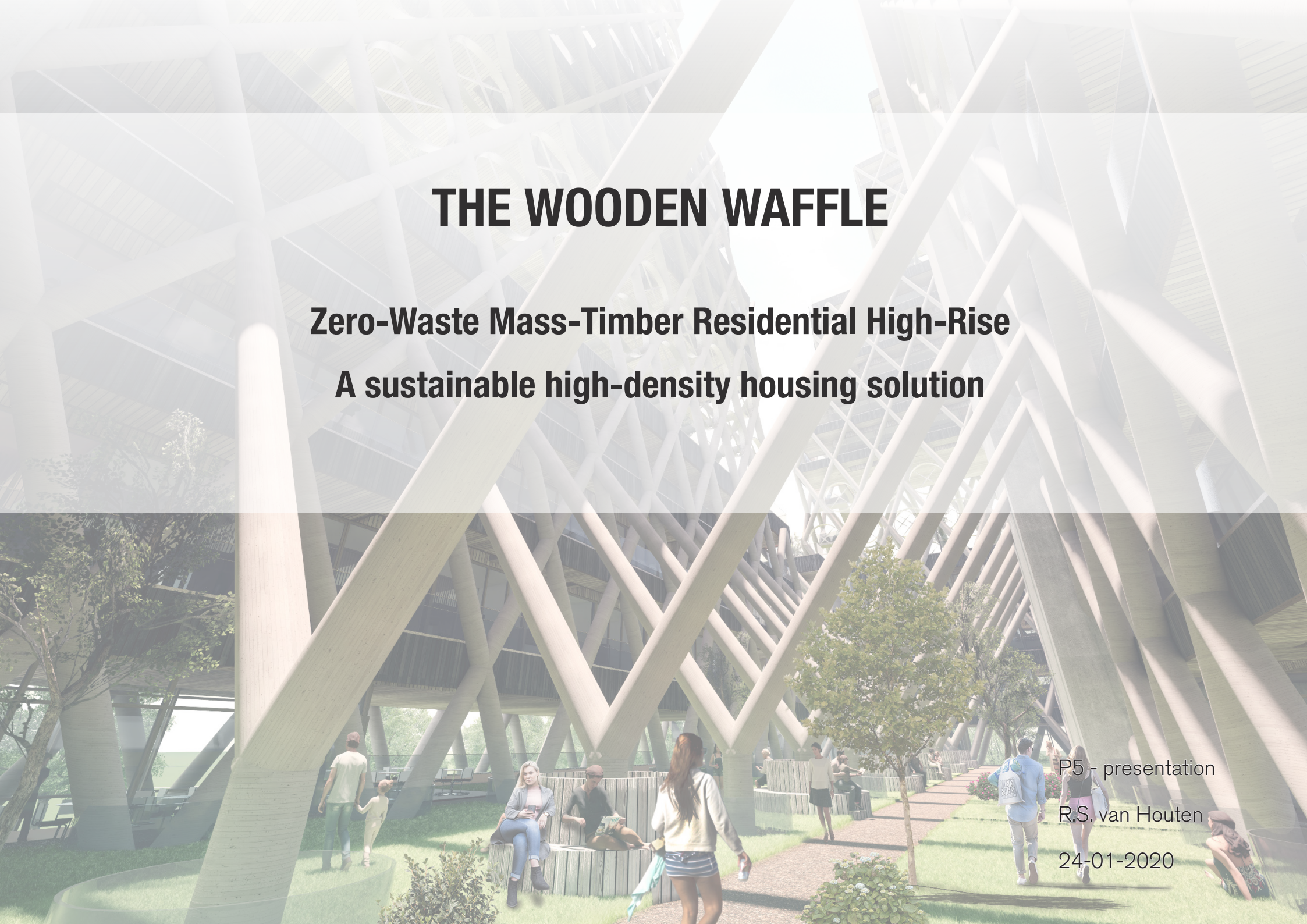
THE WOODEN WAFFLE

Zero-Waste Mass-Timber Residential High-Rise

A sustainable high-density housing solution



P5 - presentation

R.S. van Houten

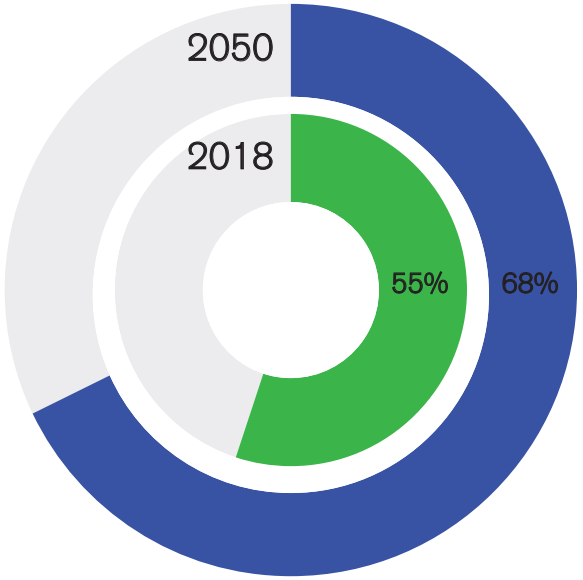
24-01-2020

Contents

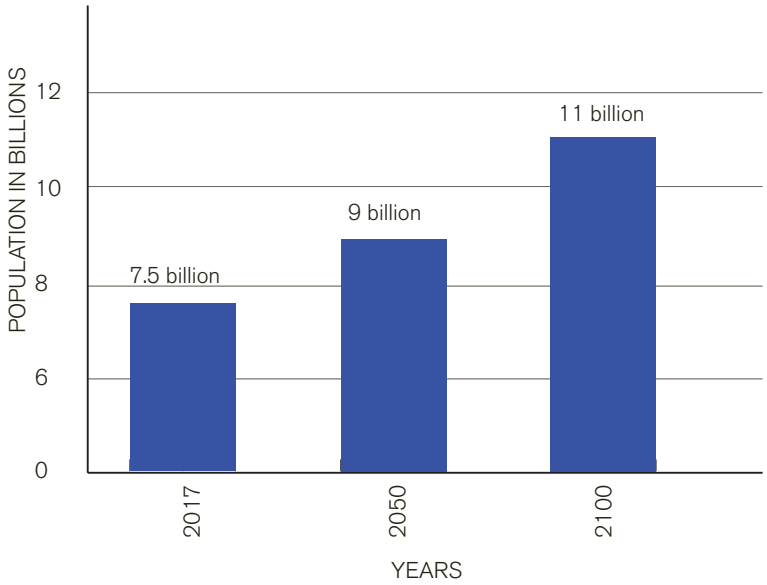
PROBLEM STATEMENT

Global urbanization

- More and more people live in cities *(The Open University, 2016)*
- 2.5 billion people will move to cities by 2050 *(United Nations, 2018)*
- New dwellings in urban areas needed



People living in urban areas *(United Nations, 2018)*



World population *(United Nations, 2017)*

Urbanization in the Netherlands

- 1 million new homes by 2030
- 100.000 new inhabitants by 2030 in Amsterdam *(Jongeneel, 2018)*
- Soaring prices in Amsterdam

InfoNu.nl › Financieel › Hypotheek › Stijging huizenprijzen in Amsterdam (2013 - 2018)

Stijging huizenprijzen in Amsterdam (2013 - 2018)

De huizenprijzen in Amsterdam wijken sterk af van de rest van Nederland. Sinds 2018 maken Rotterdam en Den Haag een inhaalslag, maar Amsterdam blijft voorlopig verruit de duurste stad. Ook Europees gezien is Amsterdam anno 2018 de stad waar de prijzen het snelst stijgen. De prijs per vierkante meter is in 2018 ruim twee keer zo hoog als in de rest van Nederland. Vanaf het begin van de crisis in 2008 zijn de huizenprijzen in Amsterdam bovendien minder sterk gedaald. Sinds het dieptepunt in 2013 stijgen ze juist weer veel sneller dan in de rest van het land. In 2016 stegen de huizenprijzen in Amsterdam gemiddeld met bijna 23% ten opzichte van 2015. Wat kost een gemiddeld huis in Amsterdam? Hoe groot is het verschil met de rest van Nederland? En hoe komt het dat de huizen in Amsterdam zoveel duurder zijn?

- Huizenmarkt Nederland in de lift
- Huizenprijzen Amsterdam in 2017 met bijna 13,5% gestegen
- Huizenmarkt Amsterdam oververhit
- Waarom zijn de huizen in Amsterdam zo duur?
- Vooruitzichten voor 2018 en 2019

Huizenmarkt Nederland in de lift

Sinds het dieptepunt in 2013 zit de huizenmarkt weer in de lift. Het CBS meldde in augustus 2016 dat de huizenmarkt de grootste prijsstijging doormaakt in 12 jaar. En die stijging zet door. Bestaande koopwoningen zijn in 2017 gemiddeld 7,6% duurder geworden (bron: NVM). Volgens de Nederlandse Vereniging van Makelaars wordt deze stijging voor een groot deel veroorzaakt door een tekort aan koopwoningen. Vergeleken met het dieptepunt in 2013 zijn de huizenprijzen in Nederland anno 2018 gestegen met 26%. De sterke stijging komt grotendeels voor rekening van een aantal grote steden en groeiregio's daar omheen.

Amsterdam goed voor een kwart

Er zijn grote verschillen op de woningmarkt in Nederland. Zo stijgen de prijzen in grote steden en de Randstad veel harder dan in de rest van Nederland. Zo kwam bijvoorbeeld een kwart van de stijging in het 2e kwartaal van 2016 (4,4%) voor rekening van Amsterdam. Zonder Amsterdam was de prijsstijging over het 2e kwartaal 3,4% geweest.

Huizenprijzen Amsterdam in 2017 met bijna 13,5% gestegen

Ook de gemiddelde transactieprijs van alle verkochte woningen laat zien dat Amsterdam een veel sneller herstel kende dan de rest van Nederland en sinds 2015 al boven het prijsniveau van 2008 zit. Tussen 2008 en 2013 daalden de huizenprijzen in Amsterdam met 17%. In 2016 stegen de huizenprijzen in een jaar tijd met ruim 23%.In 2017 kwam daar nog eens 13,5% bij.

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Tip ons

Nieuws Economie Sport Entertainment Tech Lifestyle EditieNL Uitzendingen

5° 1 files / 0 km

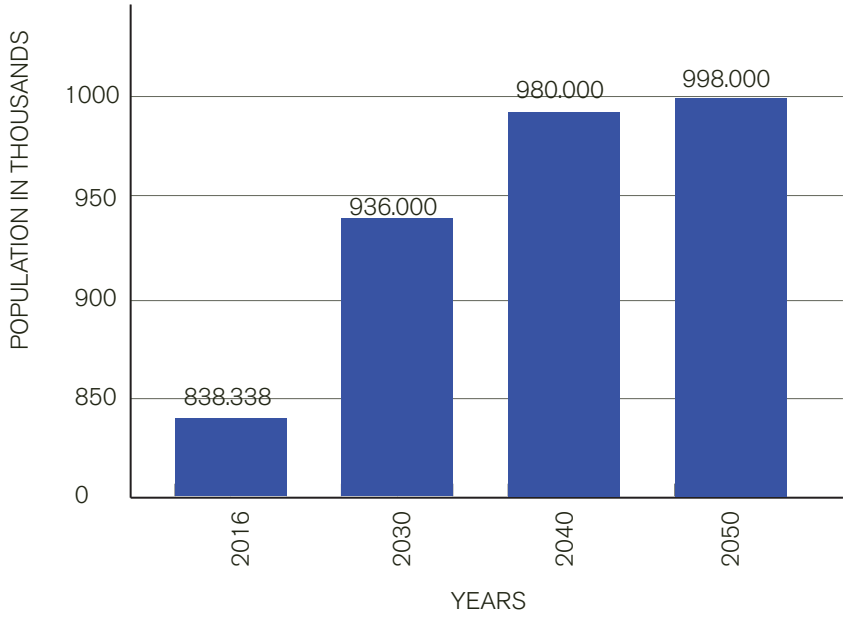
Geld en Werk

'Bouwsector wil 1 miljoen nieuwe woningen bouwen tot 2030'

17 mei 2018 07:23
Aangepast: 17 mei 2018 17:30

Er moeten honderdduizenden huizen gebouwd worden komende jaren.

De bouwsector wil tot 2030 een miljoen nieuwe huizen bouwen. Dat plan van de brancheorganisatie van projectontwikkelaars wordt donderdag aangeboden aan het ministerie van Binnenlandse Zaken.



Number of people living in Amsterdam *(OIS Gemeente Amsterdam, 2016)*

Building industry and environment

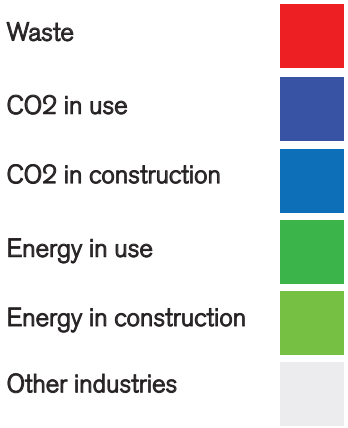
2017

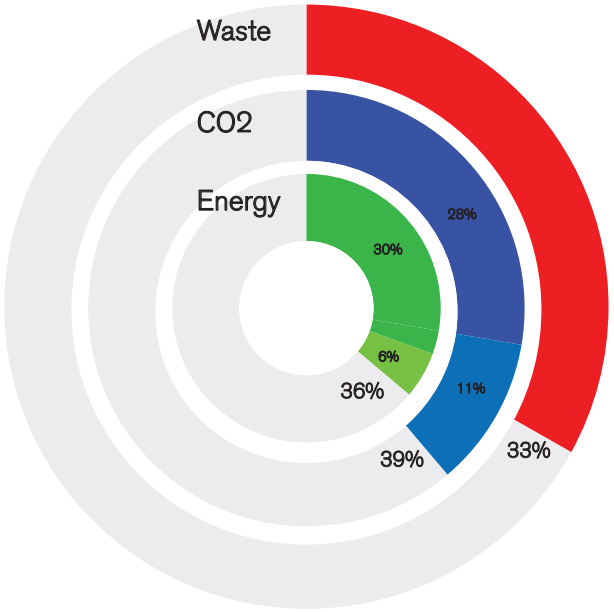
- Construction and demolition waste:

1.3 billion tons per year *(Redling, 2018)*

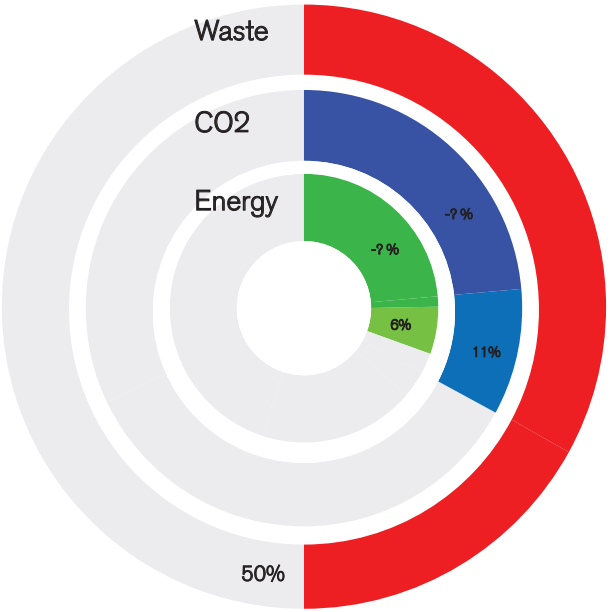
2025

- Use-phase of buildings more efficient
- Drastic increase in construction and demolition waste: from 1.3 to 2.2 billion tons per year *(Redling, 2018)*





Building industry in 2017 compared to other sectors *(United Nations Environment, 2017)*



Building industry in 2025 compared to other sectors *(Redling, 2018)*

The housing shortage (in Amsterdam) has to be solved. The current building methods do not take the end of life of buildings into consideration in the design, wasting building resources.

