done using locally sourced timber products.

GROUND INTERFACES

Timber elements must not have contact with the ground and should be raised on upstands or other structural elements to a minimum of 150mm above the final finished floor level.

WATER MANAGEMENT DURING CONSTRUCTION

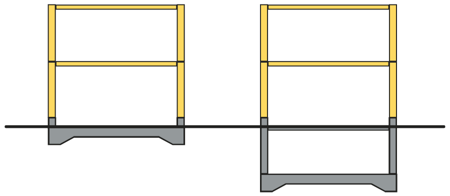
Particular attention needs to be invested to ensure the timber is not wet when the building is made weather tight. Prior to this, design must also be used to keep the timber away from moisture sources, and to ensure that any defects or damage which might expose the structure to water can be quickly and easily identified and rectified.

ROOFS

Roofs must be designed to prevent water sitting on the timber during construction or on failure of a waterproofing membrane, meaning the structure itself must be sloped. The greater the fall/pitch the lower the risk of water pooling when determining the direction of falls/ pitches, consideration needs to be given to avoid draining towards key timber structural elements such as the core, to further prevent water damage to such structurally vital areas.

WET AREAS

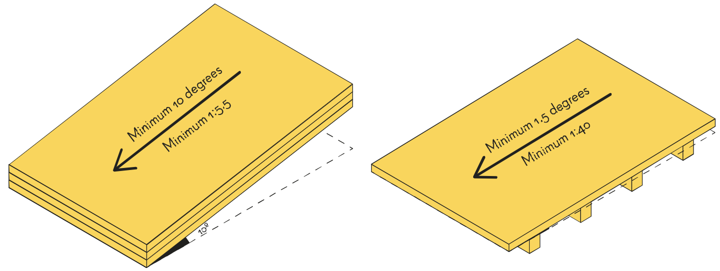
Kitchens and bathrooms should be lined with a wet room tanking membrane; applied to all low level areas, this prevents possible damage from dripping taps or leaks. Full height tanking should be applied to areas of heavy exposure such as showers and baths. Extra protection can be added to areas such as bathrooms by designing them as wet rooms and providing them with moisture sensors that allow to detect water-leaks in real time.



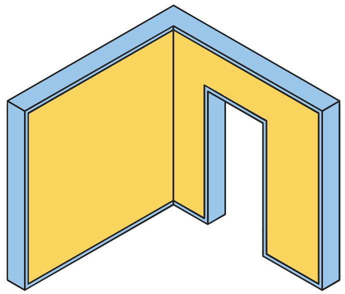
Upstands
Ground floor slab
Foundations

Upstands
Ground floor slab
Basement walls
Basement floor slab
Foundations

DESIGN PRINCIPLE FOR GROUD INTERFACES



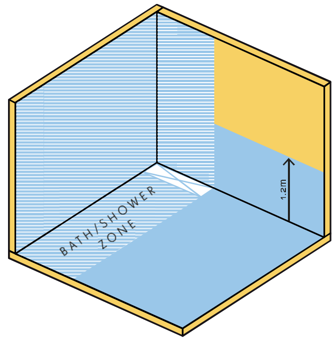
DESIGN PRINCIPLE FOR CLT ROOF PANELS



Area of CLT to be covered with coloured end grain sealer

WATER MANAGEMENT DURING CONSTRUCTION

The use of grain sealant and waterproof grouts is particularly important where the end grain is exposed (e.g. edges/ends of elements and connections) as this is where the material has the greatest hygroscopic action.



Area of CLT to be covered with robust waterproofing layer
Bath/shower zone
Gullies are recommended for additional protection

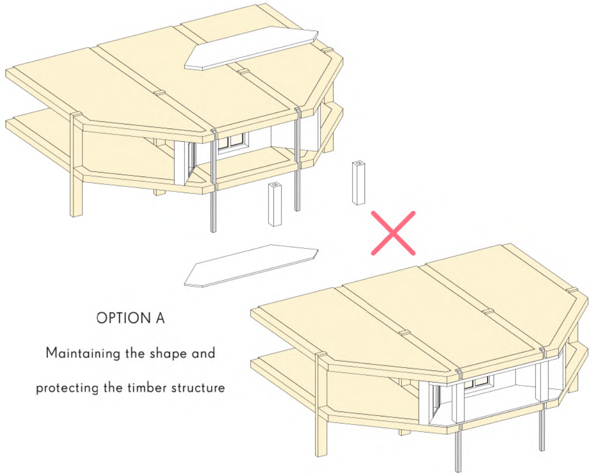
DESIGN FOR DURABILITY

BALCONIES
Balconies that cantilever from the structure, can be supported from the corresponding structural slab by thermally isolated brackets in order to mitigate the impact of cold bridging.

We anticipate that the design of the balconies will be unaffected by the use of the Build-in-Wood system. However it is important to ensure that balcony designs and loadings are defined early in the process to allow the perimeter beams to be sized correctly and it's connections to be specified to take additional forces - other than vertical ones of the facade panel - into account.

Slab/perimeter beam and wall design and specifications are to be defined well ahead of fabrication to cope with the presence of the balconies structures.

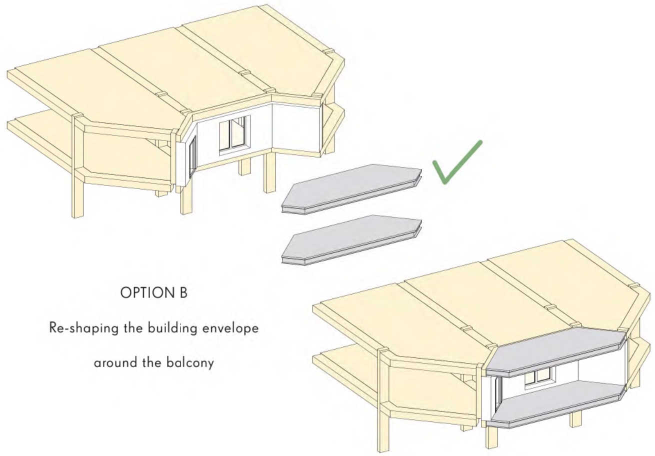
Based on our experience, we do not advocate for balconies, even when slightly recessed like at Kerswell Close, to be constructed as part of the timber structure itself given there is a greater risk for water damage in these locations.



OPTION A

Maintaining the shape and protecting the timber structure

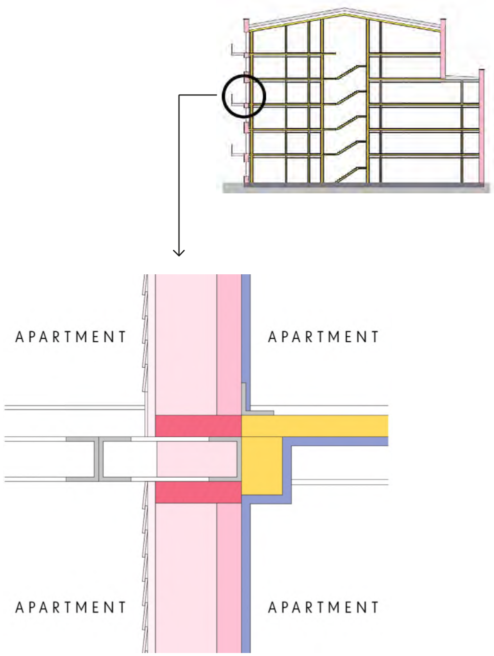
AXONOMETRIC VIEW WITH HIGHLIGHTED BALCONIES



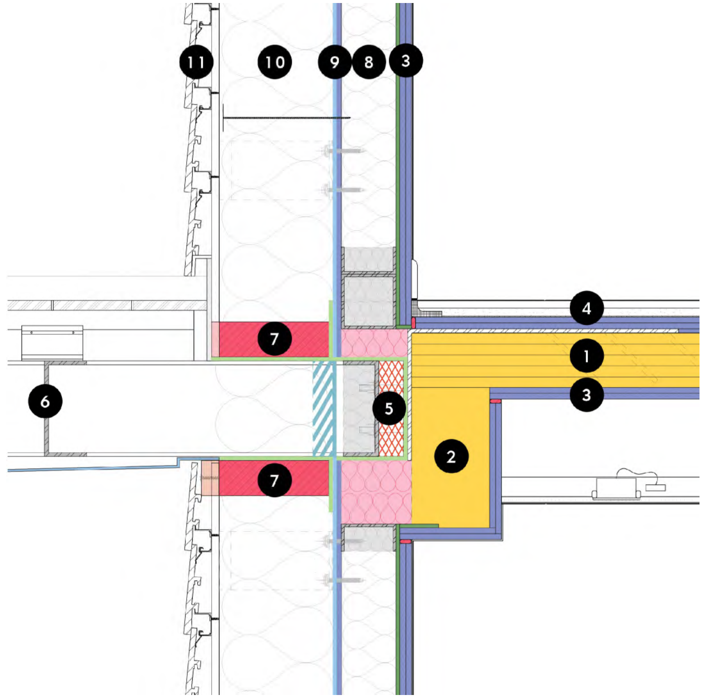
OPTION B

Re-shaping the building envelope around the balcony

TYPICAL BALCONY DETAIL



- Engineered timber structure
- 60 min K class encapsulation
- Fire stop
- Non-combustible materials
- End grain sealant



STEEL BALCONY FIXED TO TIMBER STRUCTURE
(PERIMETER BEAM/CLT SLAB)

KEY COMPONENTS

1. CLT floor panel
2. Mass timber beam
3. Encapsulation
4. Floor finishes
5. Thermally broken balcony connection
6. Prefabricated steel balcony
7. Horizontal cavity barrier
8. Light steel framing system
9. Sheathing board
10. Rainscreen insulation
11. Finishes

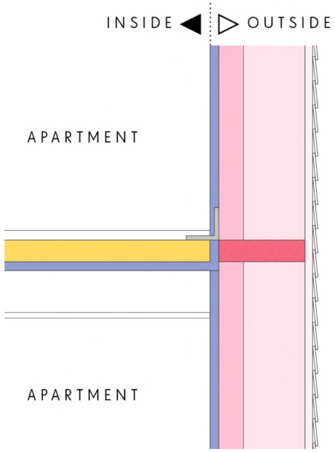
CONSIDERATIONS ON FIRE - NON COMBUSTIBLE FAÇADE

In parallel with Build-in-Wood we have been working over the past year on the "New Model Building" (NBM): a set of design principles that showcase an exemplar methodology for building UK residential developments in a climate emergency.

Fully complying with UK statutory guidance, NBM utilises the Build-in-Wood structural system, alongside a fully non-combustible version of the Build-in-Wood façade system, demonstrating a way of building, within the current UK regulation context, that responds to the challenge of meeting net zero carbon.

The non-combustible façade system is constructed from materials as defined in Approved Document Part B, Regulation 7; with regards to cladding, example materials that could be applied include non-combustible rain-screen cladding materials such as brick, clay tiles, A1 rated carrier systems, boards and insulation materials, light gauge steel framing systems and proprietary steel and aluminium fixings.

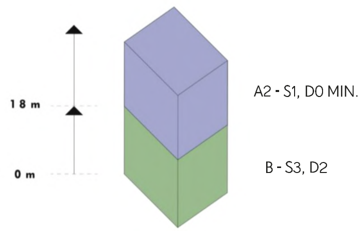
The NMB facade system has been developed from the Build-in-Wood facade system, utilising many shared principles such as the frame opening rules and connection detail, expanding this through specification of fully non combustible material build ups and further interrogation of fire stopping at critical interfaces (e.g. slab edges, penetrations, panel to panel interfaces etc.).



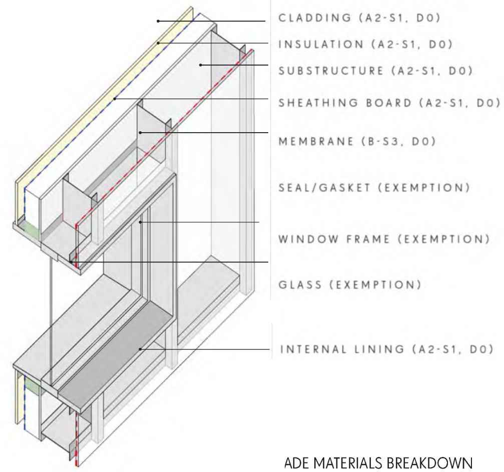
BUILD-IN-WOOD FACADE PANEL DESIGN ADAPTED TO UK FIRE PERFORMANCE REQUIREMENTS

KEY

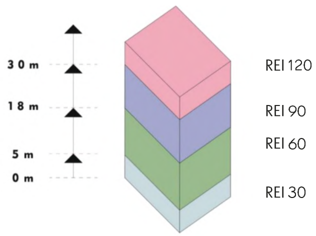
- Engineered timber structure
- 60 min K class encapsulation
- Fire stop
- Non-combustible materials
- End grain sealant



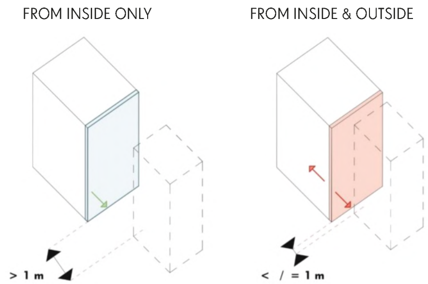
BUILDING HEIGHT AND REACTION TO FIRE



ADE MATERIALS BREAKDOWN



BUILDING HEIGHT AND RESISTANCE TO FIRE



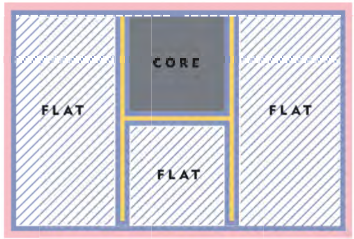
PROXIMITY AND RESISTANCE TO FIRE

FURTHER CONSIDERATIONS ON FIRE

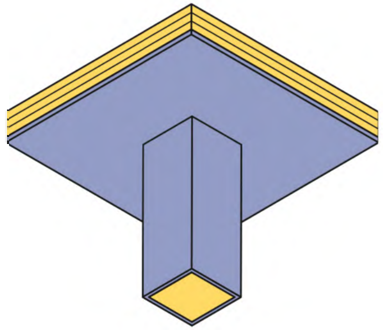
BULDING STRUCTURE
The New Model Building design is fully compliant with all current building regulations, including Part B Regulation 7. The structural design has been developed in accordance with STA Structural timber buildings fire safety in use guidance – Volume 6 – Mass timber structures. As such all timber elements are fully encapsulated with gypsum board applied in accordance with K-class test certifications. It has 60 minutes REI fire compartments following guidance in AD Part B - Table B4. Residential 1a - Block of Flats with sprinkler system - Up to 18m.

DETAILING OF INTERFACES AND PENETRATIONS
Penetrations through the fire compartments are designed to be sealed and treated with the appropriate fire collars and sealants. These are carefully selected to ensure specification, procurement and installation is carried out in line with test certifications or evidence backed engineering judgements.

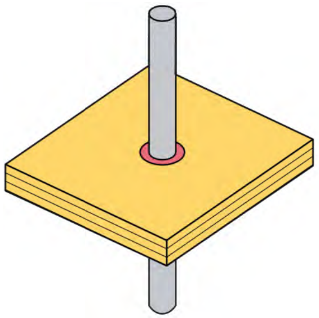
ROOF DESIGN
In a UK context the specification of roof coverings are required to be in accordance with AD Part B and as designated by BS 9991:2015 Table 8 or equivalent European classifications. Our New Model Building project includes the development of a roof build-up which is fully compliant with these requirements and can be applied to the Build-in-Wood structural system.



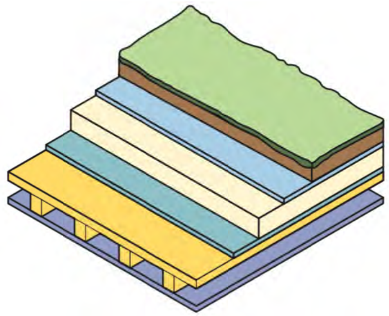
COMPARTIMENTATION PRINCIPLE



ENCAPSULATION PRINCIPLE



VERTICAL / HORIZONTAL PENETRATIONS



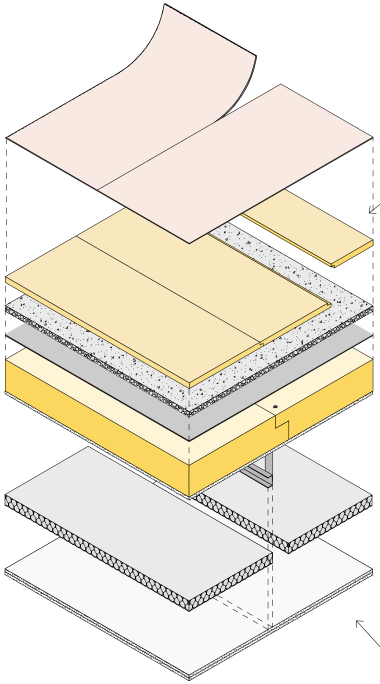
ROOF DESIGN

CONSIDERATIONS ON ACOUSTICS

The principles for mitigating sound transmission are well tested and documented for concrete buildings, however these same principles and calculation methods are not appropriate to mass timber buildings. In fact, a consequence of the lightweight nature of timber is that it performs quite differently to conventional heavy masonry structures in terms of sound transmission.

This acoustic uncertainty is most relevant to the impact sound insulative performance of floors, which has consequently been a key focus of the consortiums attention.

Build-in-Wood has developed solutions to achieve various levels of acoustic performance; these solutions achieve the necessary performance by also prioritising:
- use of 'dry' products which remove the need for wet trades
- de-mountability for better end of life prospects, e.g. preference for mechanical fixings which can be taken apart over the use of adhesives
- use of nature-based materials and products or those with the lowest embodied carbon
- use of lightweight solutions where possible to allow for material efficiency of the structure.



(*)

EXPODED VIEW OF A TYPICAL RESIDENTIAL FLOOR BUILDUP WITH HIGLIGTED COMPONETS AND ACOUSTIC IMPROVEMENT X COMPONENT

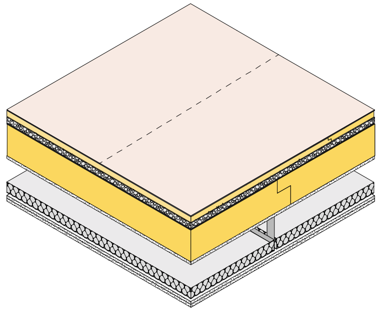
DRY SCREED BOARDS (MECH. FIXED)

GRAVEL/ GRIT OVER DECOUPLING MAT

CLT FLOOR SLABS

MINERAL WOOL INSULATION

SUSPENDED CEILINGS



(*)

60 dB IMPACT / 55 dB AIRBORNE

20 mm dry screed
10 mm impact sound insulation
60 (min.) mm grit
140 mm (min.) CLT slab
void
75 (min.) mineral wool insulation
15 mm (min.) suspended ceiling system

(*) Additonal Plasterboard panel only for fire protection, no acoustic performance

TYPICAL BUILD-IN-WOOD FLOOR BUILDUP ACHIEVING UK SPECIFIC ACOUSTIC PERFORMANCE

CONSIDERATIONS ON CLADDING

The choice of material and setting out of cladding is a unique aspect of every building, consequently the Build-in-Wood facade system aims to offer as much flexibility with regards to cladding as is possible.

However, the focus of the research has been to incorporate cladding materials whose properties align with the requirements for off-site installation.

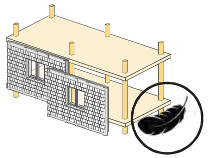
The Build-in-Wood facade system aims to mitigate the need for scaffolding on site, meaning the panels would ideally arrive to site fully externally finished, and are connected back to the main structure from inside the building.

This means the cladding materials chosen must have certain qualities which lend themselves to prefabrication, transportation and installation on site. The cladding materials recommended for the Build-in-Wood system are therefore light weight and robust at the same time (see cladding solutions to the right).

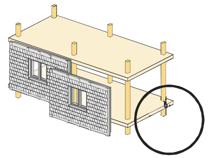
Consideration of the cladding support system is also required to ensure it can withstand the movements and deflections of the panels during transportation and installation, and similarly the fixings must also tolerate these movements without causing damage.

The setting out and detailing of the cladding elements is particularly critical at panel interfaces where consideration should be given as to how to allow movement between panels whilst also achieving the cladding alignment required from a design perspective.

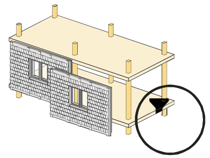
It is also possible to use any traditional site installed cladding system, such as brickwork, however it must be understood that in these situations scaffolding will still be required.
The Build-in-Wood facade system can still offer advantages in these scenarios such as quickly making the building watertight through installation of the panels themselves allowing internal fit out and first fix to commence alongside the brickwork erection.



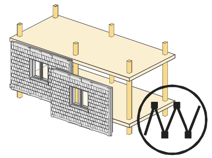
WEIGHT
- The weight of the material affects whether it can be installed in the factory, light weight materials are considered for Build-in-Wood to facilitate fully factory finished panels
- The weight of the panels for transport and lifting on site must also be considered



ROBUSTNESS
- Robust materials are require to allow for offsite construction and transportation of the panels without damage
- Installation of the panels on site also requires a robust material to prevent damage

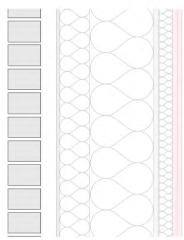


FIXINGS
- The cladding support system can affect whether it can be installed on site, robust battens provide better security than some brackets
- The fixings themselves must be robust for transport and installation, the use of glue as a fixing should be avoided

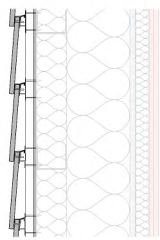


MOVEMENT ALLOWANCE
- It is important to install sufficient movement joints or leave gaps in the cladding which allow for differential movement at the joints between panels

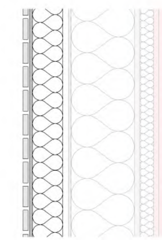
CLADDING AND DFMA - KEY JUDGMENT CRITERIA



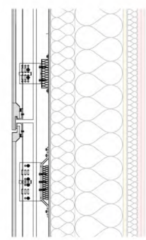
CURRENT DESIGN: TRADITIONAL BRICK CLADDING



ALTERNATIVE SOLUTION: CLAY TILES CLADDING



ALTERNATIVE SOLUTION: BRICK SLIPS



ALTERNATIVE SOLUTION: GRC SHEETS

CLADDING SOLUTIONS

THE WET AREAS CONCEPT

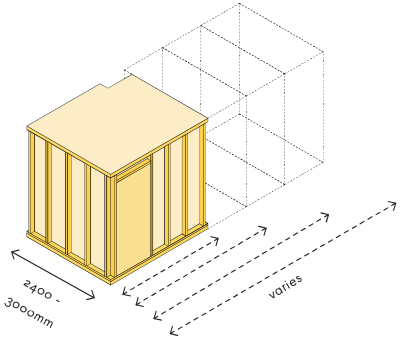
The Build-in-Wood structural system has been designed to accommodate the integration of proprietary volumetric modular wet boxes for bathrooms and kitchens.

These spaces often require a substantial amount of time to complete on site due to the complexity and the extent of services and finishes. This also means that the potential for defects and poor quality workmanship increases. As do the risks associated with the presence of plumbing which, if defective can lead to a risk of moisture damage which is of particular concern in a timber building.

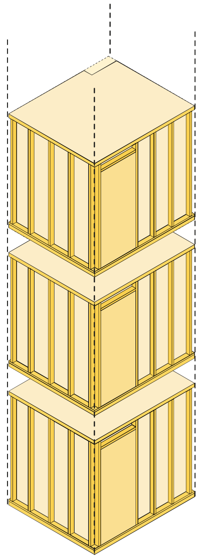
By using off-site assembled modular wet boxes for these spaces, a more accurate and higher quality can be achieved whilst also having the potential to drastically reduce the time and number of trades people on site.

There are various manufacturers of such modular products however the Build-in-Wood system focuses on the integration of modules which use a timber frame and CLT structure that aligns with the aims of the project.

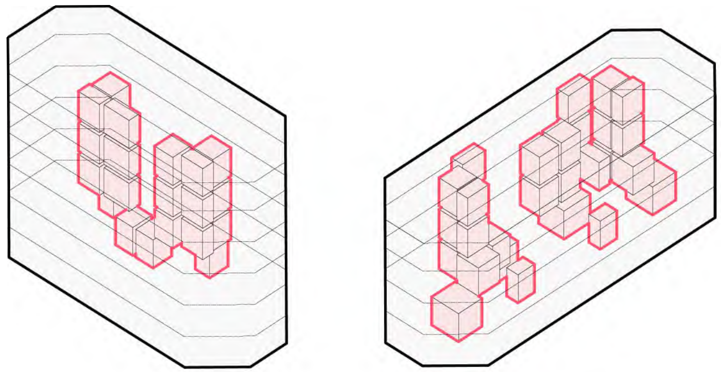
See also the "Design for Durability" annex: Design Principles for Wet Areas in particular.



TYPICAL BATHROOM POD DIMENSIONS



STACKING PRINCIPLE



KERSWELL CLOSE

WET AREAS - AXONOMETRIC VIEW

Note how the stacking principle is only partially followed in the current design; a rationalisation - where possible - of the bathroom pods positioning would allow to achieve a simpler drainage strategy.

LOGISTICS

Given the aspiration to maximise the level of prefabrication of the Build-in-Wood systems, it was of paramount importance to consider the logistics of their manufacture, transportation and installation throughout the design and development process. Analysis was undertaken to outline and consider not only the maximum manufacturable size of different elements, but also the maximum size for transportation on a standard lorry and how this is influenced by the proposed stacking / configuration of elements which also influences the efficiency and subsequent cost of transportation.

SITE ACCESS/STORAGE

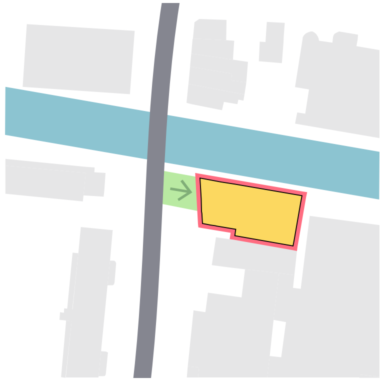
Due to the scope of the systems being so far reaching, different access scenarios had to be considered. Whilst some more rural sites may not specifically preclude the use of oversized loads, having modestly sized components that can be transported on standard lorries and easily craned into place would allow transportation costs and programme to be optimised in all scenarios, also increasing the potential for future disassembly and re-use. Just in time delivery is standard for engineered timber buildings meaning limited space for storage on site is not problematic, whilst also minimising the length of time these highly finished components are spent on site where they could be damaged or stained by moisture and UV. Due to the light weight of timber typically mobile cranes can also be used offering further benefits on constrained sites.

TRANSPORT

The orientation of prefabricated components during transportation can have bearing on the level of prefabrication possible, such as the requirements for façade panels with pre-installed external windows and doors to be transported in their 'final' orientation to prevent damage to the gaskets and seals. The decision to pre-install these components therefore also has bearing on the orientation of panels, the maximum panel height and the 'stacking' strategy for the lorry. For this reason the Build-in-Wood façade system is designed as single storey 'horizontal' panels of modest sizes that correlate to the structural grid.

INSTALLATION

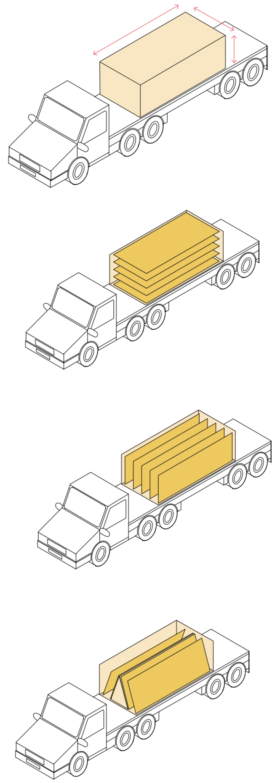
The single storey, horizontal configuration of the façade panels for the Build-in-Wood system also ensures that the panels do not need to be 'rotated' during installation which is not only practically difficult due to wind and other external factors but also typically causes the highest stresses to the panels and can require additional material either within the panel itself or as temporary support.



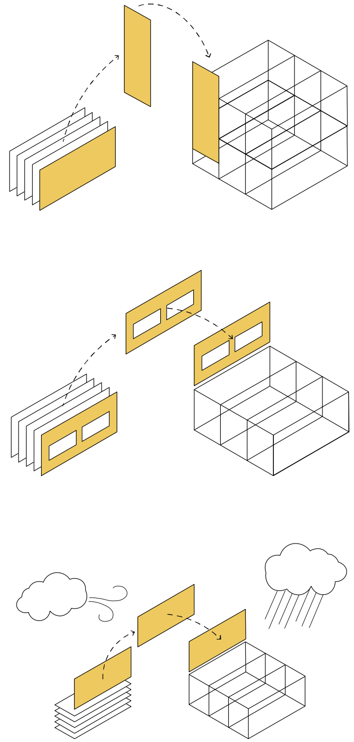
URBAN -CONSTRAINED SITE

PERI-URBAN SITE (INFRASTRUCTURAL CONSTRAINTS)

SITE CHARACTERISTICS



TRANSPORT



INSTALLATION

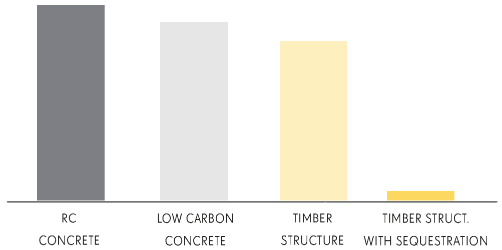
EARLY STAGE LCA : DATA DRIVEN CHOICE

As awareness of the significance of embodied carbon raises, the ability to undertake high level life cycle analysis at early stages to inform design decisions is becoming relevant and essential, in the same way that passive design principles and building regulations have been informing the design process to reduce future operational carbon emissions for years.

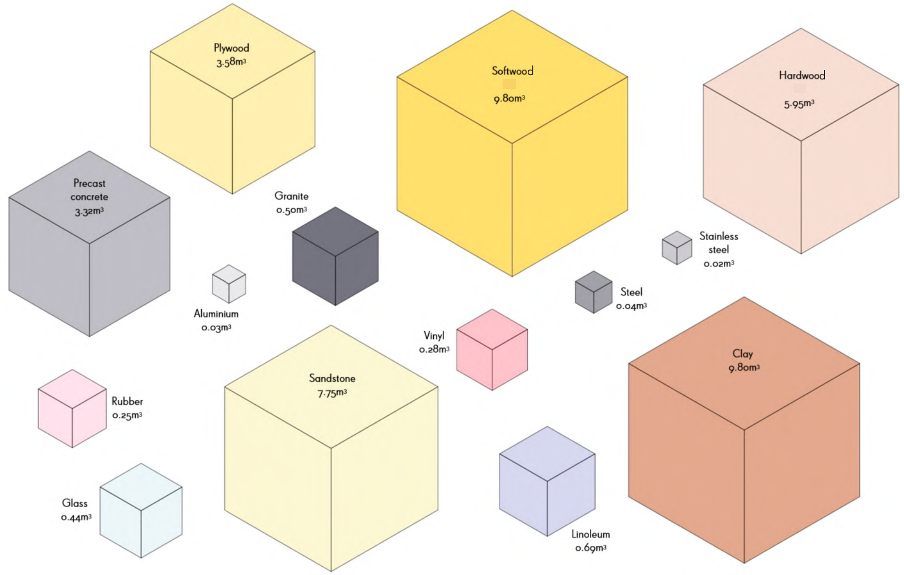
Understanding that all virgin materials have a carbon cost associated with their extraction/harvesting, processing and then delivery/installation is the starting point to understanding how we can reduce the embodied carbon of our buildings. Re-using existing buildings, through retrofit, and following that re-using materials/components in new projects will keep emissions at their lowest practical level, but at present the availability of materials for re-use is minimal. As such an understanding of the carbon cost of different material options, understanding whether recycled materials are available for each and how their embodied carbon compares, whilst also considering the quantity of material and its respective maintenance and lifespan can ensure that a holistically low embodied carbon solution is selected.

In the Build-in-Wood project our primary focus has been on substituting the material for the buildings primary structure, from carbon intensive concrete and steel to low carbon wood. Given the volume of material in the primary structure this is a logical place to start but also does not negate the requirement for consideration of material choices in other areas of the buildings design, which must also be considered through early stage LCA of the full building or specific aspects (such as the façade).

Using a lightweight material such as timber and striving for material efficiency also allows other knock on embodied carbon savings due to reductions in material volumes particularly for carbon intensive aspects such as foundations. Whilst timber stores carbon which contributes towards a new urban carbon store, this should never be used to justify unnecessary and redundant material use to offset other carbon intensive materials elsewhere in the building. For this reason we advocate following an embodied carbon target approach like that of LETI, which excludes the consideration of sequestration for the initial embodied carbon target, instead considering and quoting this separately as an additional benefit once the embodied carbon has been driven to the lowest practically achievable amount.



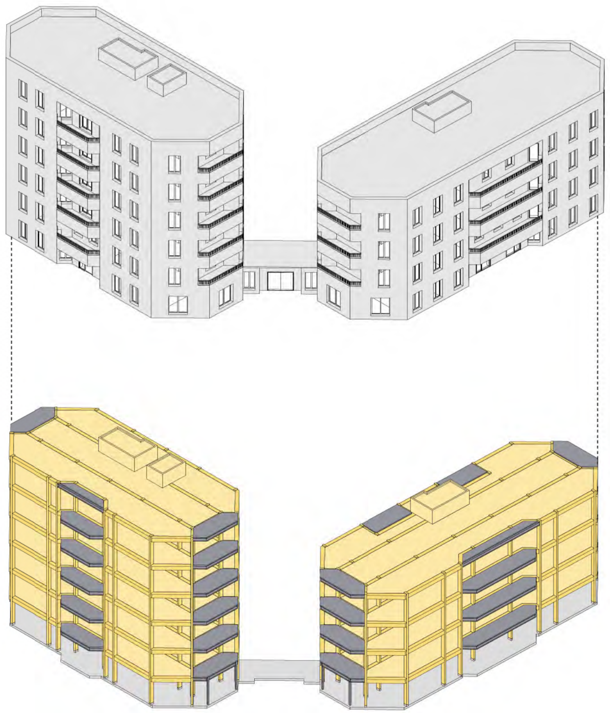
EMBODIED CARBON OF BUILDINGS WITH DIFFERENT STRUCTURES (GENERIC DATA)



VOLUME OF MATERIAL THAT CAN BE PRODUCED FOR 1 TONNE CO_2E

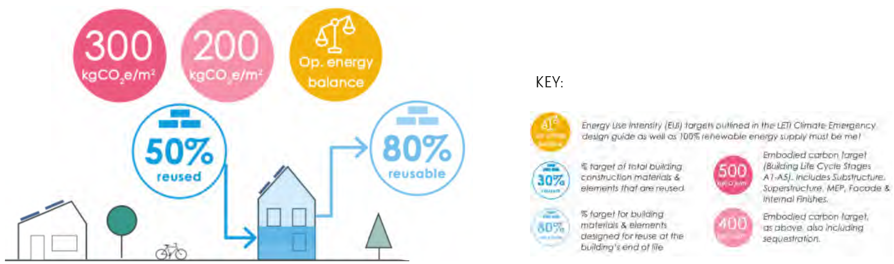
(Source: In the Scale of Carbon Poster – Materials Council, 2013)

EARLY STAGE LCA - KERSWELL CLOSE



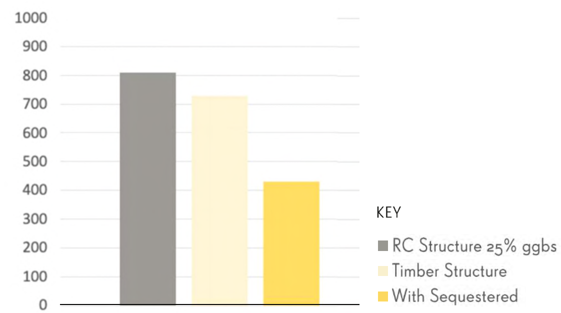
KERSWELL CLOSE DEVELOPMENT

GIA: 2881 m2 - 4 to 6 storey



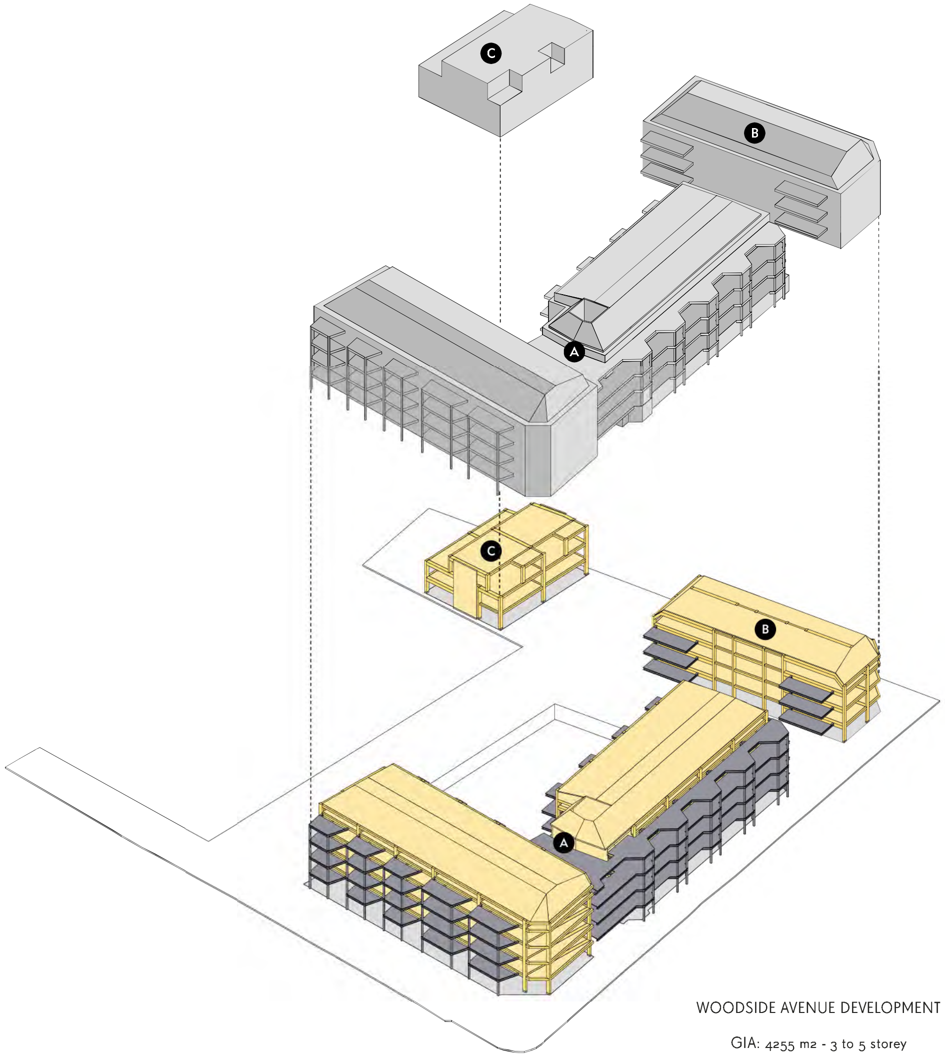
LETI WHOLE LIFE EMBODIED CARBON REDUCTION TARGETS FOR RESIDENTIAL BUILDINGS (2030)

(Source: LETI Embodied Carbon Primer, Ed. 2019)



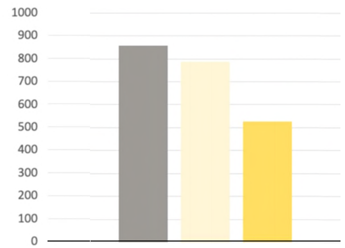
KERSWELL CLOSE DEVELOPMENT - EMBODIED CARBON A1-C4 KGCO2e/m2

EARLY STAGE LCA - WOODSIDE AVENUE

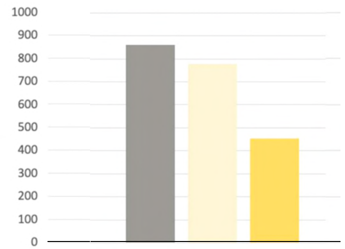


WOODSIDE AVENUE DEVELOPMENT

GIA: 4255 m2 - 3 to 5 storey



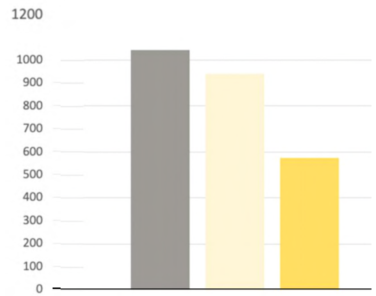
WOODSIDE AVENUE DEVELOPMENT - Build. A - EMBODIED CARBON A1-C4 KGCO2e/m2



WOODSIDE AVENUE DEVELOPMENT - Build. B - EMBODIED CARBON A1-C4 KGCO2e/m2

KEY

- RC Structure 25% ggbs
- Timber Structure
- With Sequestered



WOODSIDE AVENUE DEVELOPMENT - Build. C - EMBODIED CARBON A1-C4 KGCO2e/m2

68

SYSTEM DISASSEMBLY

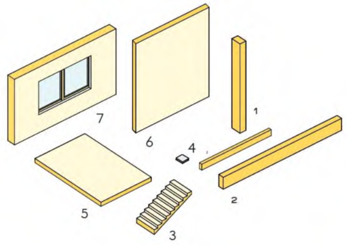
Almost all buildings built up to the early 2000s, were not designed for deconstruction: their life-cycle was conceived as linear (design - construction -demolition-disposal of construction waste), designers conceived buildings as permanent artefacts.