This is not sustainable.

CONTEXT

Construction and demolition waste

- Heterogeneous mixture
- Uneconomical to separate
- Non-recyclable materials
- Demolition biggest contributor
- Loss of resources
- Resource depletion

(de Lange & van Houten, 2016)

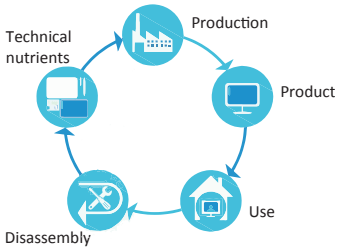
Design for Zero-Waste

Primary requirements

1

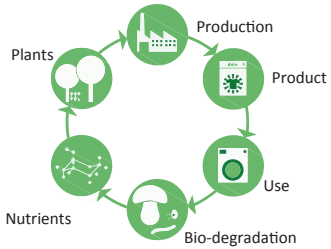
0 kg waste during all (de)construction phases of the building

2B



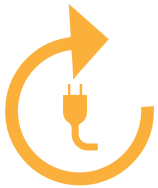
Metallic and synthetic (and all man-made) materials must remain in the technosphere cycle

2A



Natural materials must remain in the biological cycle

3

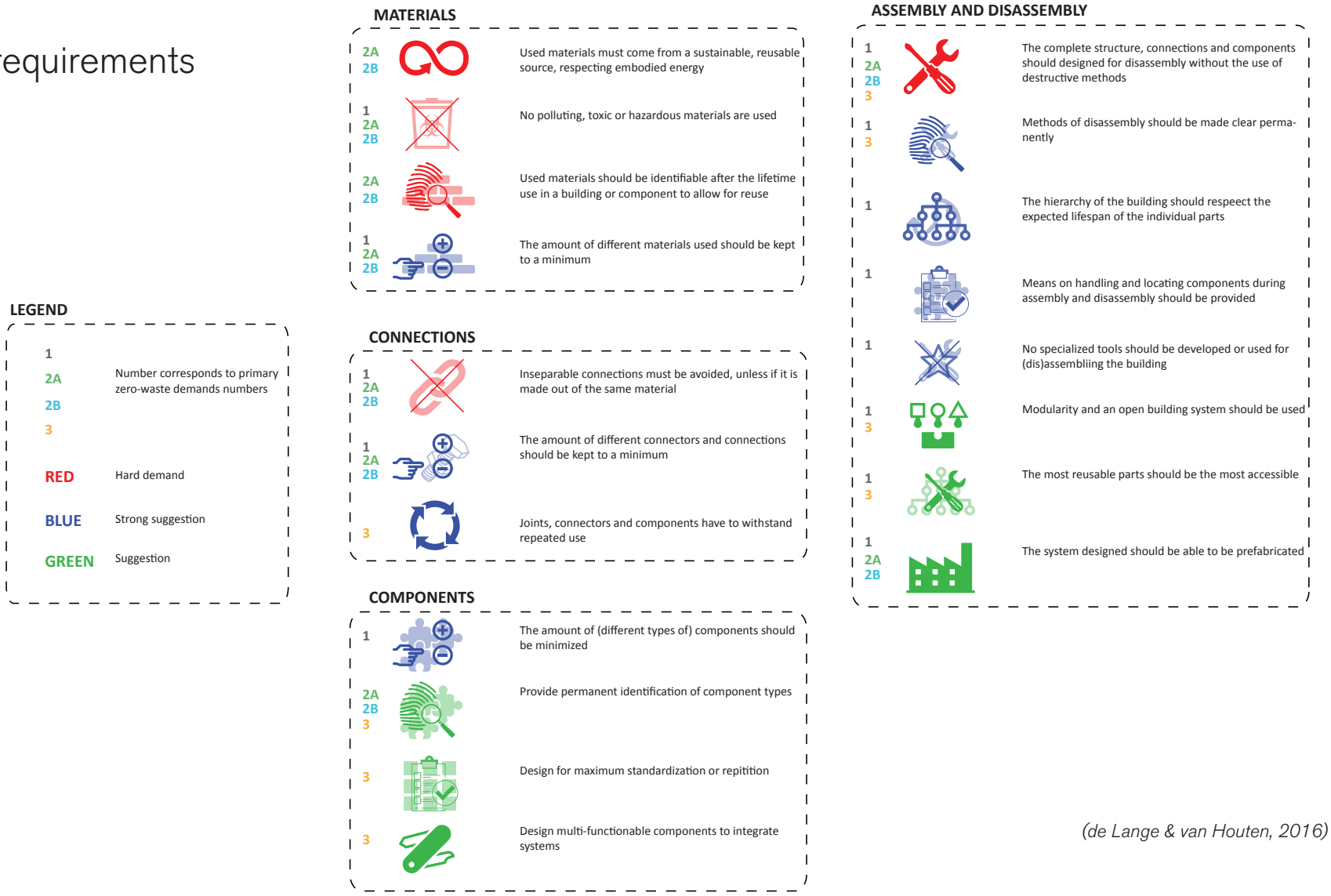


Reuse of materials should be made possible insuch a way that invested/embodied energy is maintained as much as possible, or can easliy be increased

(de Lange & van Houten, 2016)

Design for Zero-Waste

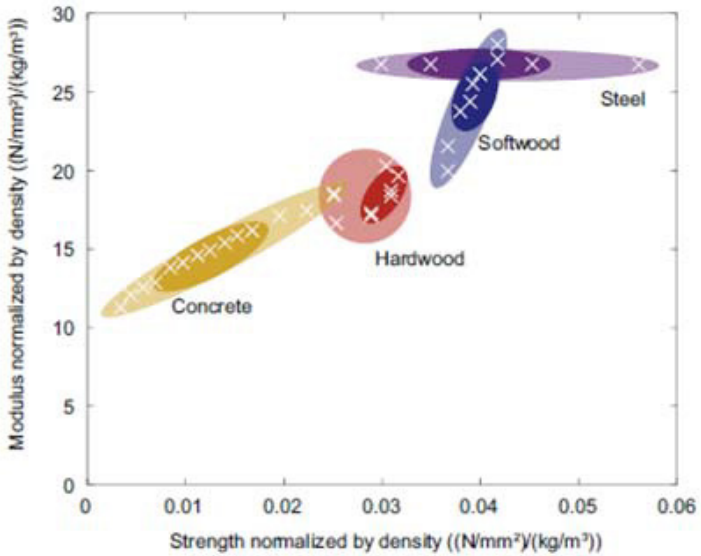
Secondary requirements



(de Lange & van Houten, 2016)

Mass-Timber

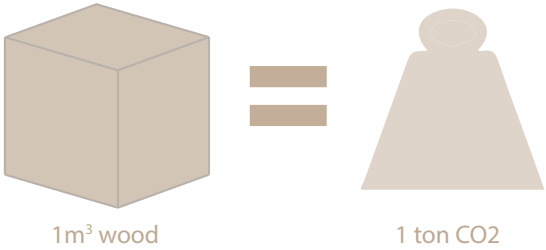
- Engineered material
- Re-growable resource
- Performs structurally comparable to steel and concrete
- Lightweight (ca. 600 kg/m^3)



Performance of timber compared to steel and concrete
(Ramage et al., 2017, p. 348)

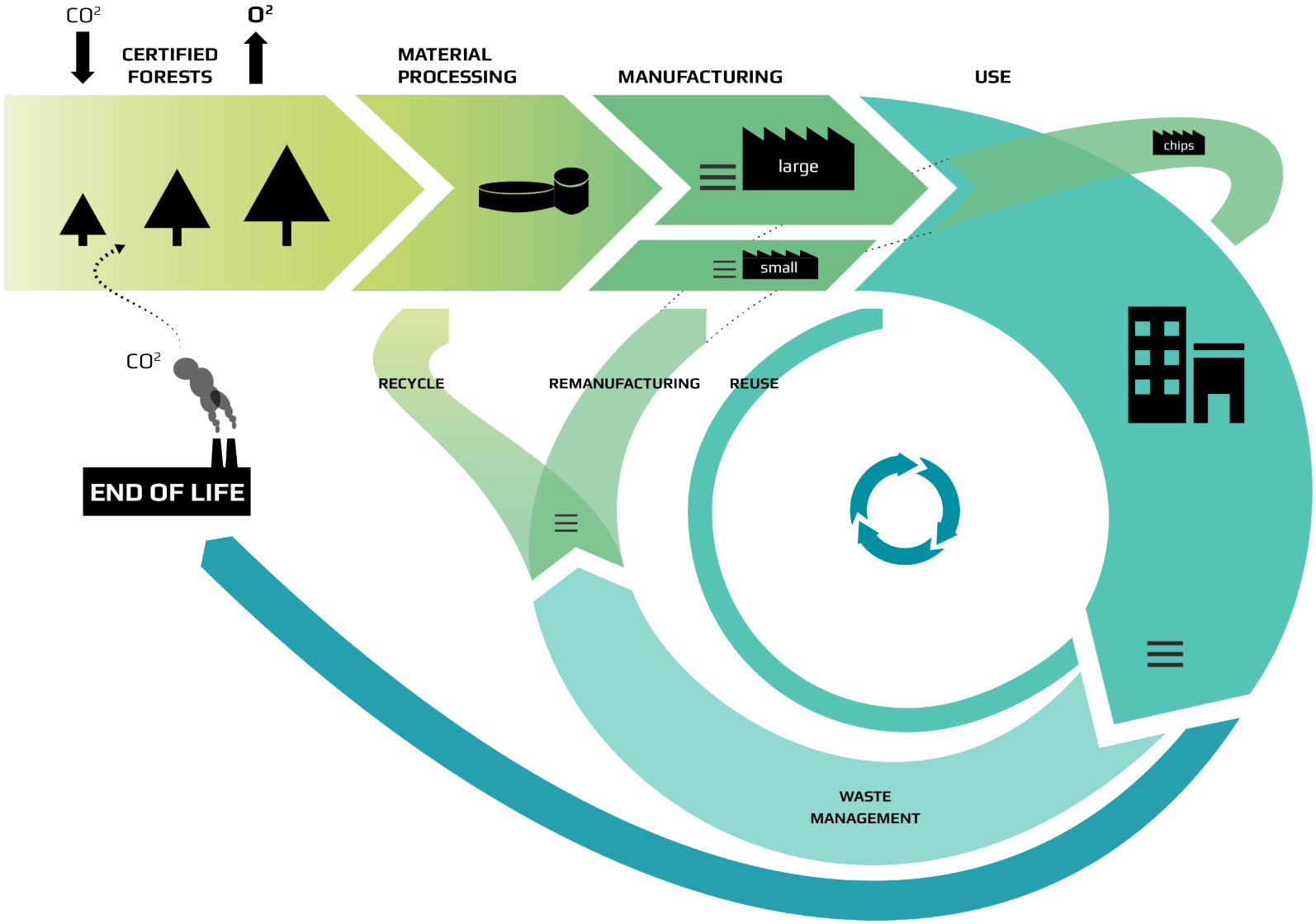
Cross laminated timber panels
(Natural Resources Canada, 2019)

Glulam beams
(Anthony Forest Products Company LLC, 2019)



Carbon sequestration *(Green, 2017)*

Life cycle of timber

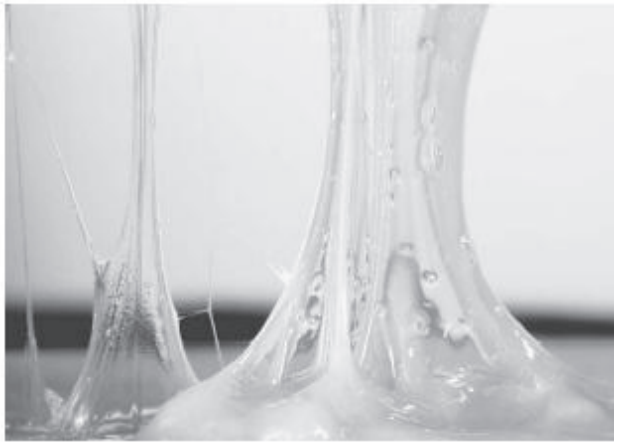


Struiksma, A.F., Smilde, J.A. van Houten, R.S. (2015).