Design for deconstruction (DfD) is not a mainstream concept yet research and thinking into this concept has been increasing for some time, however clear guidelines and standard practices about how to achieve this are only now emerging despite the many, clear benefits that such a design approach generates such as:
- Reduction of construction waste plus the related pollution and carbon emissions
- Saving embodied carbon of materials / components that are going to be re-used or further used ideally for multiple life cycles
- Huge savings in raw materials consumption

All these benefits become evident at the "end of life phase" of buildings but need to be considered as goals from the early design phases when strategic decisions are made about materials, build-ups, connections, interfaces detailing etc. Ideally outline disassembly strategy plans should be drafted by the design team at the outset of a project.

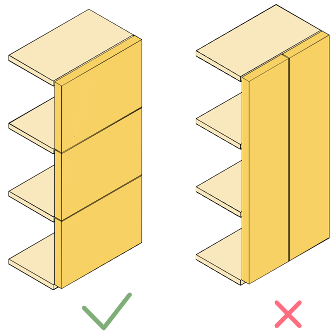
For the Build-in-Wood system we have focused on the six disassembly strategies which are visualised here. Our goal is to enable the timber building to act as "material banks" in the future.

This system is characterised by the repetition of a common module with sub-modules/increments that allow for dimensional flexibility. An intuitively simple structure with clearly defined primary (posts, beams etc.) and secondary components (floor-plates, shear walls, cores and façade panels) is formed by a kit of parts the components of which have standardised dimensions and are optimised in terms of structural performance, material efficiency and transportability (max. Dimension and weight). Connections are repeatable and demountable; they can be accessed relatively easily and rely on screws rather than adhesives or nails. All components are IDd and consequently traceable in future.



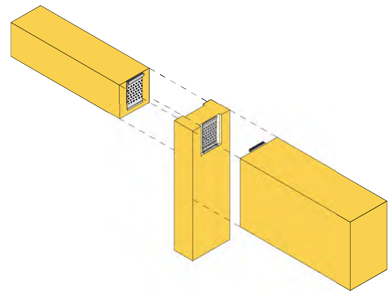
MINIMAL REPEATED COMPONENTS

System is easily legible and components easier to reuse due to 'standard' sizes.



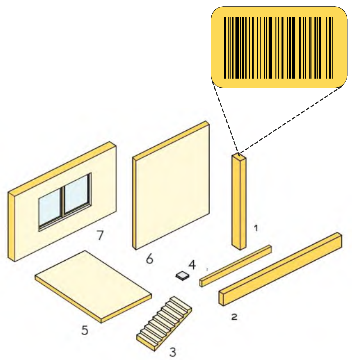
MODEST, LIGHT COMPONENT SIZES

Relatively small light components facilitate de-mounting, reducing the likelihood of damage and easing transportation for further processing or re-use.



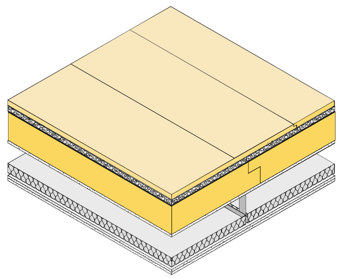
INTERFACES DESIGNED TO BE EASILY TAKEN APART AND POSSIBLY WITHSTAND MORE THAN ONE USE

We foresee the use of connections which allow for more than one use (where possible) to facilitate re-assembly of disassembled components with minimal processing.



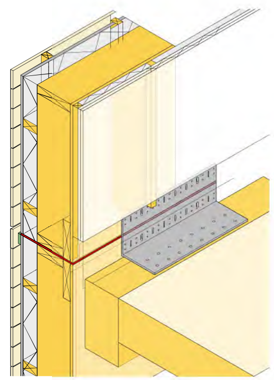
COMPONENT ID AND DATA

Components must be easily identifiable with quantitative and qualitative data made available for future users (e.g. through digital twin) as well as clear documentation describing method of deconstruction and component interdependencies.



USE OF DRY PRODUCTS AND MECHANICAL FIXINGS

Dry products and mechanical fixings in lieu of adhesives, makes it easy to separate different materials and elements without damage to components



EASY ACCESS TO CONNECTIONS

Connections made at low level from the building interior allow for easy and safe installation and straightforward access for demounting.

GLOSSARY

- Adaptability
"the quality of being able to adjust to varying or changes in conditions and requirements"

- BIM
Building Information Modelling. The collected data of the building. Often containing a 3D representation.

- Buildability
Pre-construction exercise that looks at a design from the perspective of those that will manufacture, install components, and carry out the construction works.

- Carbon footprint
Used as a collective term for greenhouse gases. Often measured in Carbon dioxide equivalents (CO_2e).

- Circular economy
CE aims to keep materials, components, products and assets at their highest utility and value at all times; material goods are designed and produced to be more durable, and to be repaired, refurbished, disassembled and reused endlessly.

- CLT
Cross-laminated timber.

- CNC machine
Computerised Numerical Control. A drilling and machining tool controlled via digital input.

- Collaborative design
Close working and partnership of everyone involved in the design and construction of a building, often facilitated by BIM.

- CDE (Common data environment)
Common data environment (CDE) is a digital location where information from consultants is combined.
- Decibel (db)
Measurement for the intensity of sound.

- DfMA(D)
Design for Manufacture and Assembly and Disassembly. Design for the ease of manufacture of parts and for the ease of assembly and disassembly.

- Disassembly
A non-destructive taking apart of an assembled product into constituent materials or components (BS8887-2:2009,3.11)

- Dynamic amplification
Multiplication of stress caused on a static load when a dynamic load is applied.

- Durability
Expectation that the structure or component will perform adequately in the context of the specified Design Working Life, Service Life and Use Class.

- Ease of disassembly
Assessment methods developed to measure the disassembly level/ potential of building components.

- Employer's requirements
Document produced by the client setting out their brief in terms of requirements and specification.

- Embodied carbon
Carbon dioxide (CO_2e) emissions generated from the formation of buildings, their refurbishment and subsequent maintenance.

- Encapsulation
The approach of protecting building elements by the application of fire lining.

- End of life
The end of life stage of a building starts when the building is decommissioned and not intended to have any further use. At this point, the building's demolition/deconstruction may be considered as a multi-output process that provides a source of materials, products and building elements that are to be discarded, recovered, recycled or reused.

- Eurocodes
Ten European standards specifying how structural design should be conducted within the EU.

- GLT (Glulam)
Glue Laminated Timber.

- Installation
On site works.

- Design Working Life
Assumed period for which a structure or part of it is to be used for its intended purpose with anticipated maintenance but without major repair being necessary.

- Life - Service life
Period of time from handover to First Maintenance Activity.

- LVL
Laminated veneered lumber.

- Manufacturing
Building the building system components within a factory environment.

- Material efficiency
Process of undertaking a building project enabling the most efficient use of materials over the life cycle of the building and its components e.g. using fewer materials.

- NIA (Net Internal Area)
The net internal area (NIA) of a building is the usable area measured to the internal finish of the perimeter or party walls at each floor level. Net internal area covers all areas that can be used for a particular purpose. NIA excludes internal structural walls

(columns, piers etc.), walls enclosing excluded areas, lifts, stairwells including landings and Corridors and other circulation areas used in common.

- GIA (Gross Internal area)
the area of a building measured to the internal face of the perimeter walls at each floor level. The GIA excludes perimeter wall thickness's, canopies, external open-sided balconies, covered ways and fire escapes as well as voids over or under structural raked or stepped floors.

- Off-site
Term for assembly and fabrication of items for construction away from the building site.

- On site fire strategy
A required strategy outlining measures to prevent and manage fire during the construction phase both on-site and off-site.

- On site
Work carried out on the construction site, as opposed to work carried out in the factory/off-site (see prefabrication).

- On site waterproofing strategy
A required strategy outlining how water will be managed on site during the construction phase both on-site and offsite.

- System
Systems are a giant 'kit of parts': a set of pre-engineered components that go together in defined ways to produce structures very efficiently. Flexibility is designed in, so that a single platform can produce an almost infinite range of different structures.

- Plug and play
MEP services that are intended to work immediately when first used or connected, without reconfiguration or adjustment by the user.

- Prefabrication
Prefabricate describes assemblies/components that are manufactured under factory conditions and then transported to construction sites for incorporation into a building.

- PSI value
The linear thermal transmittance of an element, which is used to calculate the heat loss or gain through a thermal bridge.

- Redundancy
The over-scaling of a system or component to enable back-up in the case of failure or system scale / weight increase or different potential unknown scenarios.

- Sequestered Carbon
Trees absorb CO_2 from the atmosphere while they grow. This CO_2 remains locked in the timber until the end of its life.

- Thermal (cold) bridging
A path of least resistance for heat transfer, created by a component or area which has a higher thermal conductivity than its surrounding materials.

- Tipping point
The point at which a series of small changes or incidents becomes significant enough to cause a larger, more important change. In the context of Build-in-Wood, this is the point at which incremental increase/decrease in a given performance of a particular component becomes inappropriate to achieve in the current configuration or material and so a significant alteration is proposed to the component for performance levels beyond this point.

- U-Value
Measurement of the transmission of heat through a building element.

- Use Class
The environment to which the structure or Component will be exposed, as defined in BS EN 335

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BUILD IN
WOOD

Innsbruck

Arbeitspaket 3 / Pilotprojekt

CF MØLLER
ARCHITECTS

Zanierhaus, HVW Archi[illegible]

Mühlweg, Wien, HK Arc[illegible]

Vikaholm, C.F. Møller Architects

Housing at Kaspar Wey[illegible] [illegible] Werner Burtscher and Snøhetta Studio

Wohnanlage Niedermühlbichler Gründe, HK Arc[illegible]

Wohnanlage Schützens[illegible] [illegible] Architekten

[illegible]

[illegible]

[illegible]

Projektrahmen
Innsbruck, IIG

Betreutes Wohnen
930m² NF

Kindergrippe
245 m² NF

Mietwohnungen
1,650 m² NF

Gewerbe
400 m² NF

Kindergarten
370 m² NF

NF gesamt: 3595 m²
BGF: ca.
5,500-6,000 m²

Nachbargebäude an der Grundstücksgrenze

Ansicht von der Straße, Grundstück auf der rechten Seite (Südostecke des Grundstücks)


Blick von der Mitte des Geländes auf die vorhandenen Bäume und die Nachbarschaft


Blick auf die nordöstliche Ecke des Geländes


Blick auf die Geländeunterschiede im nördlichen Teil des Geländes

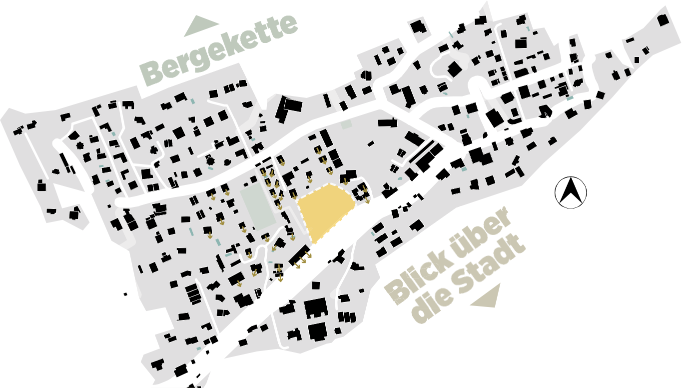

Fußweg von der Baustelle und nach Nordwesten zwischen dem Wohngebiet

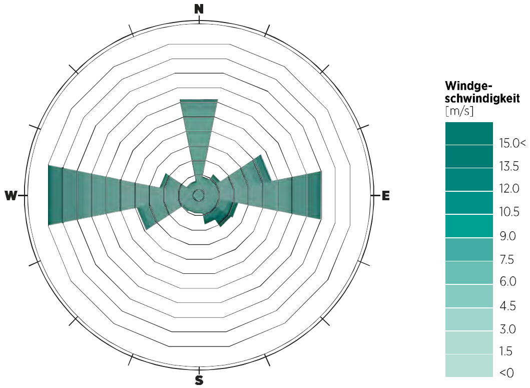

Blick auf die Baustelle von Süden auf die Berge im Norden

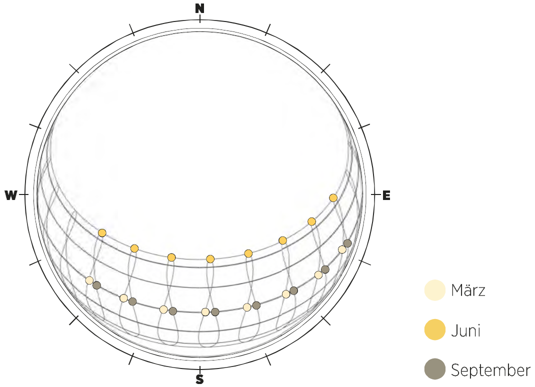

Blick vom Standort auf das Stadtzentrum von Innsbruck


Blick von der Straße südlich des Geländes - Weg gegenüber des Geländes weiter nach Süden

Standortanalyse
Hungerburg, Innsbruck







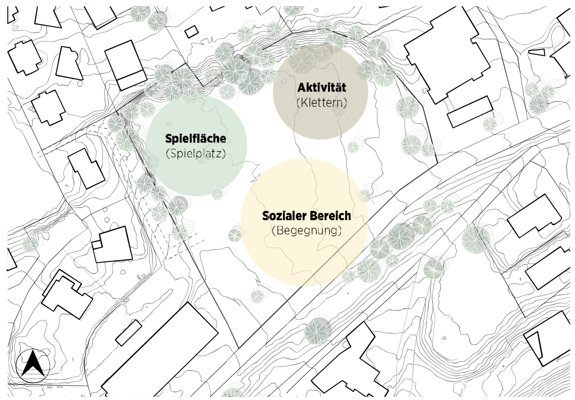
ORIENTIERUNG
Die Bebauung des Geländes folgt dem abfallenden Terrain der Hungerburg. Die Lage des Grundstücks auf der Hungerburg ermöglicht einen Panoramablick auf die Stadt Innsbruck, während die Berge eine Mauer auf der Rückseite des Grundstücks bilden.

WIND
Die stärksten Winde in Innsbrucks kommen aus Westen und Osten. Die offene Landschaft am Standort im Südwesten und Süden könnte auf starke Winde hinweisen, die von Westen her auf den Standort treffen.

SONNE
Mit den steilen Bergen im Norden und dem offenen Blick nach Süden ist der Standort optimal platziert, um sonnenbeschienene Außenräume und ein gut belichtetes Innenklima zu erhalten. Die freie Südausrichtung verlangt nach integrierten Sonnenschutzlösungen.

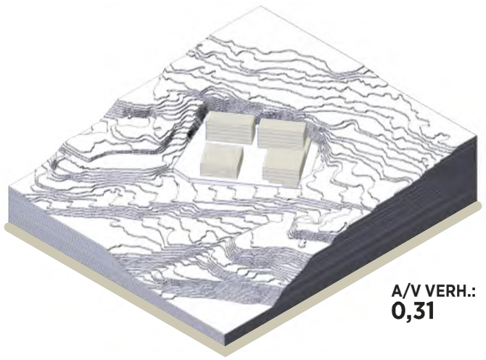
POTENTIAL: ANKOMMEN UND ERSCHLIESSEN
Der Schwerpunkt liegt auf der Ankunft (zu Fuß) durch bestehende Wege in der Nähe des Geländes, die innerhalb des Geländes in Richtung der Berglandschaft und des vorderen Geländes erweitert werden könnten. An der südwestlichen Ecke sollte die Ankunft von Autos zu einem sicheren, befahrbaren Raum gemacht werden.

POTENTIAL:VISUELLE VERBINDUNGEN
Schaffung von Ausblicken und Verbindungen zwischen Vorder- und Rückseite, um eine dunkle, leere Rückseite zu vermeiden. Die Sonne wird bis in den nördlichen Teil des Grundstücks hineingelassen, so dass entlang der steilen Berglandschaft sonnenbeschienene Außenbereiche entstehen.



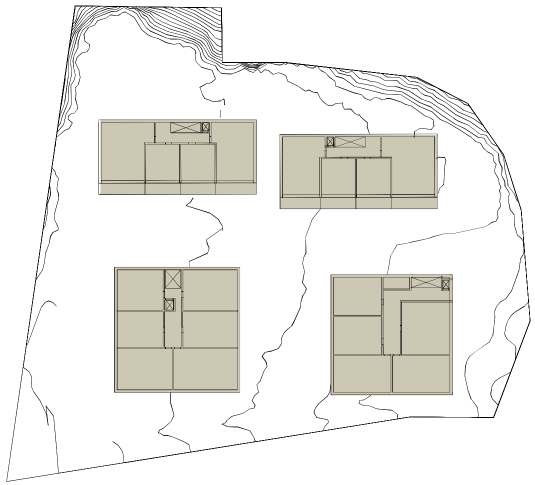
POTENTIAL: GEMEINSCHAFTLICHE AUSSENANLAGEN
Gemeinsame Außenbereiche mit verschiedenen Themen, um die Bewohner und Einheimischen dazu anzuregen, sowie die Gemeinschaft, ihre Gesundheit und ihr Wohlbefinden zu verbessern. Einige der Außenbereiche werden für den Kindergarten vorgesehen.

Volumenstudien



A/V VERH.:
0,31

Variante 1 - Ursprünglich geplantes Volumen
Zwei Arten von Volumen/Systemen
Keine Integration mit der Topographie - Schaffung einer "Rückseite".



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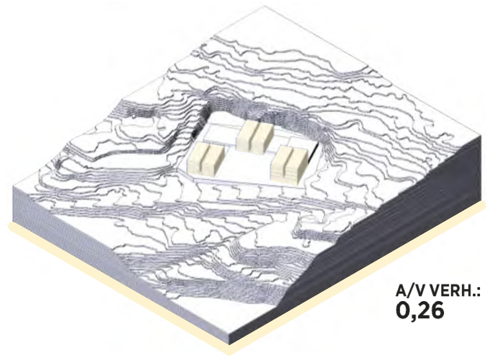
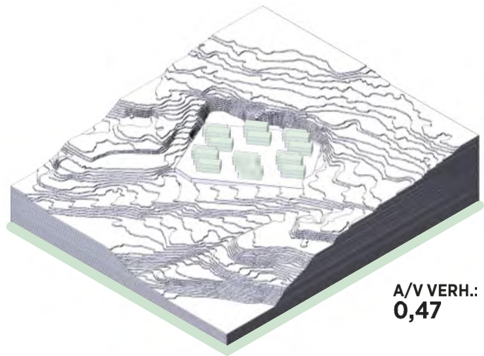


A/V VERH.:
0,26

Variante 2 - Drei gleiche Blöcke
Mittlere Größe und Dichte
Schaffung sonnenbeschienener Außenbereiche - verbindet Vorder- und Rückseite - großer Maßstab

1:1000

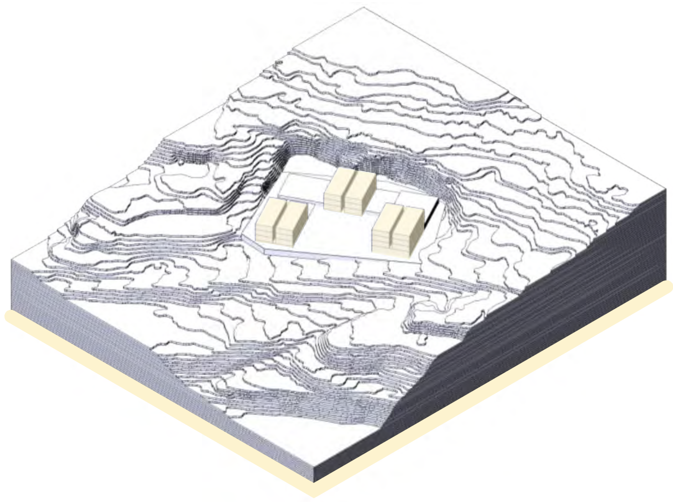


A/V VERH.:
0,47

Variante 3 - Reihenhäuser
Niedrige Höhe + hohe Dichte
Gleiche Massen/Systeme - eine neue Wohntypologie für das Gebiet - kleiner Maßstab

1:1000

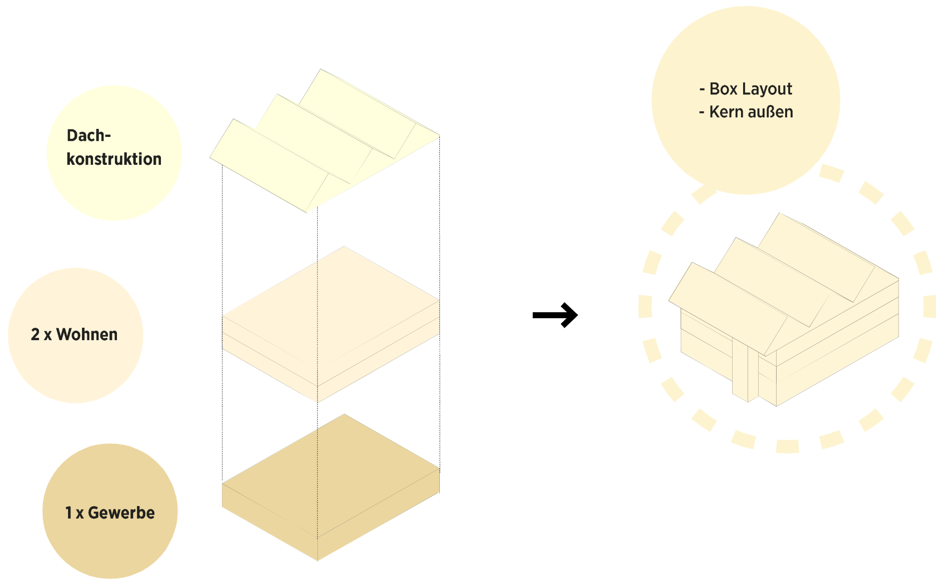
Variante 2 - Drei gleiche Blöcke



Designaspekte

Je nach Anzahl der gewünschten Wohneinheiten können die Volumen ihre Größe innerhalb des Baukörpers anpassen. Der vertikale Erschließungskern kann als freistehendes, von den Volumen unabhängiges Element angefügt werden.

Eine weitere Variable, in der Anordnung der Baukörper vor Ort, sind die Balkone: Unabhängige oder gemeinsame, etwas größere Balkone, die Möglichkeiten für spontane Interaktionen zwischen Nachbarn und eine starke Gemeinschaft bieten.



Vorteile

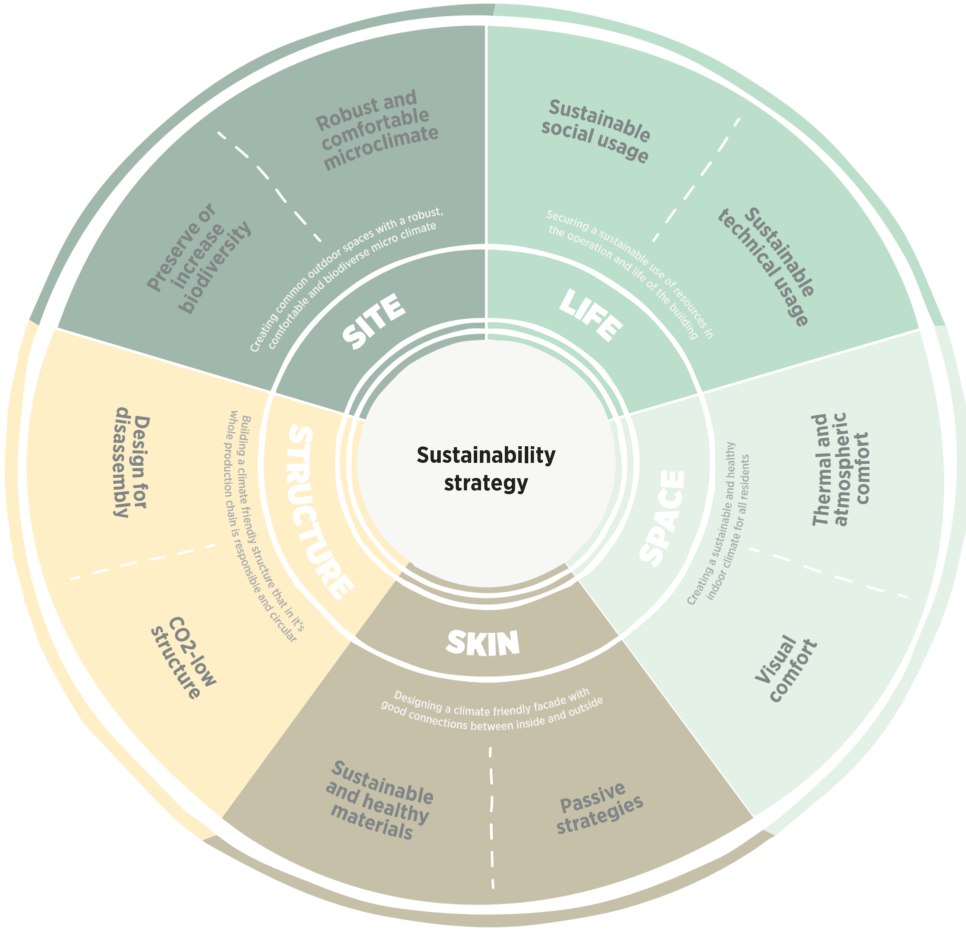
Die Variante 2 integriert sich gut in die steilen Hügel, die das Gelände im Norden und Westen umgeben.

Der Vorschlag ermöglicht eine gute Sichtverbindung von der Straße aus, die Passanten dazu einlädt, das Gelände in Hungerburg zu erkunden. Eine moderate Dichte entsteht, die die umgebende Bebauung in Maßstab und Volumen integriert.

Der Vorschlag schafft einen zentralen Platz, der die beeindruckende Berglandschaft zum Miterleben einlädt.

Die Baukörper bieten Möglichkeiten für vielfältige Nutzungen des Ortes - ein zentraler Platz fühlt sich inklusiv und intim genug an, um die Ruhe der Umgebung zu genießen.

Nachhaltigkeit



#Mission2030

Basierend auf den drei unten genannten Dokumenten wurde diese Nachhaltigkeitsstrategie entwickelt - eine klare, aber ganzheitliche Strategie, die lokale und nationale Anforderungen sowie projektspezifische Potenziale in eine architektonische Perspektive für das Innsbrucker Projekt übersetzt..

- Bauen und Sanieren /klimaaktiv auf #mission 2030 (Bundesministerium, Nachaltigkeit und Tourismus)
- Nachhaltiges und energieeffizientes Bauen und Sanieren im Sinne des Klimaschutzes (IIG - Innsbrucker Immobiliengesellsschaft)
- Leitfaden Energieffixientes und Nachhaltiges Bauen (Innsbruck)

Die Strategie zielt darauf ab, Nachhaltigkeitsziele und -initiativen auf allen Ebenen eines Gebäudes zu schaffen: vom Standort um das Gebäude herum über die Struktur und die Gebäudehülle bis hin zum Raum und dem Leben im Gebäude. Alle diese Ebenen haben einzeln und gemeinsam das Potenzial, ein nachhaltiges Wohnprojekt auf der Hungerburg in Innsbruck zu schaffen, mit Themen wie: Biodiversität, gemeinsame Außenbereiche, Holzbau, Design für Demontage, nachhaltige Materialien, gesundes Innenraumklima und eine nachhaltige Nutzung des Gebäudes für Mensch und Umwelt.

Die Nachhaltigkeitsaspekte innerhalb der Struktur und der Hülle beziehen sich hauptsächlich auf die in diesem Dokument vorgestellten Build-in-Wood-Arbeiten. Daher werden auch diese Schichten in diesem Dokument deutlicher und detaillierter dargestellt, während die anderen Schichten im Rahmen des kommenden Architekturwettbewerbs detaillierter behandelt werden müssen.

ZIEL: **Sicherstellung einer nachhaltigen Ressourcen-nutzung während des Be-triebs und der Lebensdauer des Gebäudes**

- **Nachhaltige soziale Nutzung**
- Gemeinsame Einrichtungen Sicherheit und Wohlbefinden
- Einbindung der zukünftigen Bewohner
- **Nachhaltige technische Nutzung**
- Passivhaus-Standard
- Effiziente (Wieder-)Verwendung von Energie/Wasser
- Erneuerbare Energie (PV, Geothermie)

ZIEL:**Schaffung eines nachhaltigen und gesunden Raumklimas für alle Bewohner**

- **Thermischer und atmosphärischer Komfort**
- Sommer- und Winterkomfort
- Gute Luftqualität

- **Visueller Komfort**
- Viel Tageslicht
- Ausblicke in die Natur
- Sichtbares Holz

ZIEL: **Gestaltung einer klimafreundlichen Fassade mit guten Verbindungen zwischen innen und außen**

- **Passive Maßnahmen**
- Integrierter Sonnenschutz
- Natürliche Belüftung

- **Nachhaltige Materialien**
- Gesunde Materialien
- Niederiger CO2 Gehalt
- Recyclebare Materialien
- Robuste Materialien

ZIEL: **Aufbau einer klimafreundlichen Struktur, die in ihrer gesamten Produktionskette kreislauforientiert ist**

- **Design für die Demontage**
- Recycelbare Elemente
- Vorgefertigte Elemente
- Mechanische Verbindungen

- **CO2-arme Konstruktion**
- Holz(hybrid)bauweise
- Passivhaus Bauweise
- Nachhaltige Baustelle

ZIEL: **Schaffung gemeinsamer Außenräume mit einem robusten, komfortablen und biodiversen Mikroklima**

- **Mikroklima**
- Windschutz in gemeinsamen Außenbereichen und in der Nähe von Eingängen
- Sonnendurchflutete Außenbereiche

- **Artenvielfalt**
- Verwendung von einheimischen Pflanzen
- Begrünte Dächer
- Erhalt bestehender Bäume

Die Stadt Innsbruck ist e5-Gemeinde und setzt sich für die Bauaufgabe das ausdrückliche Ziel eine sehr hohe energetische und ökologische Qualität zu erreichen. Der angestrebte Standard soll unter Berücksichtigung der Lebenszykluskosten den Energieverbrauch und den Gesamtenergieaufwand zur Herstellung des Gebäudes minimieren sowie möglichst geringe CO2 Auswirkungen verursachen. Die Zielsetzungen beruhen auf dem Leitfaden „Energieeffizientes und Nachhaltiges Bauen“.

NACHHALTIGES UND ENERGIEEFFIZIENTES BAUEN UND SANIEREN IM SINNE DES KLIMASCHUTZES
(IIG - INNSBRUCKER IMMOBILIENGESELLSCHAFT)

Konstruktion

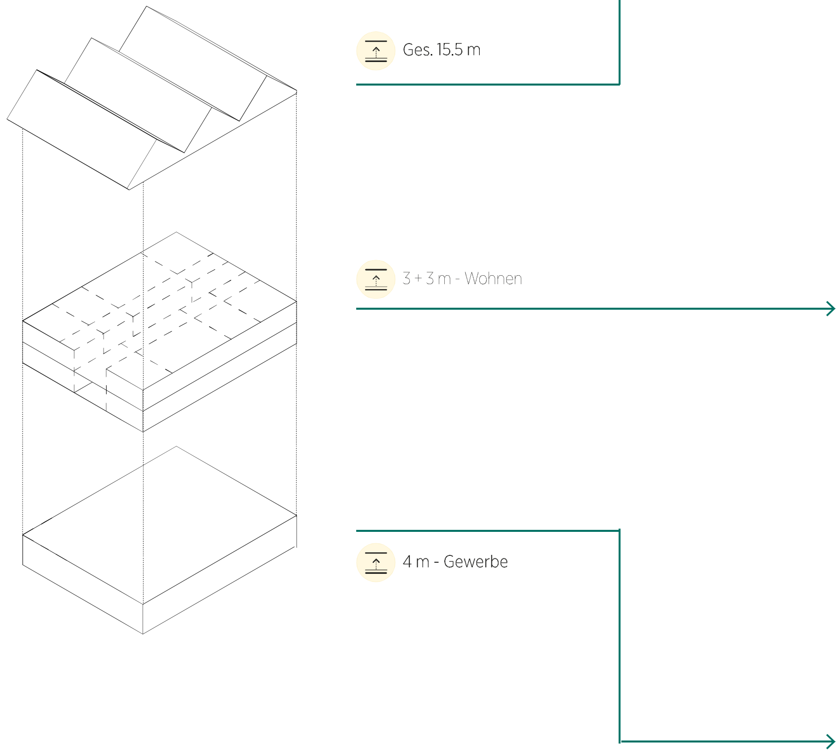
Systeme

Höhe und Nutzung

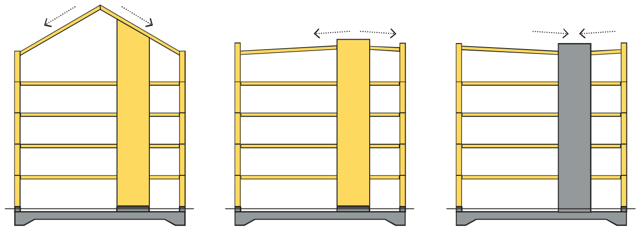
Gesamthöhe

Raumhöhe (Wohnung)

Raumhöhe (Gewerbe)



DACH



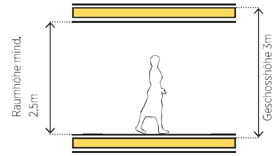
Bevorzugt Wahl von geneigten Dächern

Flachdächer sollten mit minimalem Gefälle verlegt werden, wobei das Wasser abseits von den von den wichtigen Holzbauteilen abgeleitet wird.

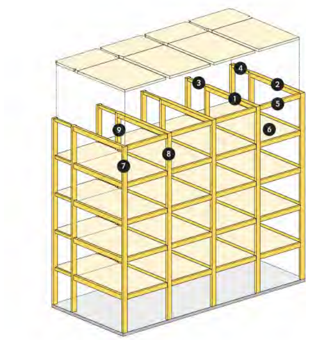
Minimales Gefälle von "flachen" Dächern kann zum Kern hin entwässert werden, wenn der Kern aus Beton ist

Das Holz muss mind. 150mm über dem fertigen Fußbodenniveau liegen. Eine Erhöhung des dafür verwendeten Betonvolumens erhöht den CO2 Anteil der Struktur. Dies sollte daher so weit wie möglich minimiert werden.

WOHNEN

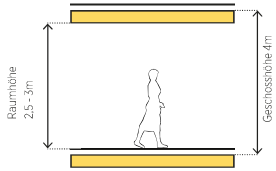


- 2kN/m² tragende Struktur
- verdeckte Struktur

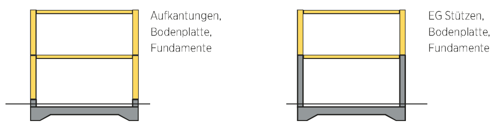


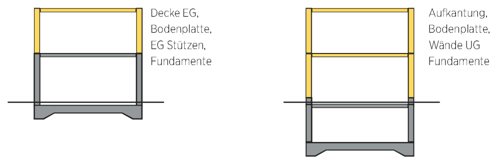
1. Hauptträger
2. Hauptrandträger
3. Nebenträger
4. Nebenrandträger
5. Fassadenträger
6. Decke
7. Eckstütze
8. Außenstütze
9. Innenstütze

GEWERBE



- 3kN/m² tragende Struktur
- verdeckte Struktur





Vorabzug aus dem Build-in-Wood Katalog

Konzept

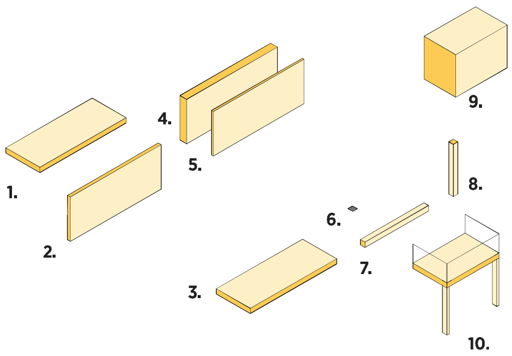
Zentrale Aspekte - Holzbau

Konstruktion: Ingenieurholzbau Pfosten-Riegel-Konstruktion

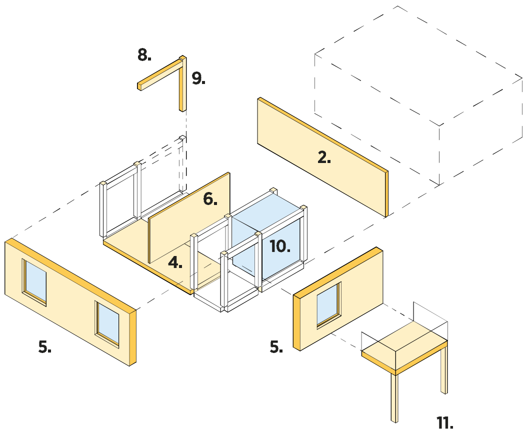
Kern: Beton/Stahl

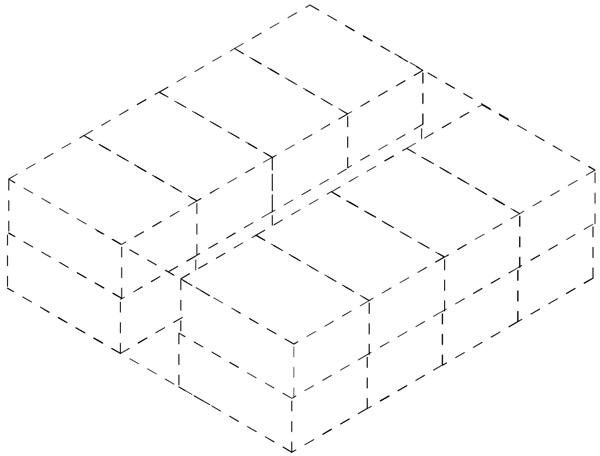
Die Verwendung des "Baukastensystem" für die Konstruktion ist ein wichtiger Aspekt, der mehrere Vorteile besitzt. Es handelt sich um eine pragmatische Gesamtidee, die auf eine schnelle und einfache Montage ausgelegt ist. Darüber hinaus bietet die Entwurfsmethodik zahlreiche Optionen innerhalb streng definierter Grenzen.

Baukastensystem für Hungerburg



Montage einer typischen Einheit





1. Dach
2. Trennwand der Einheit
3. Brettsperholz-Platte (BSP)
4. Fassade
5. Nicht tragende Wand
6. Stahlverbinder
7. Brettschichtholz (BSH) Träger 30x32
8. Brettschichtholz (BSH) Stütze 30x30
9. Nasszelle
10. Balkon

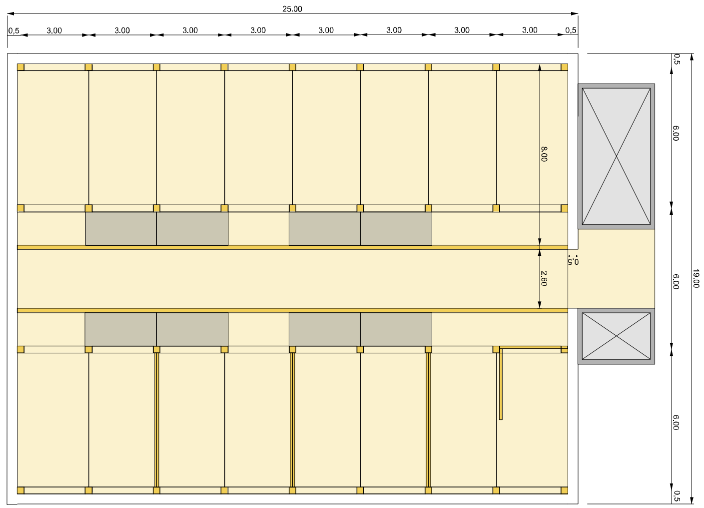
** Vertikale Erschließung:*
Freistehender Stahl- oder Betonkern

Konzept

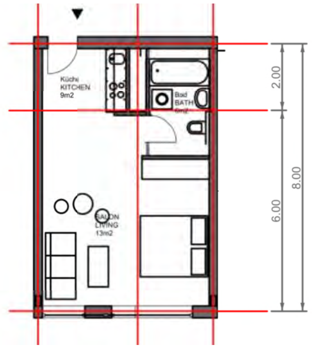
Rastergröße

Die Größe des Rasters wird zum Teil durch die erwartete Nutzung des Raumes bestimmt, die in diesem Fall in Wohn- und Geschäftsräume unterteilt ist.

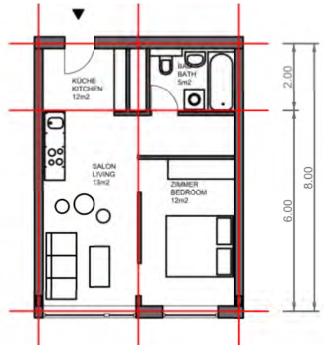
Für den Wohnraum (Obergeschosse) schlagen wir ein Raster von 3 x 6m vor, das sich zudem in unterschiedlich große Einheiten umsetzen lässt. Diese Auswahl der Größen ergibt sich aus dem vorgegebenen Programm und ermöglicht verschiedene Wohnungen.



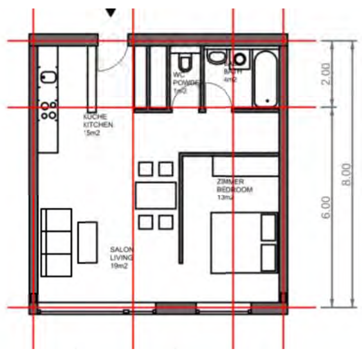
Raster 3 x 6m



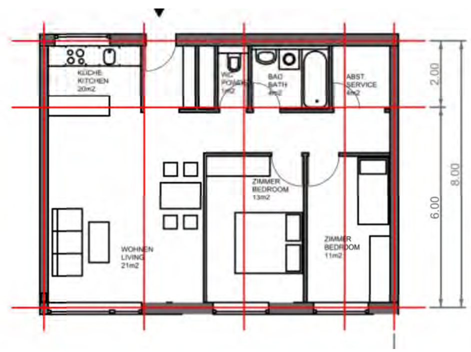
Wohntyp 1
45 m² BGF



Wohntyp 2
53 m² BGF



Wohntyp 3
65 m² BGF

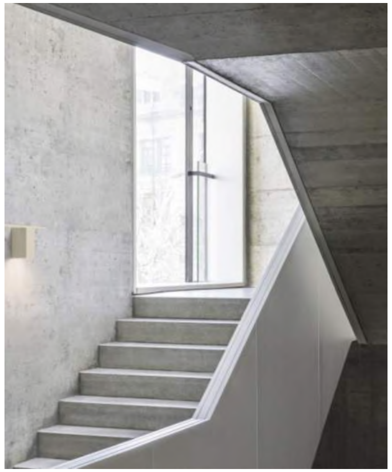


Wohntyp 4
84 m² BGF

Erschließungskern

Material

Beton



Betonkern - freistehend

Stahl

Eisberg,rundzwei Archi

Stahlkern - außenliegend

Holz

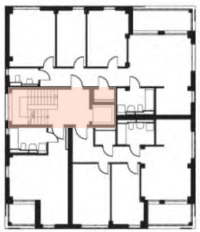
Sara Kulturhus, White Arkitekter

Holzkern - integriert

Position

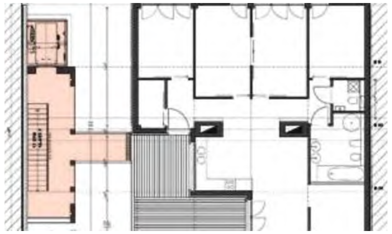
Integriert

Prinz-Eugen-Park/ Rapp Architekten



Freistehend

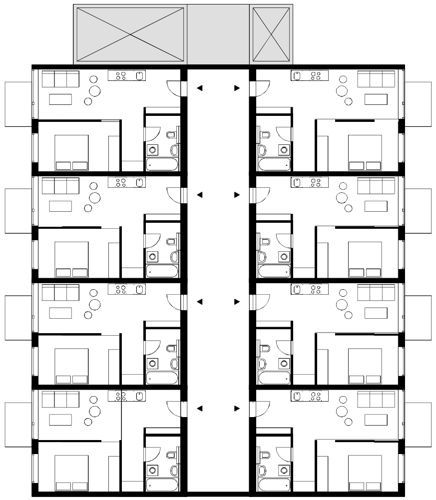
Mühlweg, Wien, HK Arc



Erschließungskern

Die Holzkonstruktion selbst wird vorzugsweise unabhängig vom Kern gebaut, welcher aus Stahl oder Beton besteht.

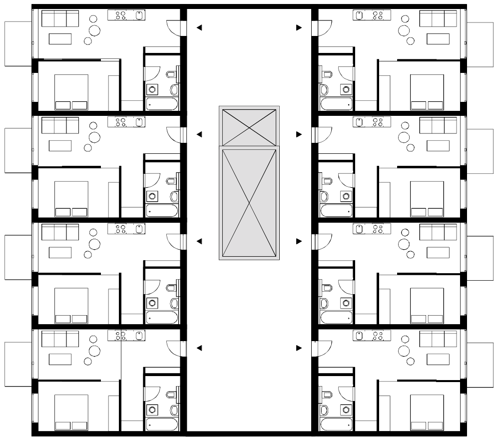
Ein außenliegender Kern ist die bevorzugte Konstruktionswahl, um Schwachstellen innerhalb der Struktur zu minimieren und eine schnelle Montage der Gebäudeteile zu ermöglichen.



Vertikaler Kern

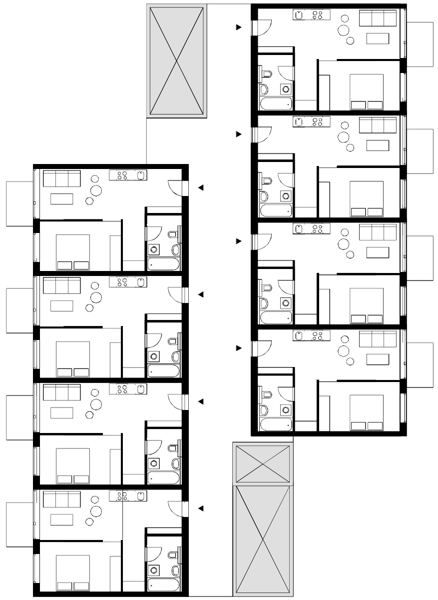
Typ 1 : Korridor und Kern außerhalb

1:300



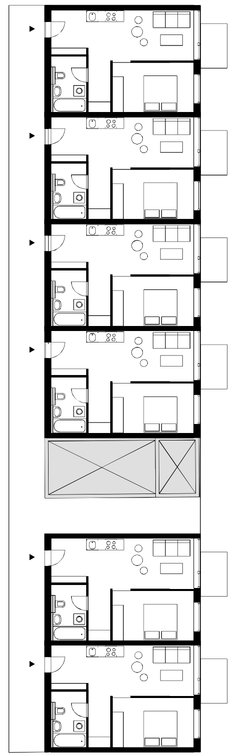
Typ 2: Kern im Inneren

1:300



Typ 3: Versetzter Korridor

1:300

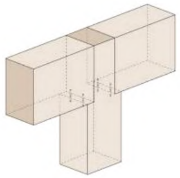


Typ 4: Einseitiger Kern

1:300

Konzept

Elemente



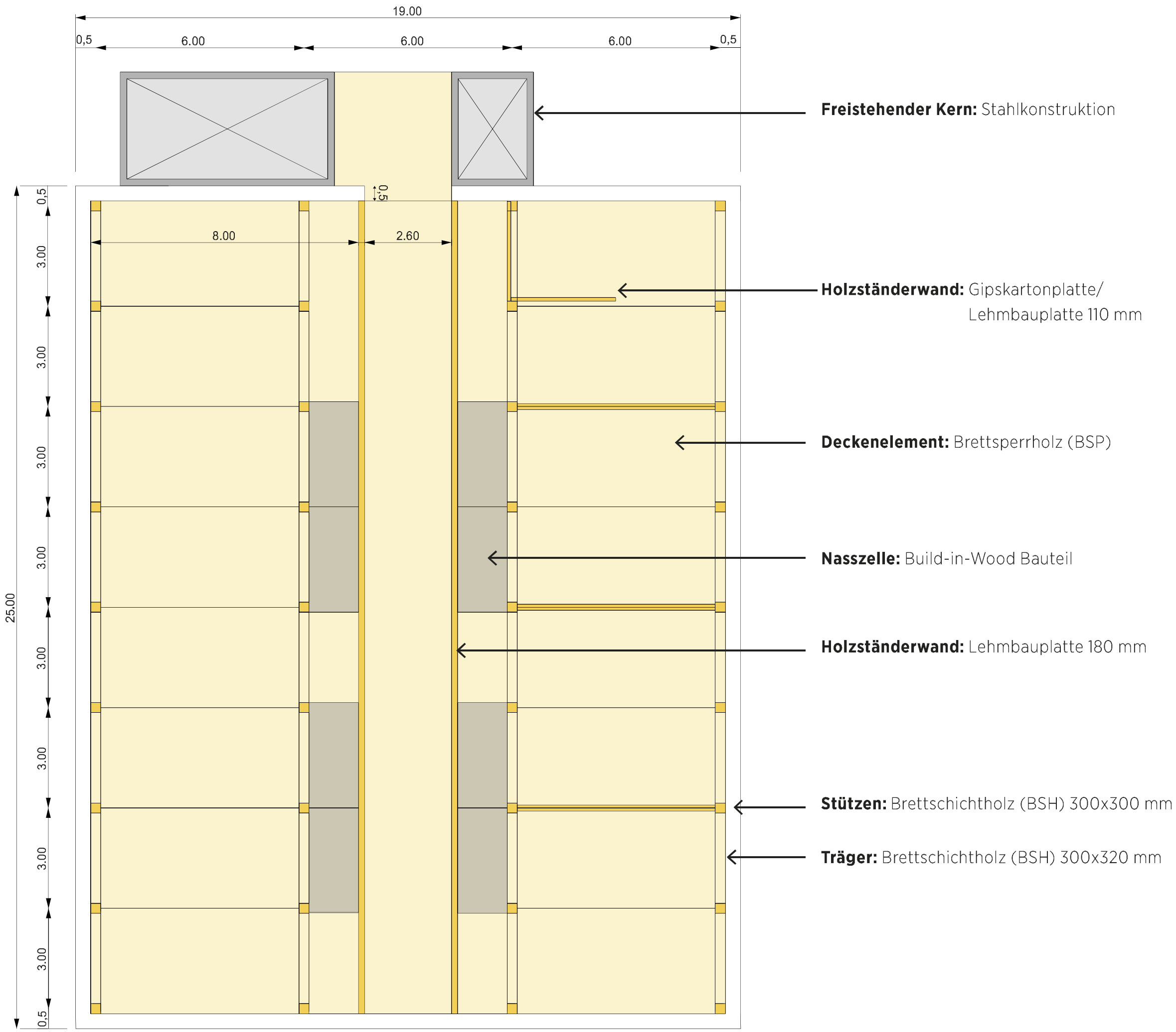
Träger zu Stütze:
Holz zu Holz Verbindungen

Lehmbauplatten

Brettsperrholz (BSP)

Brettsperrholz (BSP) mit gebundener Splittschüttung

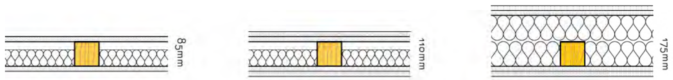
Brettschichtholz (BSH)



Technisches Design

Akustik

Wände



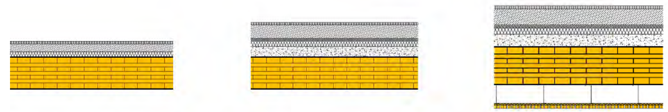
ERHÖHUNG DER FEUERBESTÄNDIGKEIT, SCHALLDÄMMUNG UND ROBUSTHEIT

- Holzständer: 60x60 mm @ 625 mm c.
- Plattendicke: 12,5 mm
- Plattentyp: feuerbeständige Platte
- Maximale Wandhöhe 3,10 m
- Schalldämmung: 37 dB
- Feuerbeständigkeit: F30

- Holzständer: 60x60 mm @ 625 mm c.
- Plattenstärke: 2 x 12,5 mm
- Plattentyp: feuerbeständige Platte
- Maximale Wandhöhe 3,10m
- Schalldämmung: 41 dB
- Feuerbeständigkeit: F60

- Holzständer: 60x60 mm
- @ 625 mm c, gestaffelt
- Plattenstärke: 2 x 12,5 mm
- Plattentyp: feuerbeständige Platte
- Maximale Wandhöhe 4,10m
- Schalldämmung: 59 - 66 dB

Decken



ERHÖHUNG DER FEUERBESTÄNDIGKEIT, SCHALLDÄMMUNG UND ROBUSTHEIT

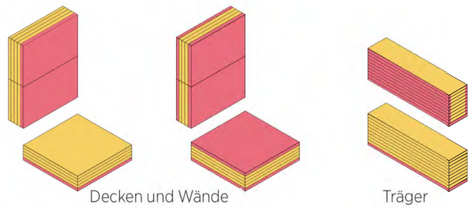
- Einfacher Deckenaufbau

- Deckenaufbau mit Schüttung

- Deckenaufbau mit Schüttung und abgehängter Decke

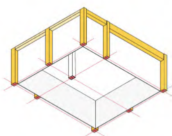
Brandschutz

Verkohlungsschicht



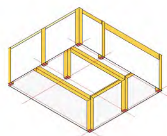
● Die Holzkohleschicht ist die zusätzliche Dicke eines Holzbauteils, die über die erforderlichen statischen Abmessungen hinausgeht und die Holzbauteile im Falle eines Brandes schützen soll.

Level der Abkapselung



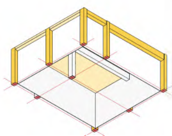
Level 1:

vollständig abgekapselt



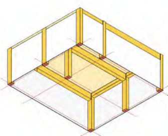
Level 2:

freiliegende Balken und Stützen



Level 3:

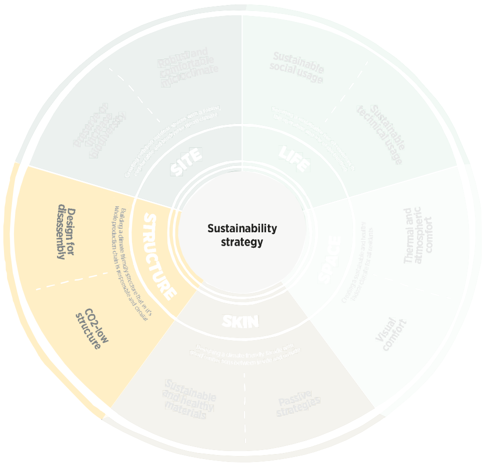
freiliegende Decken

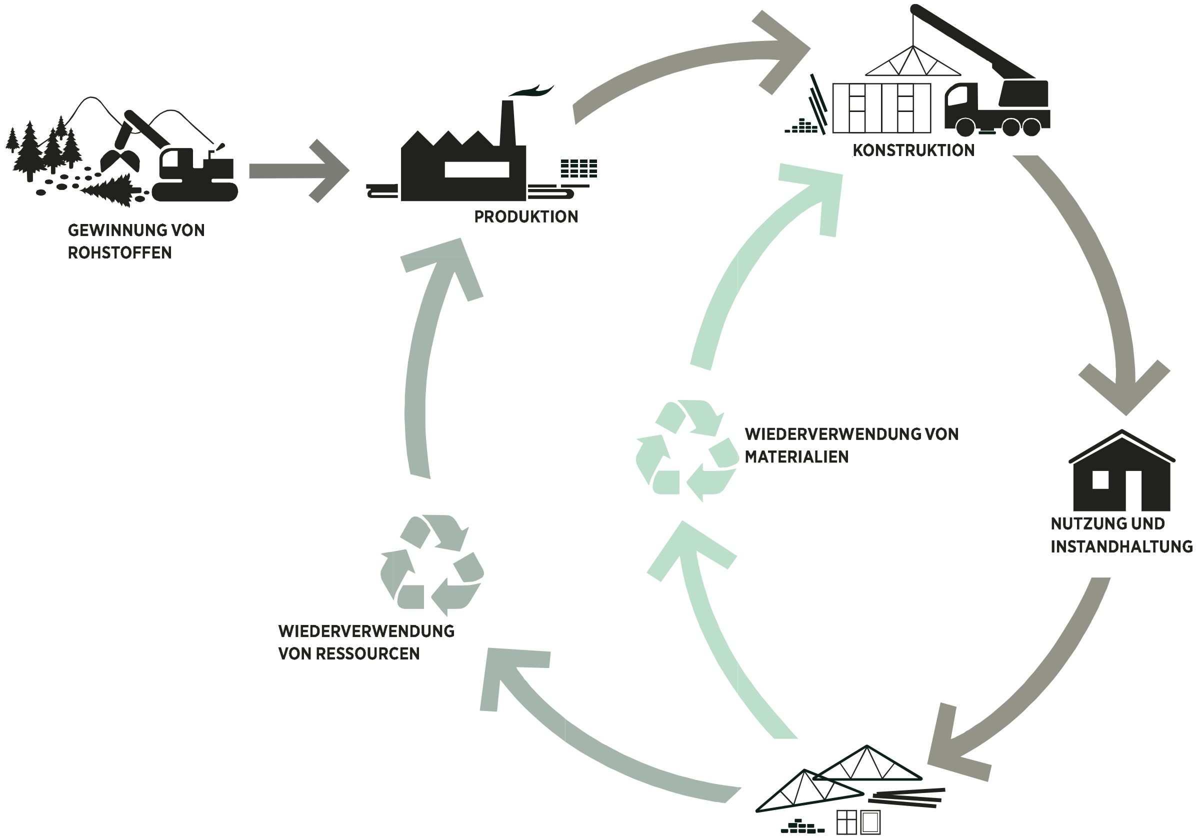


Level 4:

vollständig freigelegt

Nachhaltigkeit





Nachhaltige Nutzung von Ressourcen - aktuell und in der Zukunft

Holz wird nicht produziert - es wächst. Alles, was Bäume brauchen, sind Sonne, Boden und Regen. Sie wachsen auf natürliche Weise, bilden lebendige Ökosysteme und versorgen uns mit lebenswichtigem Sauerstoff und dem wertvollen Rohstoff Holz. In diesem Holz absorbieren die Bäume CO_2 und entlasten so die Atmosphäre vorübergehend von ihrem Treibhauseffekt.

Holz ist ein attraktives Material, weil es eine geringere CO_2-Bilanz aufweist, weniger Energie und Wasser verbraucht und zu 100 % aus nachhaltig bewirtschafteten Wäldern stammt. Im Bauwesen ist Holz sehr flexibel, leicht und stabil zugleich.

Es eignet sich gut für die Vorfertigung und kann die Bauzeit erheblich verkürzen. Gut durchdachte Holzkonstruktionen sind außerdem absolut brandsicher und sogar erdbebensicherer als gesetzlich vorgeschrieben.

Holzwerkstoffe sind hochentwickelte Baumaterialien mit einem hohen Verhältnis von Festigkeit zu Gewicht, was sie für viele kritische Anwendungen perfekt macht. Durch die Vorfertigung großer Bauelemente ist die Montage dieser Teile vor Ort schnell erledigt, was die Bauzeit, die Wetterabhängigkeit und die Belästigung der Bewohner erheblich reduziert.
Darüber hinaus eignet sich Holz für "Design for Disassembly" und kann leicht recycelt werden.

Holz-Hybrid-Baustelle:
- Weniger Transporte = bessere Umwelt (bis zu 75 % weniger Transporte)
- Kürzere Bauzeit = bessere Wirtschaftlichkeit (bis zu 25 % schneller)
- Weniger Krankheitstage = bessere soziale Bedingungen (50% weniger Krankenstand)

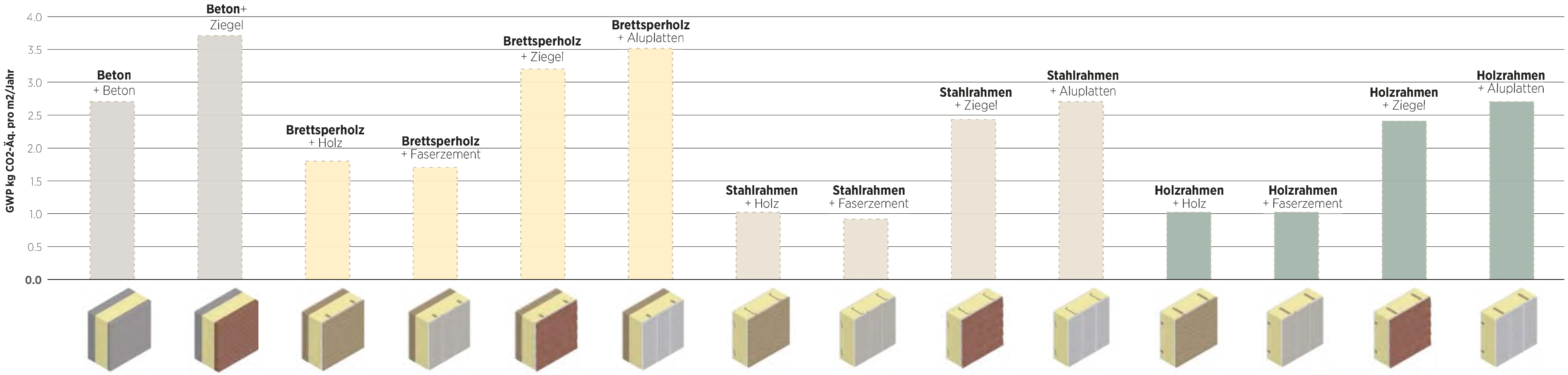
REDUZIERTE RESSOURCEN
Reduzierung des Einsatzes von Materialmassen - insbesondere die Verwendung von Beton. Bauen in Leichtbauweise und mit lokalen Materialien. Reduzierung des Ressourcenverbrauchs auf der Baustelle.

WIEDERVERWENDBARE RESSOURCEN
Einsatz von Materialien, die ganz oder teilweise recycelt sind, um den Bedarf an neuen Materialien zu minimieren. Verwendung von bereits recycelte Produkten oder Zusammenarbeit mit einem örtlichen Unternehmen.

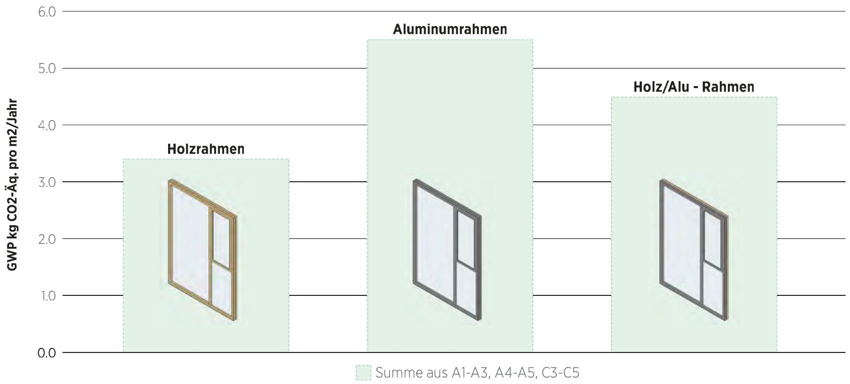
RECYCLEBARE RESSOURCEN
Konstruktion, die eine Wiederverwendbarkeit ermöglicht. Die Struktur und die Fassade sollten mit Blick auf die Demontierbarkeit entworfen werden.

ERNEUERBARE RESSOURCEN
Falls neue Materialien benötigt werden, sollten dabei erneuerbare Ressourcen (biobasierte Materialien) bevorzugt werden, die Kohlenstoff speichern können und nachhaltig nachwachsen.

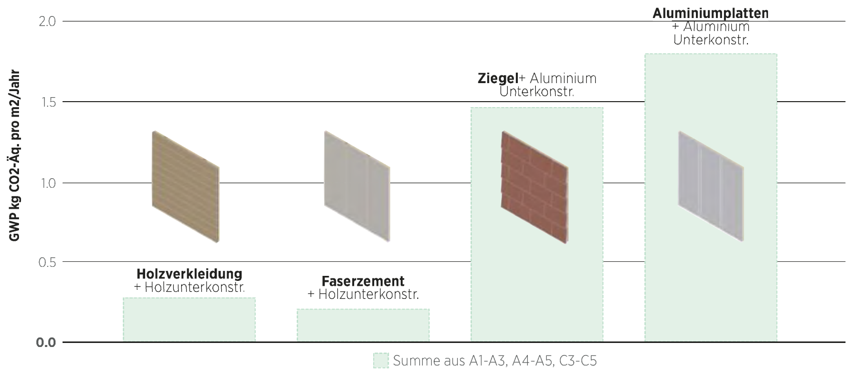
ÖKOBILANZ // AUSSENWÄNDE // 1 m²



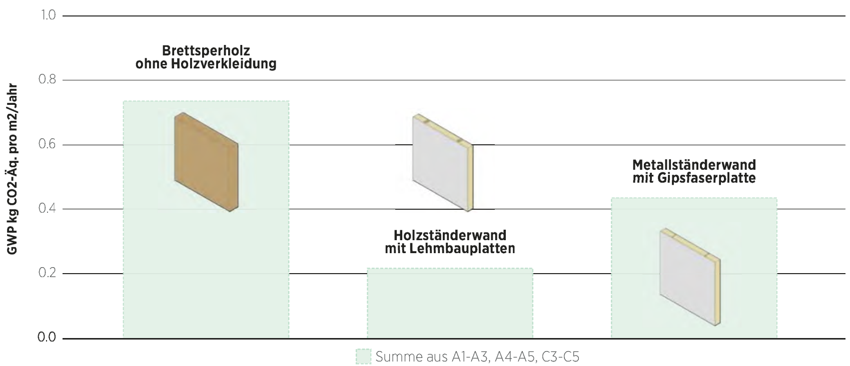
ÖKOBILANZ // HOLZFENSTER// 1 m²



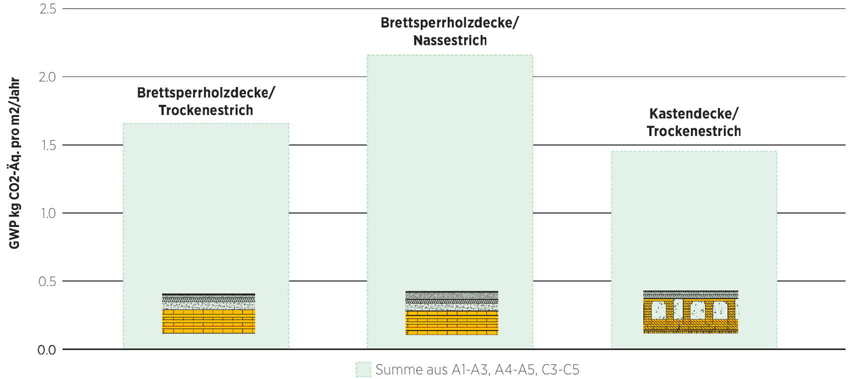
ÖKOBILANZ // FASSADENVERKLEIDUNG // 1 m²



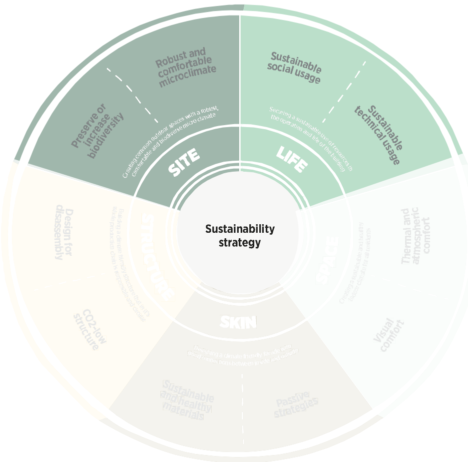
ÖKOBILANZ //INNENWÄNDE // 1 m²

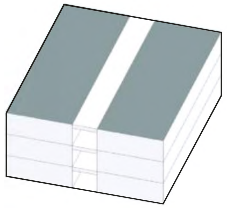


ÖKOBILANZ // DECKENSYSTEM // 1 m²

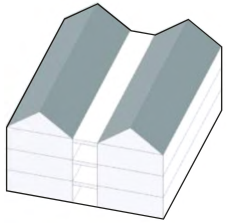


Nachhaltigkeitsmaßnahmen

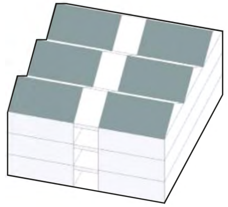




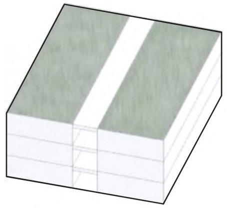
PV Flachdach
PV-Anlagen leicht geneigt auf der Unterkonstruktion: Energieproduktion für 350 m^2 PV-Anlagen: 71.400 kWh/Jahr



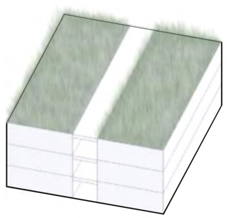
PV auf geneigtem Dach / Ost und West
Dach und PV-Winkel: 30° / Gesamtenergieprod. für 350 m^2 PV's: 67,550 kWh/Jahr
Dach und PV-Winkel: 45° / Gesamtenergieprod. für 350 m^2 PV's: 63,350 kWh/Jahr



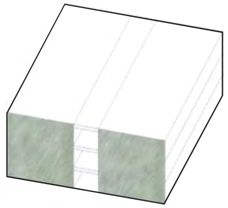
PV auf geneigtem Dach / Süden
Dach und PV-Winkel: 30° / Gesamtenergieprod. für 250 m^2 PV's: 61,500 kWh/JAhr
Dach und PV-Winkel: 45° / Gesamtenergieprod. für 250 m^2 PV's: 62,000 kWh/Jahr



Extensiv begrüntes Dach
DGNB-Biofaktor: 0,7
DGNB-Biofaktor-Index für 350 m^2 Dach: 1.76
Kann unter PV's platziert werden



Intensiv begrüntes Dach
DGNB-Biofaktor: 0,7
DGNB-Biofaktor-Index für 350 m^2 Dach: 1.76
Bessere Lebensräume für lokale Arten schaffen



Grüne Fassade
DGNB-Biofaktor: 0,5
DGNB Biofaktor-Index für 144 m^2 Fassade: 0.52
Sichtbarkeit und Integration in die Architektur

Nachhaltiges Leben

GRÜNRAUM/BIODIVERSITÄT
Eine wichtige Nachhaltigkeitsinitiative im Rahmen des Standorts und des Lebens ist die Erhaltung oder Erweiterung der biologischen Vielfalt. Dies gilt sowohl für die Landschaft um das Gebäude herum als auch für die Oberflächen des Gebäudes. Die Verwendung einheimischer Pflanzen und die Schaffung von Unterschlupfmöglichkeiten für einheimische Tierarten sollten Vorrang haben.

ERNEUERBARE ENERGIEN
Erneuerbare Energien sollten vor Ort integriert werden, um die Bereitstellung klimafreundlicher Energie für alle Bewohner zu reduzieren. Hierfür könnten Geothermie und/oder Photovoltaikanlagen eine Option sein. Bei der Wahl von PV-Anlagen sollte untersucht werden, welche PV-Anlagen am klimafreundlichsten produziert werden. Wie auf den Diagrammen zu sehen ist, wurden verschiedene Lösungen für PV-Anlagen auf dem Dach für diesen spezifischen Standort als Richtlinie berechnet.

PEFC-/FSC-ZERTIFIKATE
Bei der Auswahl von Holz ist es wichtig, die Nachhaltigkeit unserer Wälder und der Natur zu unterstützen. Die Menschen sind auf die Wälder angewiesen. Sie filtern das Wasser, das wir trinken, und die Luft, die wir atmen. Die Wälder sind die Heimat von fast der Hälfte aller Arten auf der Welt.
Die Abholzung und Schädigung von Wäldern ist die zweitwichtigste Ursache für die Kohlenstoffverschmutzung und verursacht 20 % der gesamten Treibhausgasemissionen. Deshalb ist es wichtig, zertifiziertes Holz (PEFC oder FSC) zu wählen. PEFC-zertifizierte Wälder werden nach strengen ökologischen, sozialen und ökonomischen Standards bewirtschaftet und haben das Ziel Waldgebiete zu erhalten und zu schützen. Die FSC-Zertifizierung bestätigt ein Waldwirtschaft in der die biologische Vielfalt erhalten bleibt und das Leben der lokalen Bevölkerung davon profitiert, während gleichzeitig die wirtschaftliche Lebensfähigkeit gewährleistet wird.

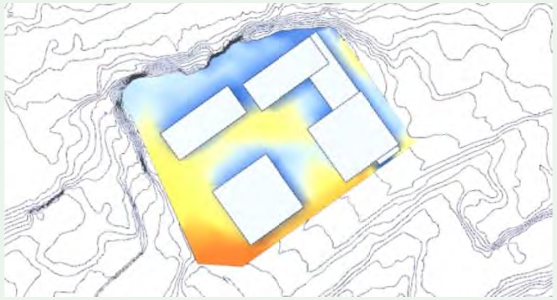
NACHHALTIGES LEBEN FÜR DIE MENSCHEN
Schwerpunkt: Wohlbefinden, Sicherheit, Gemeinschaft, Mülltrennung, klimabewusster Lebensstil, Gemeinsame Einrichtungen/Dinge, etc.

NACHHALTIGES LEBEN FÜR DAS GEBÄUDE
Schwerpunkt: geringerer Energieverbrauch, geringerer Wasserverbrauch, lange Lebensdauer der Materialien, schöne Patina, Kreislaufwirtschaft, etc.

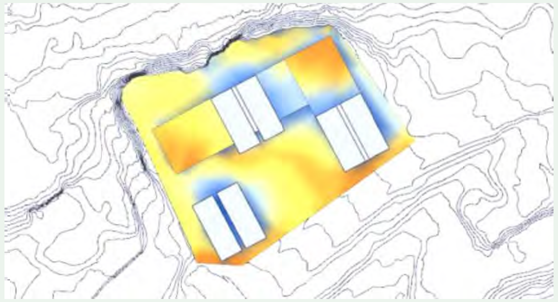
NACHHALTIGES LEBEN FÜR DIE UMGEBUNG
Schwerpunkt: Natur, Bodengleichgewicht, gemeinsame Räume, lokale Gemeinschaft, Mikroklima, nachhaltige Baustelle usw.

NACHHALTIGES LEBEN FÜR DEN PLANETEN
Schwerpunkt: Erhaltung und/oder Erweiterung der Artenvielfalt, (Wieder-)Gewinnung erneuerbarer Ressourcen, CO2-Reduzierung usw.

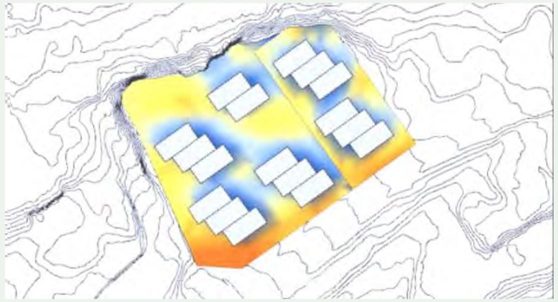
Simulationen / Durchschnittliche monatliche Sonnenstunden - Außenraum



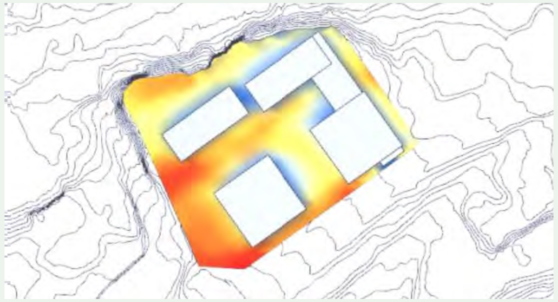
VOLUMEN 1 / MÄRZ



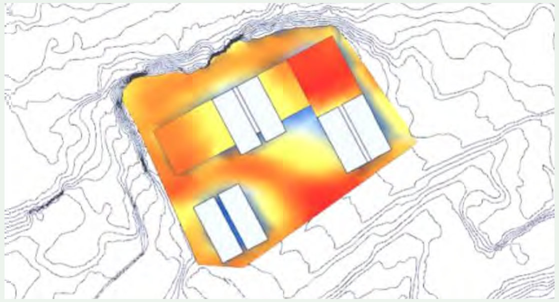
VOLUMEN 2 / MÄRZ



VOLUMEN 3 / MÄRZ

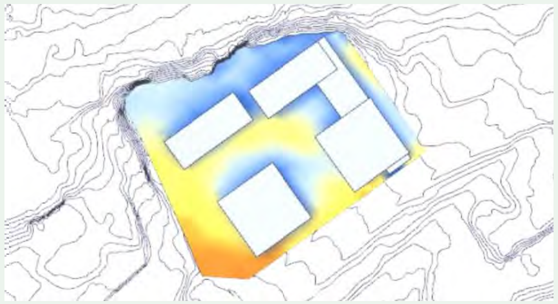


VOLUMEN 1 / JUNI

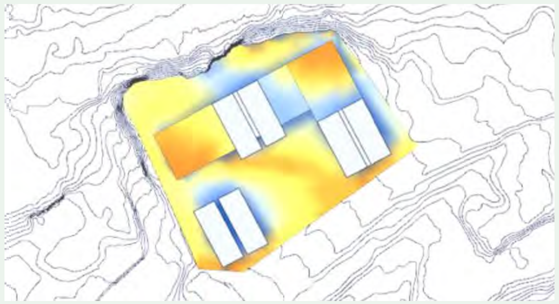


VOLUMEN 2 / JUNI

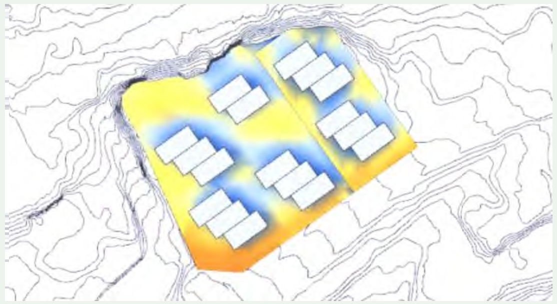
VOLUMEN 3 / JUNI



VOLUMEN 1 / SEPTEMBER



VOLUMEN 2 / SEPTEMBER



VOLUMEN 3 / SEPTEMBER

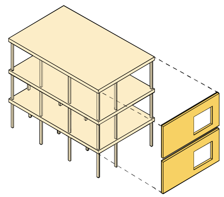
Sonnenlichtstunden

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16

Fassadensystem

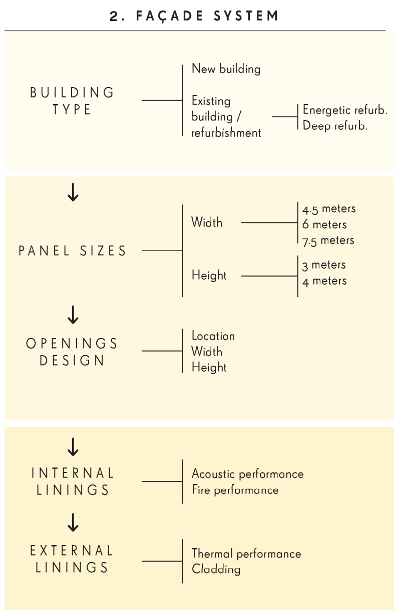
Designparameter

Gebäudehülle



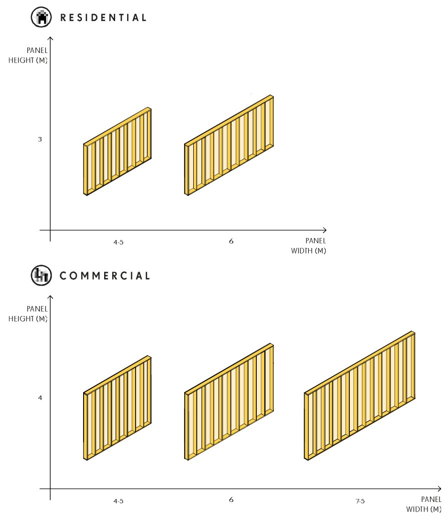
Gebäudetyp - Neubau

Das Build-in-Wood Fassadensystem wurde primär für die Verwendung in Verbindung mit einem Build-in-Wood-Strukturrahmen entwickelt.



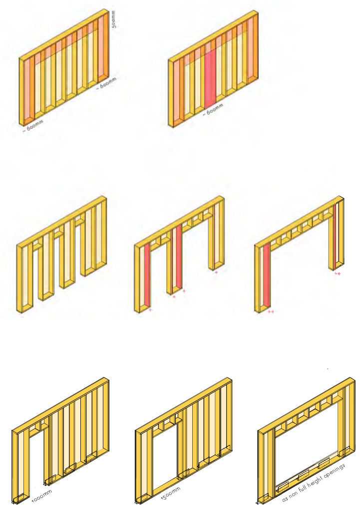
Paneelgrößen

- Das Build-in-Wood Fassadensystem ist nicht tragend und ist nur mit Windlast und Eigengewicht belastet.
- Die Holzständerbau-Paneele werden vorgefertigt auf die Baustelle geliefert und können den Anforderungen an Größe und Öffnungen entsprechend angepasst werden.
- Für den Wohnraum (Obergeschosse) schlagen wir ein Raster von 2 x 6 vor, weshalb sich die Breite der Paneele auf diese Maße bezieht.



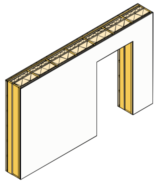
Öffnungen

Die Lage der Öffnungen ist völlig flexibel, solange ein massiver Teil des Elements, mindestens 500 mm tief, über der Oberseite der Öffnung beibehalten wird, sowie beidseitig ca. 600 mm (Abstand der Pfosten).