Lamination

Adhesives

- Fingerjoints
- Small part of total volumetric weight
- Synthetic material
- Not fully recyclable
- Bio-resins in the future



Lamination with adhesives

Mechanical lamination with nails *(ThinkWood, 2017)*

Mechanical lamination

- Screws or nails
- Dowels

Mechanical lamination with hardwood dowels *(Rombach)*

Durability

Moisture

Molds

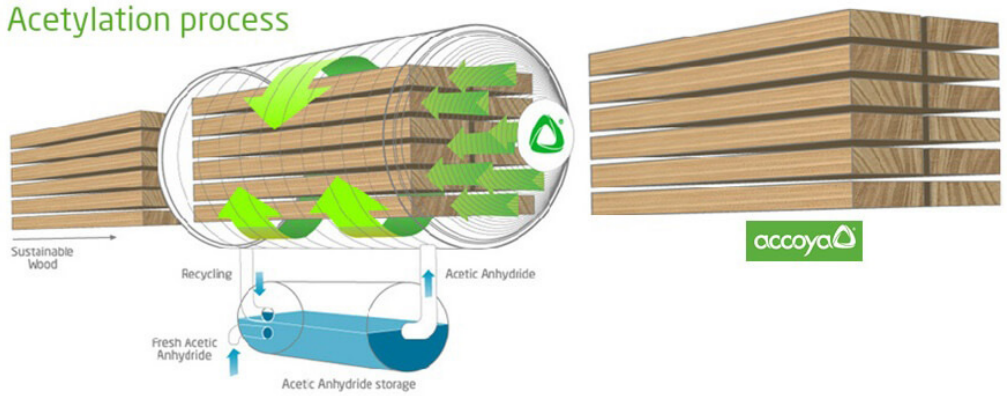
Biodegration

Traditional treatments:

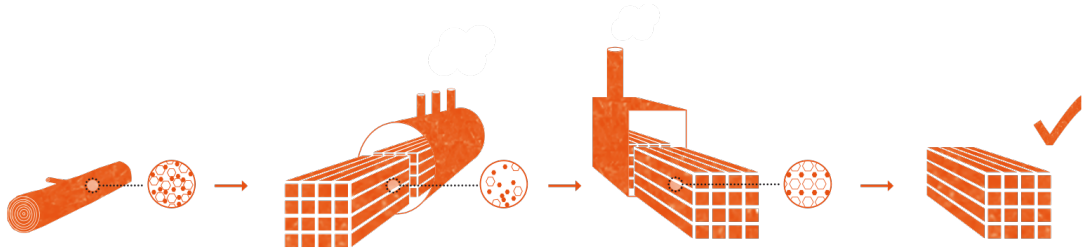
- Chemical impregnation

Zero-Waste Treatments

- Acetylation *(Accoya)*
- Hydro-thermal modification *(Platowood)*
- Biopolymers *(Nobelwood)*
- Charring *(Houzz)*



Schematic representation of the acetylation process *(Accoya)*

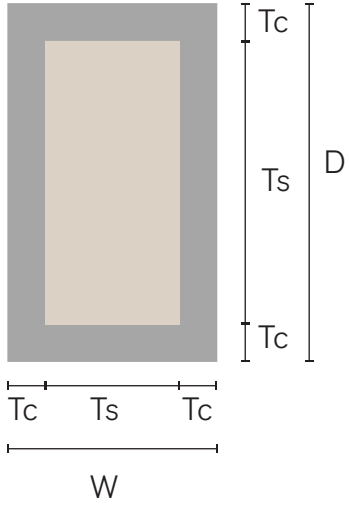


Schematic representation of hydrothermal modification *(Platowood)*

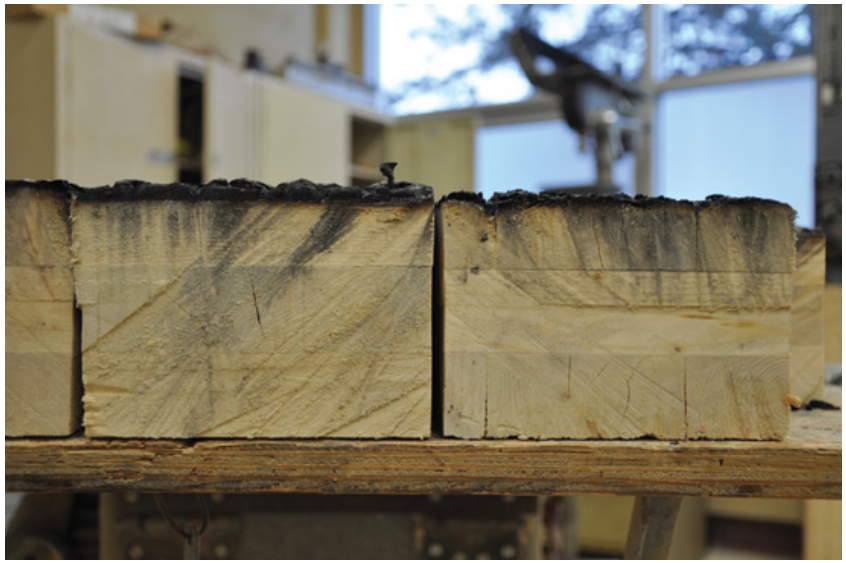
Fire

- Charring
- Keeps strength in higher temperatures
- Encapsulation
- Sprinkler system

D = total depth
W = Total width
Tc = charring thickness
Ts = structural thickness



Charring rate *(Green, 2017)*



Mass- Timber products

- Boards
- Veneers
- Strands

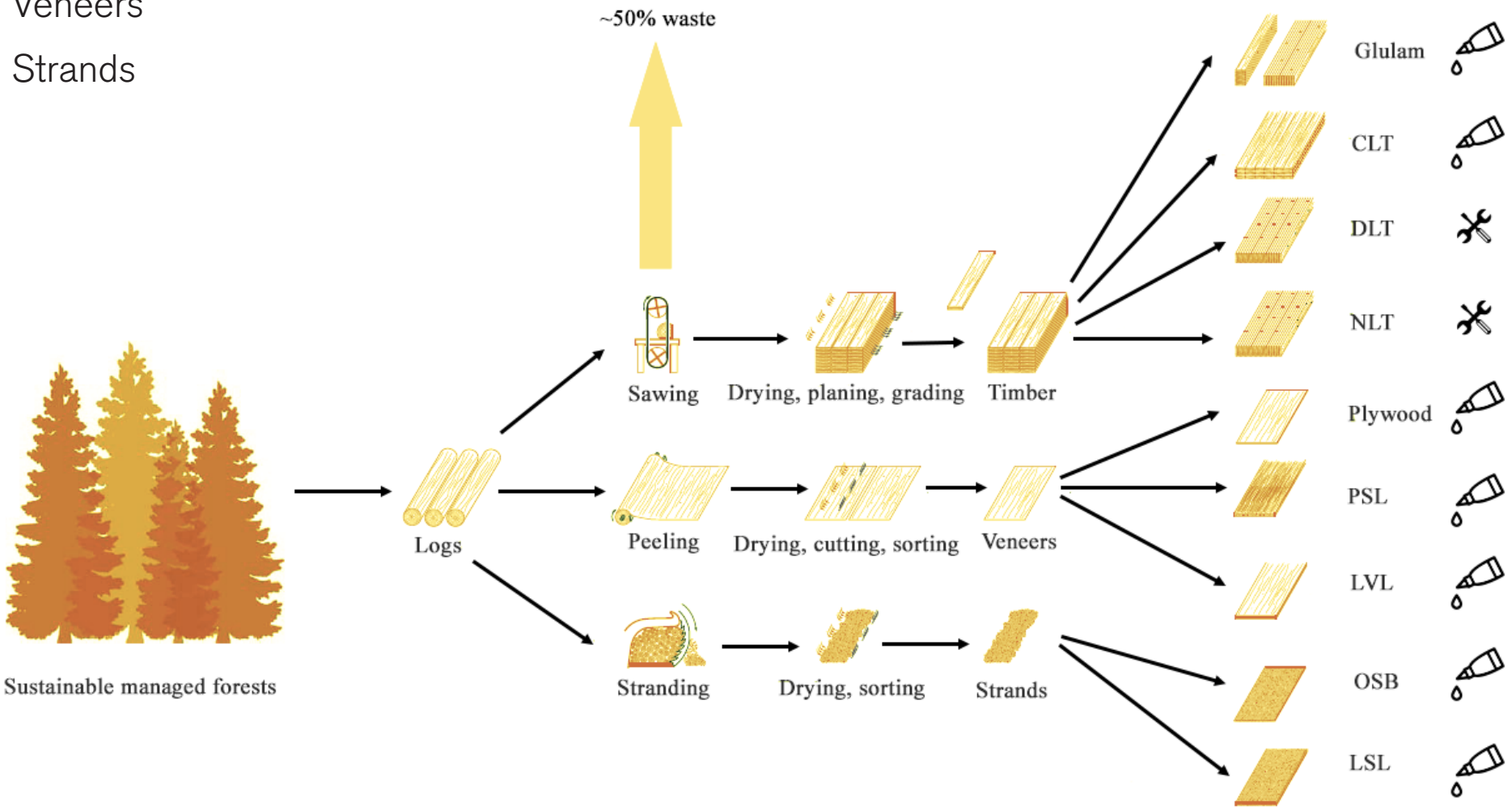
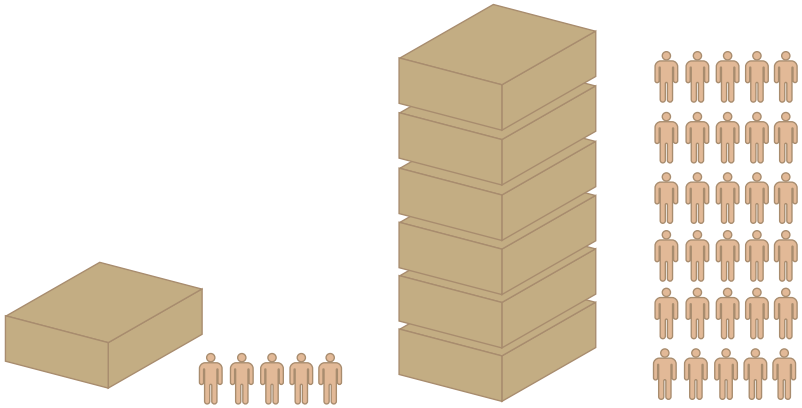


Illustration based on image from Ramage et al. *(2017, p. 344)*

Building tall

- Increase density
- Efficient use of space
- Mass-timber high-rises
- Extension of existing buildings



High rises create more space on the same footprint

Mjøstårnet, Brumenddal in Norway
(Block, 2019)

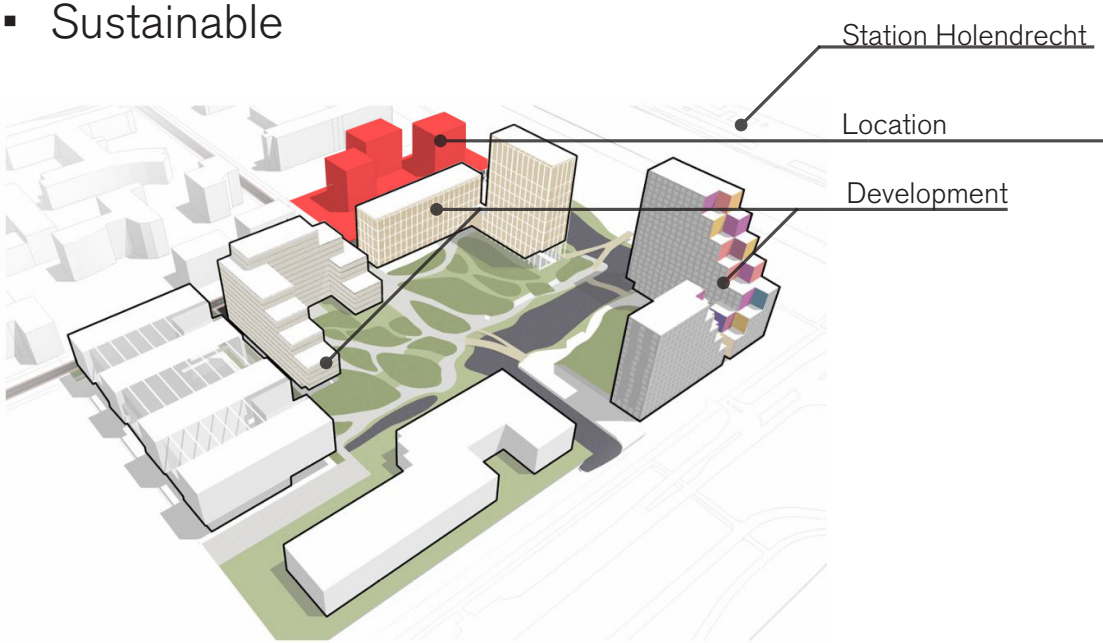
Karel Doorman, Rotterdam
(Ibelings & van Tilburg, 2013).

How can zero-waste mass-timber high-rise buildings contribute to sustainable densification (of Amsterdam)?

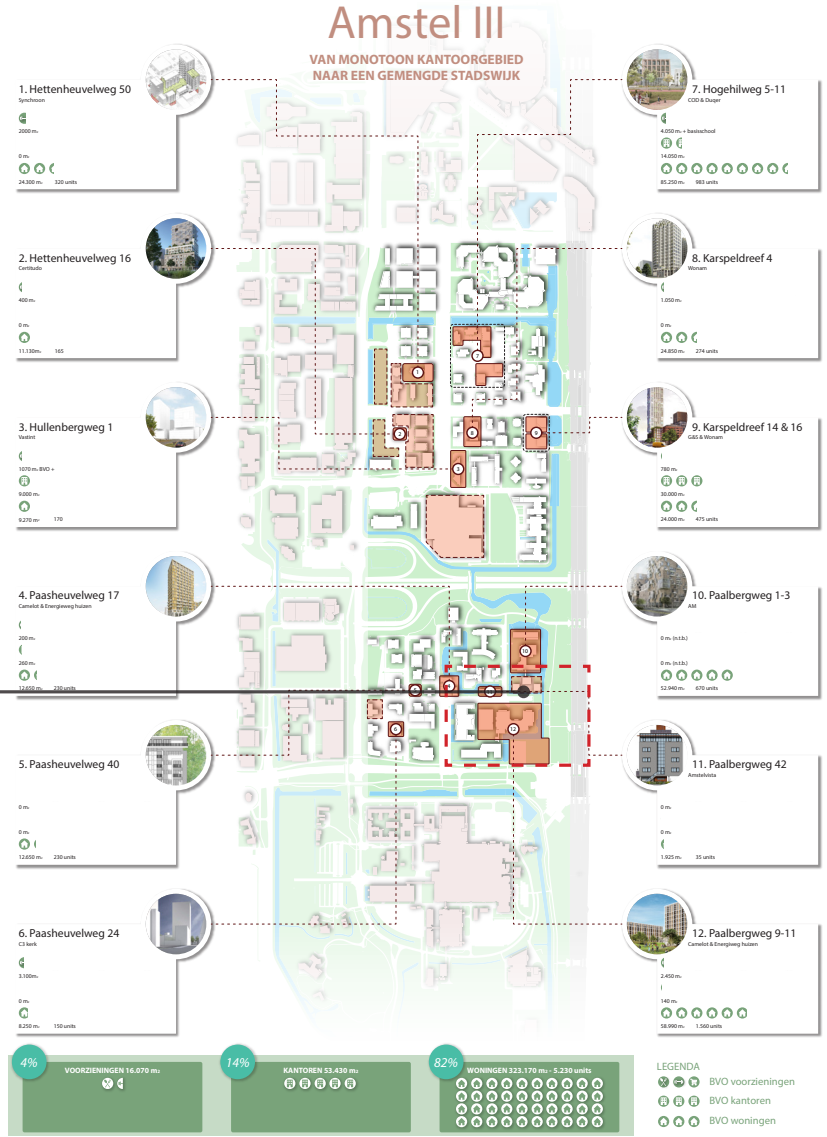
The goal of this study is to explore the possibilities of sustainable densification in cities using zero-waste timber high-rises.