Aufbau

Fassadenelement



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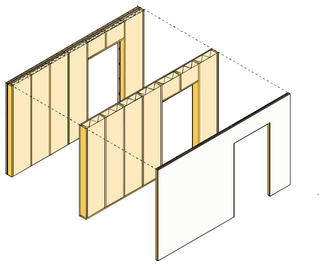

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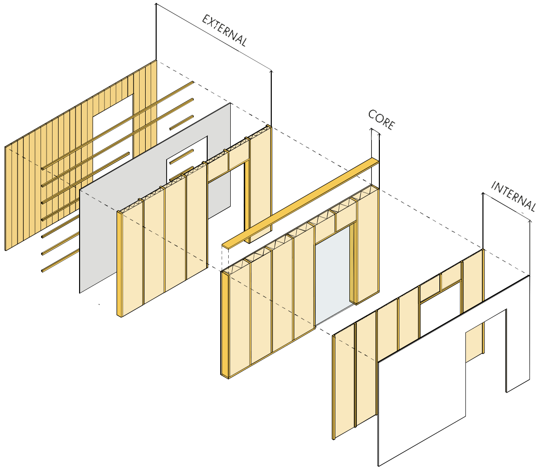

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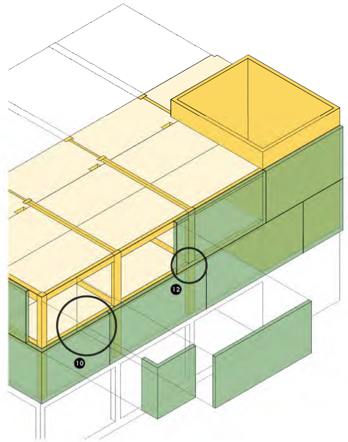


Fassadenpaneel

3 Schichten

- Reduzierung Komplexität

- Anpassung an unterschiedliche Anforderungen

- Die äußere und innere Verkleidung besitzt eine variable Dicke, wobei die zentrale Kernschicht sich nicht verändert

Aufbau

- Variable Paramter, um den Anforderungen bestimmter klimatischer Bedingungen und optischen Gesichtspunkten gerecht zu werden

-Kernschicht: Holzrahmen mit Mineralwolledeämmung, OSB-Platte als Ummantelung, Dampfschicht

Systemzusammenstellung

(Details siehe Anhang)

Verkleidung

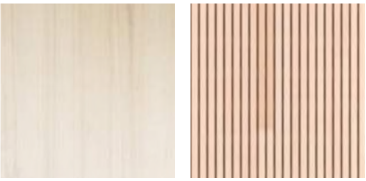
Innen

- Sichtbare Oberfläche

- Brandschutz

- Akustik

Die, im Build-in-Wood Katalog vorgeschlagenen Systeme (Aufbau: OSB-Schalungsplatte, Dampfsperrschicht, Hohlraum, Glaswolle-Isolierung, Holzlatten und eine feuerfesten Platte) bieten verschiedene Lösungen für unterschiedliche Anforderungen.

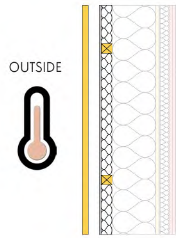


Beispiele Verkleidung (innen)

Außen

Beispiele Verkleidung (außen)

- Thermische Aspekte/ Dämmung

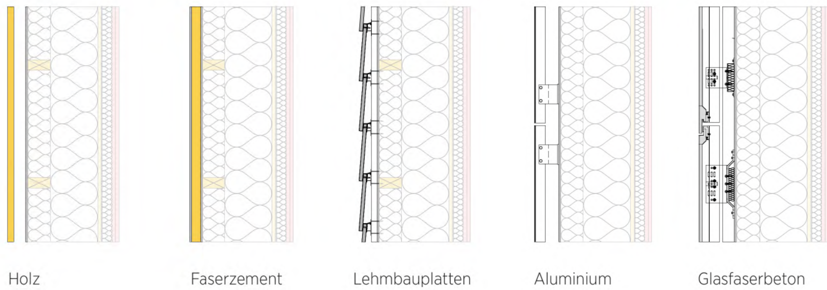


Innsbruck:

Moderates Klima: 0,2 W/m2K u-Wert

50 mm zusätzliche Mineralwolldämmung

- Oberfläche/ Verkleidung



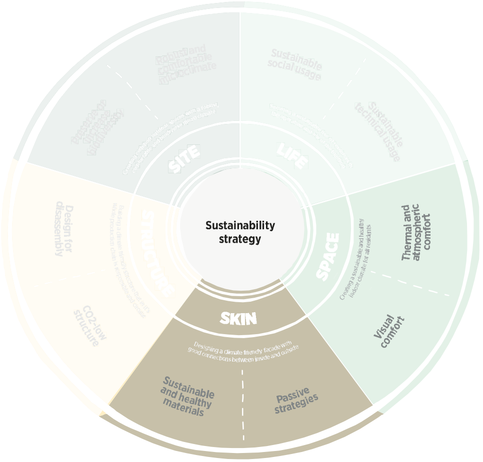
- Gewicht

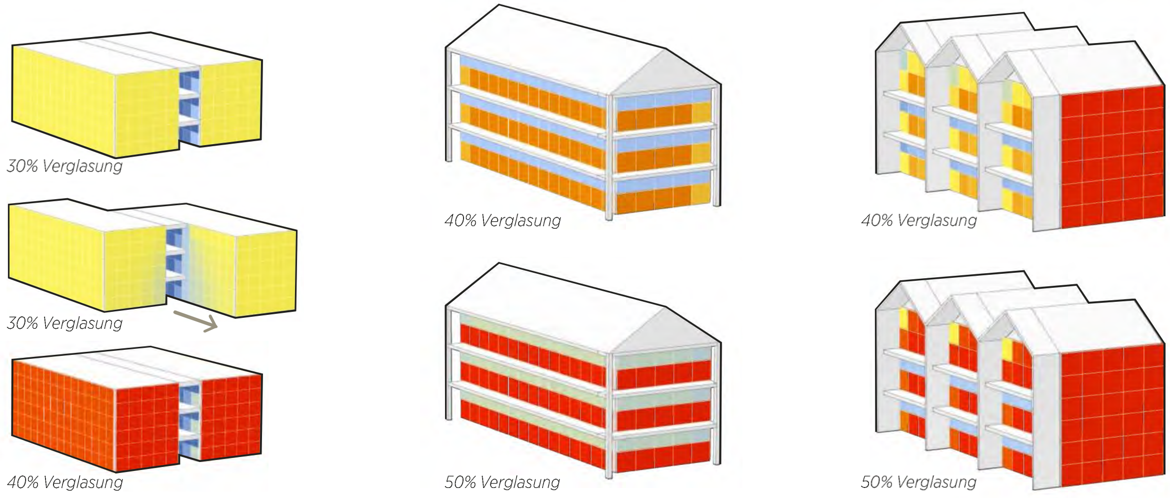
- Robustheit

- Befestigungselemente

- Toleranzen

Nachhaltigkeit





Basispunkt / Kein Sonnenschutz
Gefahr der Überhitzung ohne Sonnenschutz nach Osten, Süden und Westen.
Ausgleichsvolumen zur Minimierung des dunklen Korridors

Ausgebaute Dächer und Balkone
Dachvorsprünge und Balkone: 1,5 m
Verringerung des Überhitzungsrisikos an Süd- und Westfassaden

Zusätzlicher Sonnenschutz und Balkone
Tiefe des Sonnenschutzes: 2,0 m
Verringerung des Überhitzungsrisikos an den Westfassaden

300 Lux-Methode / sDA / Räumliche Tageslichtautonomie

0	10	20	30		50	60	70	80	90	100

kein/wenig Tageslicht **ausreichend Tageslicht** **Risiko der Überhitzung**

Nachhaltige Fassade und ein gesundes Innenraumklima

PASSIVHAUS STANDARD

Gemäß dem Dokument "Nachhaltiges und energieeffizientes Bauen und Sanieren im Sinne des Klimaschutzes" muss das Gebäude die Anforderungen eines Passivhauskonzepts erfüllen. Daher sollte ein großer Schwerpunkt auf der Gestaltung der Fassade und der Räume liegen, um mit passiven Strategien ein Innenraumklima mit hohem Komfort zu schaffen. Strategien wie natürliche Belüftung und passiver Sonnenschutz.

Die Simulationen zeigen verschiedene Szenarien für die Platzierung der Volumen, die Größe der Volumen, die Ausrichtung und die Fassadengestaltung je nach den Anforderungen an das Tageslicht. Blau bedeutet kein/zu wenig Tageslicht, während Orange/Rot das Risiko einer Überhitzung/eines geringen thermischen Komforts anzeigt.

GESUNDE MATERIALIEN

Als organisches Material kann Holz atmen und für ein angenehmes und gesundes Raumklima sorgen. Umgebungen mit Holzstrukturen können positive psychologische und physische Auswirkungen auf den Menschen haben. Sie können Blutdruck und Puls senken und eine beruhigende Wirkung haben. Verwurzelt in unserer Vergangenheit, verbinden wir mit Holz das behagliche Gefühl von Geborgenheit und Heimat.

GESUNDES INNENRAUMKLIMA

Um ein gesundes Raumklima zu schaffen, sollten gesunde Materialien mit niedrigem VOC-Gehalt zusammen mit einer guten Belüftungsstrategie bevorzugt werden.

KOMFORTABLES INNENRAUMKLIMA

Der atmosphärische und thermische Komfort für die Bewohner sollte gut in den Entwurf integriert werden - auch um den Energieverbrauch zu reduzieren.

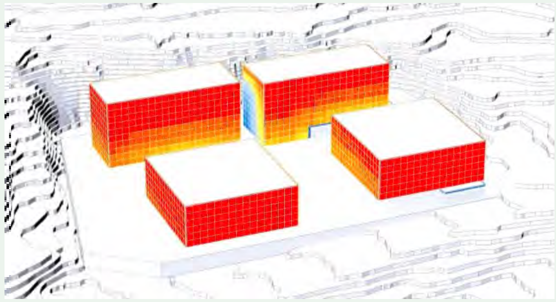
PASSIVHAUS STANDARD

<= 45 kWh/m²EBFa: erneuerbare Primärenergie // >= 60 kWh/m²GRUND: Erzeugung von erneuerbarer Energie am Gebäude, am Standort

INNEN - AUSSEN VERBINDUNGEN

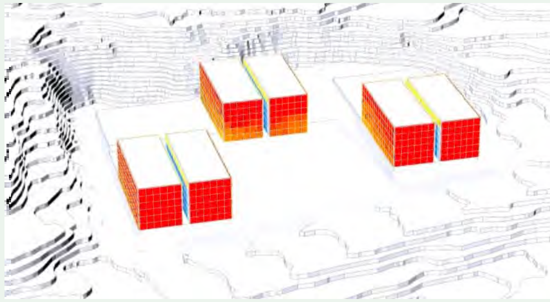
Neben dem Tageslicht konzentriert sich der visuelle Komfort auf die Verbindung zwischen Innen und Außen: Ausblicke auf die Natur, Ausblicke auf soziale Aktivitäten und eine sichere Privatsphäre.

Simulationen / Sonneneinstrahlung - Qualität der Tageslichtausnutzung (sDA) - Fassade



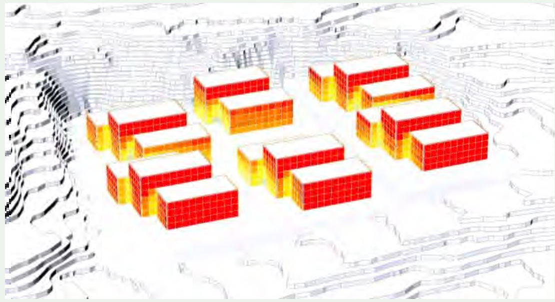
VOLUMEN 1 / SÜD-WEST

Annahme: 40% Verglasung



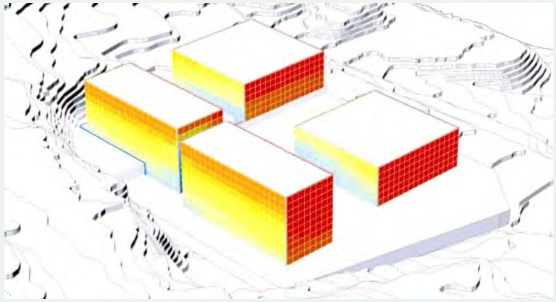
VOLUMEN 2 / SÜD-WEST

Annahme: 40% Verglasung



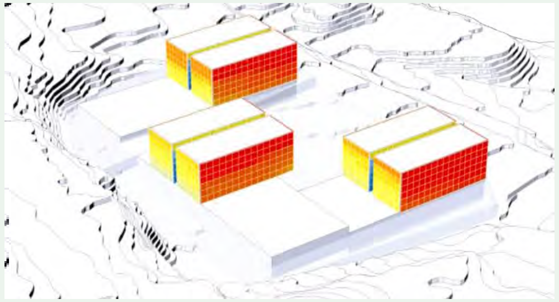
VOLUMEN 3 / SÜD-WEST

Annahme: : 40% Verglasung



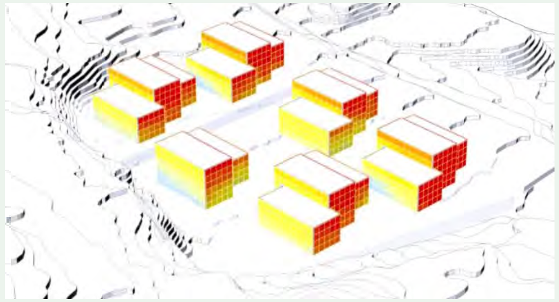
VOLUMEN 1 / NORD-WEST

Annahme: : 40% Verglasung

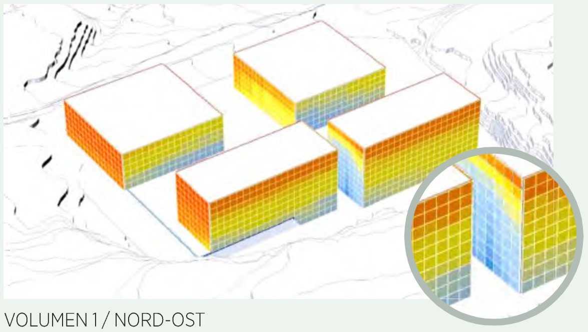


VOLUMEN 2 / NORD-WEST

Annahme: 40% Verglasung

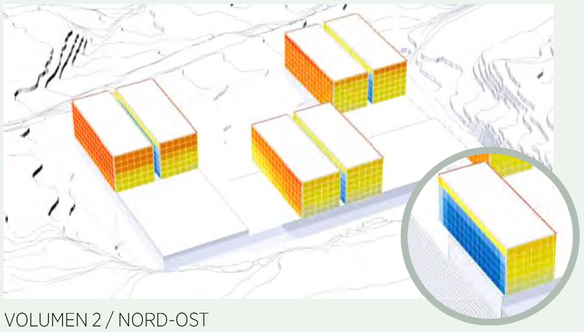


Annahme: 40% Verglasung



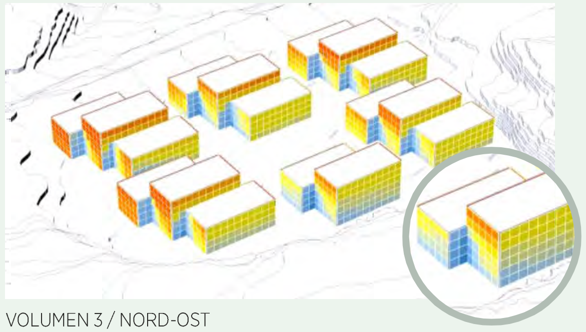
VOLUMEN 1 / NORD-OST

Die beiden rückwärtigen Gebäude werfen in der engen Passage Schatten aufeinander und minimieren die Aussicht.
Gefahr der Überhitzung an den Süd- und Westfassaden.



VOLUMEN 2 / NORD-OST

Die drei Gebäude werfen keinen Schatten aufeinander. Fokus auf die Bereiche zwischen der einzelnen Körper: Passage, Gewächshäuser, etc.
Die Baukörper könnten versetzt/verschoben werden.
Risiko der Überhitzung der Süd-, West-. und Ostfassade.



VOLUMEN 3 / NORD-OST

Aufgrund der dichten, aber niedrigen Bebauung werfen die Gebäude nur ein Minimum an Schatten aufeinander.
Gefahr der Überhitzung an den Süd- und Westfassaden.

Anhang

Build in Wood - Innsbruck Pilot Project
Cost Estimate based on the Concept Drawings from April 2023
Date: 06.12.2023

CF MØLLER ARCHITECTS

BGF	3003,37	m2
BGF R	2304,23	m2
BGF S	699,14	m2
BRI	8248,71	m3
NUF	1823,23	m2

Number	Cost Group		Amount		Unit Price	Total		Remarks
200	**Site and Prep Work**				**psch**			
300	**Building Costs**					**3.427.186,43 €**		
310	Baugrube		2.306	m3	75,00 €	172.950,00 €		
320	Gründung		567	m2	435,00 €	246.449,25 €		Sonderfundamente (Hanglage) nicht berücksichtigt
330	Außenwände vertikal		1.919	m2	485,00 €	930.666,50 €		inkl. Fenster
340	Innenwände vertikal		435	m	291,00 €	126.477,33 €		inkl. Türen
350	Decken horizontal		2.246	m2	465,00 €	1.044.176,10 €		
360	Dächer		856	m2	465,00 €	398.249,25 €		
380	Baukonstr. Einbauten		699	m2BGFs	465,00 €	325.035,00 €		
390	Sonstiges		3.003	m2BGF	61,00 €	183.183,00 €		
400	**Technical Infrastructure**		**3.003**	**m2BGF**	**315,00 €**	**945.945,00 €**		
500	**Landscape and Surrounding Areas**		**7.000,00 €**	m2	**psch**	**150,00 €**		

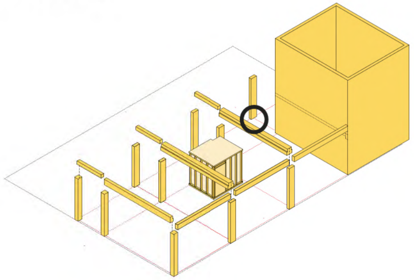
Summary			
200	**Site and Prep Work**	**0,00 €**	0%
300	**Building Costs**	**3.427.186,43 €**	78%
400	**Technical Infrastructure**	**945.945,00 €**	22%
500	**Landscape and Surrounding Areas**	**150,00 €**	0%
TOTAL		**4.373.281,43 €**	

Additional Remarks

planning fees not included
Site not included
Legal and other fees not included
Tax not included

DETAIL 01 - COLUMN BASE

LOCATION



COMPONENTS

- **A** Steel column base on threaded bar with double nut + self-expanding mortar
- **B** Raised floor system
- **C** Screwed angle brackets

COMPONENT GUIDE

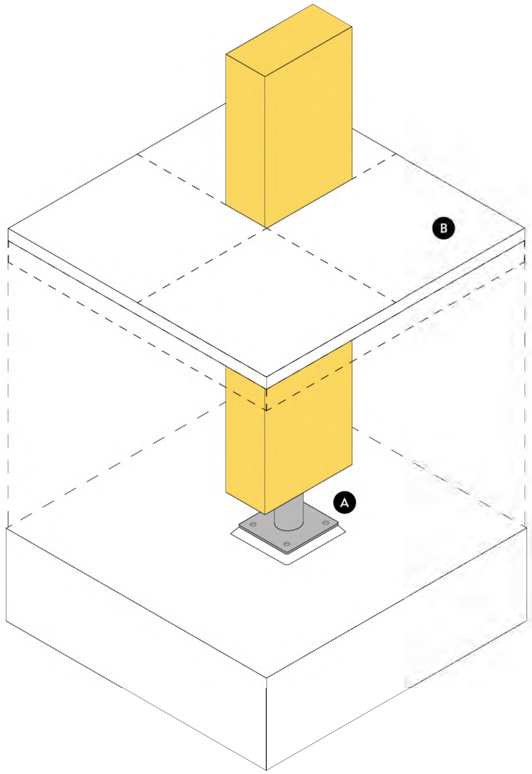
Section 1.1.3 Bay & Grid Size

Section 1.1.3.4 Columns

Section 1.1.7.1 Charring & Delamination

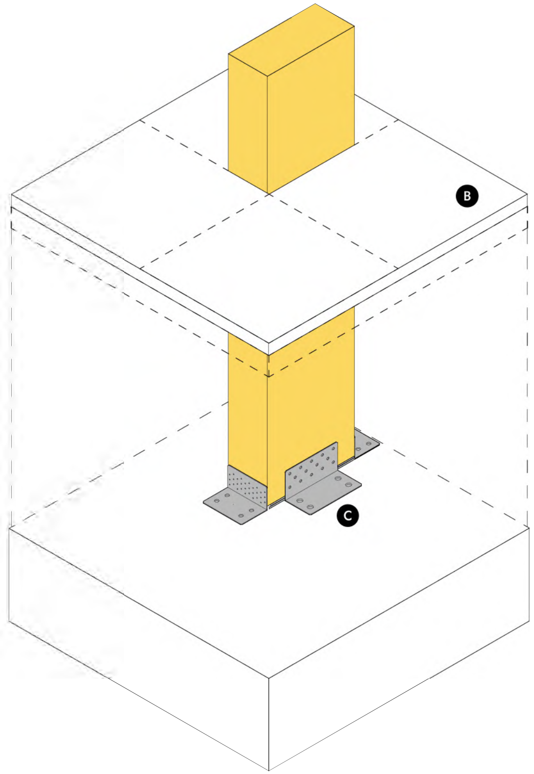
Section 1.1.7.3 Fire Resistance

Detail drawings PP2 - D01, D07 and D08



COLUMN BASE - GROUND FLOOR

We foresee the use of custom-made steel post bases: a connection that deals with the compression forces/loads generated by the structure above. To increase the durability of timber column bases, it is common practice to raise them (min. 150 mm) from the RC slab surface. The steel column base needs to be intumescent painted or encased with concrete to fire-protect them and make them less vulnerable in general.

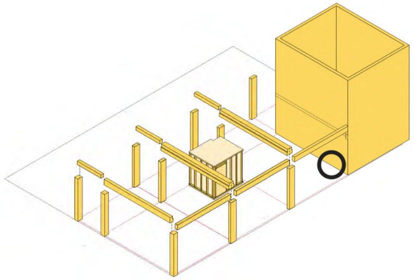


COLUMN BASE - PODIUM

In RC podium type/raised areas, screwed angle brackets constitute a valid alternative to the steel post base. Steel shims can be used as spacers to level the substrate before landing the column; a bituminous membrane must also be installed under the column's footprint to prevent moisture damage. A similar approach informs the timber floorslab to column connections in general as the columns are expected to take vertical loads only.

DETAIL 02 - WALL BASE

LOCATION



COMPONENTS

- (A) Hold down bracket
- (B) Angle bracket (screwed)
- (C) Angle bracket (SCREWED) + SPECIAL BASE PLATE
- (D) LIne of raised floor level
- (E) Plasterboard lining

COMPONENT GUIDE

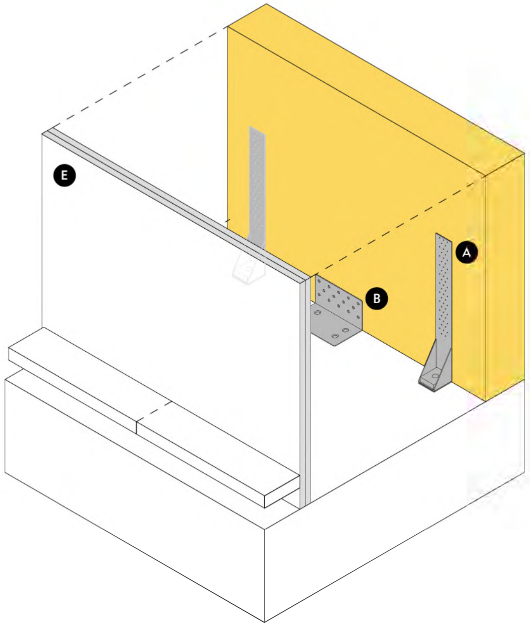
Section 1.1.4 Stability Structure

Section 1.1.7.1 Charring & Delamination

Section 1.1.7.2 Fire Load & Compartimentation

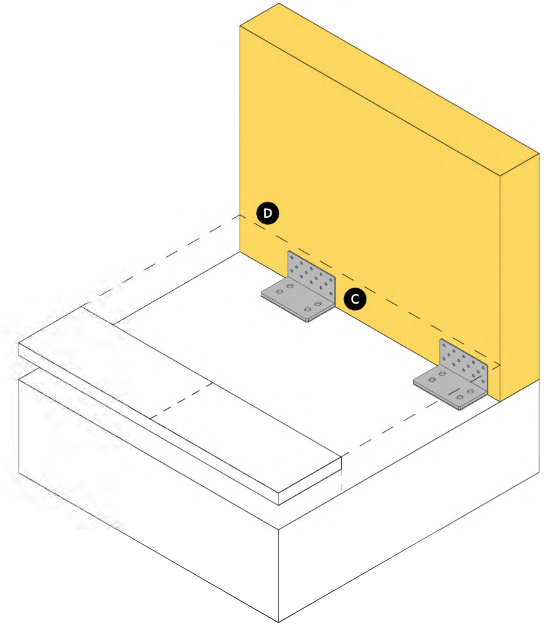
Section 1.1.7.3 Fire Resistance

Annex 02: Connection Strategy



CONCEALED WALL

Hold down brackets (A) deal with vertical tension forces whilst angle brackets (B) deal with horizontal shear forces. Connectors type A is visually quite impactful and used mainly where CLT walls are hidden behind plasterboard lining.

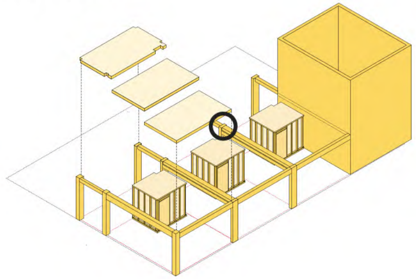


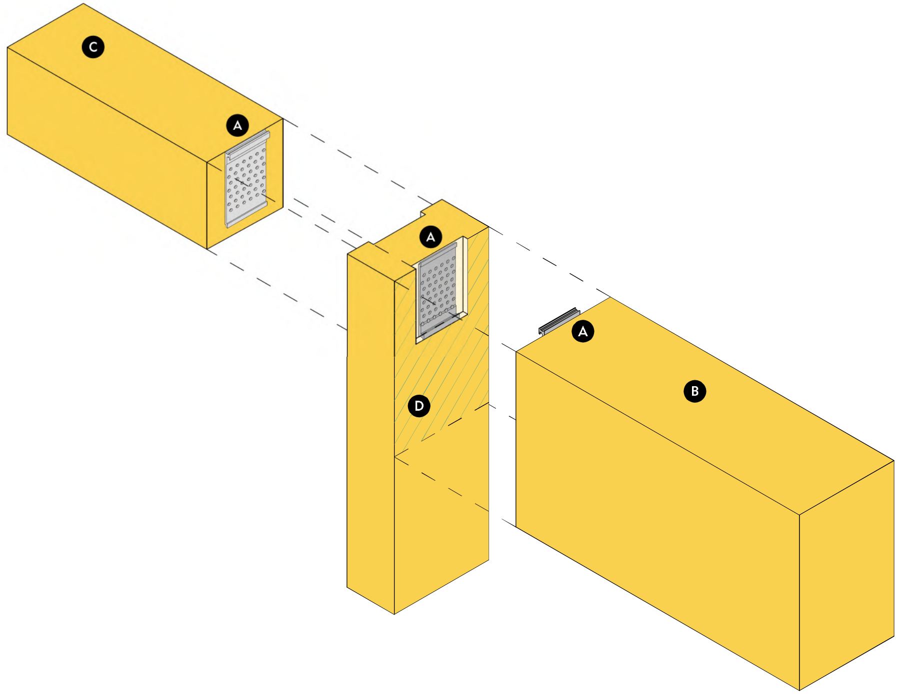
EXPOSED WALL

If the architectural intention is to expose CLT walls, there is the option to use screwed angle brackets with special (thicker) base-plates that allow them to deal with tension forces avoiding the need for hold-down brackets.

DETAIL 03A - COLUMN TO BEAM CONNECTION

LOCATION





COMPONENTS

- **A** Hook shaped connector - concealed
- **B** Primary beam
- **C** Service beam
- **D** Connection fire protection area

COLUMN TO BEAM CONNECTION - EXPOSED

The column to beam connection is achieved by vertically sliding the hook shaped connectors into place. This approach allows for ample vertical axial (column inclination/beam length) and lateral tolerances; furthermore, there is no need for further on-site assembly operations all conenctions can be installed off-site with a negligable impact on the overall dimension increase of both beams and columns.

COMPONENT GUIDE

Section 1.1.3 Bay & Grid Size

Section 1.1.7.1 Charring & Delamination

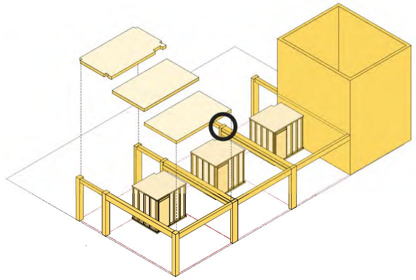
Annex 01: Structural Component Sizes

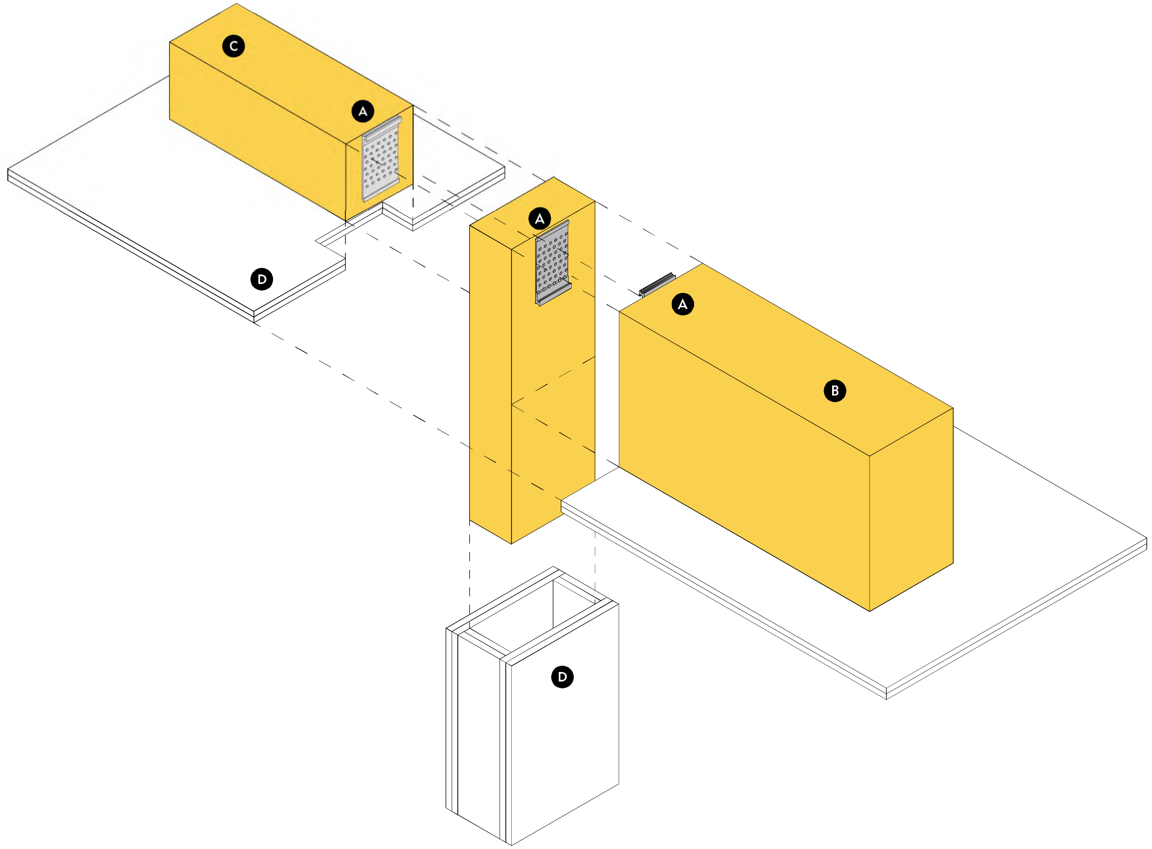
Annex 02: Connection Strategy

Vorabzug aus dem Build-in-Wood Katalog

DETAIL 03B - COLUMN TO BEAM CONNECTION

LOCATION





COMPONENTS

- **A** Hook shaped connector - exposed
- **B** Primary beam
- **C** Service beam
- **D** Plasterboard encapsulation

COMPONENT GUIDE

Section 1.1.3 Bay & Grid Size
Section 1.1.7.2 Fire Load & Compartimentation
Section 1.1.7.3 Fire Resistance
Annex 01: Structural Component Sizes
Annex 02: Connection Strategy

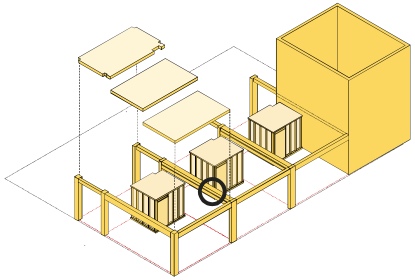
COLUMN TO BEAM CONNECTION - CONCEALED

Connections need to be constructed with a fire-resistance equal to that of the connecting members. Depending on whether the structure is exposed or encapsulated, the connector can be concealed and protected by a sacrificial layer of timber, or left exposed and rely on the protection of plastreboard cladding as shown in this image).

Vorabzug aus dem Build-in-Wood Katalog

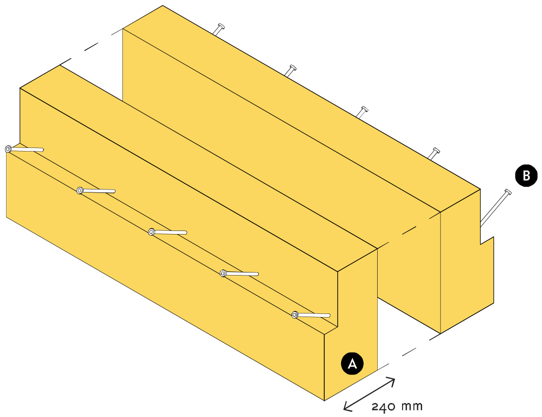
DETAIL 04 - DOUBLE BEAM ASSEMBLY

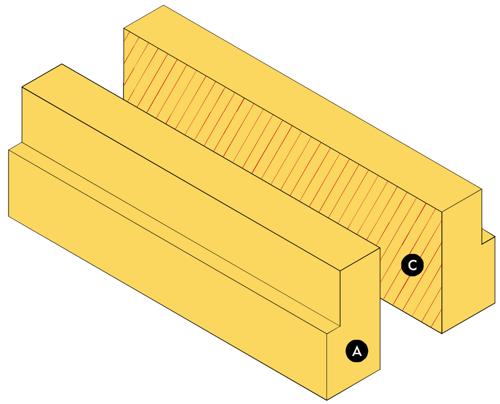
LOCATION



COMPONENTS

- **A** Single glulam section (max. 240 mm width)
- **B** Countersunk wood screw (45 deg. angle)
- **C** Glued surface





DOUBLE BEAM - SCREWED CONNECTION

The maximum width of standard sized glulam beams is 240 mm. If wider sections are required then beams are usually screwed together to form a double or multiple section.

DOUBLE BEAM - GLUED CONNECTION

Block-gluing of beams is an alternative production method for large glulam sections. Not many manufacturers are currently able to certify this production procedure.

COMPONENT GUIDE

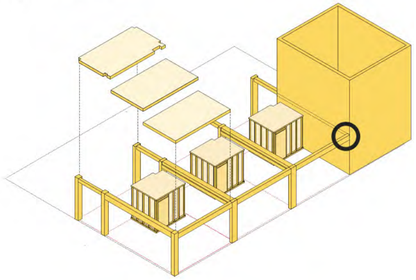
Section 1.1.3 Bay & Grid Size

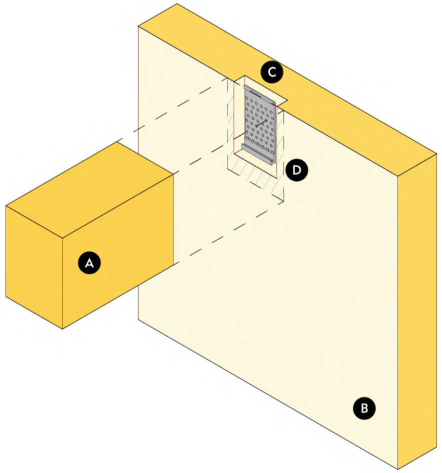
Section 1.1.3.2 Primary Beams

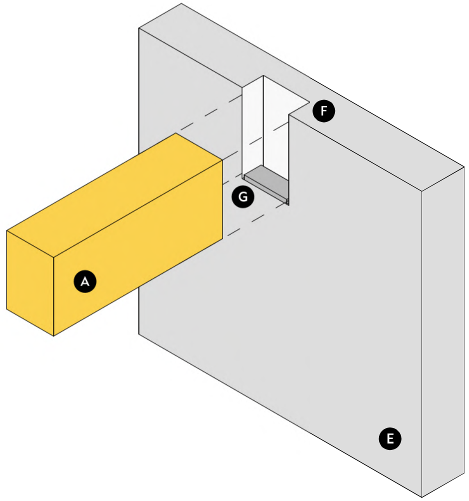
Annex 01: Structural Component Sizes

DETAIL 05 - BEAM TO CORE CONENCTION

LOCATION







COMPONENTS

- **A** Perimeter beam
- **B** Core wall (CLT)
- **C** Hook shaped connectors with horizontal screws
- **D** Fire protection area (exposed walls)
- **E** Core wall (RC concrete)
- **F** Recess to RC concrete wall
- **G** Steel plates

COMPONENT GUIDE

Section 1.1.3 Bay & Grid Size
Section 1.1.3.4 Façade Beams
Section 1.1.4 Stability Structure
Section 11.7.1 Charring & Delamination
Annex 01: Structural Component Sizes

BEAM TO CLT CORE INTERFACE

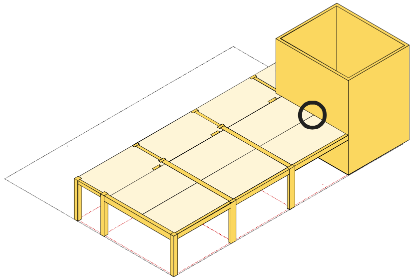
This type of connection would be optimal for single storey CLT core walls but can also be used in multistorey wall configuration provided the carveout in the CLT wall is high enough to allow for the top-down movement of the beam positioning process. The connector can be concealed and protected by a sacrificial layer of timber or left exposed and rely on the protection of plasterboard cladding depending on whether the wall is exposed or encapsulated.

BEAM TO RC CORE INTERFACE

Timber beams can sit in RC concrete core wall recesses; they don't need to be fixed to the wall as the angle brackets that link the CLT slab edges to the core-walls create the necessary connection. Steel plates are likely to be needed as levelling devices given that the allowed tolerances for RC walls are much larger (20 mm) than those permitted for timber construction (2-3 mm).

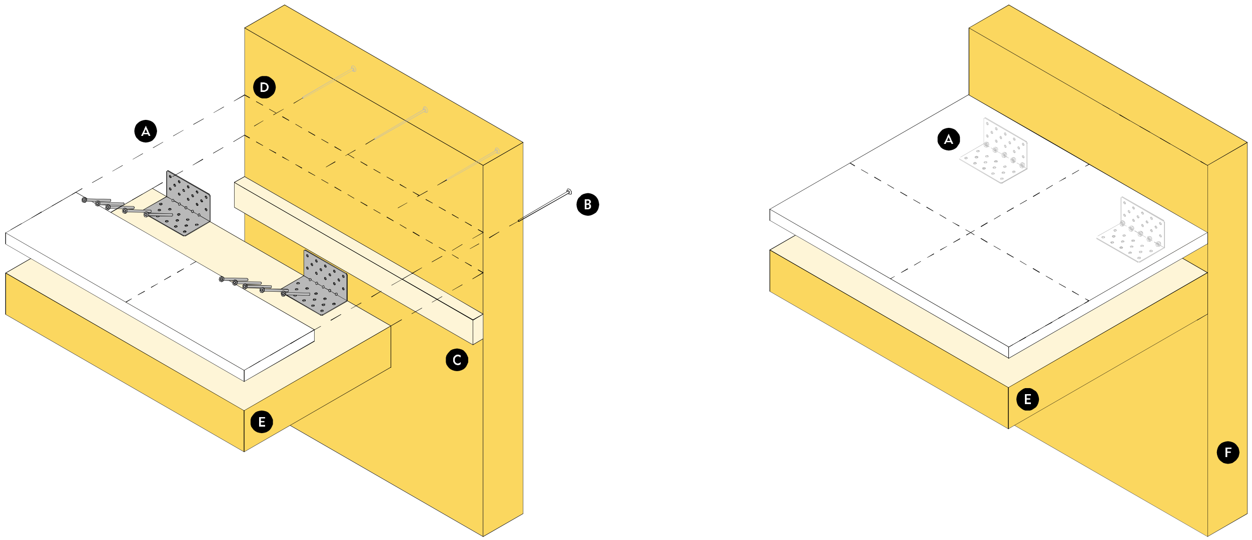
DETAIL 06 - FLOOR PANEL TO CORE CONNECTION

LOCATION



COMPONENTS

- **A** High horizontal force connection
- **B** Screws to floor panels for vertical forces
- **C** Timber battens (temporary - floor slab installation phase only)
- **D** Line of raised floor level
- **E** CLT floor plate spanning perpendicular to core wall
- **E** CLT core wall (single or multisorey)



FLOOR PANELS TO CLT CORE CONNECTION
(DURING ASSEMBLY AND ASSEMBLED)

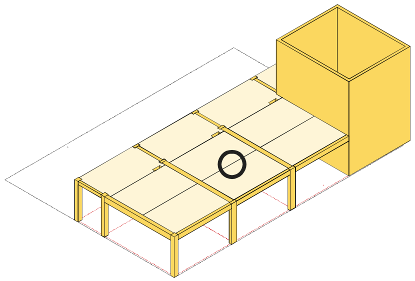
The angle bracket connection is positioned above the floor plate: a configuration that allows the bracket to be fire-protected by the floor buildup above whilst also allowing the soffit of the floor slab and the CLT core wall to be completely exposed if desired.

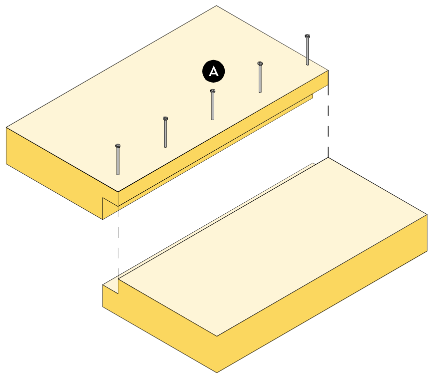
COMPONENT GUIDE

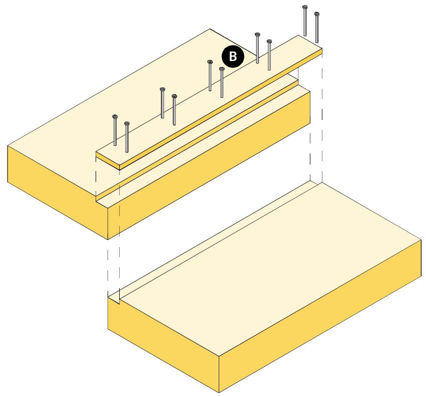
Section 1.1.3.1 Slabs
Section 1.1.4 Stability Structure
Annex 01: Structural Component Sizes
Annex 02: Connection Strategy

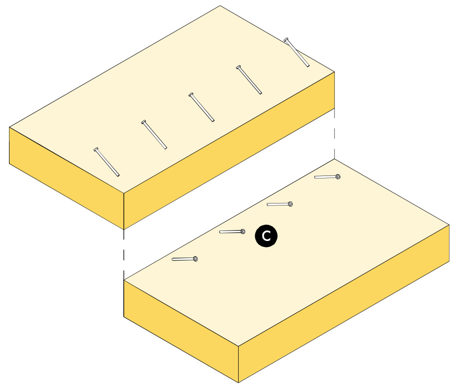
DETAIL 07: PANEL TO PANEL CONNECTION

LOCATION









COMPONENTS

- **A** Vertical self-tapping screws
- **B** Plywood strip
- **C** 45 deg. inclined screws

HALF-LAPPED JOINT CONNECTION

This type of connection has good fire performance (smoke and heat transfer) but both panels need to be shaped to form the half-lap reducing the net-area of each panel.

SINGLE SURFACE SPLINE CONNECTION

Surface spline connections are made using plywood strips placed into a routed section situated along the floor panel joints. These type of connections require machining of the panel edges although there is less material loss and no net-area loss compared to half-lap joints.

Good fire performance especially in terms of heat transfer provided intumescent seals/tapes are installed along the slab joint.

PLANE JOINT CONNECTION WITH CROSSED SCREWS

A simple, plane joint connection is the most cost-effective method of transferring shear forces between CLT panels. Screws are installed at a 45° angle to the floor panel edge, creating a connection for a minimum of half the panel's thickness. The plane joint connection's fire performance is not comparable to the ones achieved by half-lap and spline connections.

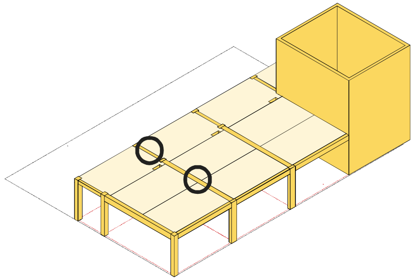
COMPONENT GUIDE

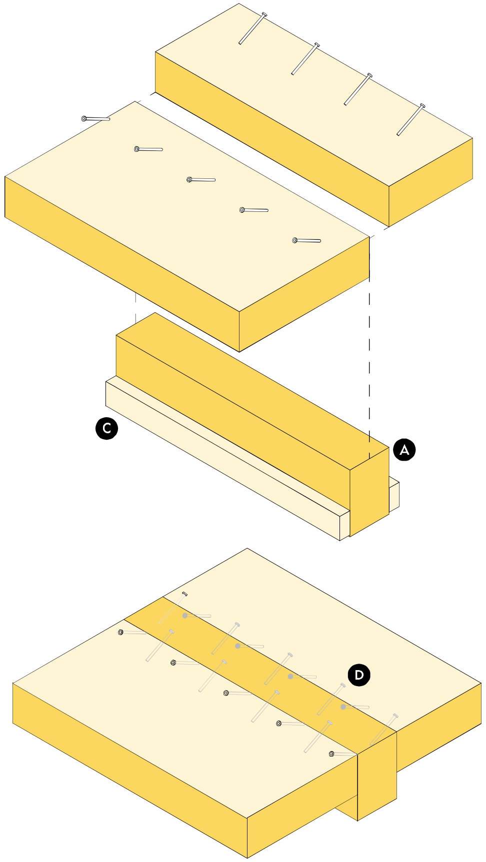
Section 1.1.3.1 Slabs

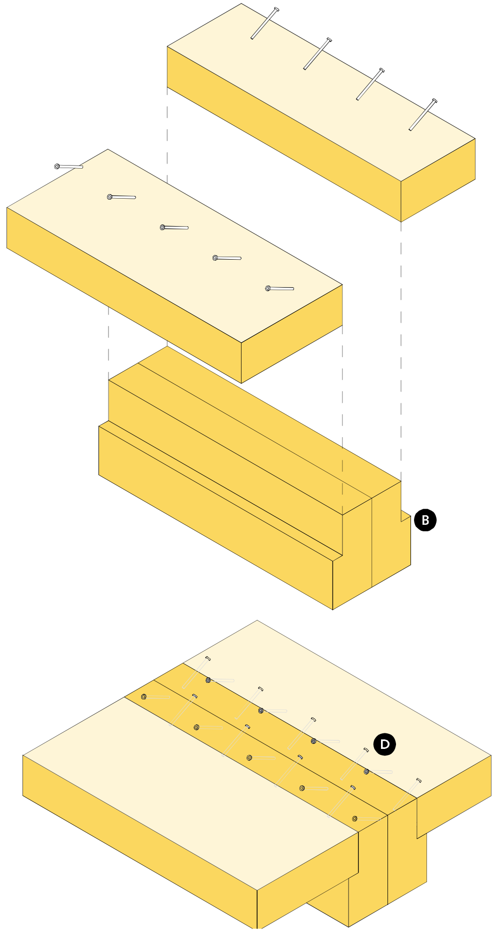
Section 1.1.4 Stability Structure

DETAIL 08: SLAB PANEL TO BEAM CONNECTION

LOCATION







COMPONENTS

- **A** Service beam
- **B** Primary beam
- **C** Timber battens (temporary - floor slab installation phase only)
- **D** Angled fasteners arranged in a screw cross

COMPONENT GUIDE

Section 1.1.3.1 Slabs

Section 1.1.3.2 Primary Beams

Section 1.1.3.2 Service Beams

Annex 01: Structural Component Sizes

CONNECTION TO SINGLE BEAM
(DURING ASSEMBLY AND ASSEMBLED)

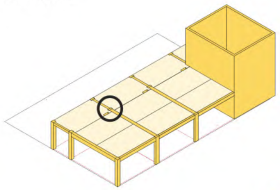
This configuration will be typical for service bays where the beams are predominantly single. This details offers the potential to pre-assemble the beam to the slab edge either on or off-site.

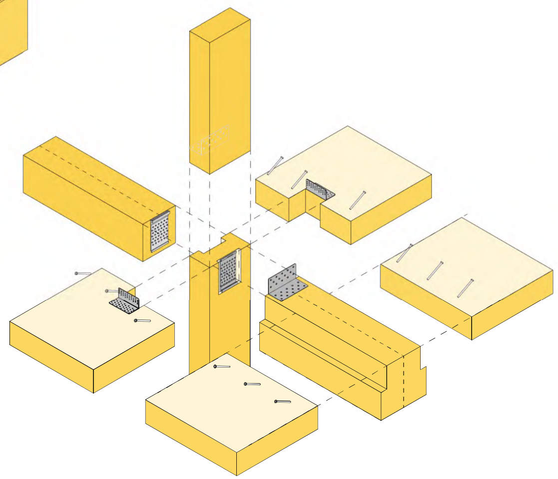
LATERAL CONNECTION TO DOUBLE BEAM
(DURING ASSEMBLY AND ASSEMBLED)

The double beams to the primary bays are notched to the outside to recieve the slab. This notch allows the slab to bear onto the beam working in combination with the screwed connections.

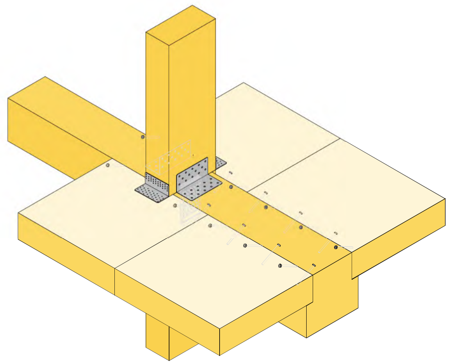
DETAIL 09A: COLUMN/BEAM NODE

LOCATION





AMALGAMATION OF DETAILS 03. 04 AND 08
(DURING ASSEMBLY)



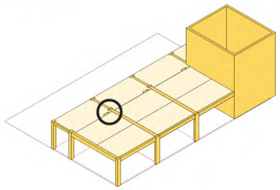
AMALGAMATION OF DETAILS 03. 04 AND 08
(ASSEMBLED)

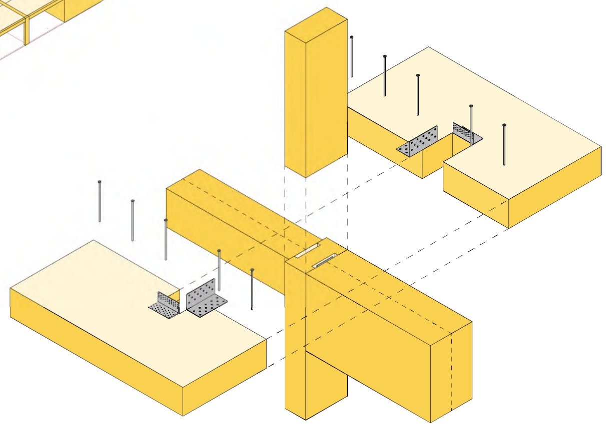
COMPONENT GUIDE

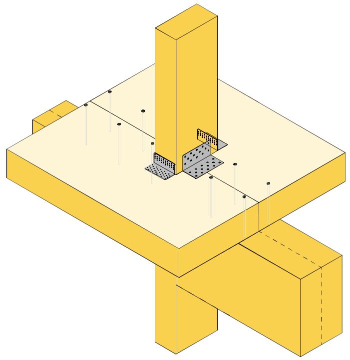
Section 1.1.3.1 Slabs
Section 1.1.3.2 Primary Beams
Annex 01: Structural Component Sizes
Annex 02: Connection Strategy

DETAIL 09B: COLUMN/BEAM NODE

LOCATION







COMPONENT GUIDE

Section 1.1.3.1 Slabs

Section 1.1.3.2 Primary Beams

Annex 01: Structural Component Sizes

Annex 02: Connection Strategy

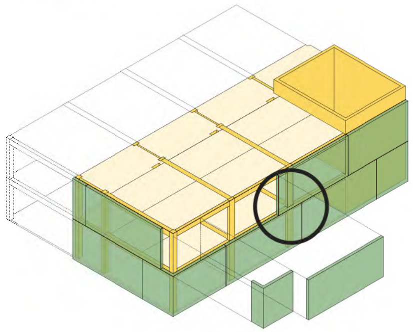
AMALGAMATION OF DETAILS 03. 04 AND 08
(DURING ASSEMBLY)

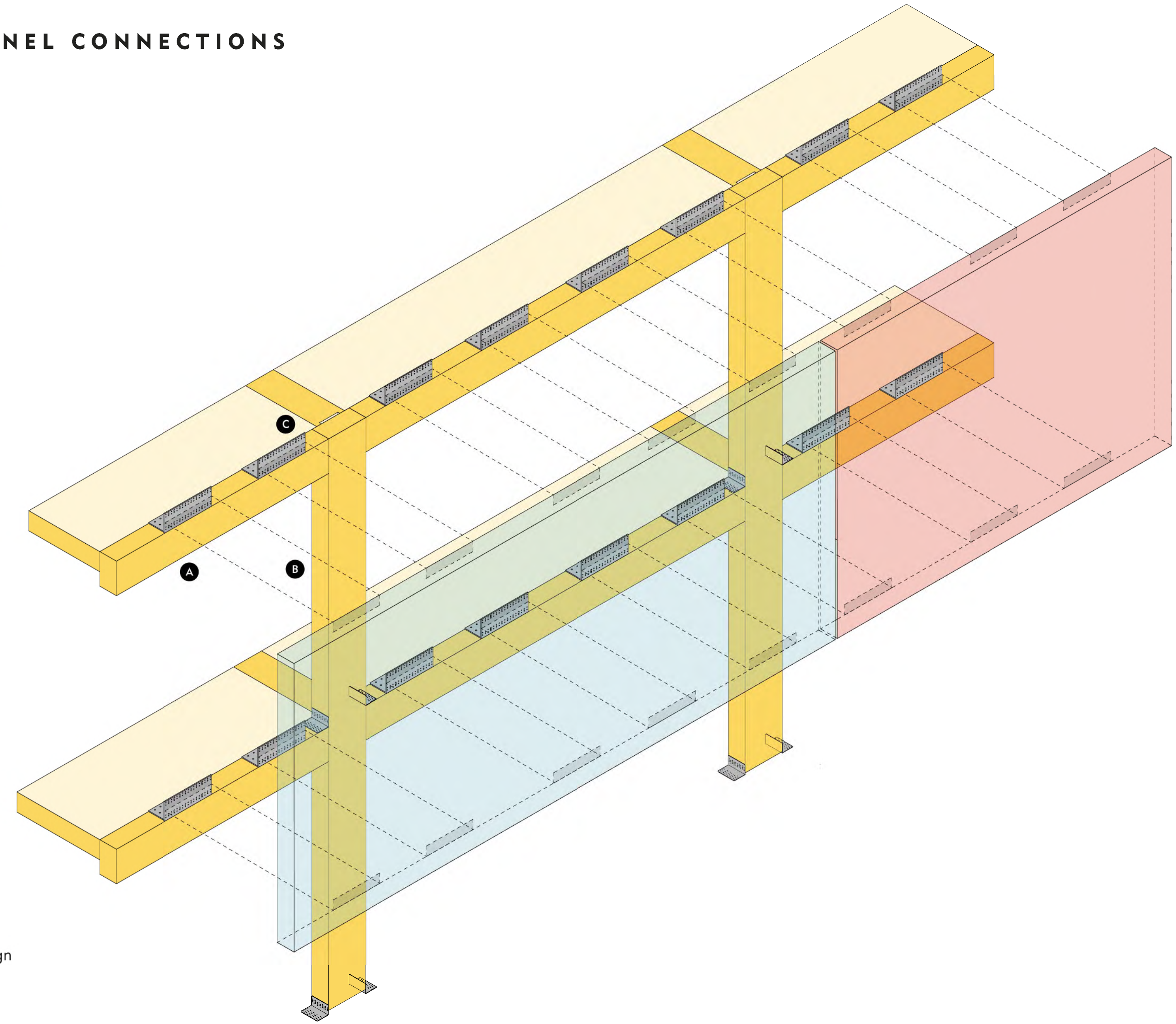
AMALGAMATION OF DETAILS 03. 04 AND 08
(ASSEMBLED)

Vorabzug aus dem Build-in-Wood Katalog

DETAIL 10: FACADE PANEL CONNECTIONS

LOCATION





COMPONENTS

- **A** Façade beam
- **B** Perimeter column
- **C** Angle bracket - façade panel connection

COMPONENT GUIDE

Section 1.2 Façade System

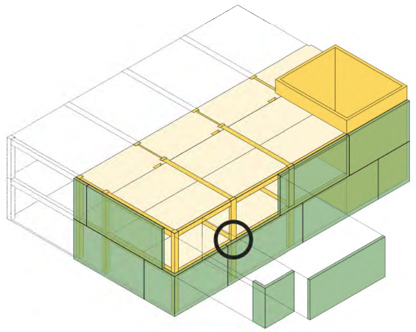
Section 1.1.3.4 Façade Beams

Section 1.1.3.5 Columns

Annex 11: Angle bracket and facade panel design

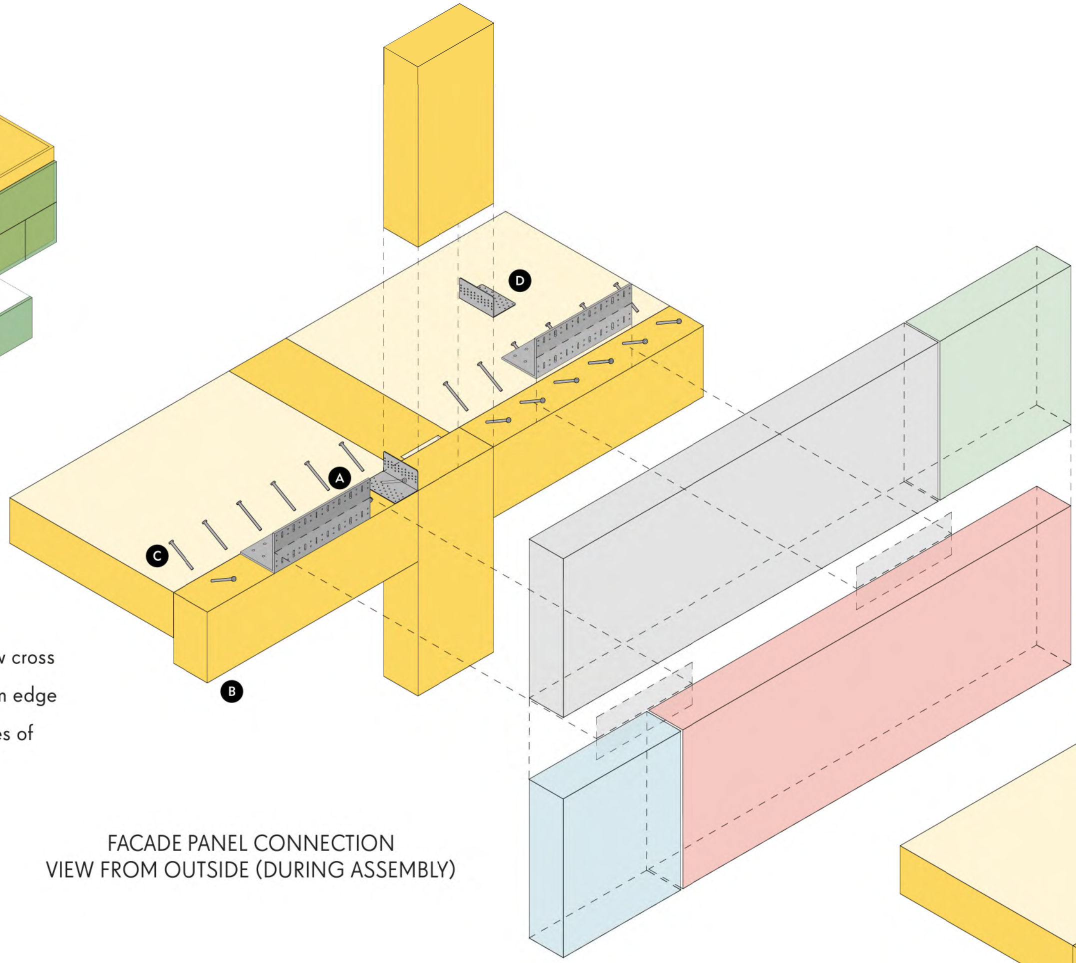
DETAIL 11: FACADE PANEL /STRUCTURE INTERFACE

LOCATION



COMPONENTS

- **A** Facade bracket
- **B** Perimeter beam
- **C** Angled fasteners arranged in a screw cross (45 deg.) along slab/perimeter colum edge
- **D** Angle brackets connections on 3 sides of perimeter columns



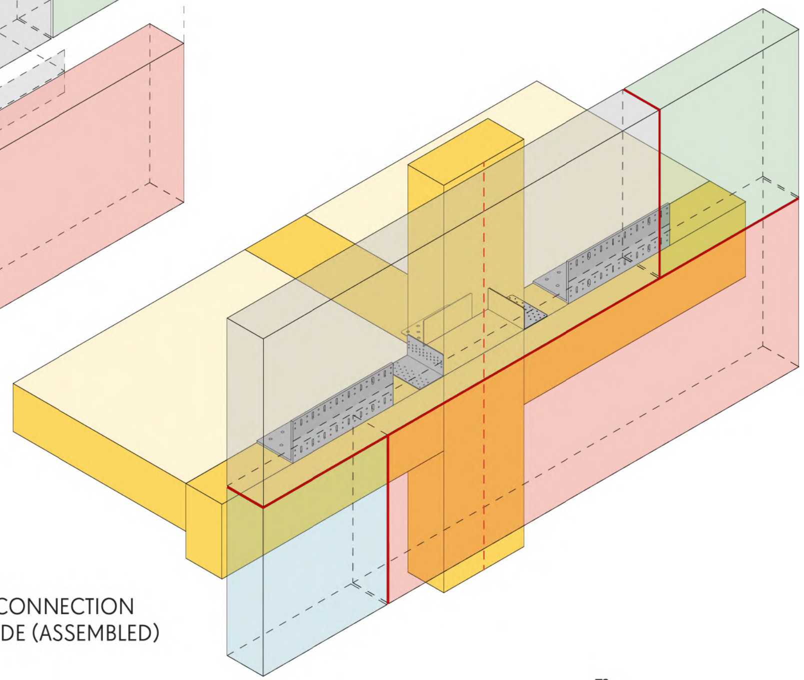
FACADE PANEL CONNECTION
VIEW FROM OUTSIDE (DURING ASSEMBLY)

COMPONENT GUIDE

Section 1.2 Façade System

Section 3 Detailed Drawings

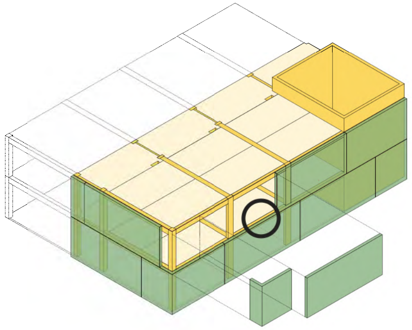
Annex 11: Angle bracket and facade panel design



FACADE PANEL CONNECTION
VIEW FROM OUTSIDE (ASSEMBLED)

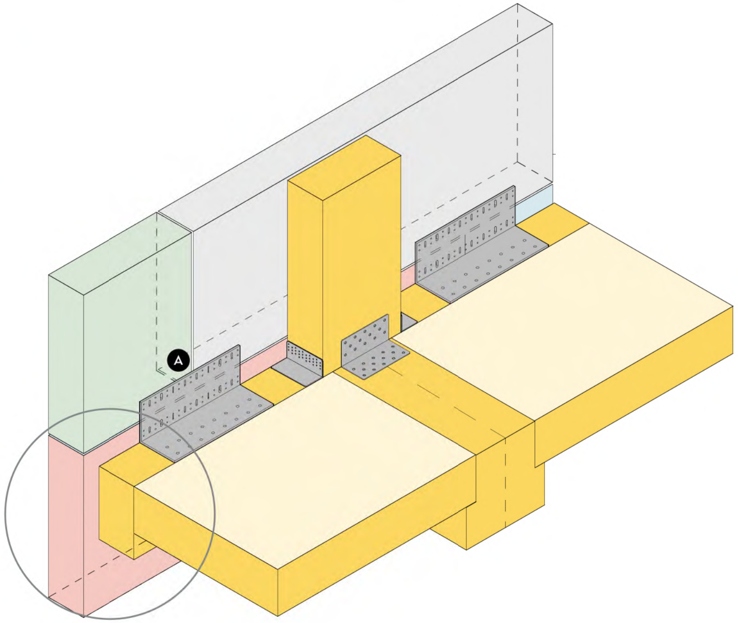
DETAIL 12: PANEL TO PANEL INTERFACE

LOCATION

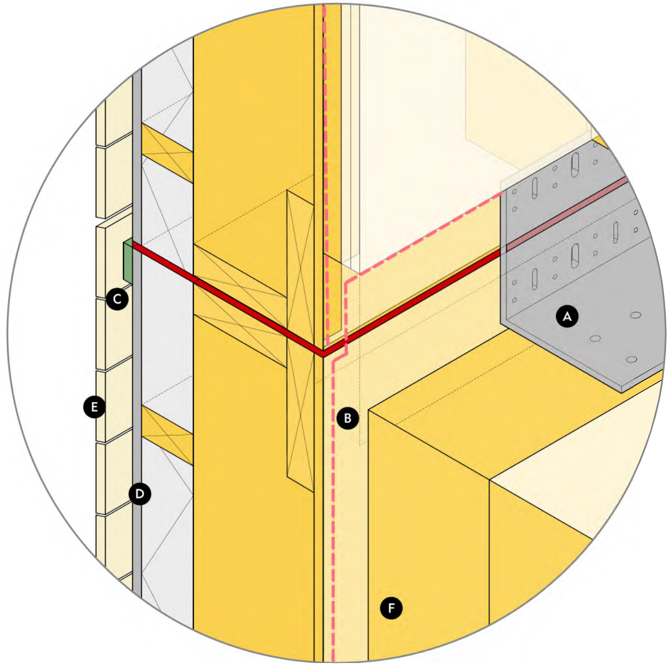


COMPONENTS

- **A** Angle bracket
- **B** Vapour control layer
- **C** Intumescent cavity barrier
- **D** Cement board
- **E** Rainscreen cladding
- **F** Perimeter beam



FACADE PANEL CONNECTION
VIEW FROM INSIDE



PANEL DETAIL

COMPONENT GUIDE

Section 1.2 Façade System

Section 3 Detailed Drawings

Annex 11: Angle bracket and facade panel design

Annex 12: Non combustible facade panel

BUILD IN WOOD

CF MØLLER ARCHITECTS

INNS' BRUCK

pro:Holz Tirol

IIG – Innsbrucker Immobiliengesellschaft

This project has received funding from
the European Union's Horizon 2020
research and innovation programme
under grant agreement No 862820

BUILD IN
WOOD

Trento - Wooden Bike Tower

work package 3 / pilot project

October 2022

CF MØLLER
ARCHITECTS

Fehmarn Tower / Fehrmarn, Germany

Harzturm / Altenau, Ger[illegible]

Herdla Birdwatching To[illegible]

Cheisacherturm / Gansingen, Germany

Strand East Tower / London

Urbach Tower / Remstal, Germany

Bicycle parking, Upsala

Elgtårnet / Esoedalen, N[illegible]

Pyramidenkogel / Kärnten, Austria

Periscope Tower / Seinäjoki, Finland

Lattice Observation Tower / Sweden

Seljord Watch Tower

Project scope

Trento City | Bike Parking Tower

A showcase for green mobility

Bike tower for bikes and e-bikes
Renewable energy (PV's)
A new bus station

Respecting the historical towers

Height: 20-30 m
Architectural principles of the towers
(eg. footprint, proportions)

Sustainable use of resources

Timber construction
(Build-In-Wood)
Design for disassembly

Understanding the site and context

Microclimate
Future development
(arrival and conenctions)

Giving back to the city

Viewpoint
Landmark
Light and safety

Palazzo Pretorio / Torre Grande

Antica Abbaziale di Sant'Apollinare

Torre Vanga

Santa Maria Maggiore

Chiesa dei Santi Cosma e Damiano

Torre Campanaria

Torre Verde

Gardolo church

MUSE (Museum of Science)

Piazza del Duomo and Neptune Fountain

Le Albere Area

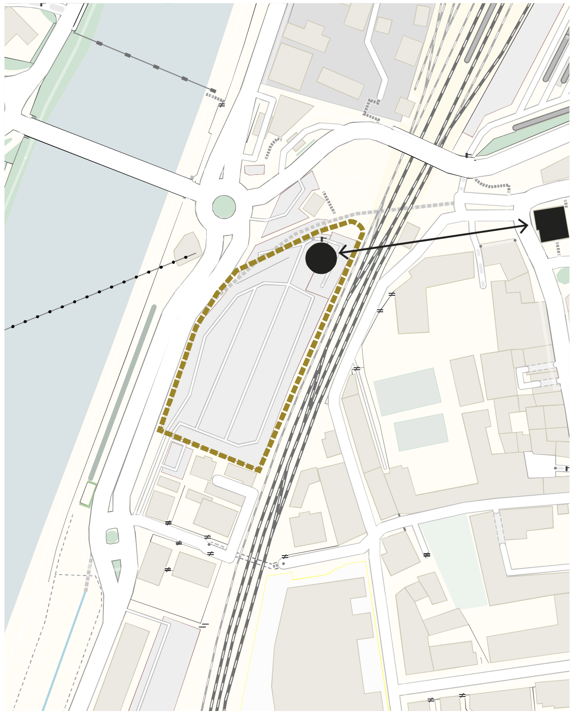
Castello del Buonconsig

Site analysis

Trento City | Tower location

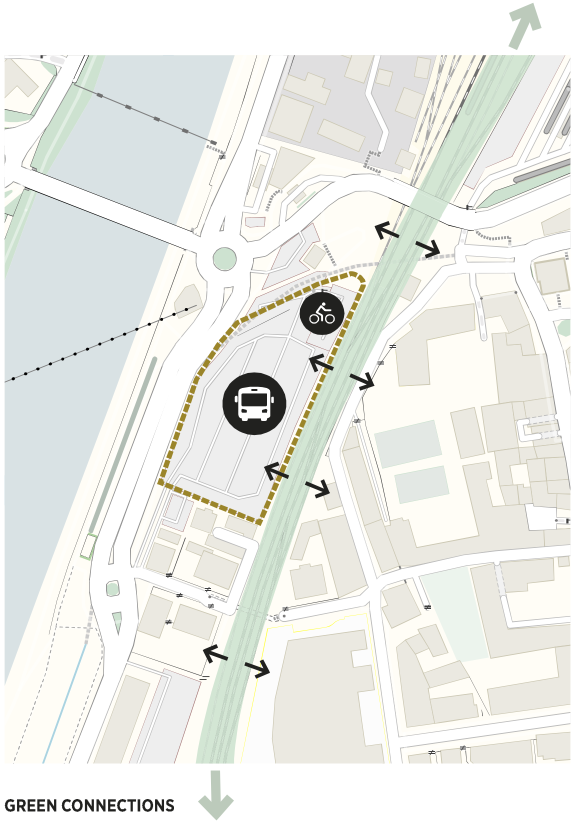
TRANSPORTATION

Around the site heavy car and train traffic runs by while paths along the river is filled with people biking and walking. In future planning cars and train traffic will be reduced or duck down while improving the site for walking and biking. The site and the bike parking tower is near the main train station of the city - an optimal location for a new green mobility hub when arriving to the city by train, bus or car.



HISTORICAL TOWERS

The bike parking tower is placed in the northern part of the site. This to be closer to the train station and to create a strong connection with the historical city and the historical towers - especially the Torre Vanga tower just next to the new bike parking tower. Additionally, with this location the tower will be visible when arriving to the city over the bridge to the east, walking around the city center or arriving with train north of the site - a new landmark of Trento.

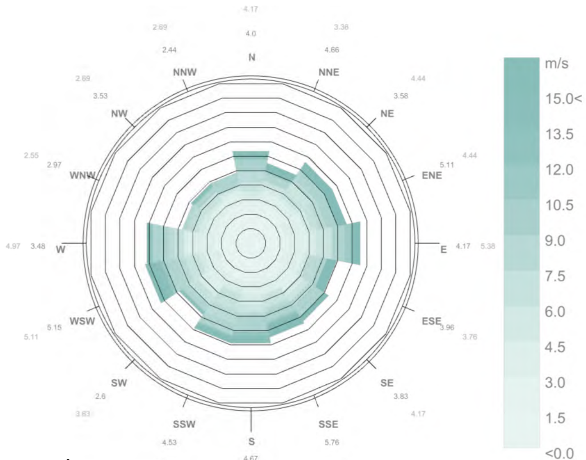


GREEN CONNECTIONS

One of the main concepts for the future development of the city of Trento is the new green connection following the train line. The train will be dug down allowing the groundfloor to florish with greenery and people.
The green connection will in the future pass by the new bike parking tower and the bus station area around. Therefore, the design must integrate this connection and arrival by foot as well in the design.

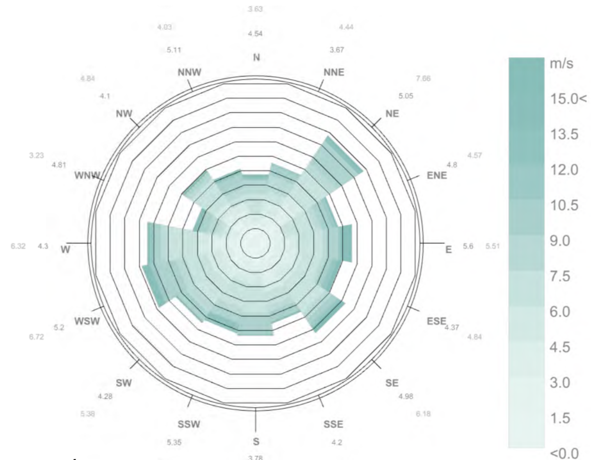
Site analysis

Wind



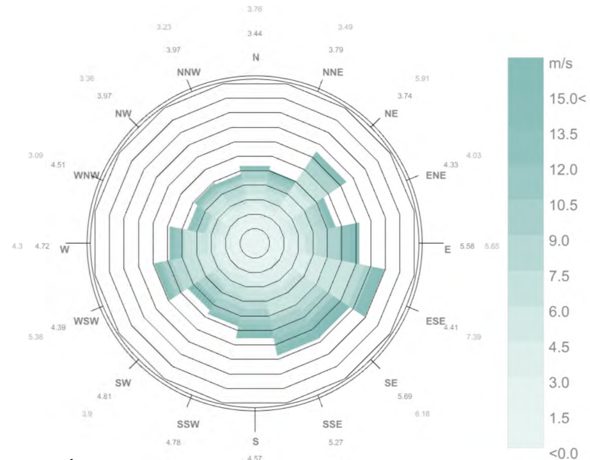
WIND / JANUARY

Average for January (1st - 31st)
Calm/no wind: 34.94 % of the time = 260 hours
Strongest wind: West and East



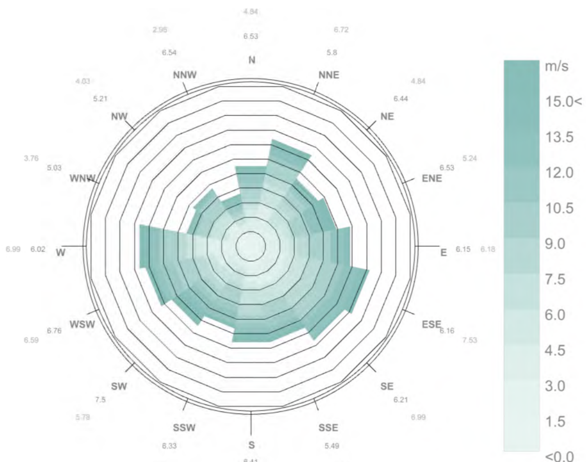
WIND / MARCH

Average for March (1st - 31st)
Calm/no wind: 17.88 % of the time = 133 hours
Strongest wind: Northeast and West



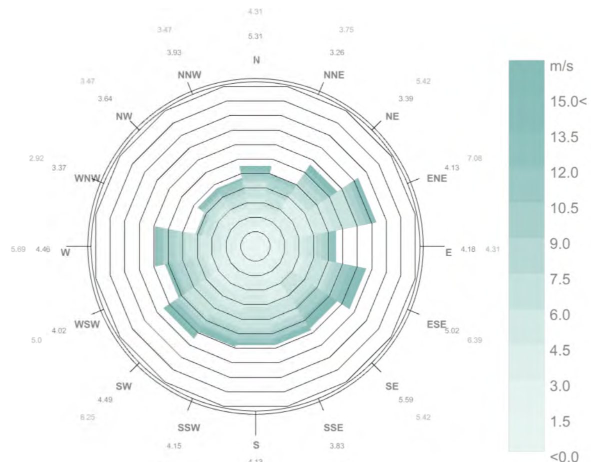
WIND / MAY

Average for May (1st - 31st)
Calm/no wind: 25.00 % of the time = 186 hours
Strongest wind: Southeast and Northeast



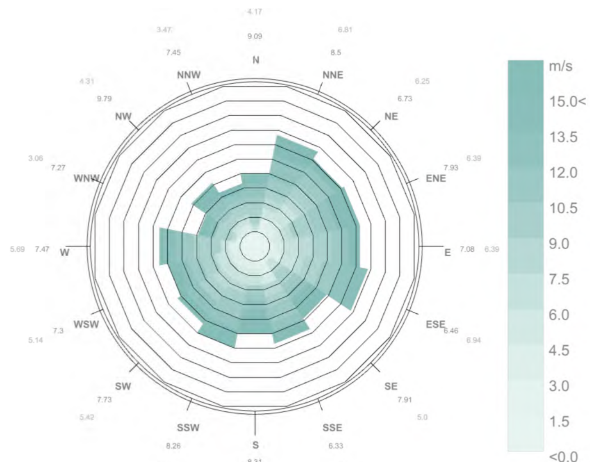
WIND / JULY

Average for July (1st - 31st)
Calm/no wind: 10.75 % of the time = 80 hours
Strongest wind: Southeast, Northeast, West



WIND / SEPTEMBER

Average for September (1st - 30th)
Calm/no wind: 19.72 % of the time = 142 hours
Strongest wind: Northeast, Southeast



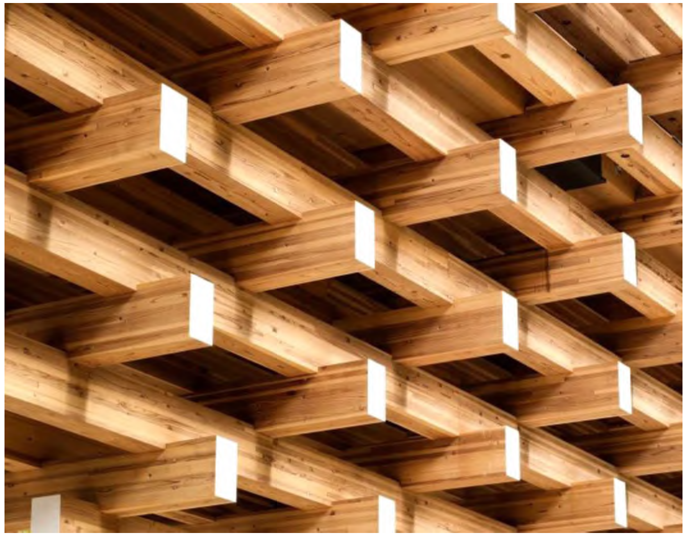
WIND / NOVEMBER

Average for November (1st - 30th)
Calm/no wind: 13.89 % of the time = 100 hours
Strongest wind: Northeast, East, Southeast

View of the site from Lungadige Monte Grappa

Architectural concept

VIEW POINT / The viewpoint platform at the top of the tower can be reached by all by staircase/ramp or elevator.

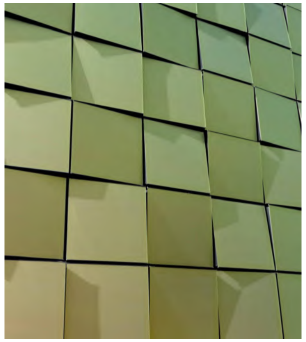


TORRE VERDE / Respecting the historical towers of Trento

LIGHT / Creating safety in the area and a new landmark for Trento

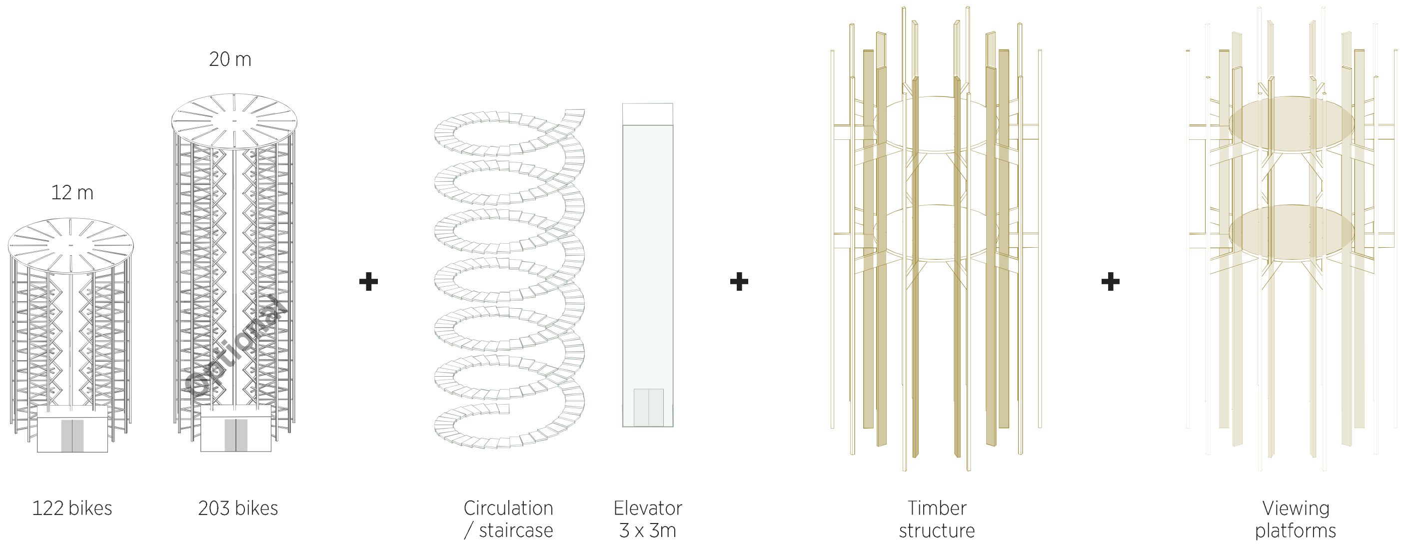
BUILD IND WOOD / Timber structure and timber facade of FSC-certfified wood

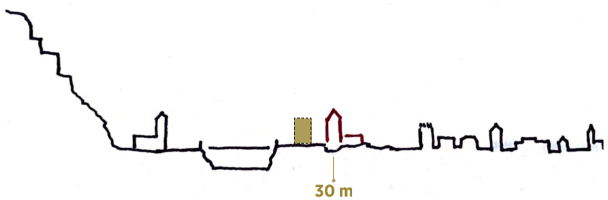
BIKE PARKING / Visible Bike Parking WÖHR system with glass skin



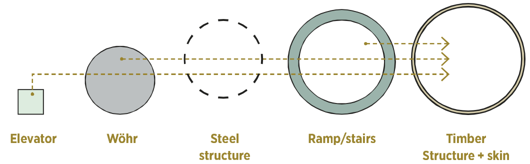
PV PANELS / Energy production and a reference to the roof shingles of the historical towers of Trento

Design principles

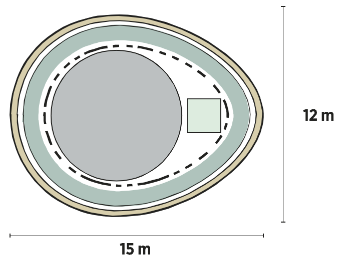




The height of the tower must be between 20-30 m. To respect the historical towers of Trento, the tower should be closer to 20 m than 30 m. This puts an extra focus on the shape and the proportions of the tower to accondate the restrictions while creating an elegant tower landmark.