Site

- Amstel III
- Redevelopment
- Mix of work and living
- Extension of existing buildings
- Average household 1.5-2.0
- Students & starters
- Sustainable



(OZArchitect, 2016)



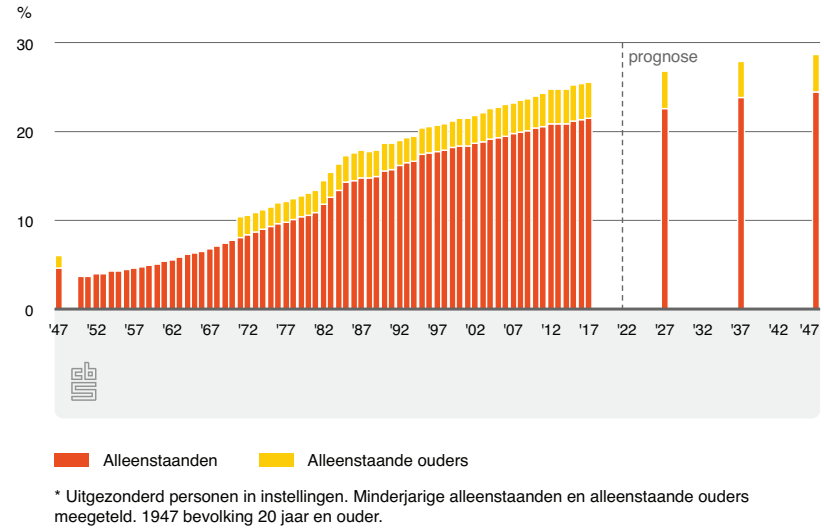
(Gemeenteraad Amsterdam, 2017)

Target group

- Singles & starters
- Micro-apartments
- Character of building - address
- Privacy
- Volume vs square footage
- Quality of shared spaces

(Architectuurcentrum Amsterdam)

Alleenstaanden en alleenstaande ouders in meerderjarige bevolking*



* Uitgezonderd personen in instellingen. Minderjarige alleenstaanden en alleenstaande ouders meegeteld. 1947 bevolking 20 jaar en ouder.

Demographics of singles as percentage *(CBS, 2018)*


Het Parool

Nederland | Wereld | Kunst & Media | Sport | Columns & Opinie

Aantal alleenstaanden groeit: straks 1 op 4 volwassenen alleen

Het aantal alleenstaanden neemt explosief toe. Nog nooit waren er zo veel alleenstaanden in Nederland. Sinds 2013 is het aantal alleenstaandenhuishoudens in Amsterdam met 6,4 procent gestegen.

Hanneke van Houwelingen 25 juni 2018, 15:11


deVolkskrant

Columns & Opinie | Video | Wetenschap | Mensen | De Gids | Cultuur & Media

Wonen op 40 vierkante meter rukt op: de microwoning is in opkomst

Onder druk van hoge huren en huizenprijzen gaat de stadsbewoner weer kleiner wonen. Projectontwikkelaars spelen met de bouw van microwoningen slim in op deze vraag naar 'betaalbaar'. Het eenkamerappartement van minder dan 40 vierkante meter rukt op in de Randstad, al roept het wonen in zulke 'hokken' ook weerstand op.

Marc van den Eerenbeemt 18 maart 2017, 14:00


BUSINESS INSIDER NEDERLAND

TRENDING ONDERNEMEN TECH FINANCE POLITIEK

HOME » ARCHIEF » 'SINGLE EN STARTER OP HUIZENMARKT KANSLOOS IN GROTE STEDEN'

'Single en starter op huizenmarkt kansloos in grote steden'

05 Jul 2016

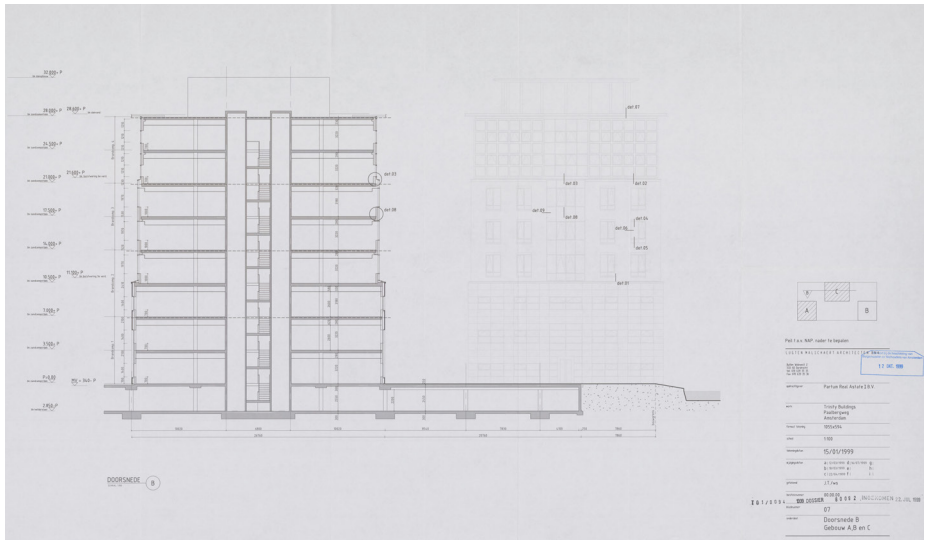
ARCHITECTURAL DESIGN

Design

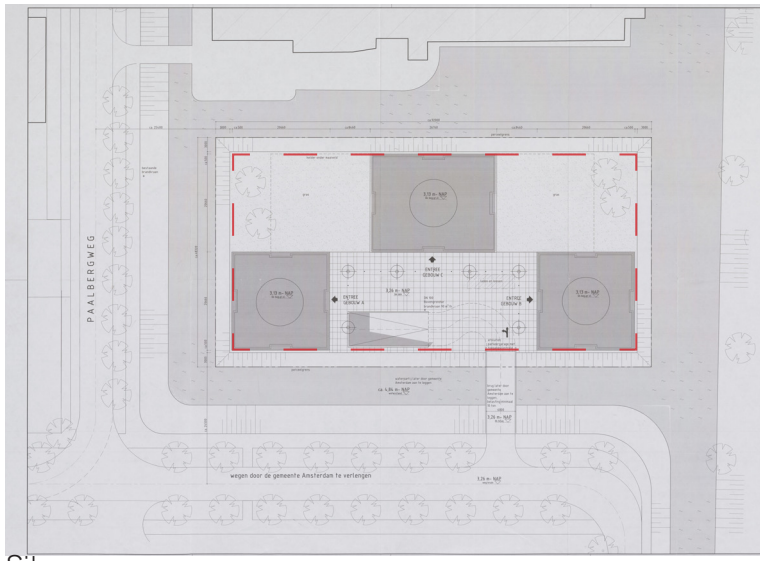
- 98m tall
- 355 apartments
- Closed building block with cut outs
- Shared, public and commercial functions in plinth
- Public parks on the 1st, 5th and 11th floor
- 13 storeys with apartments

Trinity Buildings

- 3 towers of roughly 20x20m
- Concrete core of 7x7m
- Load bearing prefab concrete facade
- 8 Storeys, 32m high
- Office space
- Parking garage



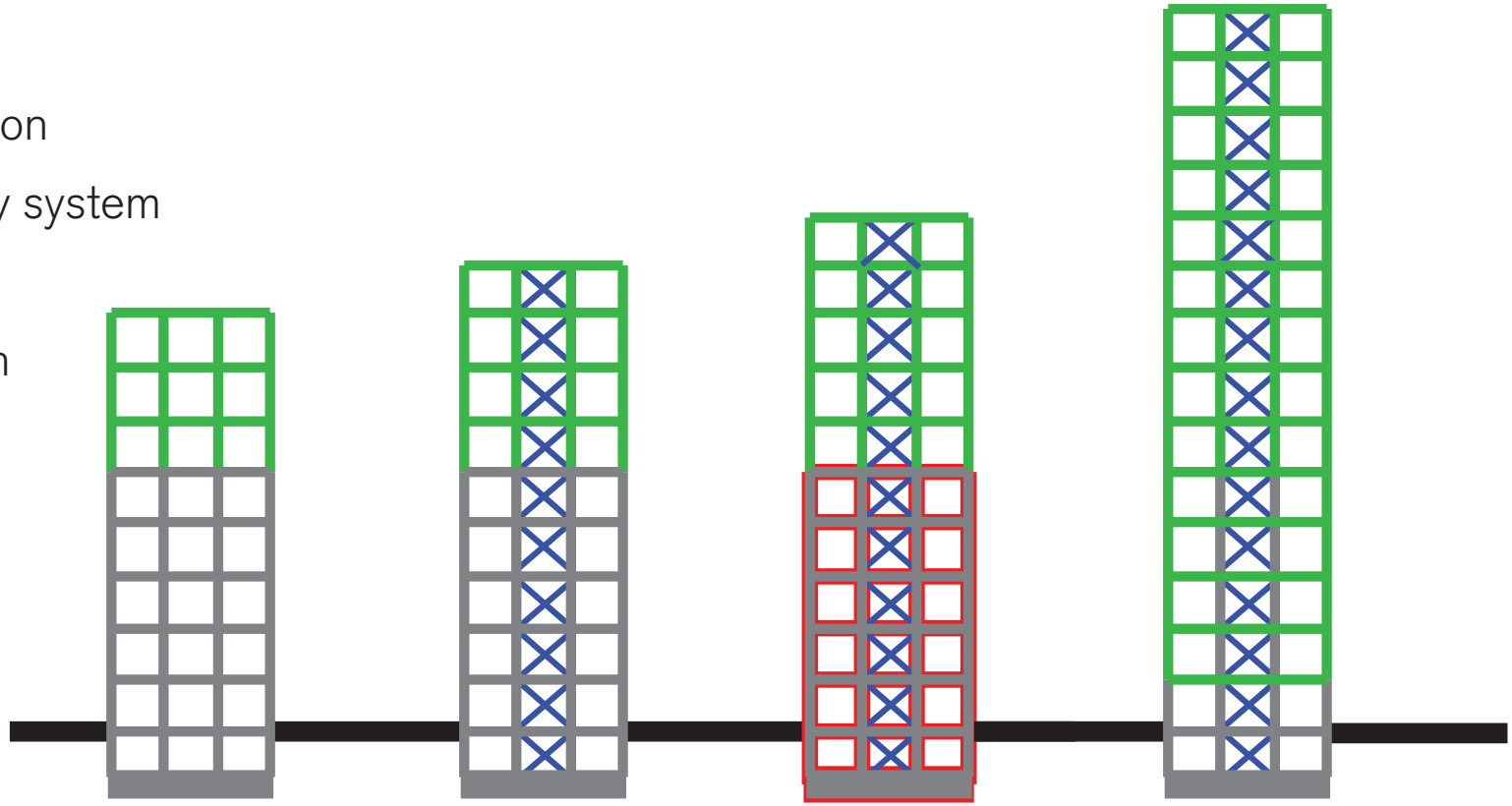
Section



Site

Extension methods

- Recalculation
- Concrete becomes stronger over time
- Soil compaction
- Change of function
- Improved stability system
- Strengthening
- Partial demolition



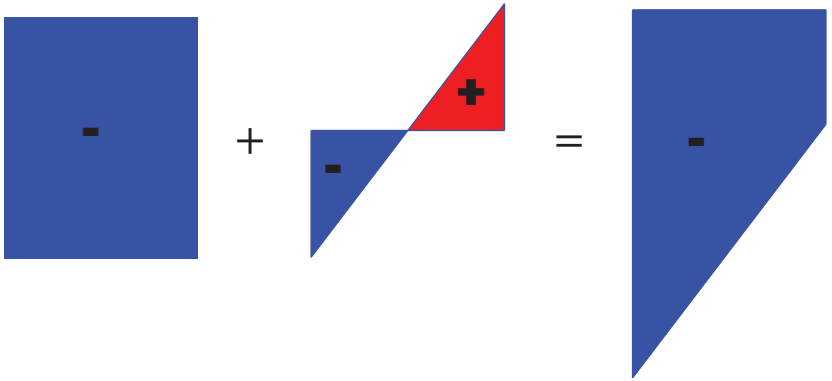
Strength to weight ratio

- Mass timber 600 kg/m^3
- Reinforced concrete 2400 kg/m^3
- 4 times lighter
- Comparable ratio relative to steel
- Smaller foundation strength required

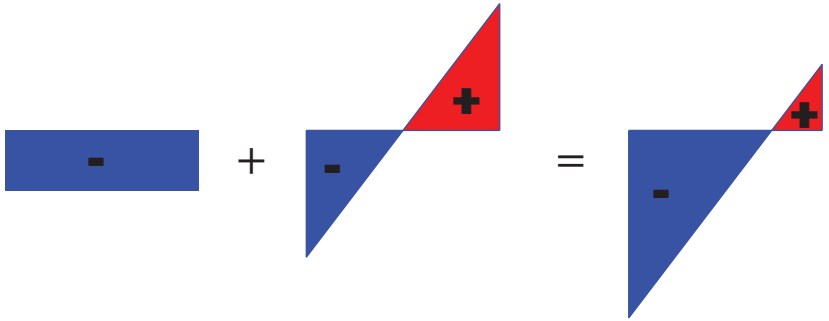
	Existing	New design
Permanent loads	83472 KN	47243 KN
Live loads	34848 KN	51450 KN
Total	118320 KN	98692 KN

Comparison of loads

Lightweight also disadvantage!