The footprint dimensions of the tower comes from fitting in the Wöhr bike parking system with its fixed dimensions, together with an elevator for the viewpoint at the top of the tower and the construction of the tower - this with a focus on creating the right balance between width and height.



The stretched shape (egg/ellipse) gives space to integrate elevator, Wöhr system, and staircase spiral while creating a slimmer tower construction from specific angles. The elliptical shape create a simple yet dynamic tower without a backside but with different expressions depending of the viewing point.

Sustainability strategy

The city of Trento has a great focus on **green mobility** with a vision of strengthening the infrastructure for buses and bikes - while at the same time improving the city for walking, biking, and recreational, green areas. A part of this vision is the *Bike Parking Tower* that connects the vision for green mobility with the Build-In-Wood vision of building more timber architecture. Therefore, this sustainability strategy has been made to holistically integrate the wishes from Trento Commune, TrentoLab, and the Build-In-Wood consortium - added with sustainability potentials, we at C.F. Møller Architects, found relevant and important within this project scope.

Therefore, the sustainability strategy focus on the following themes:

- **Sustainable resources:** how can the tower use resources in the most sustainable way in both production and usage?
  Renewable energy, timber construction, CO2-low resources
- **Circular design:** how can the design be built for future reuse and make sure that resources used stays within a circular production chain? FSC-certified timber, local resources, recyclable materials, design for disassembly
- **Microclimate:** how can the tower create a comfortable microclimate in regards of sun, wind, temperature and make sure, that the new area will be safe for alle to use during the day and night time? Wind analysis, artificial lights, views, solar shading.

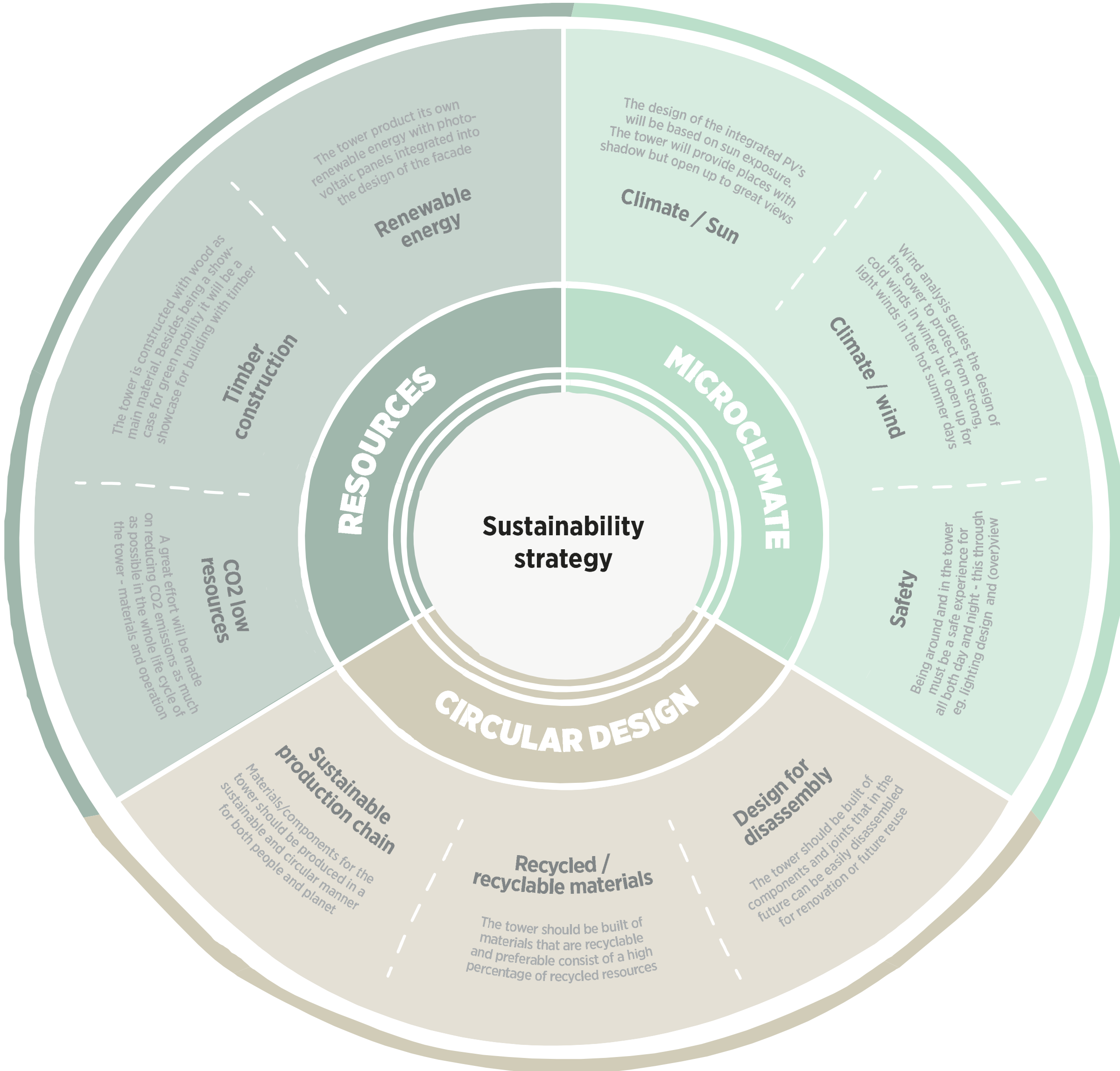
Sustainable resources / Timber construction
Wood is not produced - it grows. All trees need is sun, soil and rain, growing naturally, forming lively ecosystems and providing us with vital oxygen and the precious resource called wood. In this wood, trees absorb CO2, temporarily relieving the atmosphere of its greenhouse effects.

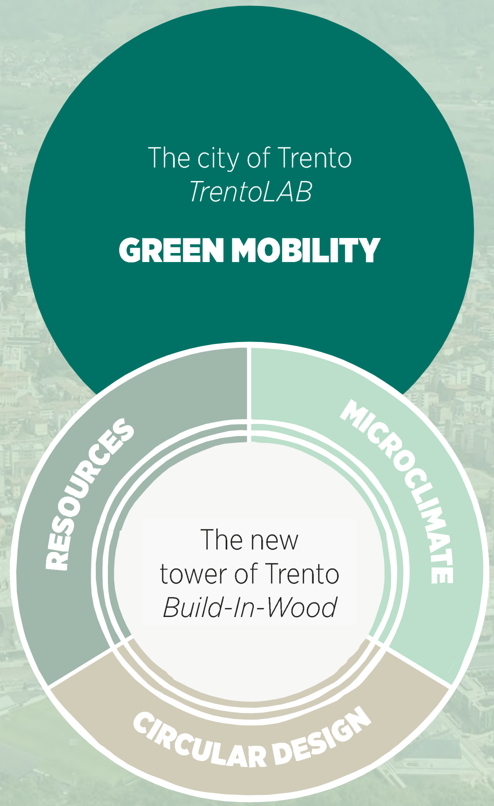
Timber is such an attractive material because it has a lower carbon footprint, uses less energy and water and is 100% renewable from sustainably managed forests. In construction, wood is highly flexible, light and strong at the same time.

It's well-suited for prefabrication and can significantly reduce the construction time. Well engineered, wooden constructions are also perfectly fire-safe and even more earthquake stable than legally required.

Engineered timber is a highly developed building material with a high strength-to-weight ratio, making it perfect for many critical applications. With prefabrication of mayor building elements, the on-site assembly of these parts is quickly done, significantly reducing construction time, weather-dependence and resident annoyance. Additionally, wood is suited for "design for disassembly" and can easily be recycled.

Timber hybrid construction site:
- Fewer transports = **better environment** (up to 75% less transport)
- Shorter construction time = **better economy** (up tp 25% faster)
- Fewer sick days = **better social conditions** (50% less sick leave)

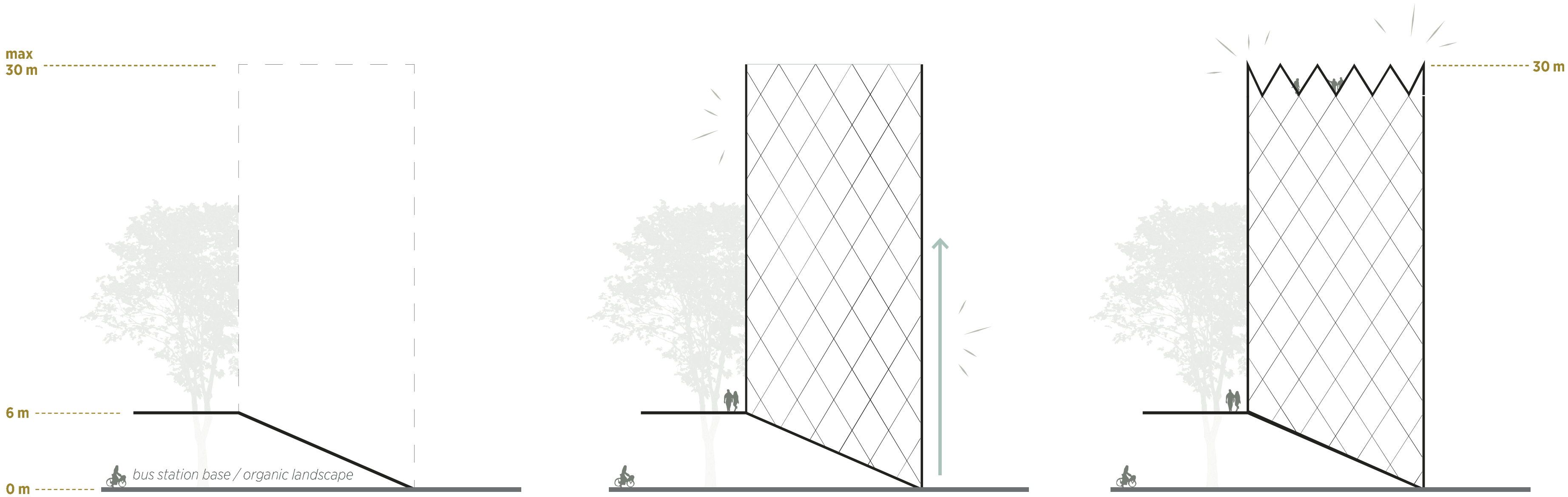



The city of Trento
TrentoLAB
GREEN MOBILITY
RESOURCES
MICROCLIMATE
CIRCULAR DESIGN
The new
tower of Trento
Build-In-Wood

Structural system

Massing principles

Volume concept



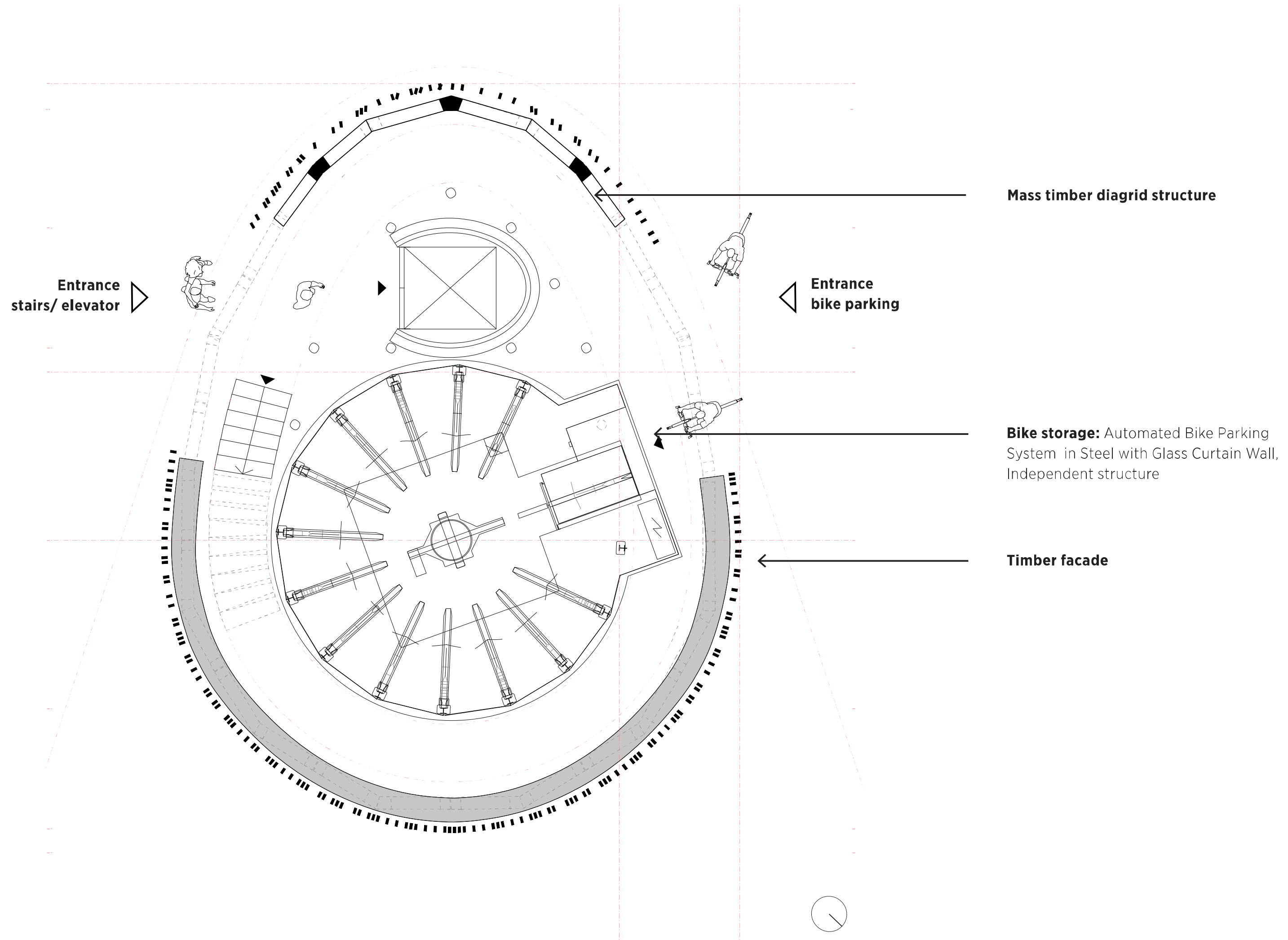
BASE
Integrated into the bus station base.
Integrating the elevator and the stairs.
Minimize the footprint of the tower to
make the tower more slim

BODY
Focus on emphazising
the verticallity of the tower in
the volume and construction/facade.
Posibility to integrate PV's.

TOP
A spectacular crown as
reference to Torre Vanga.
Viewing platform.
PV's integrated.

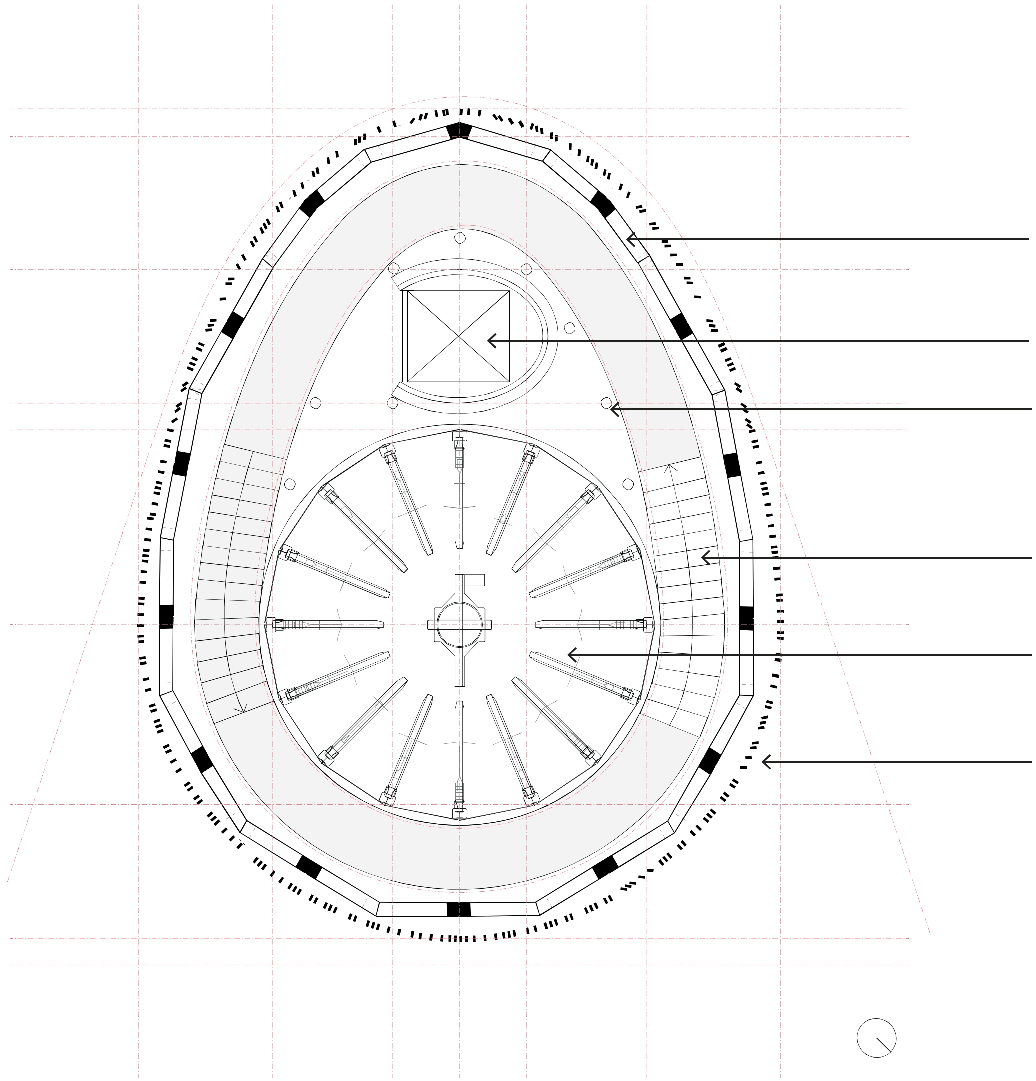
Massing principles

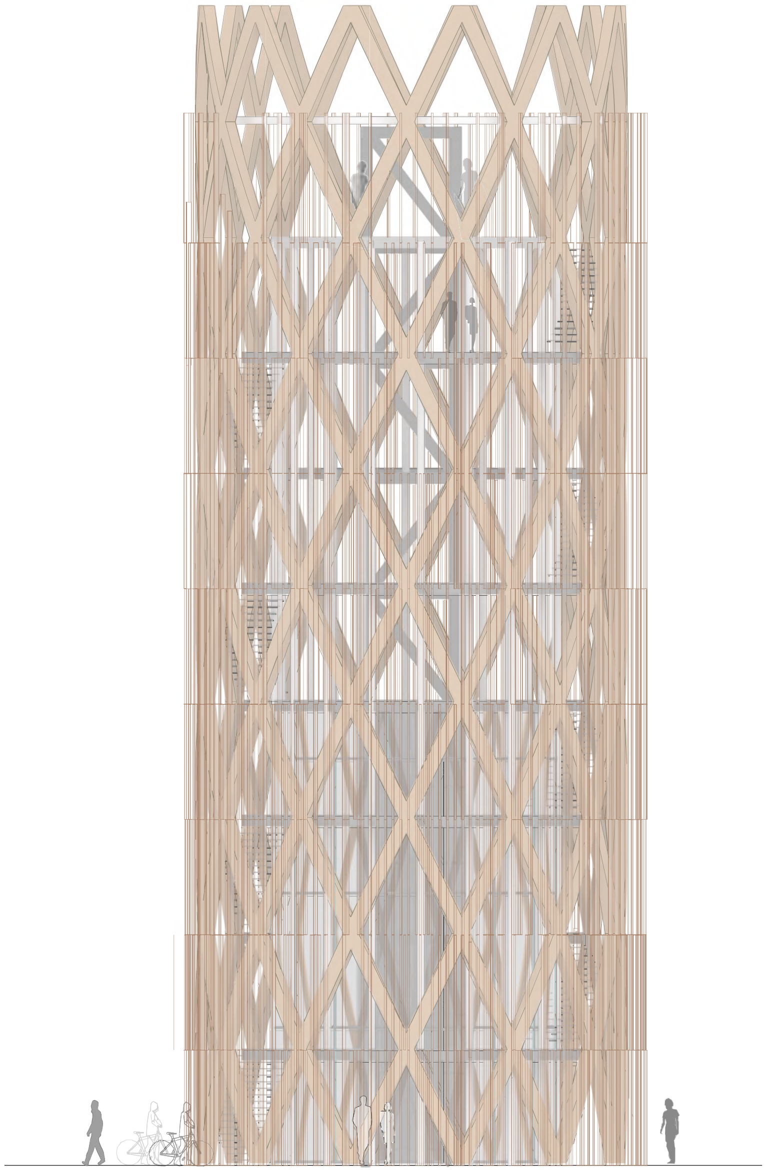
Groundfloor: +/- 0m



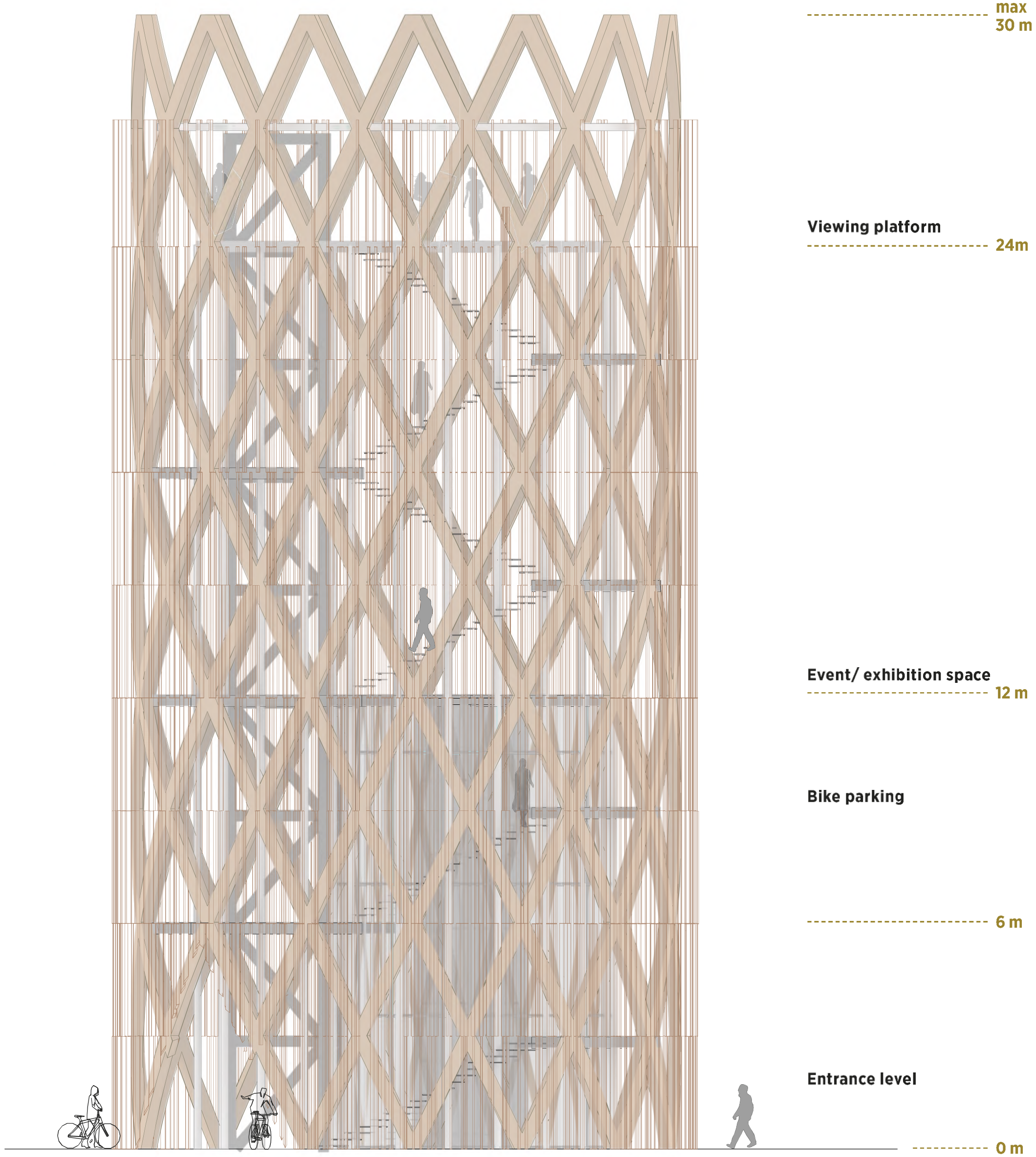
Massing principles

Regular Floor: +6-21m





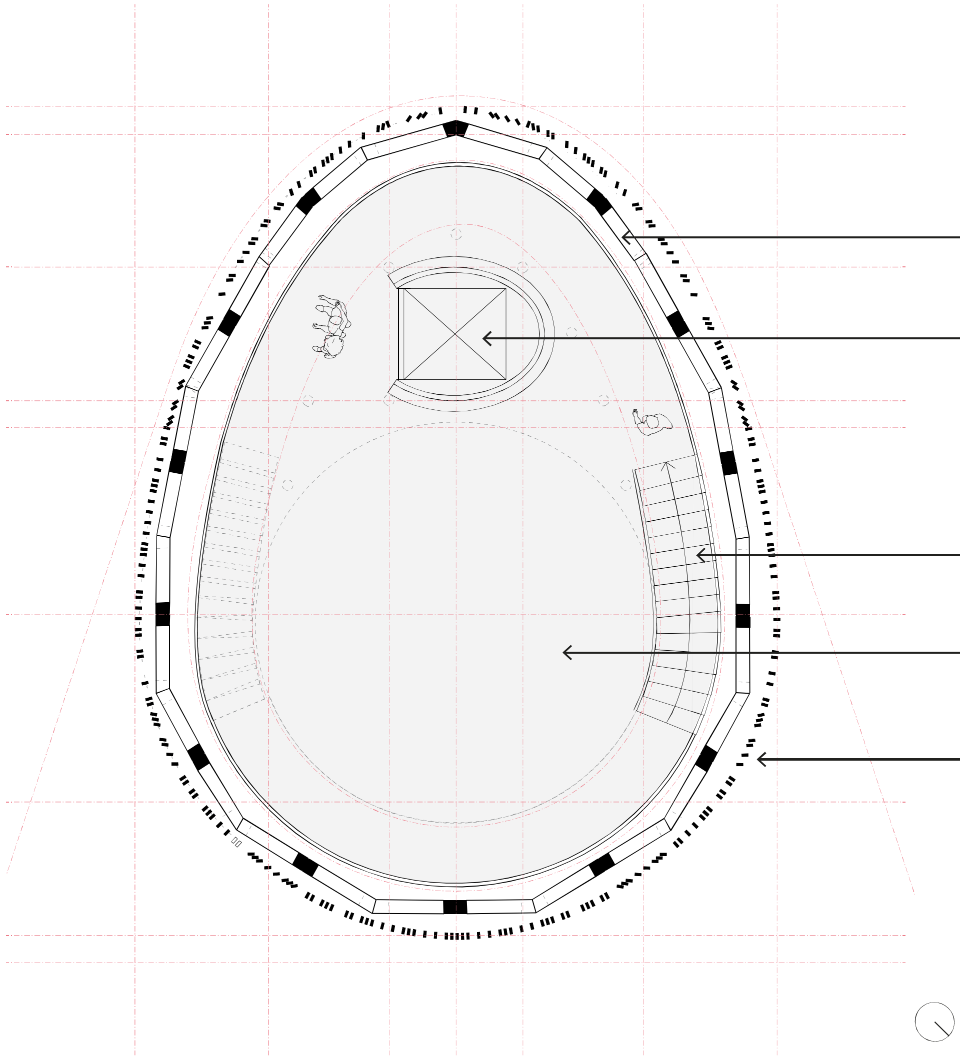
Elevation/East

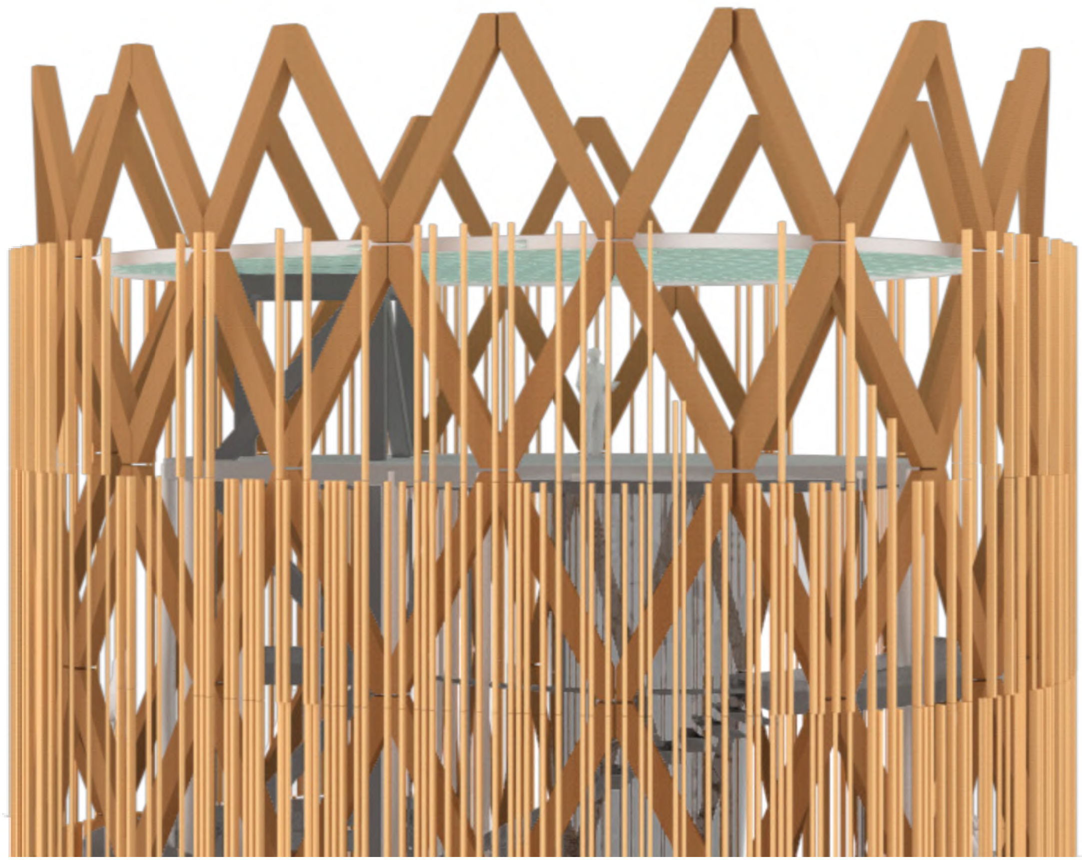


Elevation/North

Massing principles

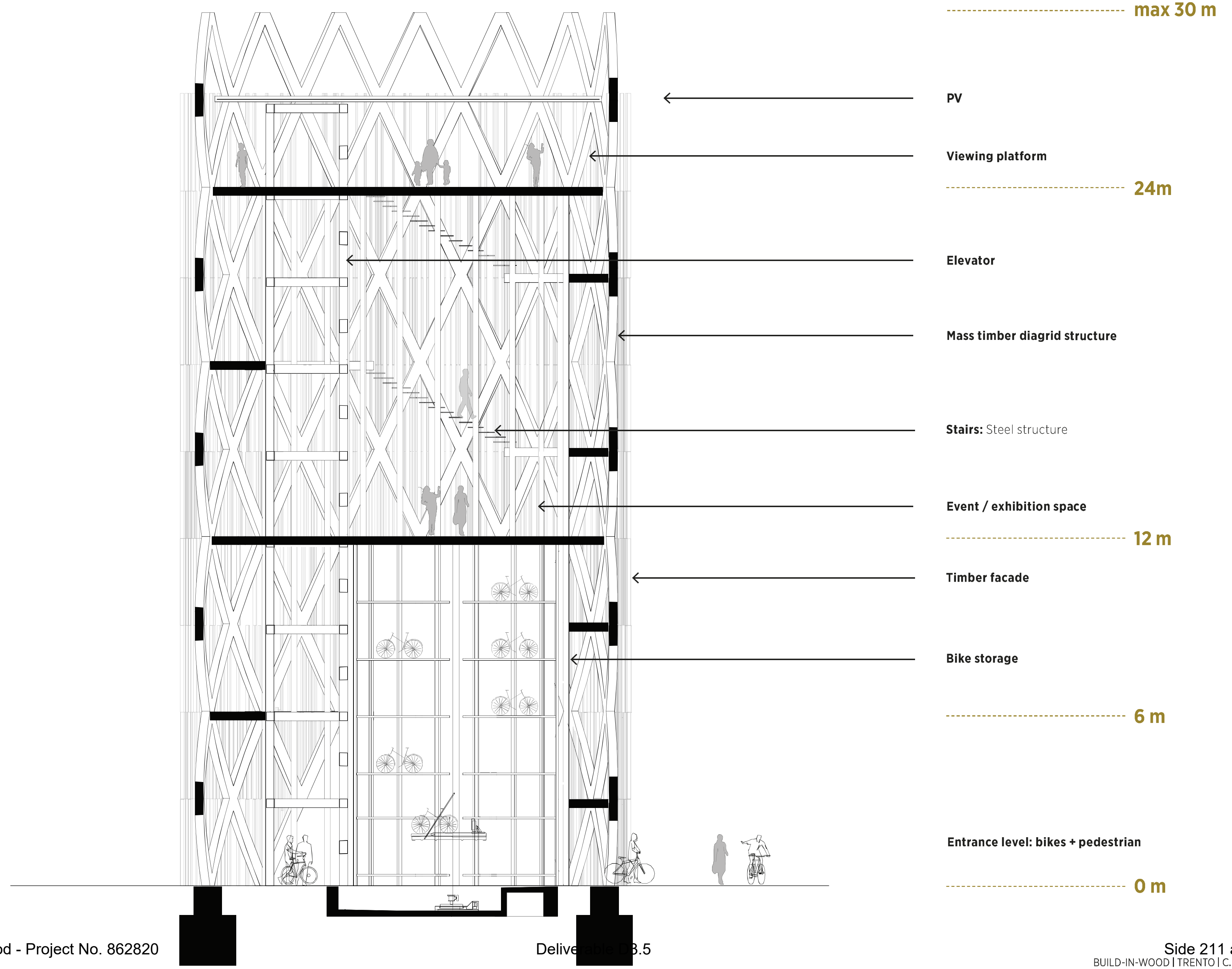
Viewing platform: +24m

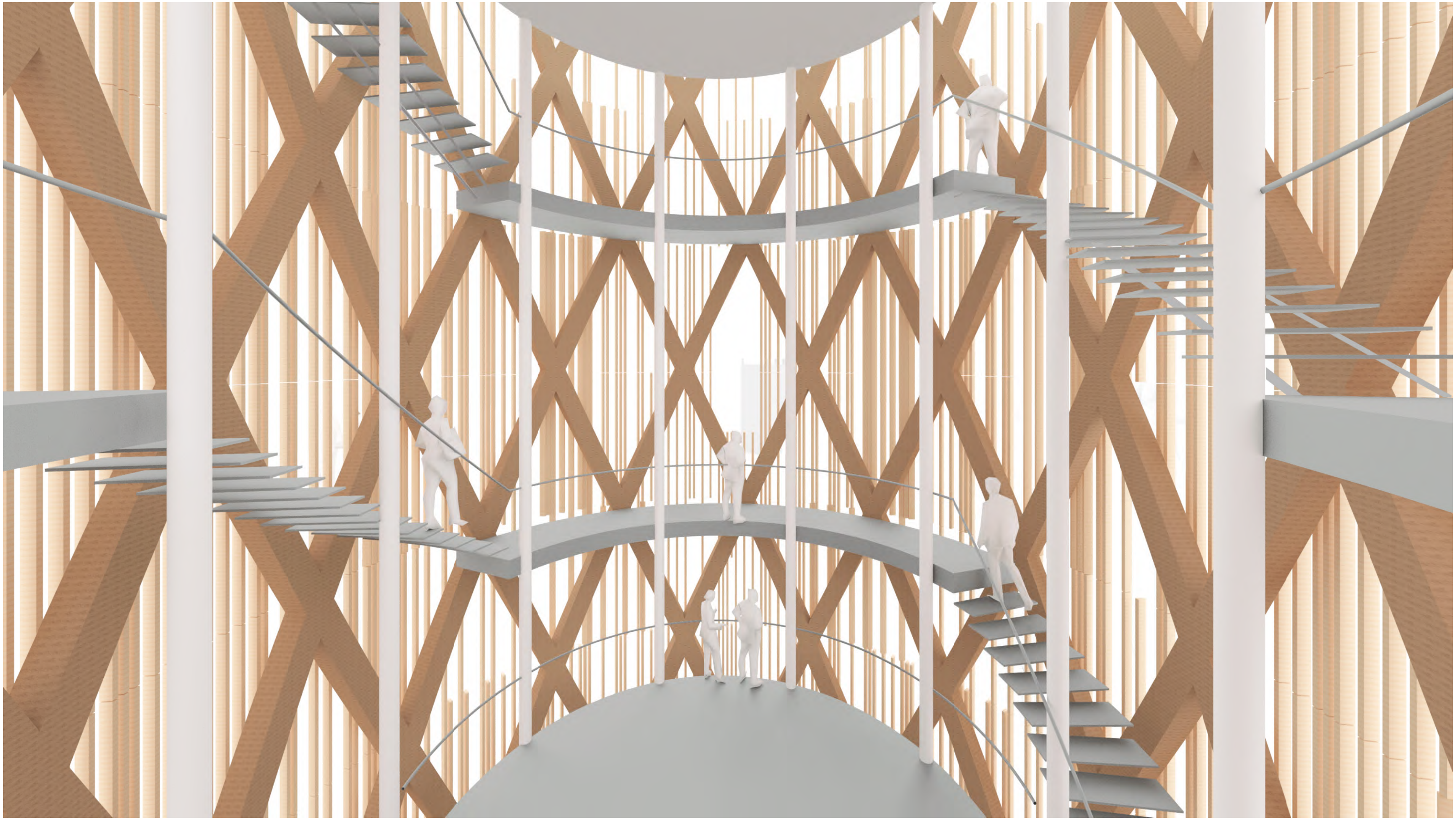



ROOF: PV-Panels attached onto steel substructure fixed to mass timber frame
VIEWING PLATFORM
TIMBER FACADE

Massing principles

Section





Structural system

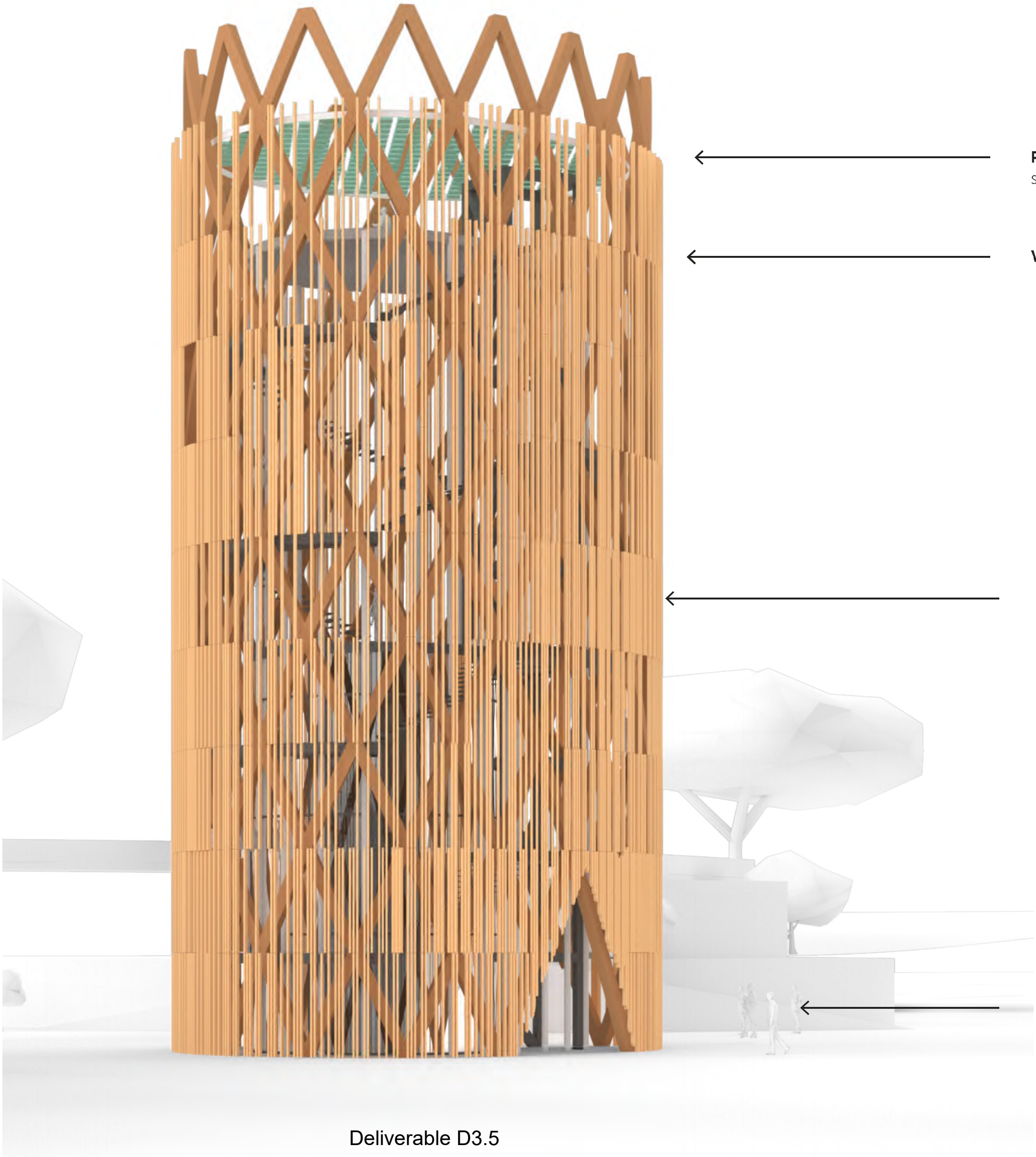
Mass timber diagrid structure

Structure as ornament

The foremost intentions of illustration sustainability and innovation through the use renewable materials, a state of the art bike storage system and energy producing PV-Panels is expressed very clearly to the outside. No further cladding or facade is necessary. The exposed mass timber elements are forming a rigid, simple and elegant diagrid structure. Repetitive joint in wood to wood or wood to steel.
The elements which are within this structure are reduced in their appearance and are mainly articulated in black powder coated steel.

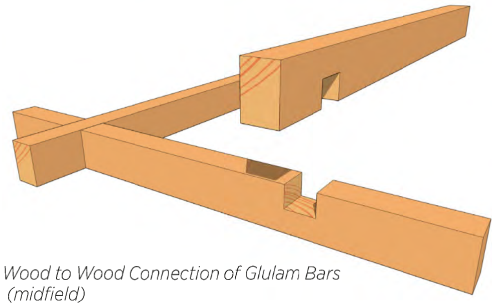
The bike parking system is a self-supported and free standing element. The elevator core is providing additional lateral stability and anchors the whole system safely to the ground. The core can be build in steel or concrete and will be evaluated in later phase.

The stairs are attached to the mass timber diagrid structure by steel components. The two viewing platforms are embedded into the primary timber structure and can be constructed out of steel or timber. The PV-Panels which form the so called "Crown" are attached onto a steel substructure holding onto the timber diagrid. Therefore the PV-Panels are ventilated and oriented towards the sun for an optimal performance.

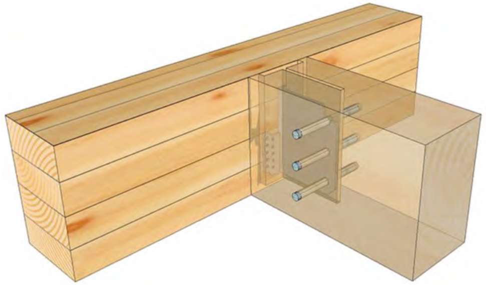


Technical design

Joints and assembly



Wood to Wood Connection of Glulam Bars (midfield)



Wood to Steel Joint with Steel Dowels (Joining four member together)

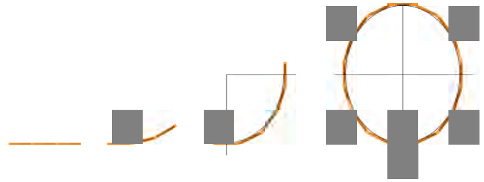
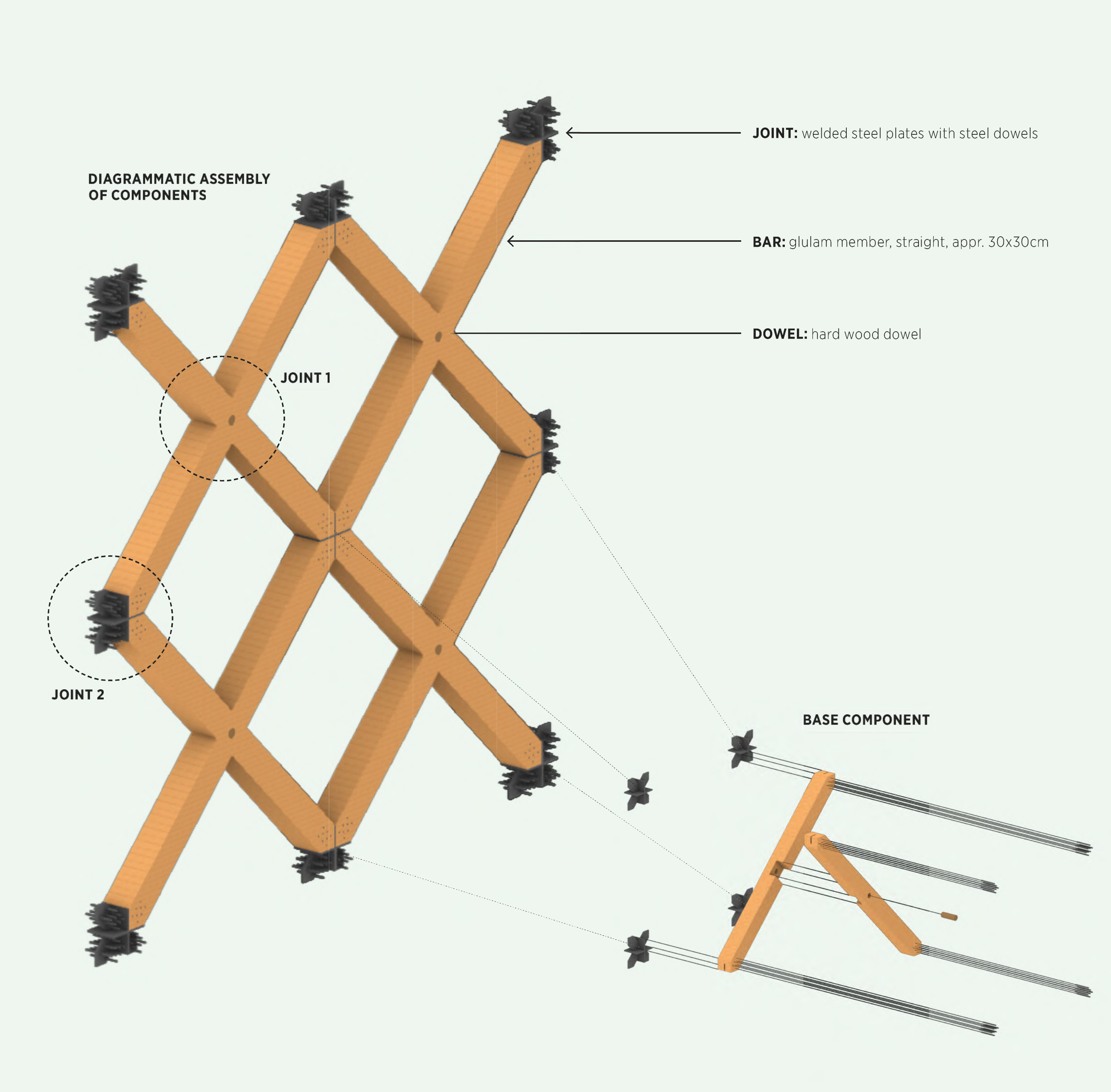


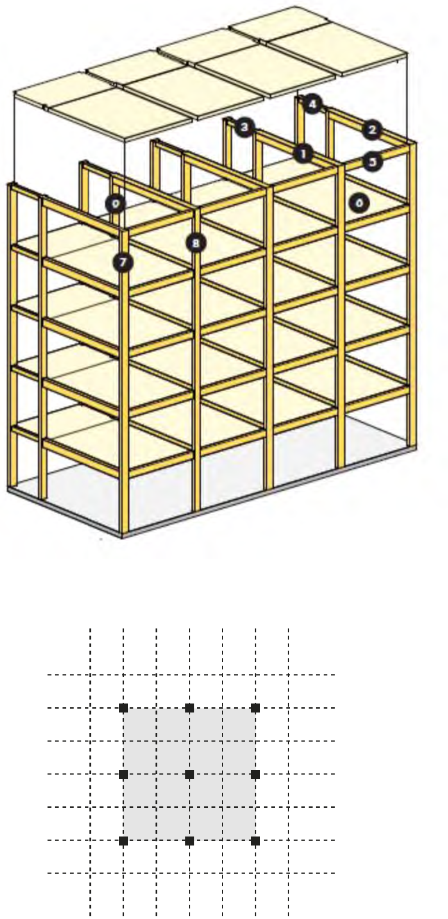
Diagram of the folded glulam bars

The Structural system is using two basic joints:
1. Wood-to-wood Joint
2. Wood-to-steel Joint

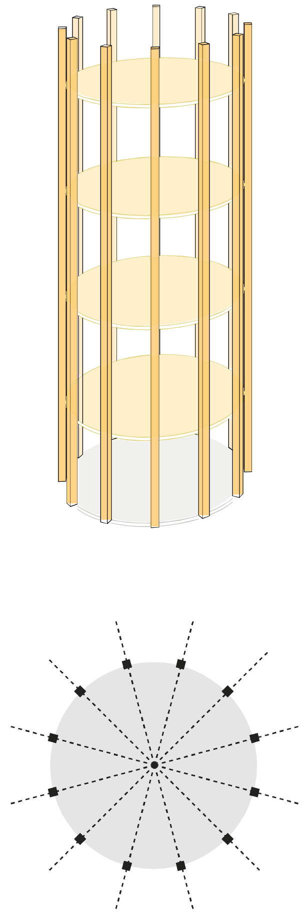
This allows for a simple and repetitive assembly.
The glulam bars are straight and have a square profile of appr. 30x30cm. In order to bend this lattice work of straight members, only the joints need to incorporate the angle, the bars remain straight.



Technical design

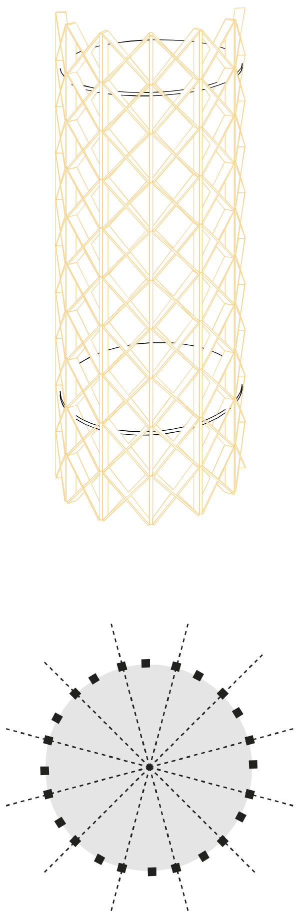


ORTHOGONAL POST
AND BEAM STRUCTURE
(PLATFORM BASED)



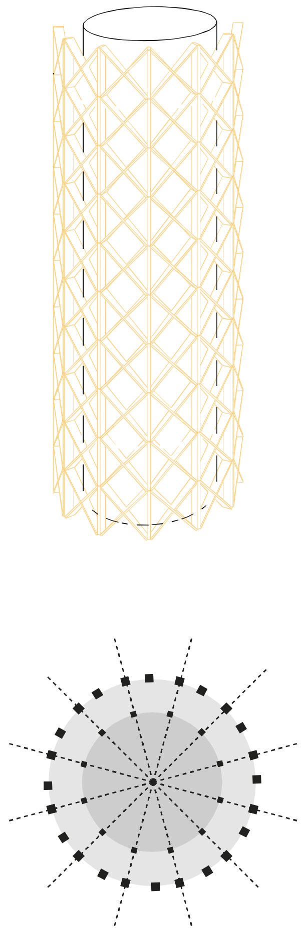
CONTINOUS VERTICAL STRUCTURE
(SIMILAR TO BALOON FRAMING)

Technical design



Timber structure

FRAMED TUBE



Timber structure

+

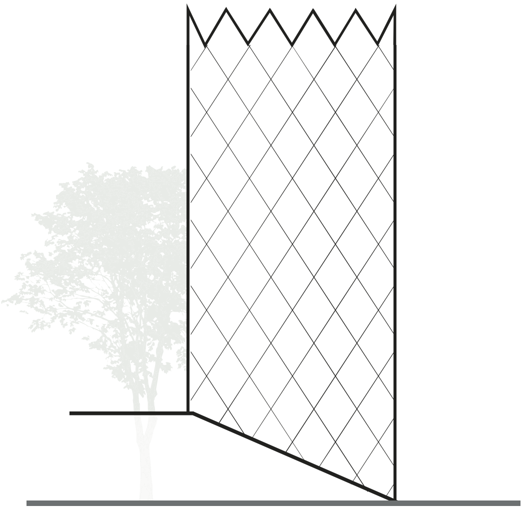
Steel structure

TUBE IN TUBE SYSTEM

Facade system

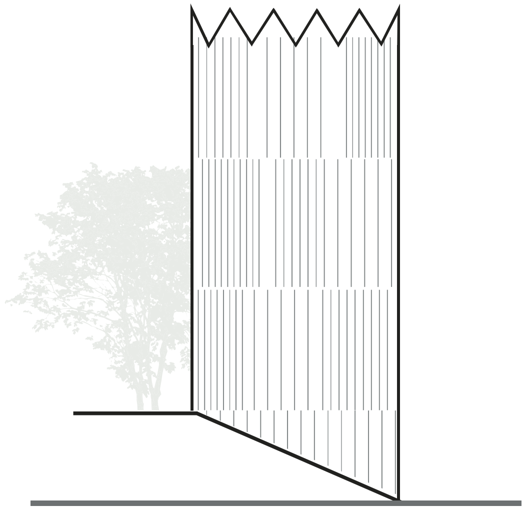
Massing principles

Facade options



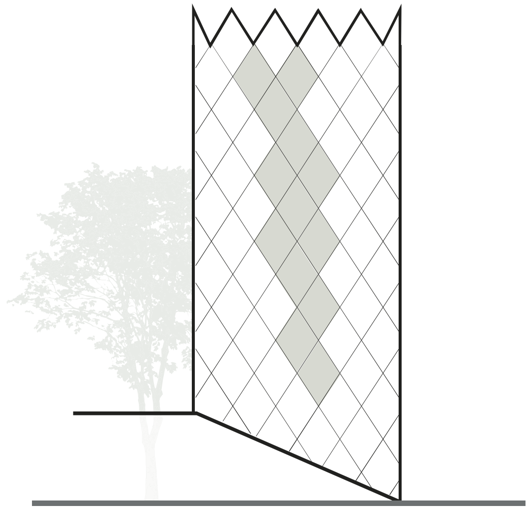
1. Structure as the ornament

The structure itself will be designed and detailed to be the ornament of the tower. This to showcase the beauty of timber structures and minimaze material use.



2. Wooden lamellas

The wooden lamelles can vary in length and distance between eachother to create a simple or dynamic facade with less or more open areas for specific views to towers of Trento or to close more from the wind.



3. Integrated PV's

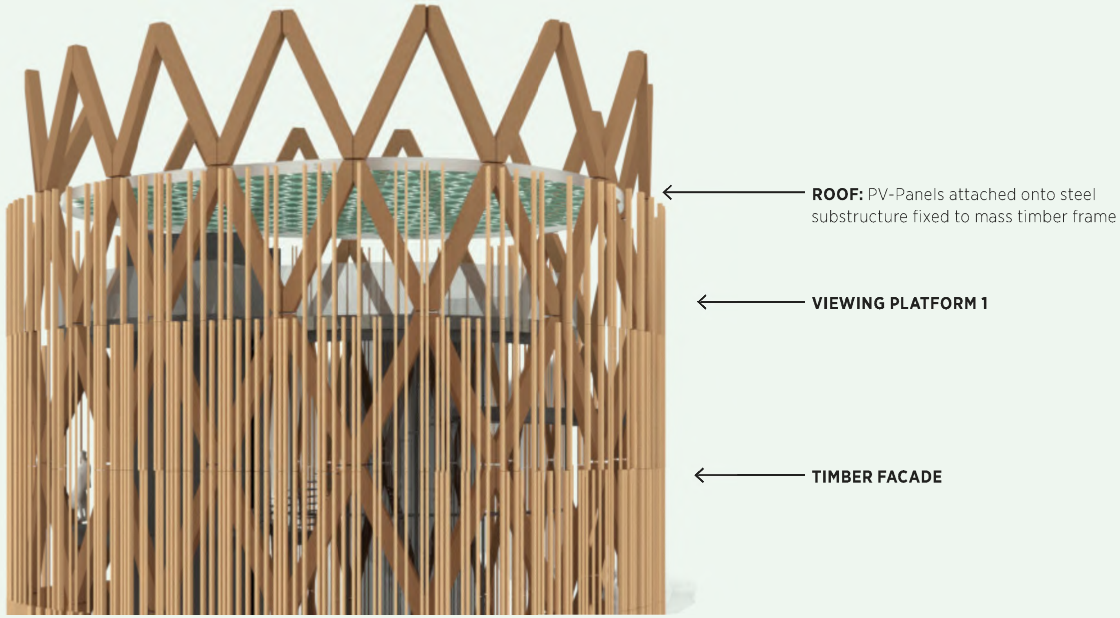
As a possibility photo voltaic panels can be integrated into the facade to make the PV's visible (if only placed on the roof they will not be visible) and to gain more solar energy.

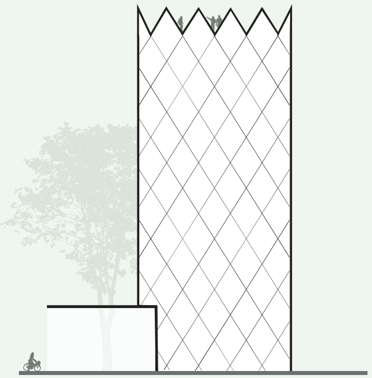
Facade
crown, entrance, base

The tower gives back to all the city by providing view along the circulation of the tower and on the viewing platforms of the tower. On top of the Wöhr biking system the first platform will be placed. This big open space can an event space or simple a place to take a pause sheltered from sun and rain on the way further up to the top. In the crown of the tower the second platform is placed. Both platforms can be reached by stair an elevator. From the second platform a viewing deck and ramp will take the viwers even furter up for a panoramic view over Trento.

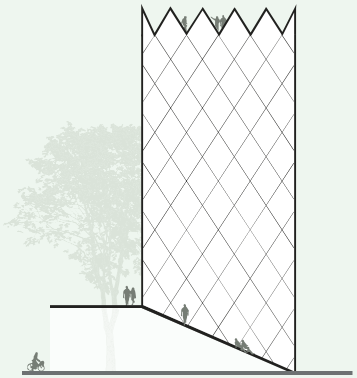
Along the circulation up the tower, viewing points can be integrated as openings in the lamella facade.

The base around the tower should be further detailed to also give back to the city in the most valuable way; as a green, lush and organic landsacape, or a staircase landscape for movement and seating.

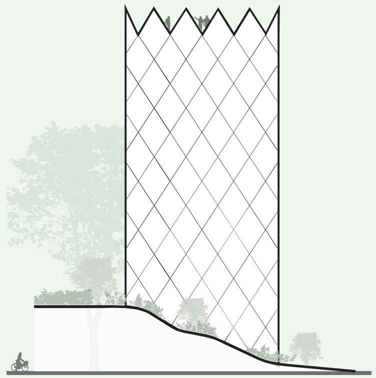




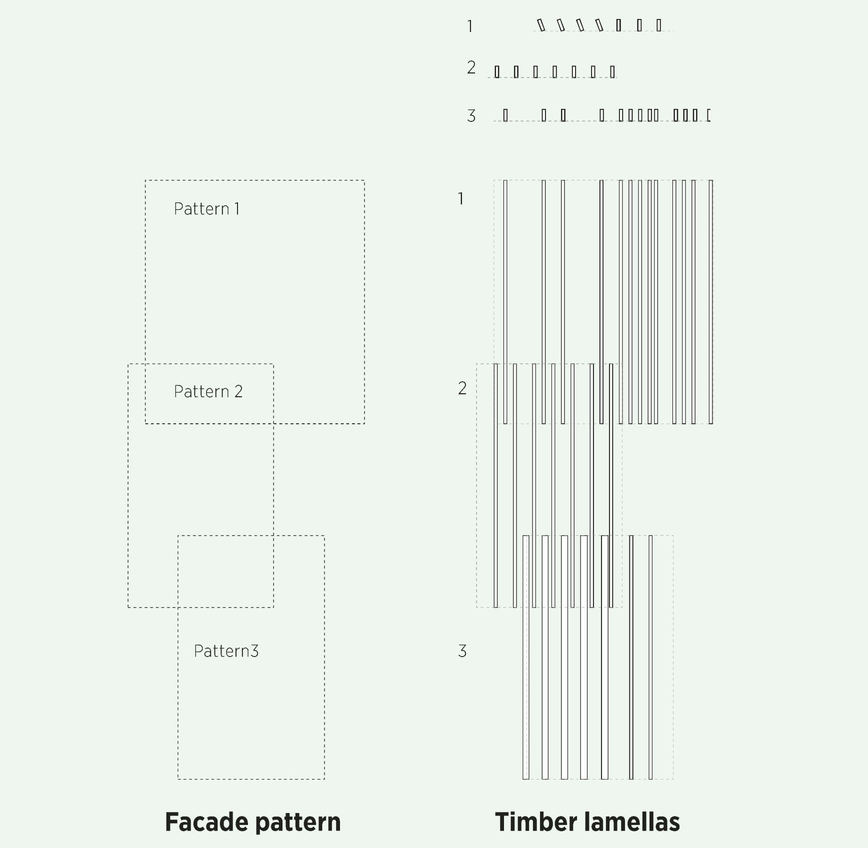
Reference to Torre Vanga base



A landscape of stairs

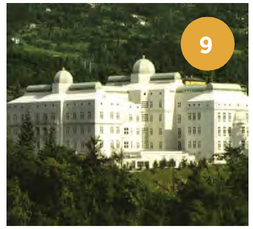


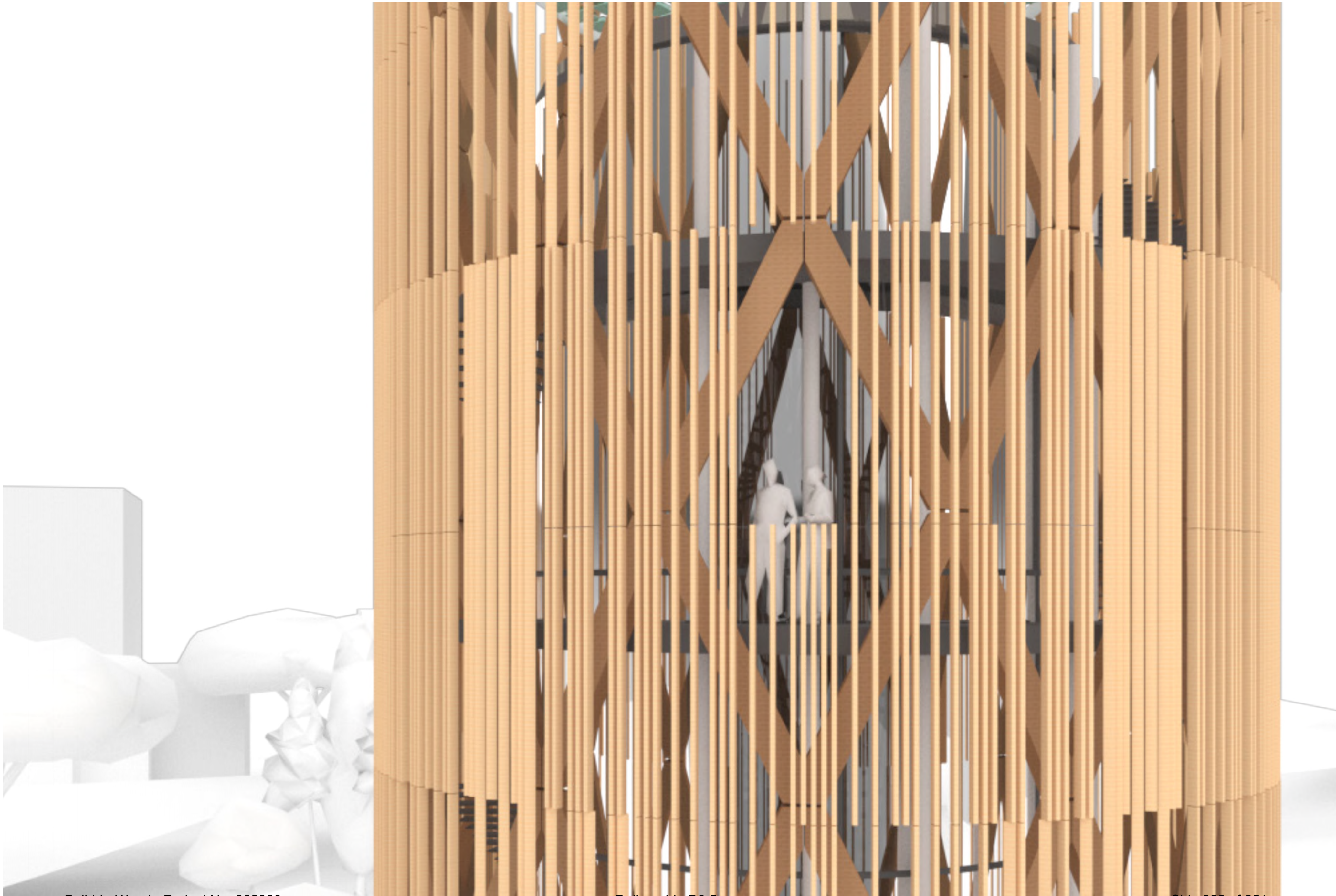
A landscape of greenery


1
2
3
Pattern 1
Pattern 2
Pattern3
1
2
3
Facade pattern
Timber lamellas

Facade

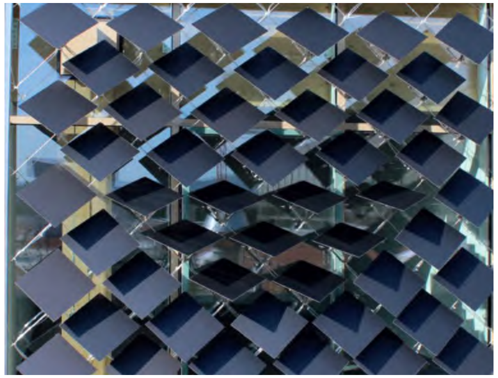
View points



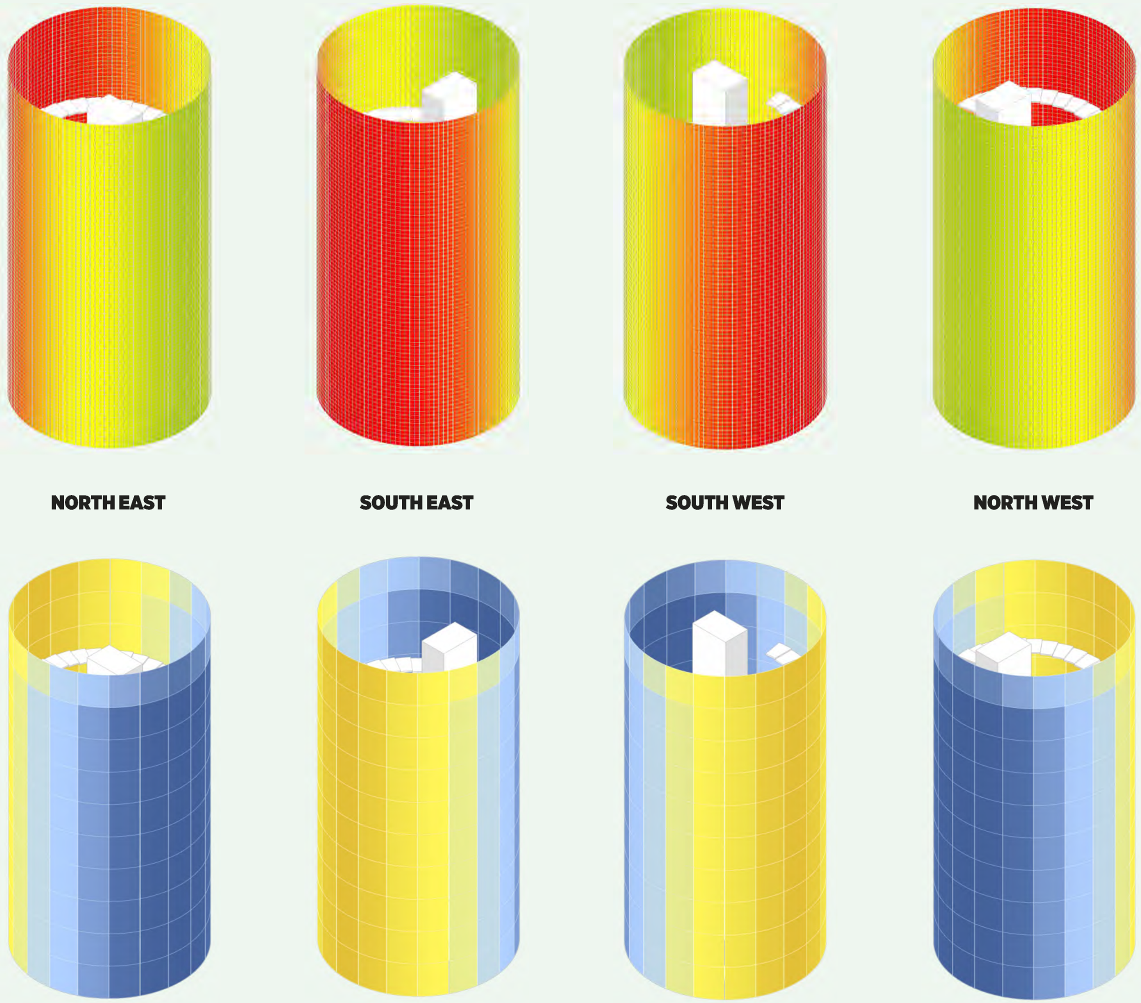


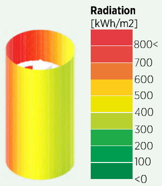
Renewable energy

Integrated PV's



To investigate the potential of integrating PV-panels into the design, simulations in Rhino/Grasshopper have been made.
The first initial simulations are made for the full volume of the tower to simulate the solar radiation potential of the facade depending on the orientation af of the sun. This gives an idea of where the PV should be placed to perform the best.
The second simulations on the right simulates the PV production potential adjusted according to the module efficiency of PV's on the market.
After these initial simulations, design variations with PV's have been sketched and modelled to calculate the different energy production of each design solution. See next page.

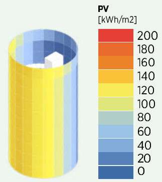




Full solar radiation potential

How much sun will reach the surface.

Yearly average



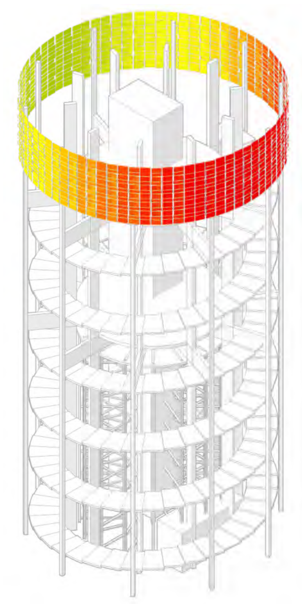
PV production potential

The simulations include the module efficiency for PVs, which for the best PVs on the market is maximum 20%.

Yearly average

PV simulations

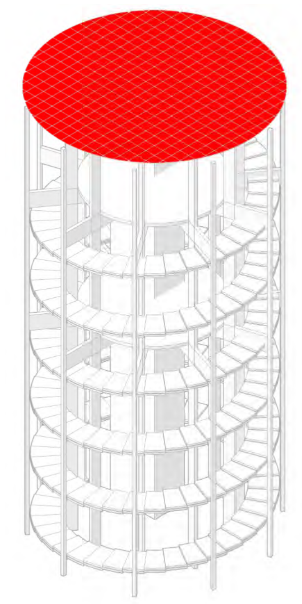
Variations



1. CROWN

Amount of PVs
228 m²

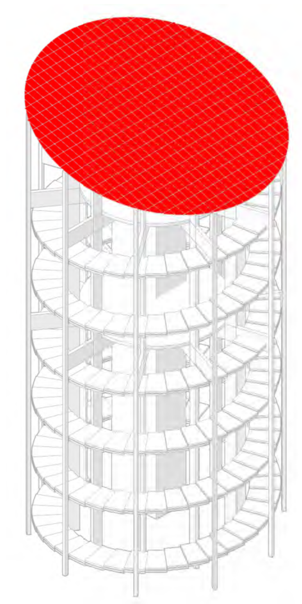
PV production
6.8 MWh



2. FLAT ROOF

Amount of PVs
126 m²

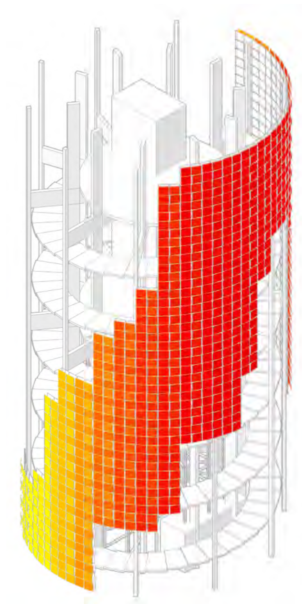
PV production
17.1 MWh



3. CUT 15⁰

Amount of PVs
131 m²

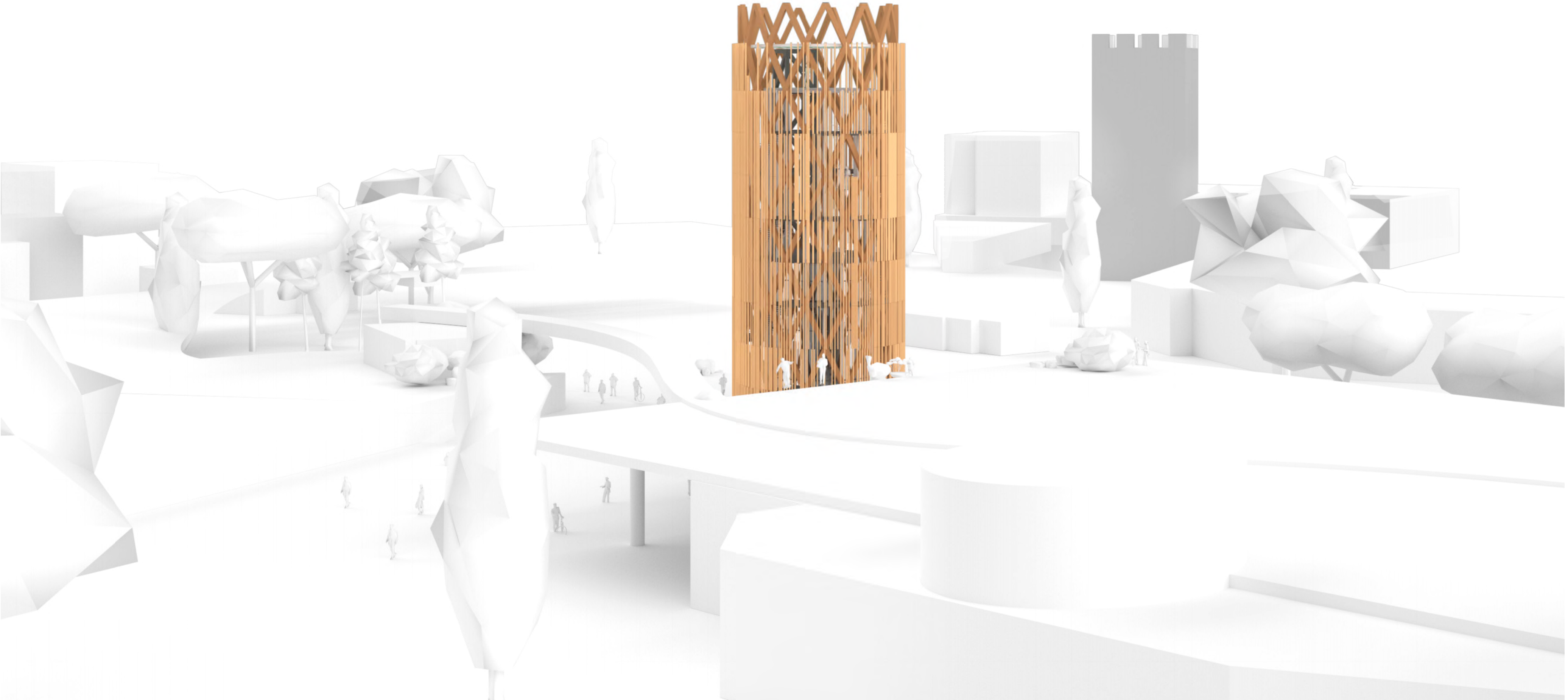
PV production
21.5 MWh

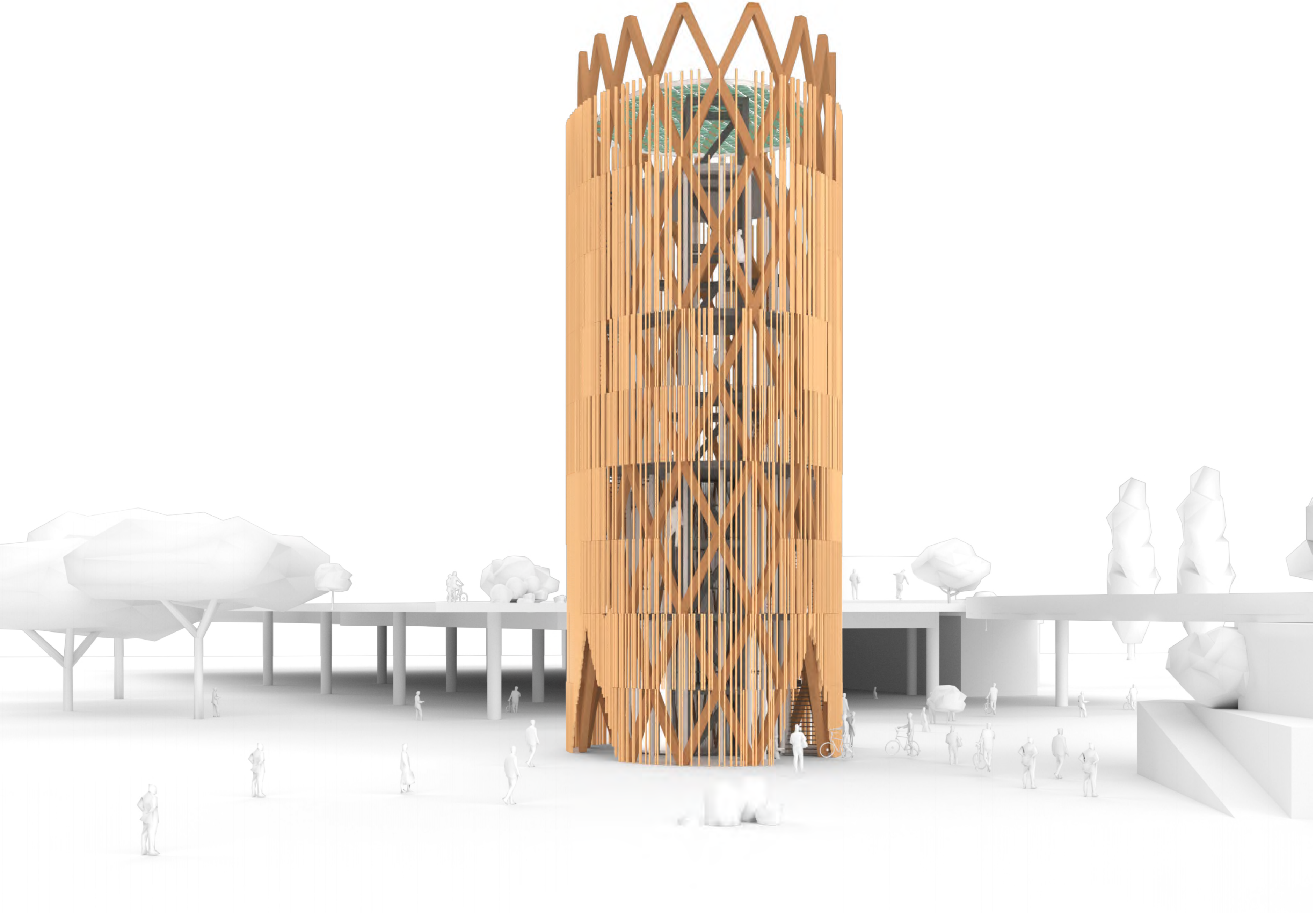


4. ON FACADE

Amount of PVs
345 m²

PV production
26.9 MWh





Build in Wood - Trento Pilot Project - Wood Bike Tower
Cost Estimate based on the Concept Drawings from july 2022
Frame: plus/minus 25%
Date: 30.09.2020