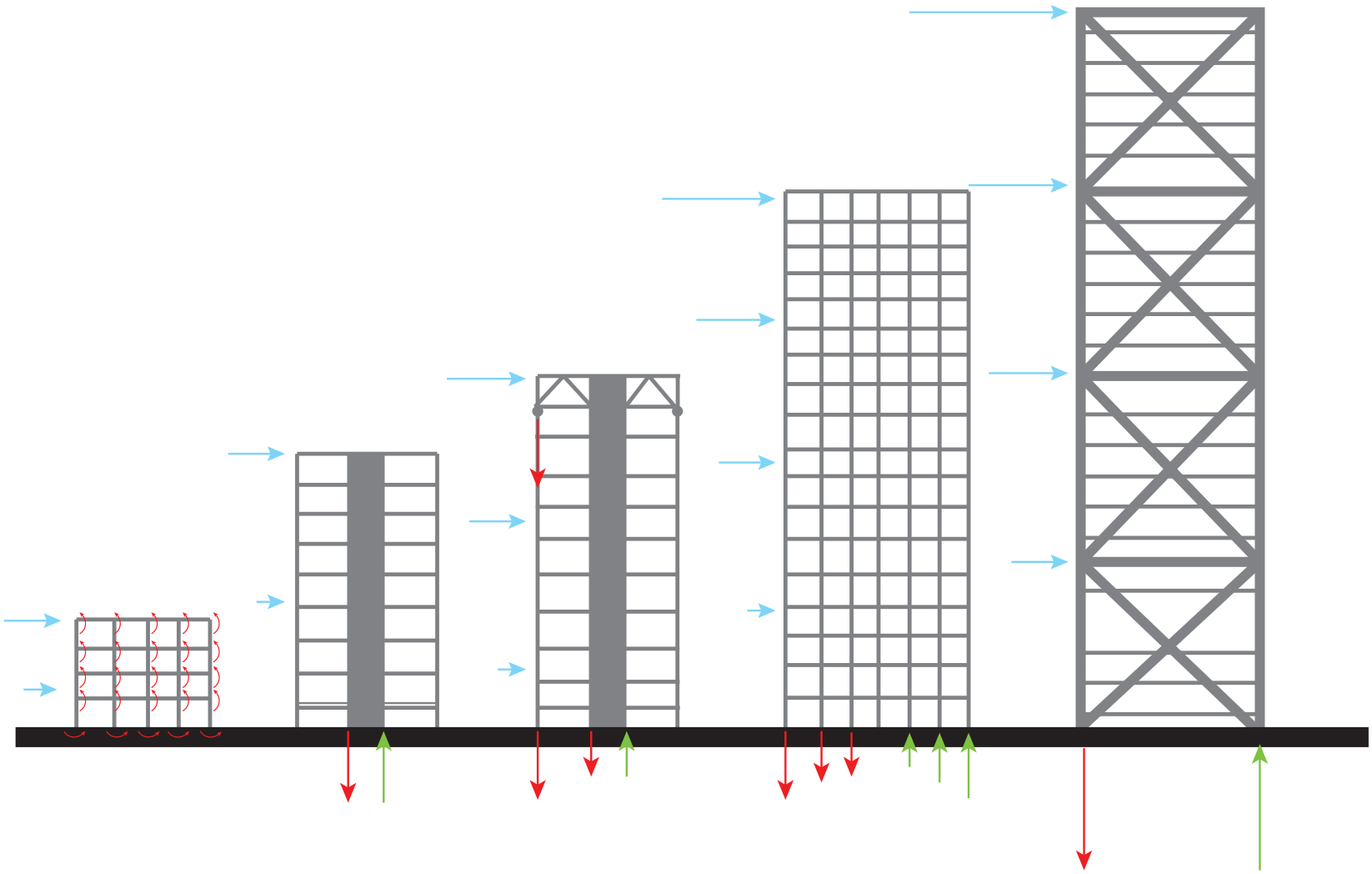


High rise with traditional materials



Similar high rise with mass timber

High-rise lateral stability methods



Strip

- Potential strength

Extrude

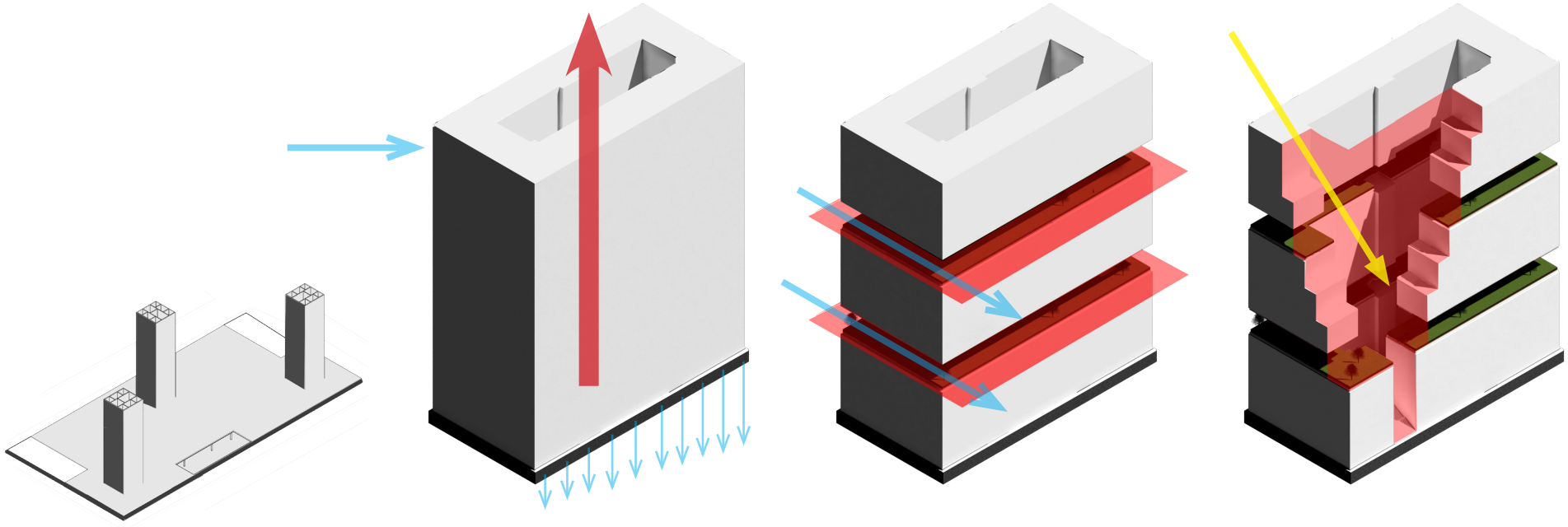
- Building block
- Density
- Large footprint