CF MØLLER ARCHITECTS

Number	Cost Group	Amount		Unit Price	Total	Remarks
200	**Site and Prep Work**			**psch**	**120.000,00 €**	
300	**Building Costs**	**4.014**	**m3 gross volume**	**62,90 €**	**3.446.680,00 €**	
	building pit	330	m3	125,00 €	41.250,00 €	building pit h=1,5m, with sloped edges
	Foundations	165	m2	750,00 €	123.750,00 €	flat slab foundation with piles
	Concrete (retaining) walls	250	m2	750,00 €	187.500,00 €	
	Mass Timber Structure total	1	psch		820.000,00 €	cost estimate from Rubner:Glulam in Larch, Steel knots, Wood lamella skin and stairs
	Bike Parking system from Wöhr	1	psch		950.000,00 €	cost estimate from Wöhr including the glass curtain wall
	Inner steel tube	142.200	kg	2,40 €	341.280,00 €	1m3 Steel = 7.900kg
	Elevator	1	psch		250.000,00 €	50.000€ per stop, 5stops
	Stairs	160	m2	440,00 €	70.400,00 €	
	Platforms	540	m2	150,00 €	81.000,00 €	
	PV Panels	135	m2	300,00 €	40.500,00 €	
	Wood Cladding	1.260	m2	300,00 €	378.000,00 €	
	Miscelleanous	1	psch		100.000,00 €	
	Lighting	1.260	m2	50,00 €	63.000,00 €	
400	**Technical Infrastructure**	**4.014**	**m3 BRI**	**49,00 €**	**196.686,00 €**	
500	**Landscape and Surrounding Areas**			**psch**	**90.000,00 €**	
600	**Specialities**			**psch**	**50.000,00 €**	

Summary			
200	**Site and Prep Work**	**120.000,00 €**	3%
300	**Building Costs**	**3.446.680,00 €**	88%
400	**Technical Infrastructure**	**196.686,00 €**	5%
500	**Landscape and Surrounding Areas**	**90.000,00 €**	2%
600	**Specialities**	**50.000,00 €**	1%
TOTAL		**3.903.366,00 €**	

Additional Remarks
planning fees not included
Site not included
Legal and other fees not included
Tax not included

BUILD IN WOOD

COMUNE DI TRENTO

CF MØLLER ARCHITECTS

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement no. 862820

BUILD IN WOOD

VESTLIA TRONDHEIM EXTENSION

WAUGH THISTLETON ARCHITECTS

77 LEONARD STREET LONDON EC2A 4QS +44(0) 20 7613 5727 WAUGHTHISTLETON.COM

EXISTING

THE SITE

Construction :1972-75

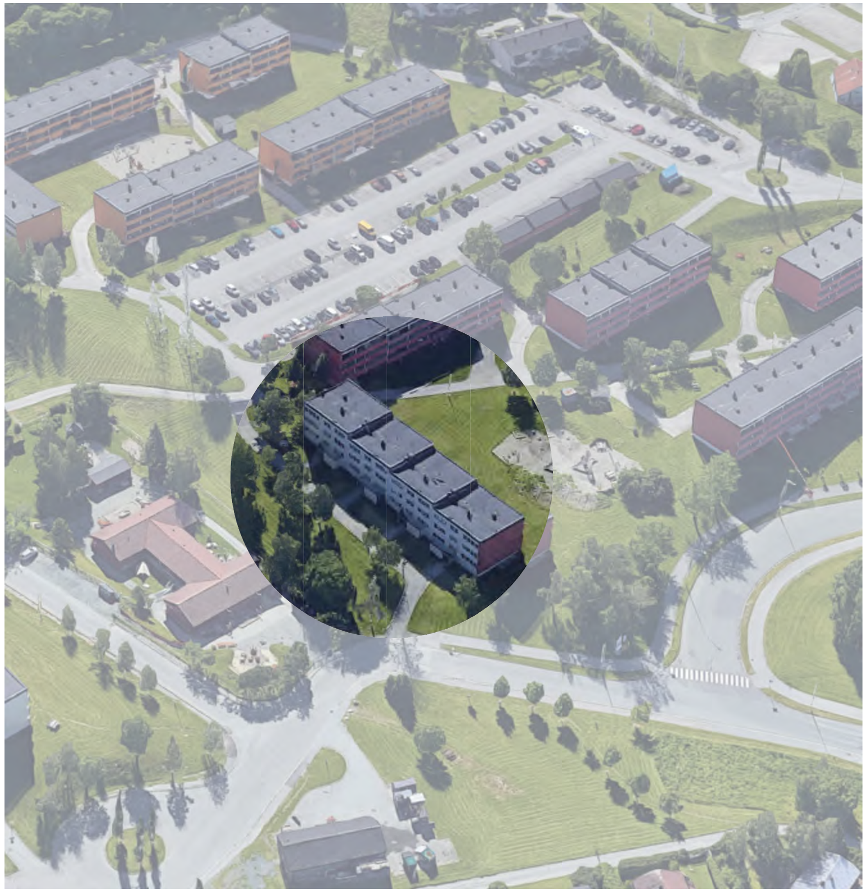
Total buildings: 16

Levels/floors: 3

Total living units: 324

Units x building: 20

SW view



NW view

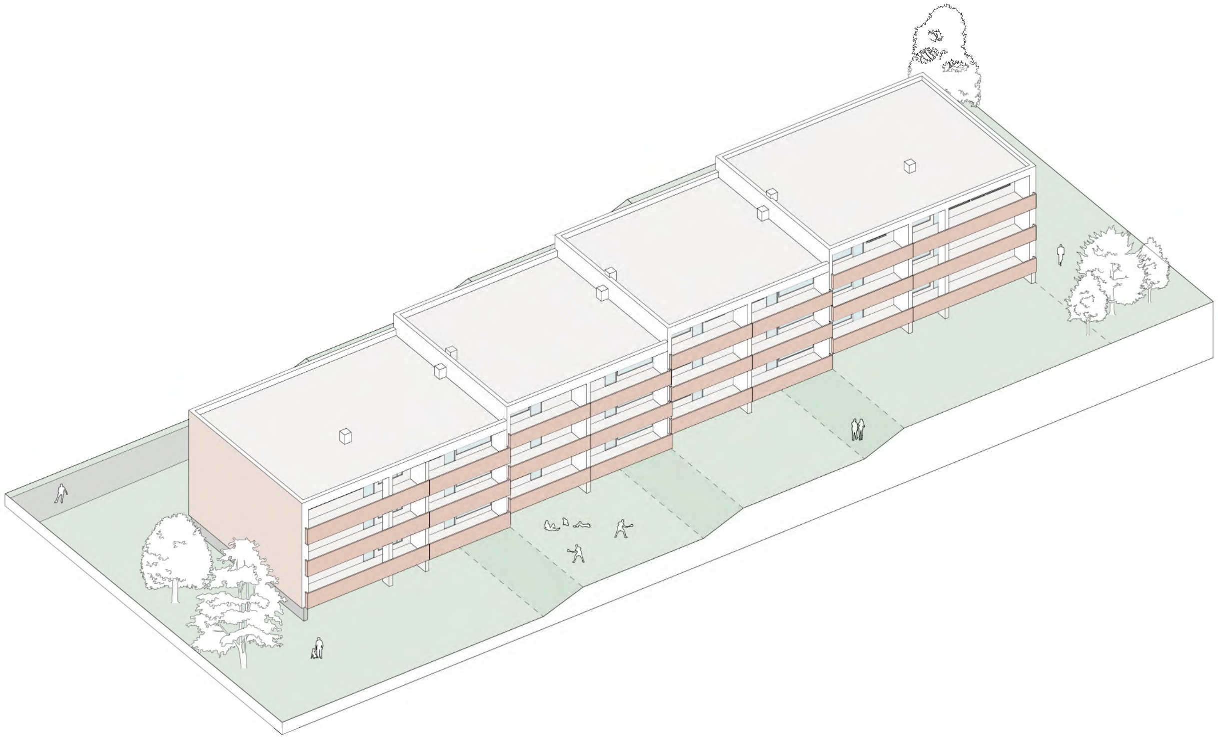
MATERIALS - TEXTURES

South elevation

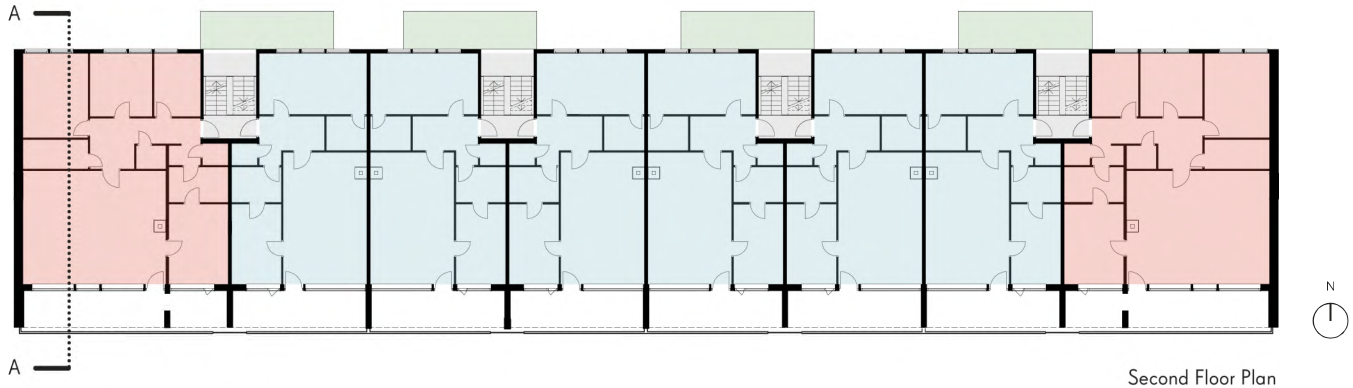
North elevation

NORTH-WEST VIEW

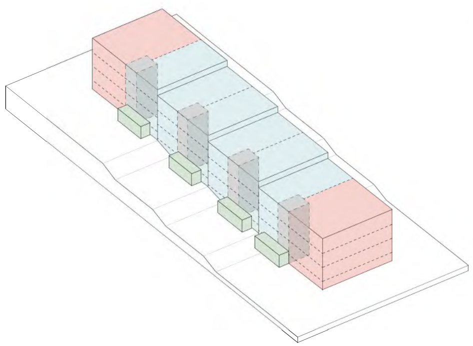
SOUTH WEST VIEW



TYPICAL PLAN - SECTION



Second Floor Plan



Building height (m): 9.8 / 3

Floor to floor height (m): 2.65

GIA (m2): 2580

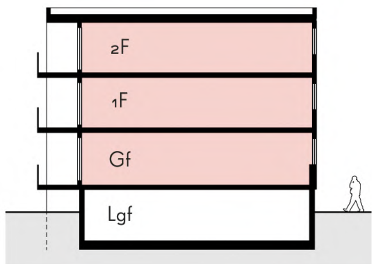
Façade area (m2): 1200

3B/5P apartments (no.): 8

1B/2P apartments (no.): 16

Stars (no.): 4

Entrances (no.): 4



Section AA

P R O P O S E D

THE CONCEPT

"TODAY'S RESIDENTS"

THE ANDERSSON FAMILY

The Andersson family consists of Kristin and her two children. They all enjoy Vestlia and the housing association and are looking forward to many more years in their beloved home in Trondheim. However, the building's age is showing. The sizable bills from power consumption, the old balconies, the lagging maintenance, as well as the old technical solutions are becoming more and more noticeable.

The Andersson family would like better indoor air quality and for the balconies to be renovated. Installing elevators in or onto the building would also be greatly appreciated. Kristin and the family's financial situation is not strong, but the housing association has saved up some means to accommodate change.

JANNE

Janne is a retired widow living in Vestlia. She has always loved walking and hiking but as of late she is feeling her age. Looking to the future, Janne would like to stay in her home for as long as possible. However, the apartment block is missing elevators. Such an upgrade could prolong her independence, mobility and general living quality.

Janne's financial situation is stable and comfortable, but she is not eager to spend a large amount of money on the apartment. Nonetheless, the installation of an elevator would be much to Janne's liking. The housing association has a tight budget, with little saved means to facilitate the initiative.

KAMILLA, RASHIID OG LOTTE

Kamilla, Rashiid and Lotte moved into their apartment last year. They inhabit a small three-room apartment and are very happy with their home in Vestlia. They do, however, miss more outdoor areas with great sun conditions. For the future they would also like to improve the housing associations financial situatio. Specifically so that the facade can be repainted, and the balconies renewed or refurbished.

Their dream is to get a large rooftop terrace with lots of sun and a nice view of Trondheim. On the rooftop they envision lots of greenery and seating arrangements, as well as small places for gardening and opportunities to cultivate food.

VESTLIA | 0

VESTLIA 2021

Vestlia housing association. Photos by Jørgen By, Trondheim Kommune

Address: Edgar B. Schieldrops veg
Site: 7030 Trondheim
Construction: 1972-1975
Total living units: 324 units
Apartment blocks: 16
Levels/ floors: 3
Property manager: TOBB

CONCEPT | 1

FULL UPGRADE AND SUSTAINABLE LONGEVITY

Two completely new apartment floors added on the rooftop, along with appropriate elevator-installations and a new climate shell for the entire building. All private balconies are refurbished.

✓ Amount, new levels house top: +**2 floors**

- ☑ Full facade rehabilitation
- ☑ Increased energy performance
- ☑ Improved indoor air quality
- ☑ Reduced power consumption
- ☑ Elevator installation
- ☑ Renewal or refurbishment of balconies
- ☐ Added shared roof terrace
- ☐ Added outdoor social areas on ground floor

CONCEPT | 2

ELEVATOR AND INCREASED LIVING QUALITY

Two completely new apartment floors added on the rooftop, along with appropriate elevator-installations and a new climate system for better indoor air.

✓ Amount, new levels house top: +**2 floors**

- ☐ Full facade rehabilitation
- ☑ Increased energy performance
- ☑ Improved indoor air quality
- ☑ Reduced power consumption
- ☑ Elevator installation
- ☐ Renewal or refurbishment of balconies
- ☐ Added shared roof terrace
- ☐ Added outdoor social areas on ground floor

CONCEPT | 3

ROOFTOP TERRACE AND NEW SOCIAL AREAS

Two completely new apartment floors added on the rooftop, along with appropriate elevator-installations.

A new rooftop terrace is installed over the new apartments, along with minor new social installations on ground level.

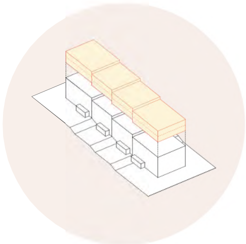
✓ Amount, new levels house top: +**2 floors**

- ☐ Full facade rehabilitation
- ☐ Increased energy performance
- ☐ Improved indoor air quality
- ☐ Reduced power consumption
- ☑ Elevator installation
- ☑ Renewal or refurbishment of balconies
- ☑ Added shared roof terrace
- ☑ Added outdoor social areas on ground floor

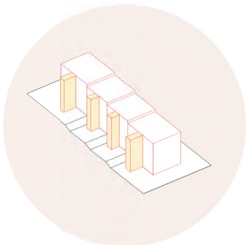
NORTH-WEST VIEW

SOUTH-WEST VIEW

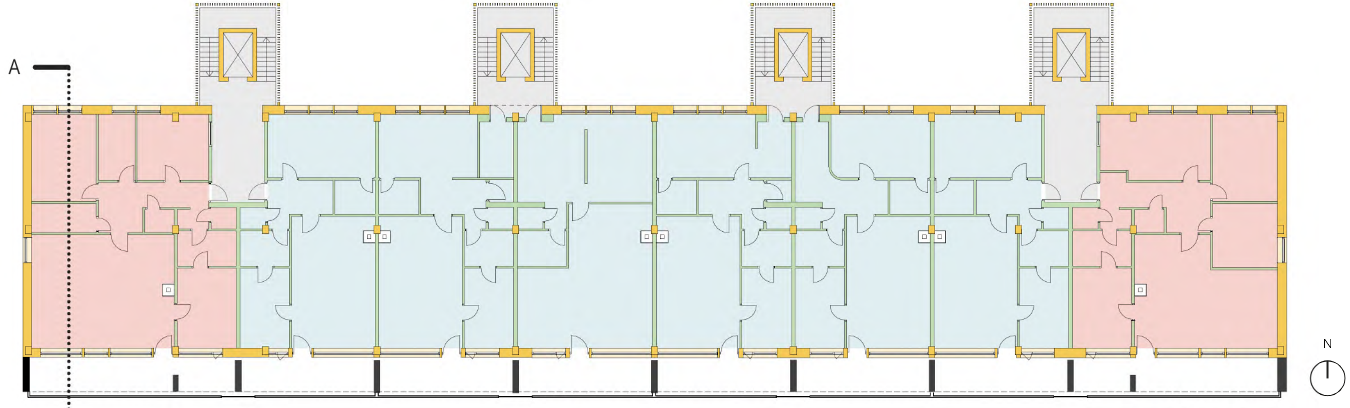
EXTENED, INCLUSIVE



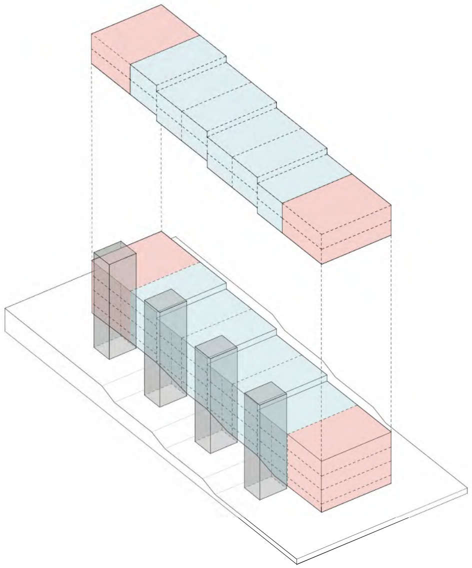
16 new flats
Flexible layouts
Shared roof terraces



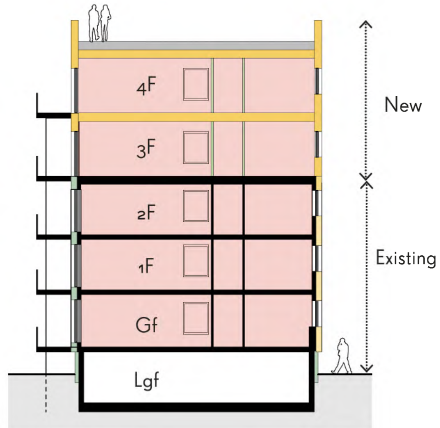
New elevators and stair towers



Fourth Floor Plan

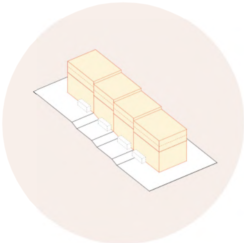


- Building height (m): 16 / 5 storey
- Floor to floor height new (m): 3
- GIA (m2): 4300
- Façade area (m2): 2440
- 3B/5P apartments (no.): 12
- 1B/2P apartments (no.): 28
- Stars (no.): 4
- Entrances (no.): 4

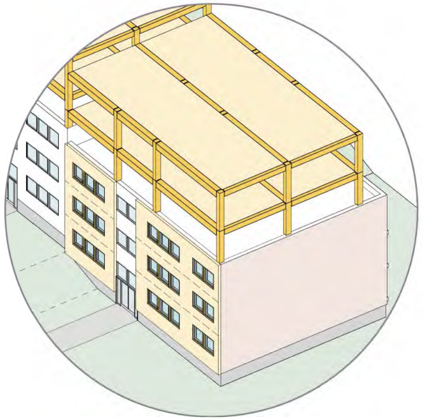


Section AA

ENHANCED

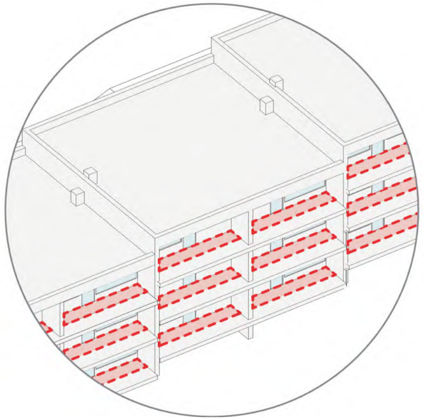


Enhanced envelope thermal performance
South facing balconies refurbished



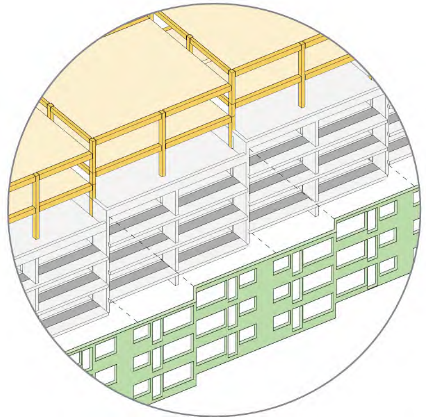
N-E-W ELEVATIONS

Enhanced thermal performance through addition of facade panels (type B). Potential for window replacement (depending on thermal performance)



S ELEVATION

Eliminate cold bridging in terrace area through partial demolition of concrete slab and insertion of thermal break.



S ELEVATION

External Thermal Insulation Composite System (ETICS) used in areas that are difficult to reach.

BUILD-IN-WOOD FOR VESTLIA

BUILD-IN-WOOD INTEGRATED SYSTEM

MULTI-STOREY BUILDINGS BETWEEN 4 & 10 STOREYS

DIFFERENT USES (OFFICE, RESIDENTIAL, HOTEL ETC.)

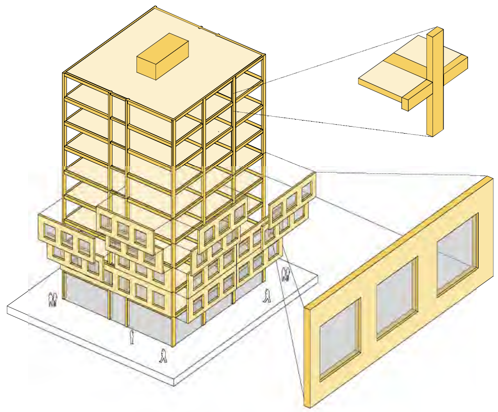
DIFFERENT EUROPEAN CLIMATIC REQUIREMENTS

DIFFERENT EUROPEAN REGULATORY REQUIREMENTS

DIFFERENT EUROPEAN MARKET REQUIREMENTS

RETROFITTING TO EXISTING BUILDINGS (FACADE ELEMENT ONLY)

ADAPTABLE TO



OPTIMISED FOR

MAXIMUM USE OF TIMBER & NATURAL MATERIAL PRODUCTS

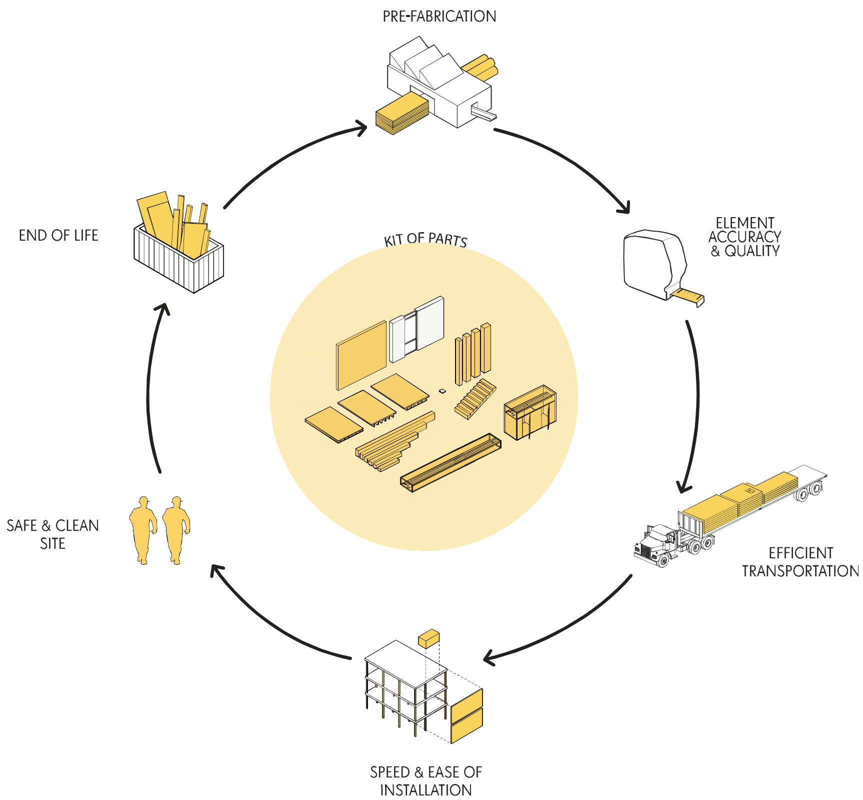
RE-USE, DIS-ASSEMBLY & RECYCLING

RESOURCE EFFICIENCY

USE OF COMPONENTS WHICH ARE AVAILABLE FROM MULTIPLE SOURCES

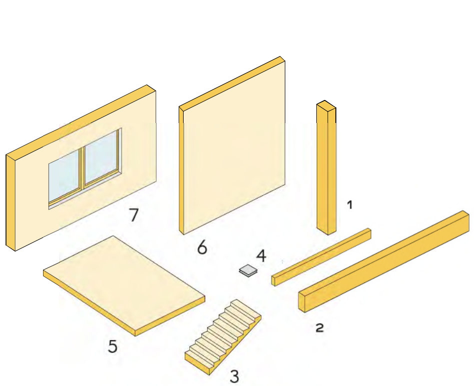
Structural and façade systems are designed to work in harmony in new developments but can also be used for extensions or energetic refurbisment of existing buildings.

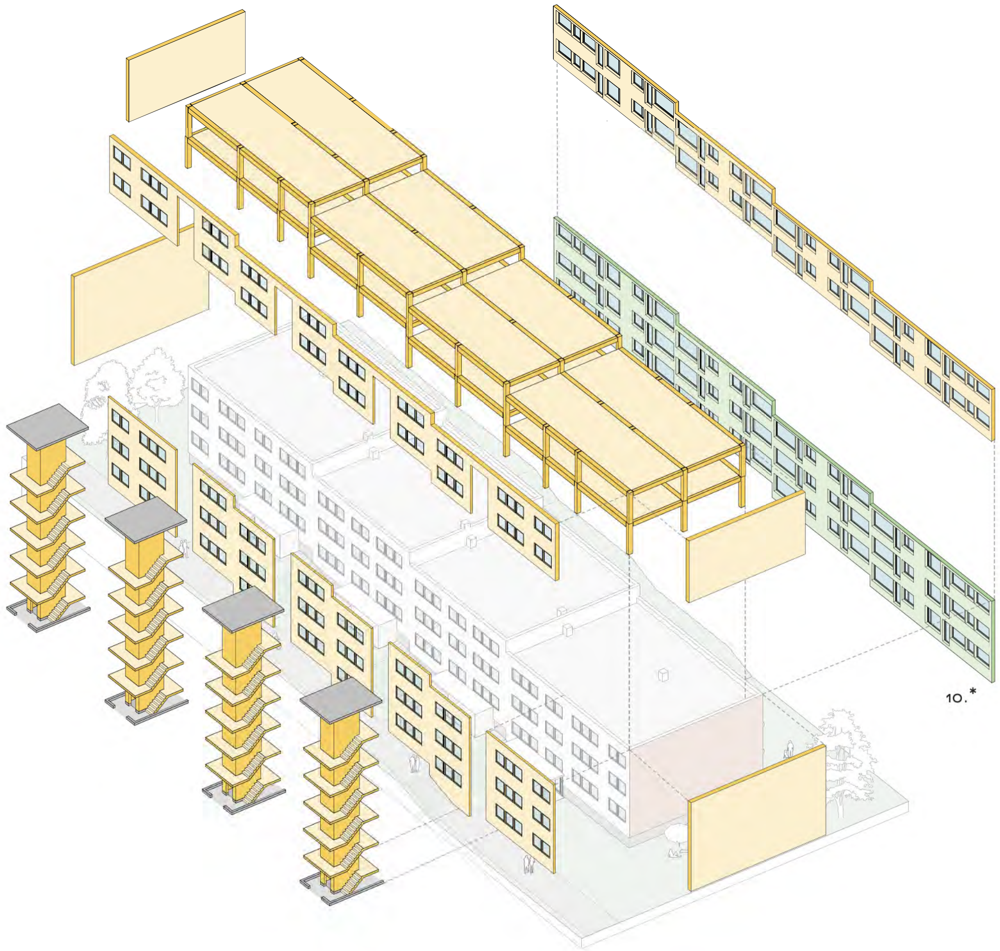
BUILD-IN-WOOD: A KIT OF PARTS



The Build-in-Wood systems have been developed as a kit of parts for DFMAD (Design for Manufacturing, Assembly and Disassembly) construction taking into account factors such as efficient transportation, ease of installation and demountability.

KIT OF PARTS FOR VESTLIA



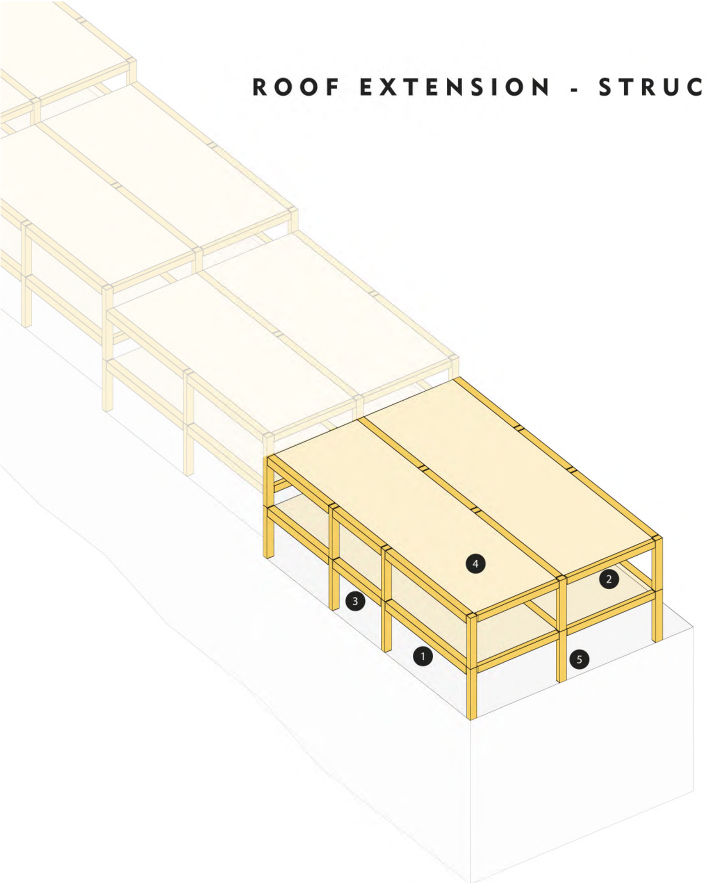


BUILD IN WOOD KIT

1. Structural timber columns
2. Structural timber beams
3. Cross laminated timber stairs
4. Steel connections
5. Cross laminated timber slabs
6. Cross laminated timber walls
7. Facade panels (type A and B)

10.* ETICS (External Thermal Insulation Composite System) - Not part of BiW system

ROOF EXTENSION - STRUCTURE



STRUCT. BAY COMPONENTS

1. Primary beam
2. Façade beam
3. Service beam
4. CLT Slab
5. Perimeter column

Structural system
Engineered timber post and beam

Construction
Safe, clean, almost noiseless construction site

Sustainability
Use od low embodied carbon materials
Carbon sequestration

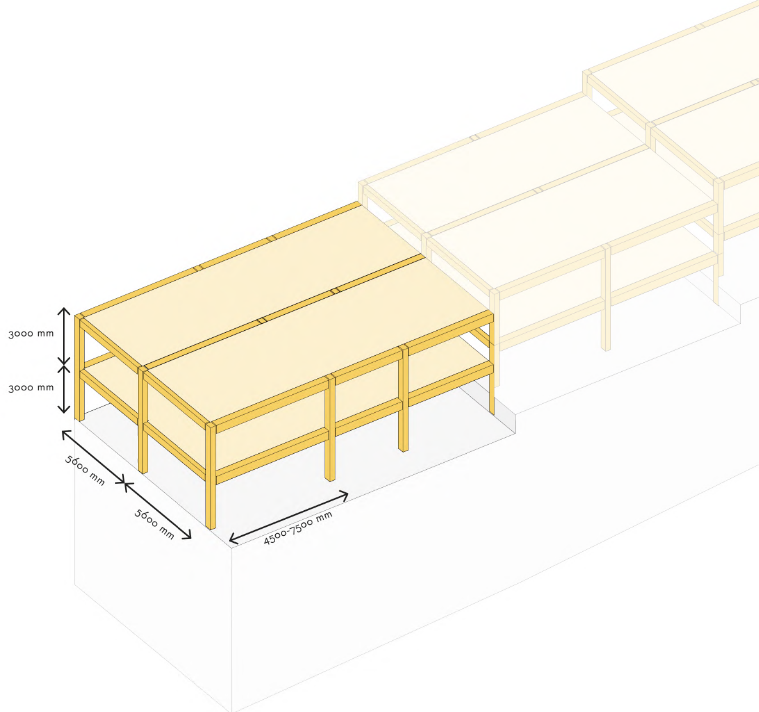
Financial aspect
Fast construction time

Financial/Material use
Light structure and facade panels

Prefabrication
DfMA optimised, fully demountable solutions

Kit of parts
Simple design, repeating base components

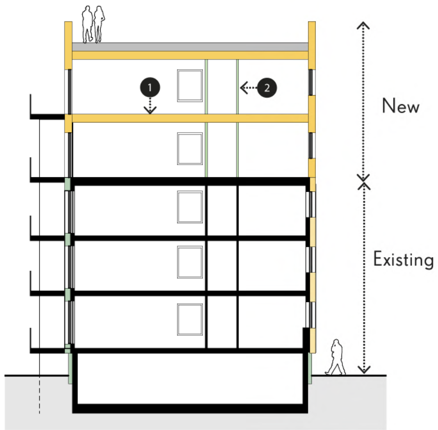
KEY ASPECTS



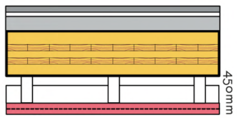
STRUCT. BAY SIZES

Structural bays have been designed to be flexible in size, adapting to the size of each building.

ROOF EXTENSION - FURTHER COMPONENTS



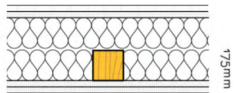
Typical section



2kN/m2 - 6m span

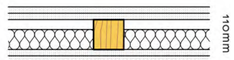
55 dB impact / 52 dB airborne

F90



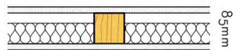
59-66 dB airborne

F90



41 dB airborne

F60



37 dB airborne

F30

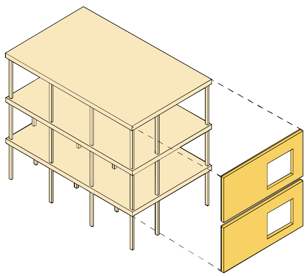
❶ OUTLINE FLOOR BUILDUP_EXTENSION

The solutions Build-in-Wood developed achieve high fire and acoustic performance without resorting to the typical approach of heavy wet screeds; the goal is to use prefabricated, clean and dry materials, simple to demount and reuse.

❷ INTERNAL WALLS_EXTENSION

Internal partitions are predominantly non-loadbearing - aside from the stability/shear walls - meaning that they can be positioned anywhere on the floor plate. Any non-structural walls can be used in combination with the Build-in-Wood system.

FACADE SYSTEM: TWO TYPES OF PANELS



Refurbishment
No refurbishment - new building

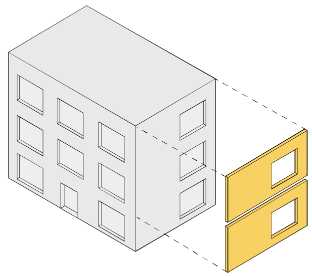
Structural system
Engineered timber post and beam

Impact on users
No existing users

Build-in-Wood façade system applicability
100%

PANELS TYPE A-ROOF EXTENSION

Application to a newly design and constructed timber structure
(Build-in-Wood structural system).



Refurbishment
External façade performance enhancement only

Structural system
Existing concrete frame

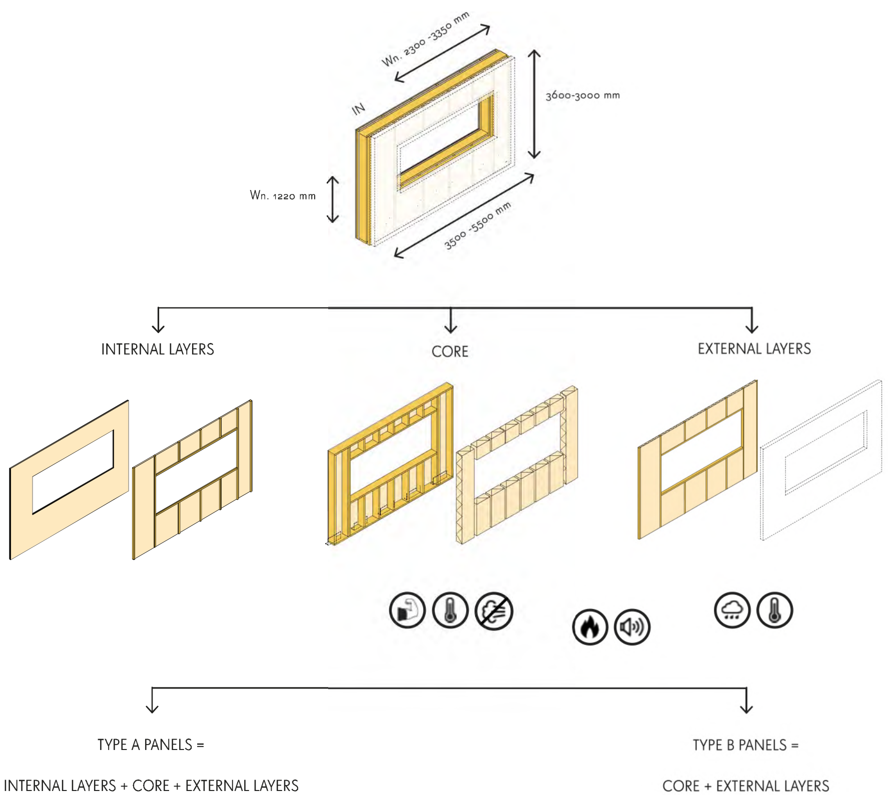
Impact on users
Building can remain occupied during works

Internal layer omitted (see drawing to the right)
Performance criteria must be individually verified in combination with existing wall.

PANELS TYPE B -ENERGETIC REFURBISHMENT

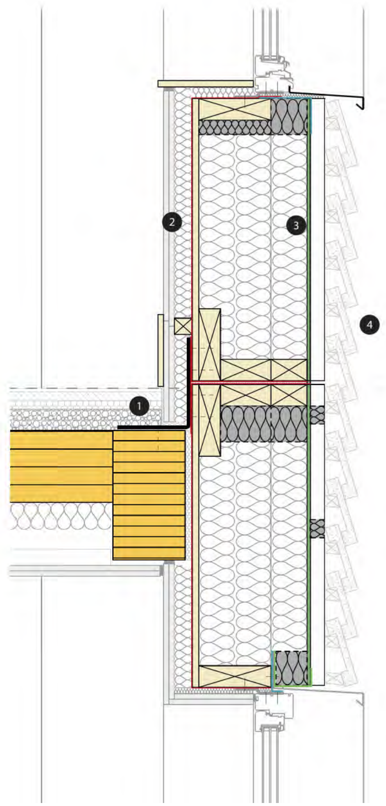
Application to an existing building undergoing minimal refurbishment works,
including minimal replacement of the external facade.

FACADE PANELS: SIZES AND COMPONENTS



FAÇADE PANEL TYPES

The panels are composed of three layers, each dealing with a different aspect of the overall performance: structural, acoustic, thermal and fire. The structural core has a fixed depth whilst the thickness of the other layers are variable.



TYPICAL TYPE A PANEL DETAIL

1. Angle bracket (connect. to facade beam)
2. Vapour control layer
3. Cement board
4. Cladding - indicative only

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