Divide

- Spatial qualities
- Public space
- Reduce windloads

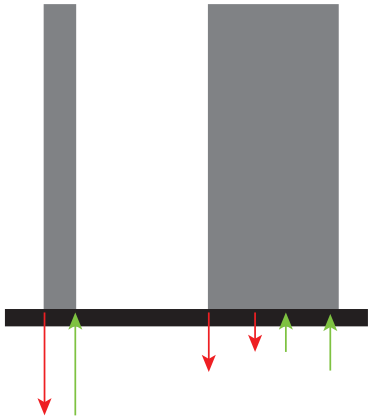
Cut

- Light
- Entrance
- Views
- Profile



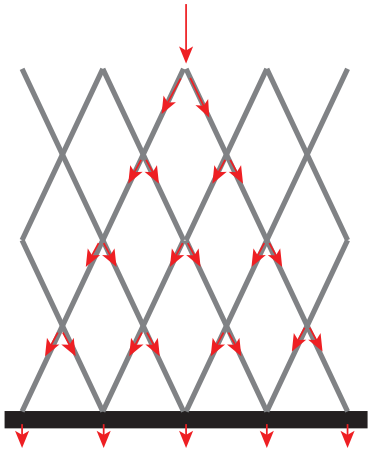
Footprint

- Prevent overturning
- Reduce forces



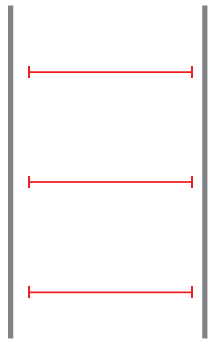
Diagrid

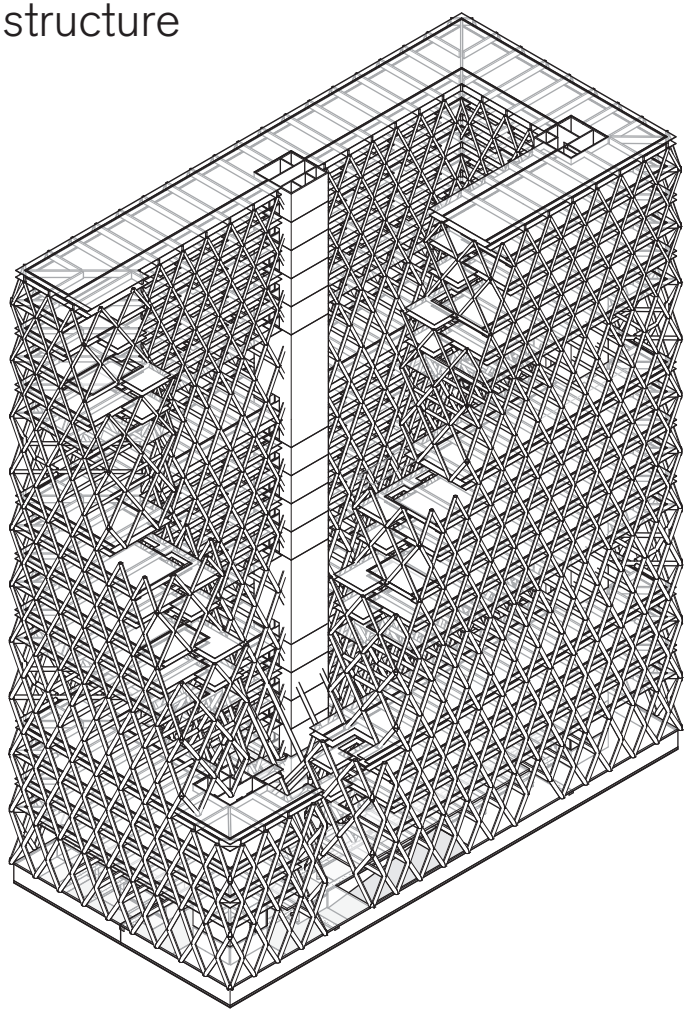
- Spread loads
- Stability



Load-bearing facade

- Flexible floor plans
- Visible structure

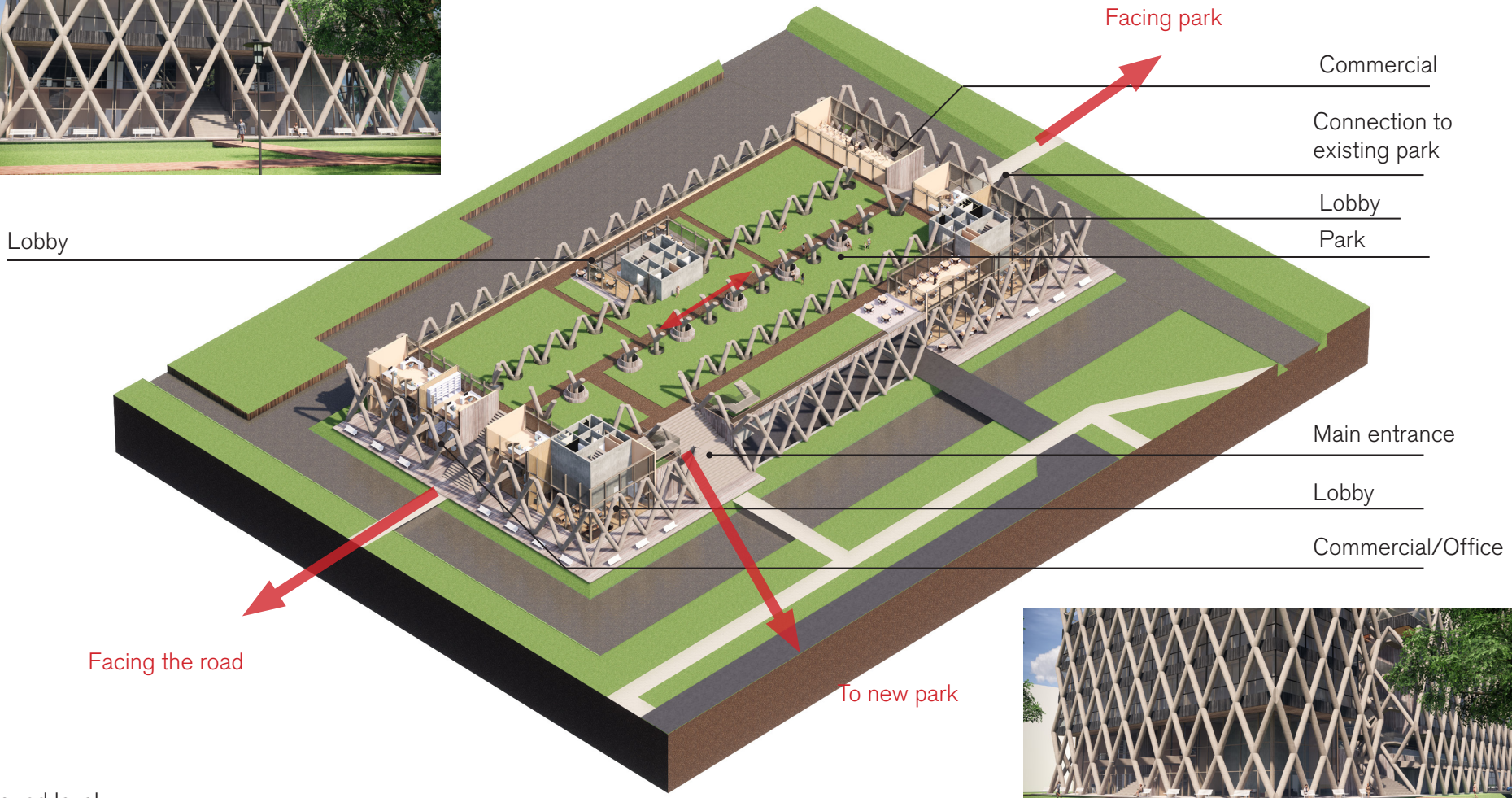




Site

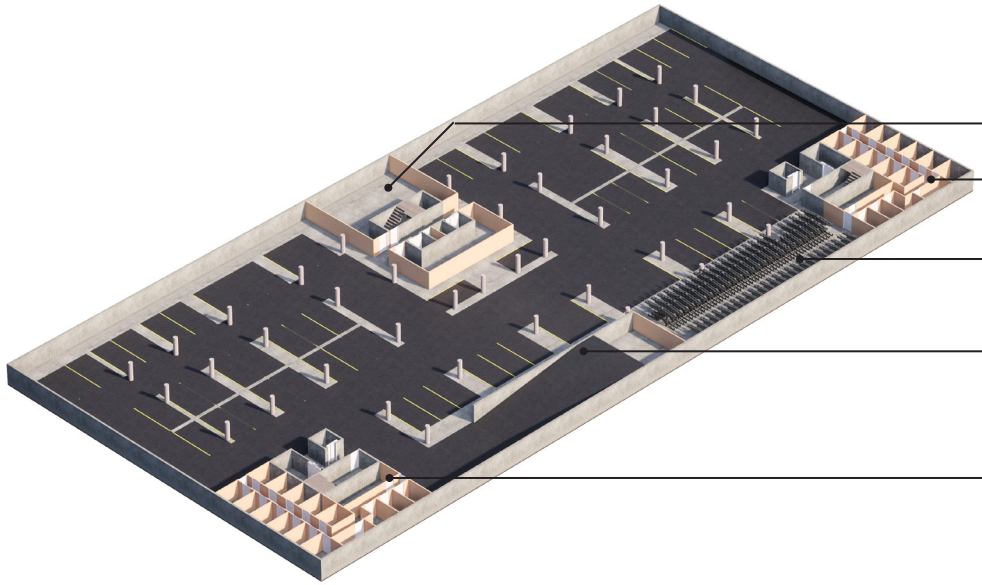

Entrance facing new park
Connection to park
New development
Station Holendrecht

Site

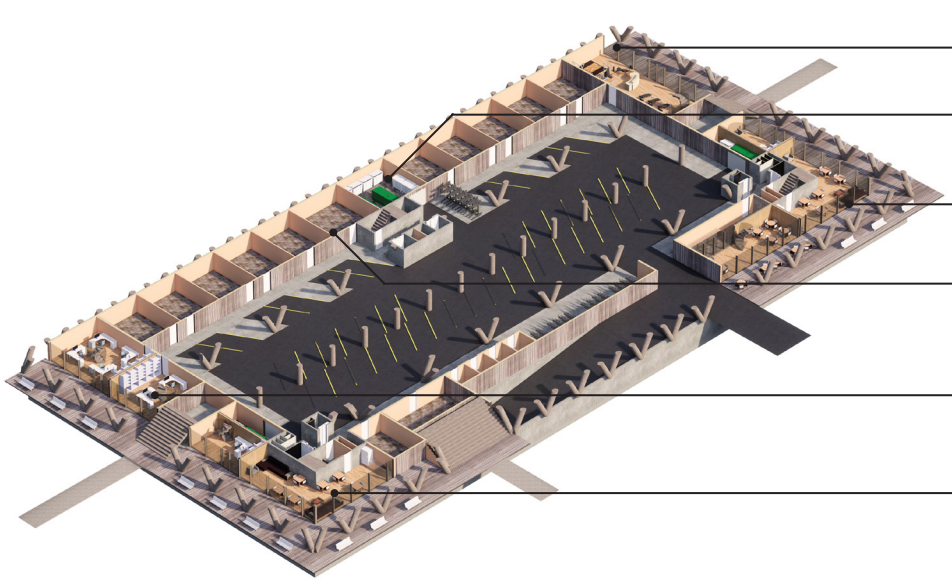


Ground level

Lay-out

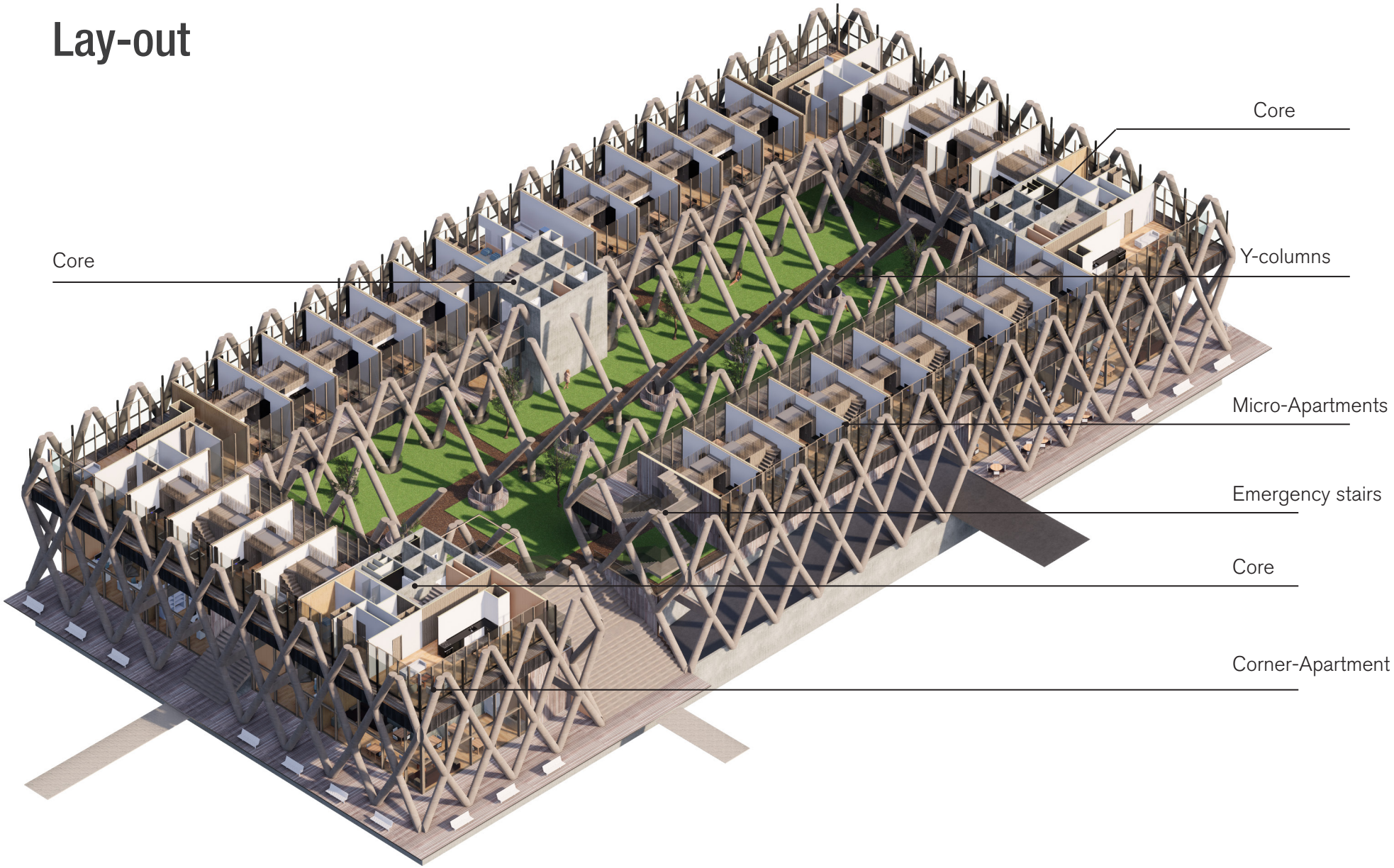


Basement

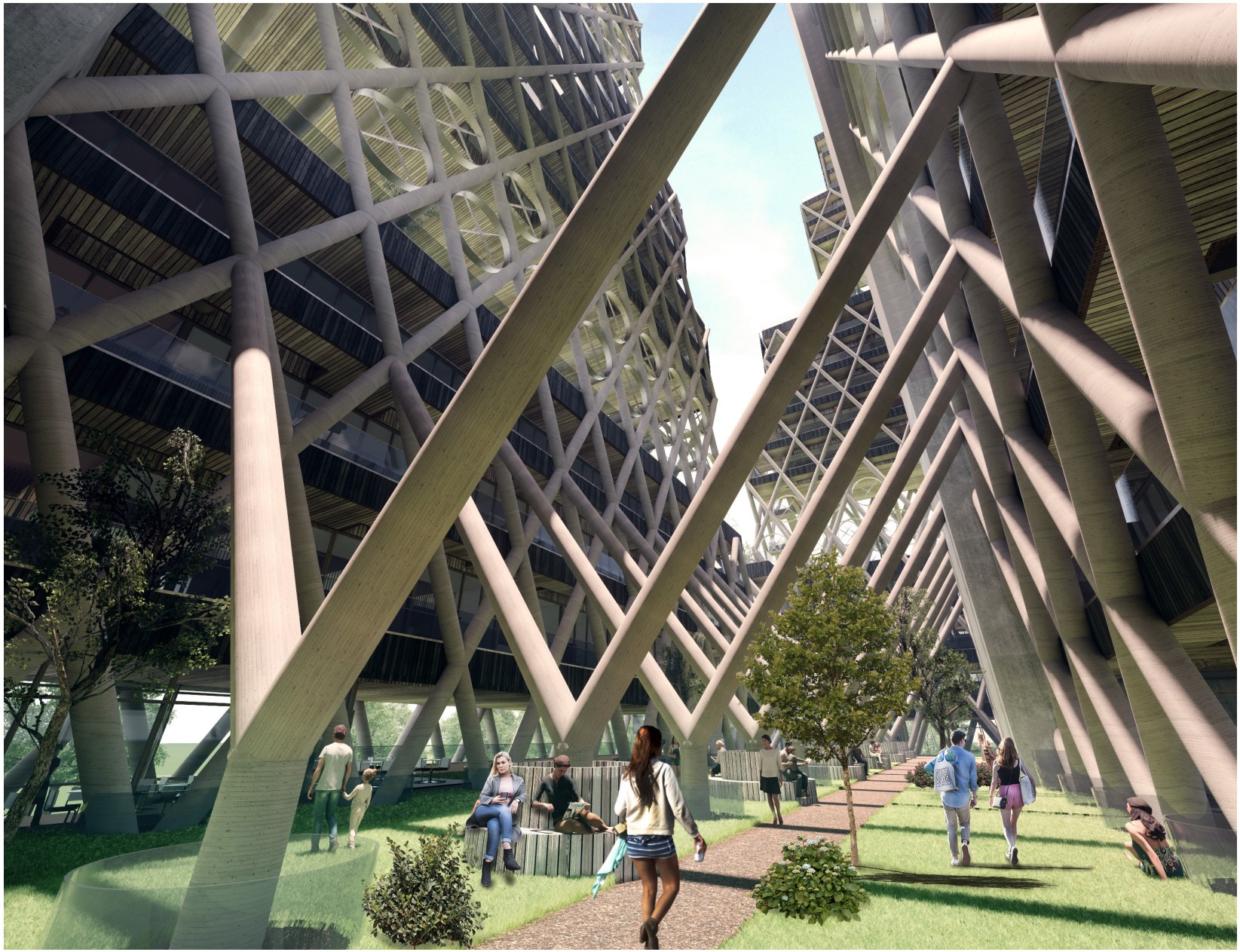


Ground level

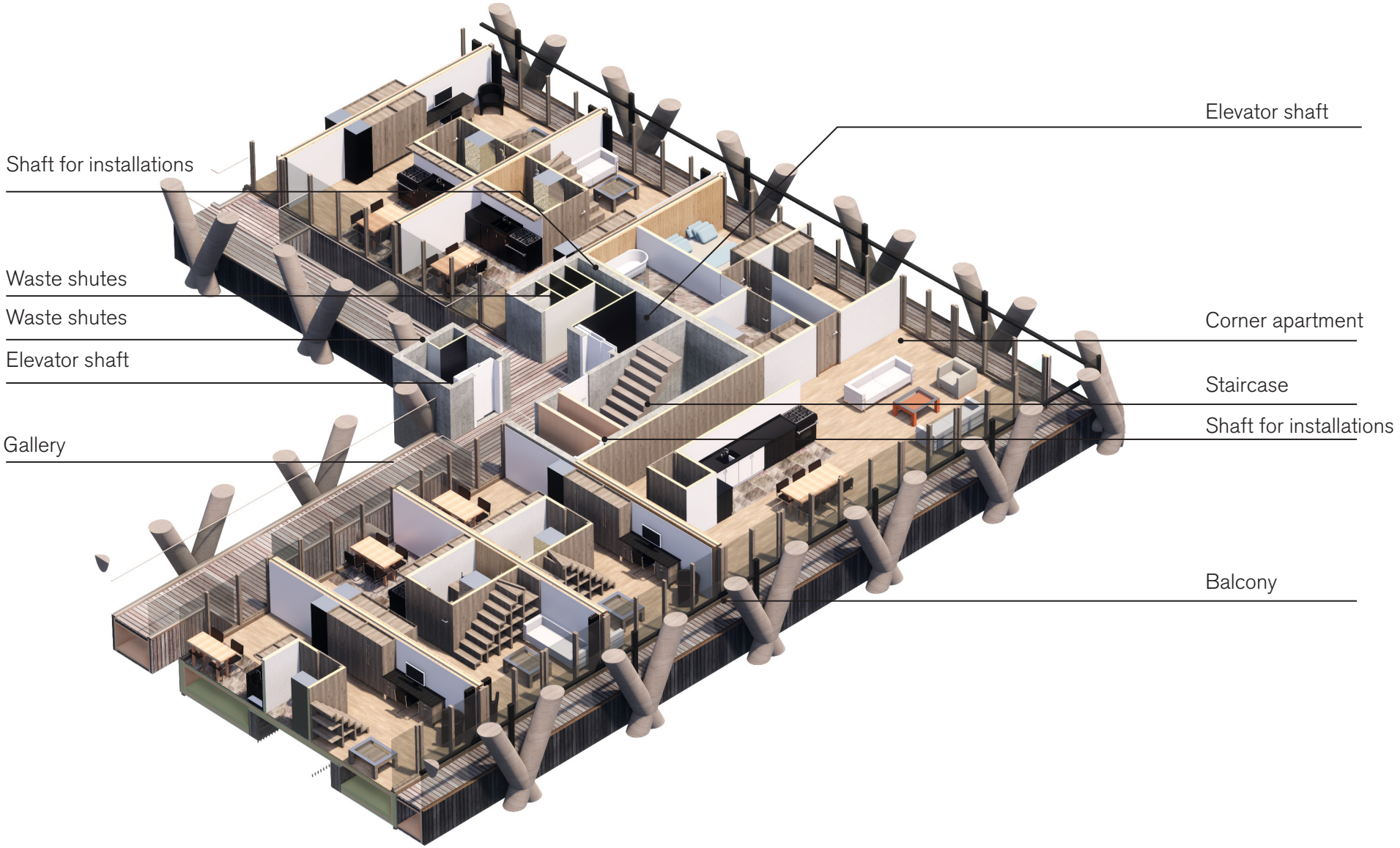
Lay-out



Second floor



Fragment of building



Micro-Apartment

Mezzanine level

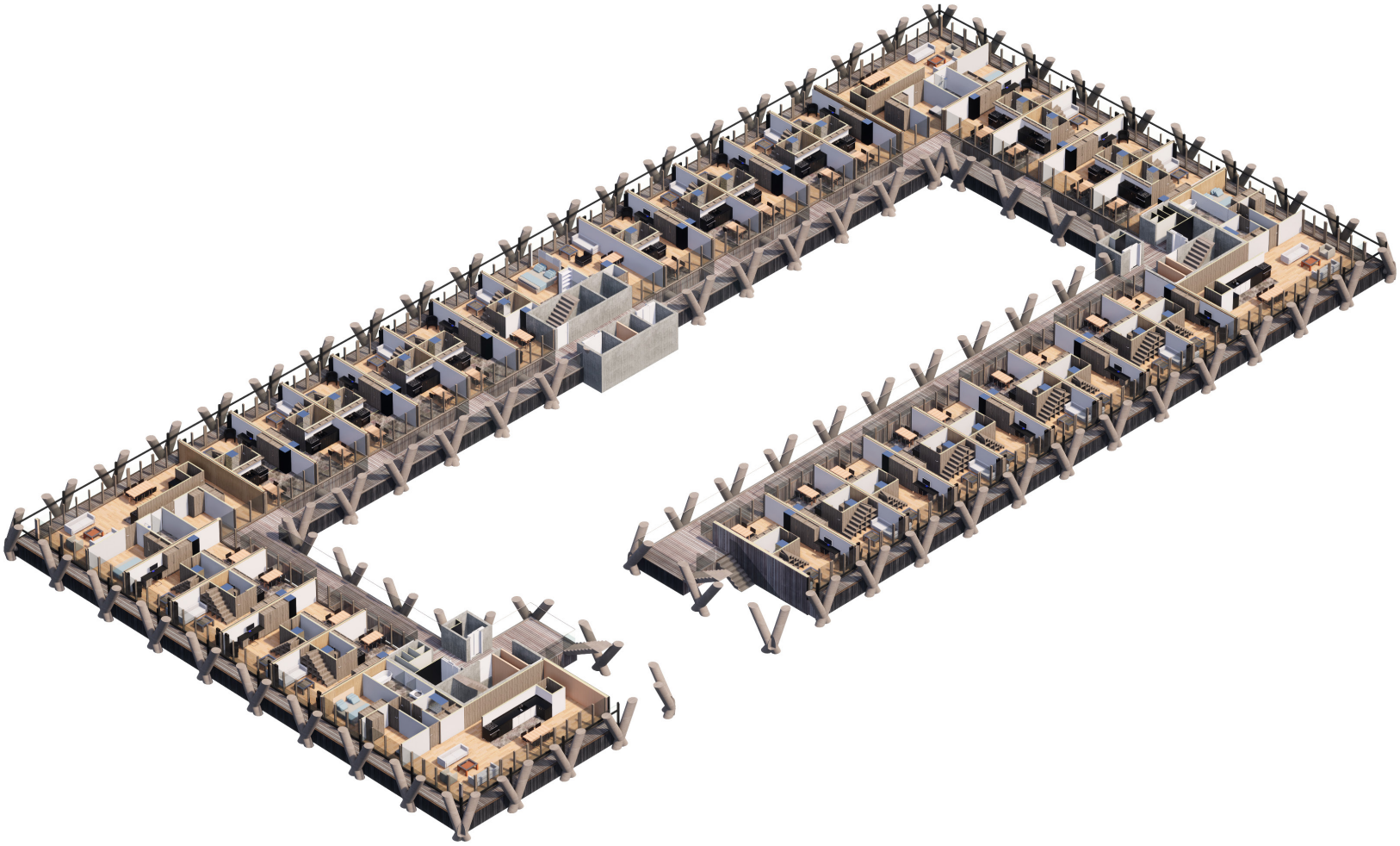
Ground level

Kitchen impression

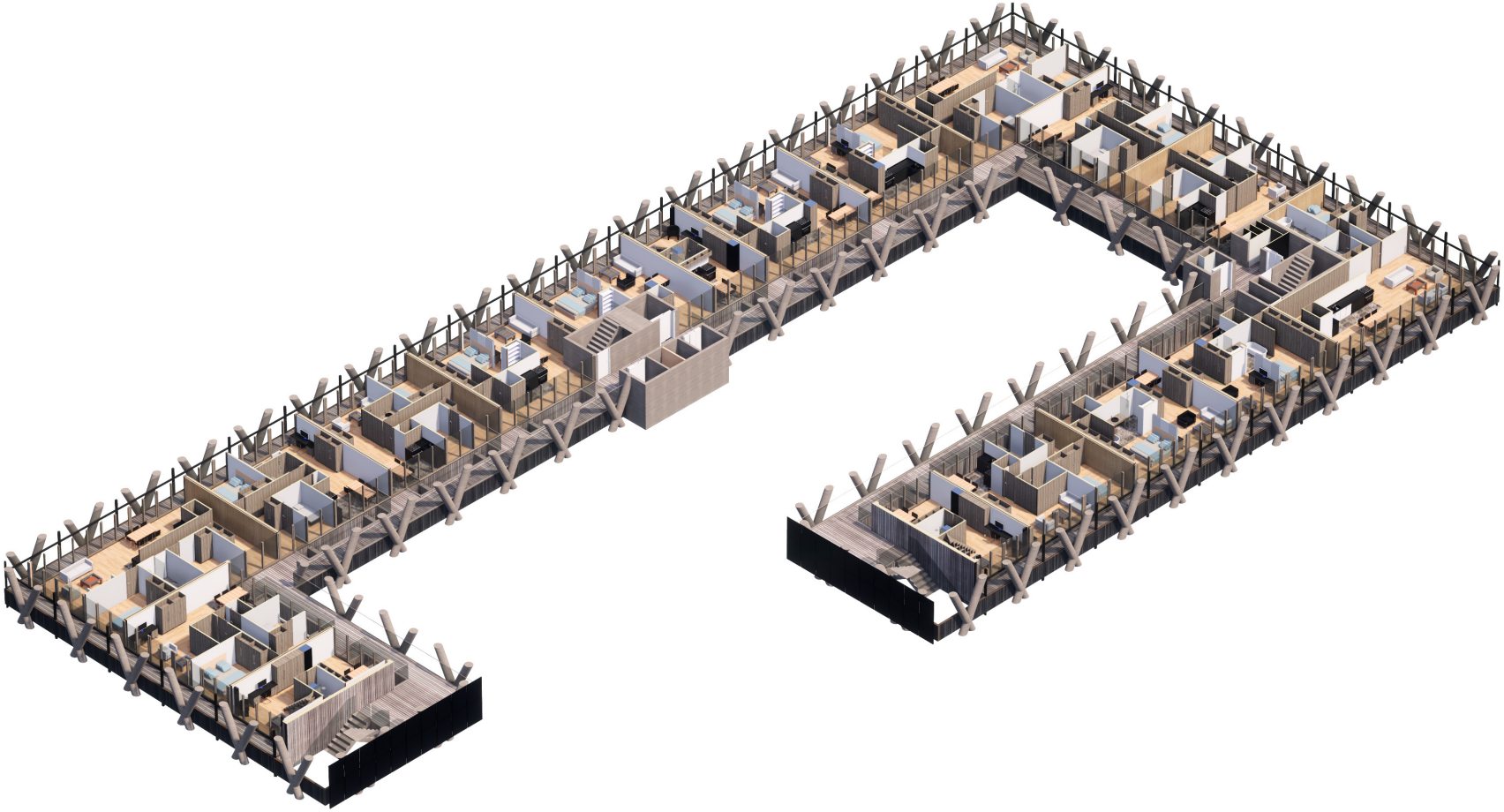
Living room impression

Corner-apartment

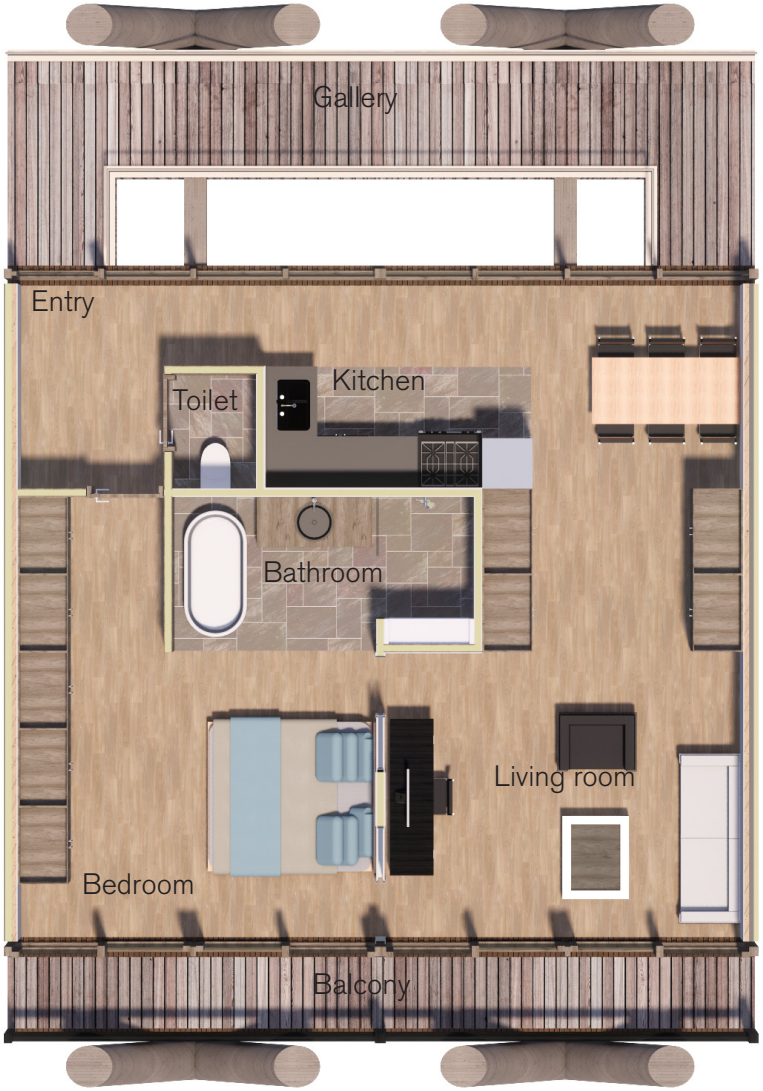
Lay-out micro-apartments



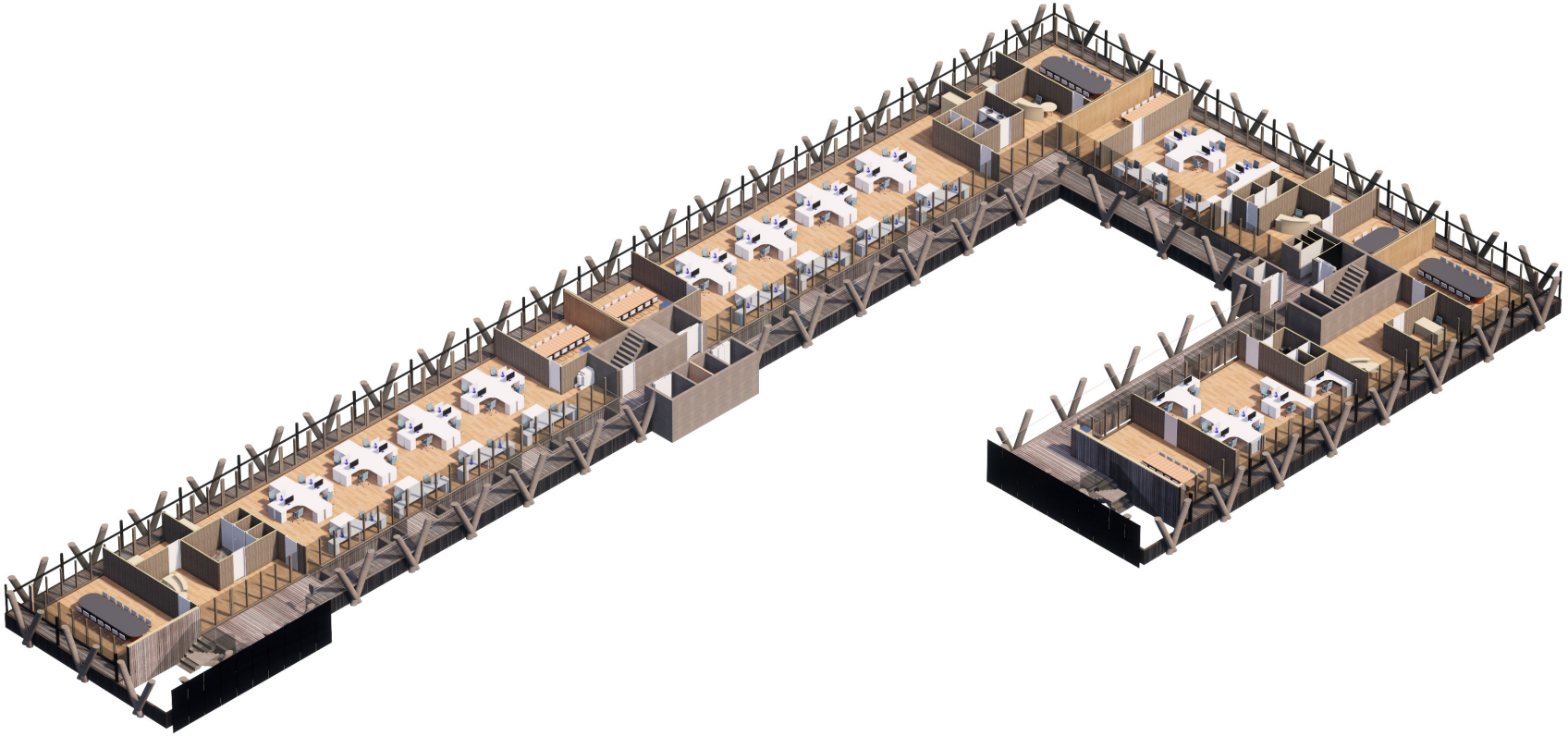
Alternative - Apartments for 2-3 persons



Alternative - Apartments for 2-3 persons



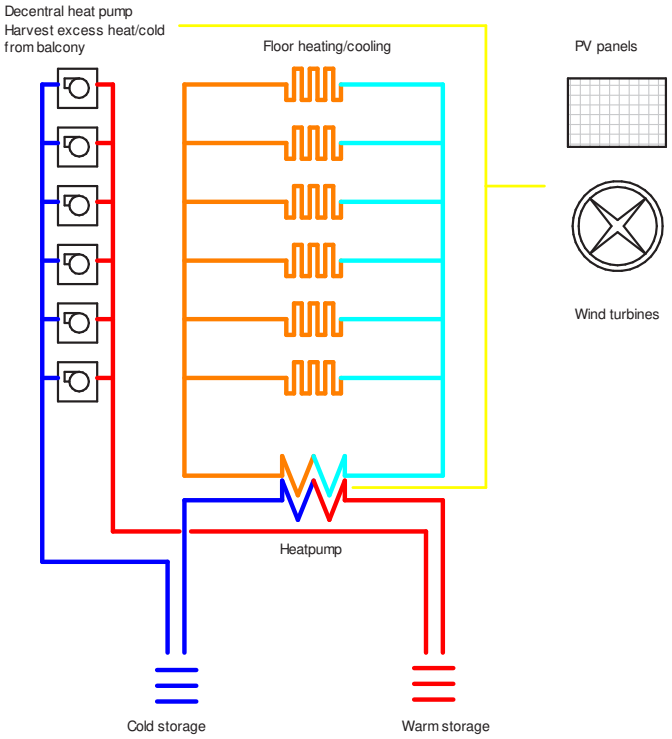
Alternative - Offices



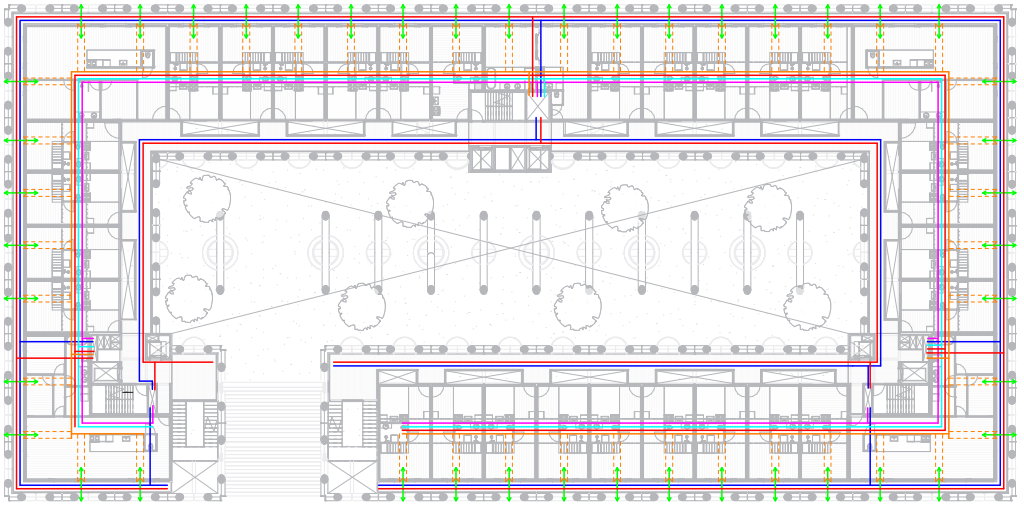
TECHNICAL DESIGN

Climate design

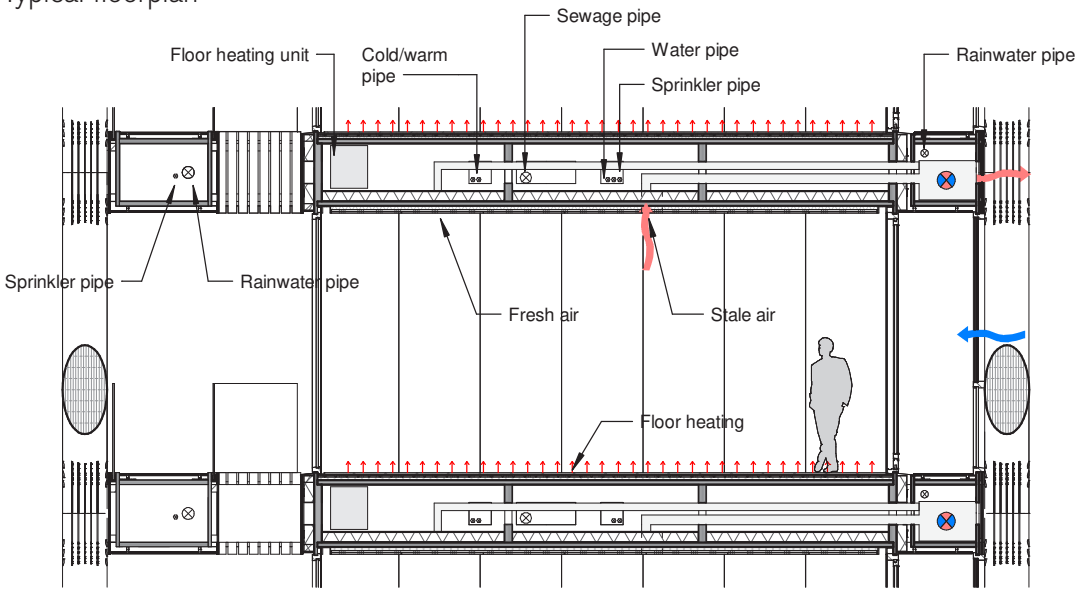
- Decentral ventilation
- Hot/cold storage



Climate schematic



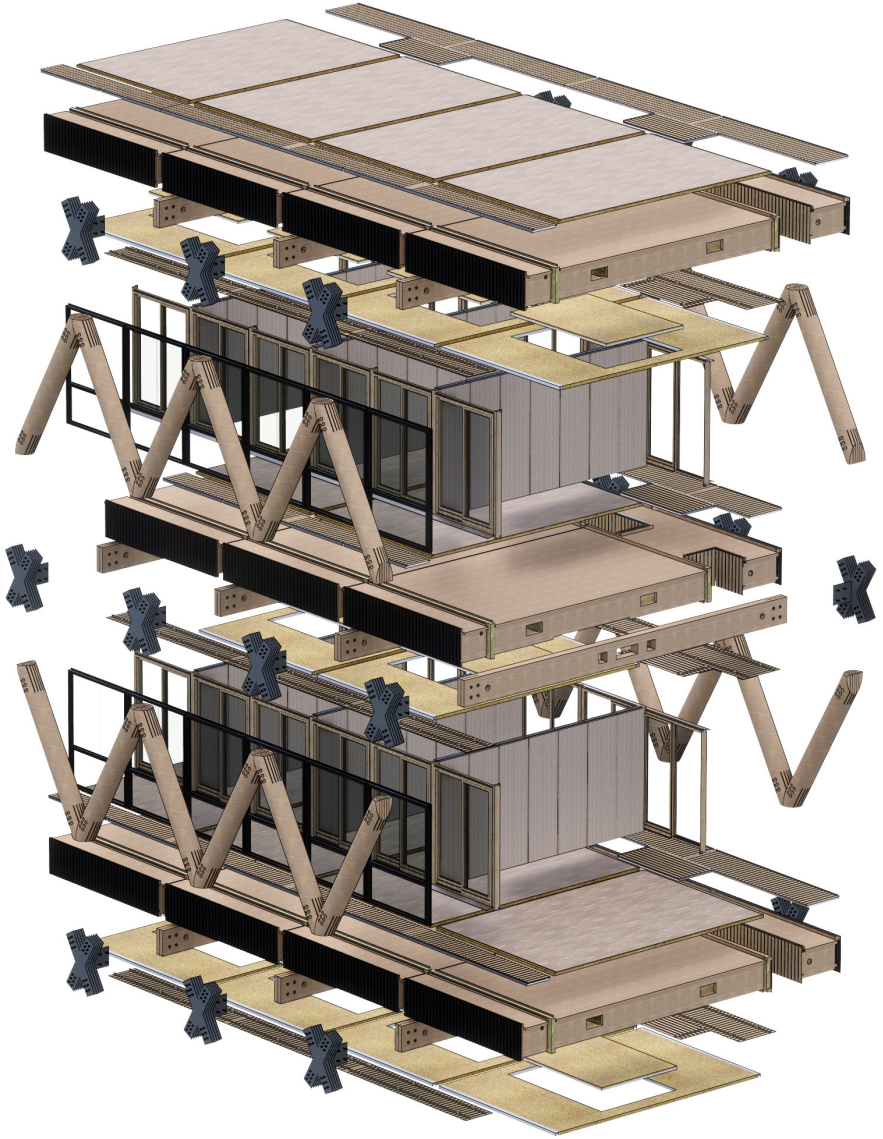
Typical floorplan



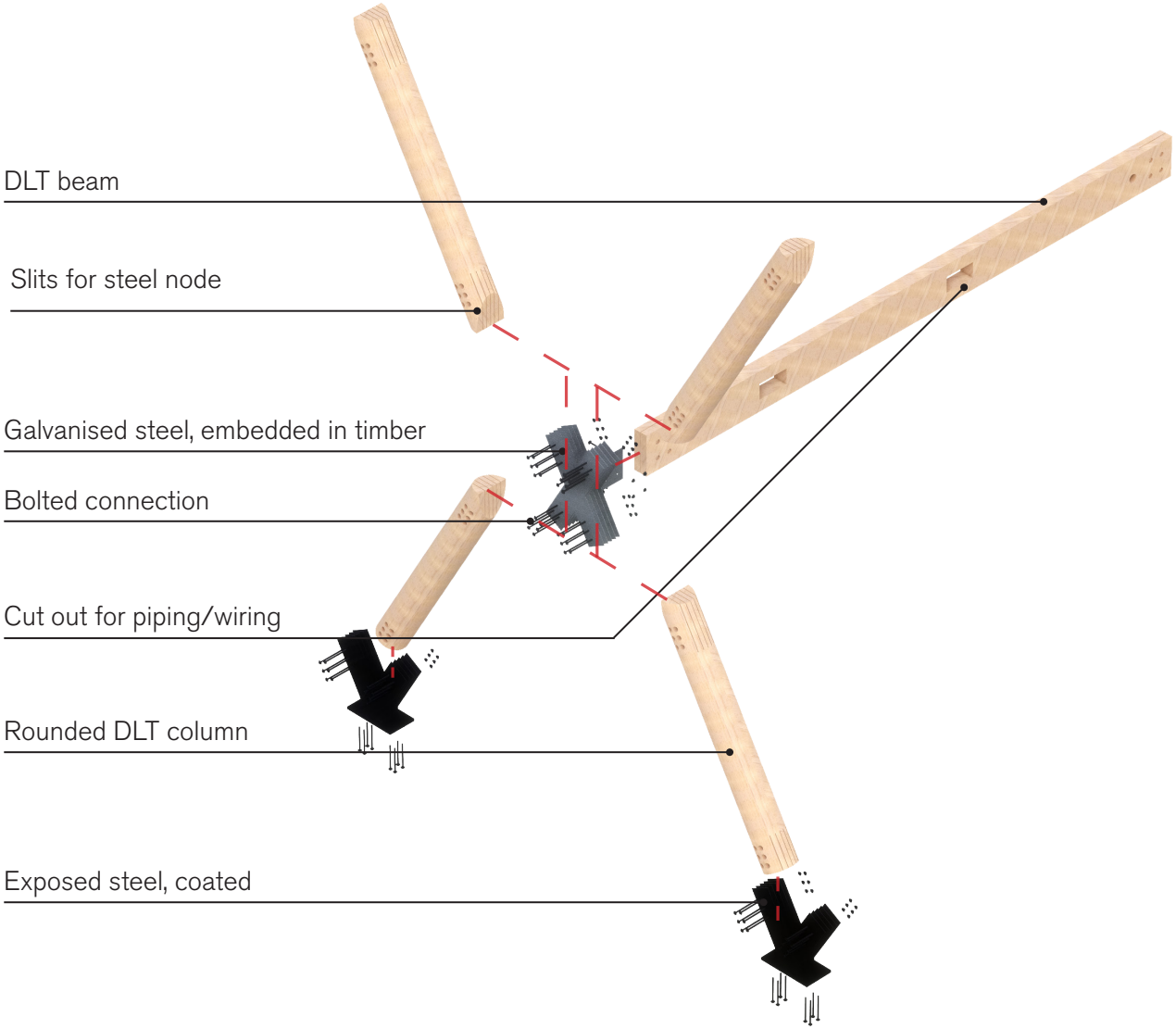
Typical section

Overview

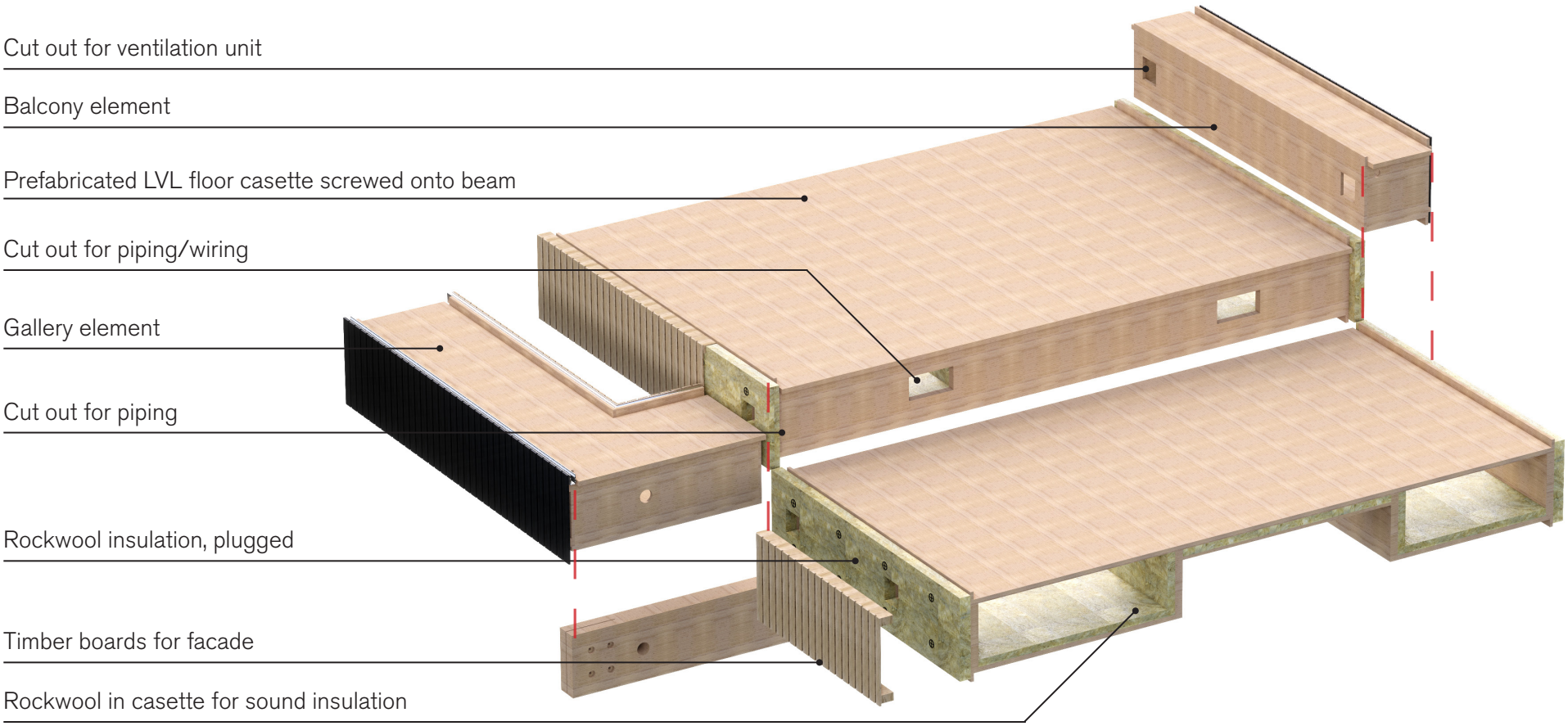
- Design for disassembly
- Fully recyclable materials:
  - Cork
  - Timber
  - Aluminium
  - Glass
  - Steel
- Elements:
  - Columns, beams and nodes
  - Floor and roof elements
  - Window frames
  - Walls, ceilings, floor finishing



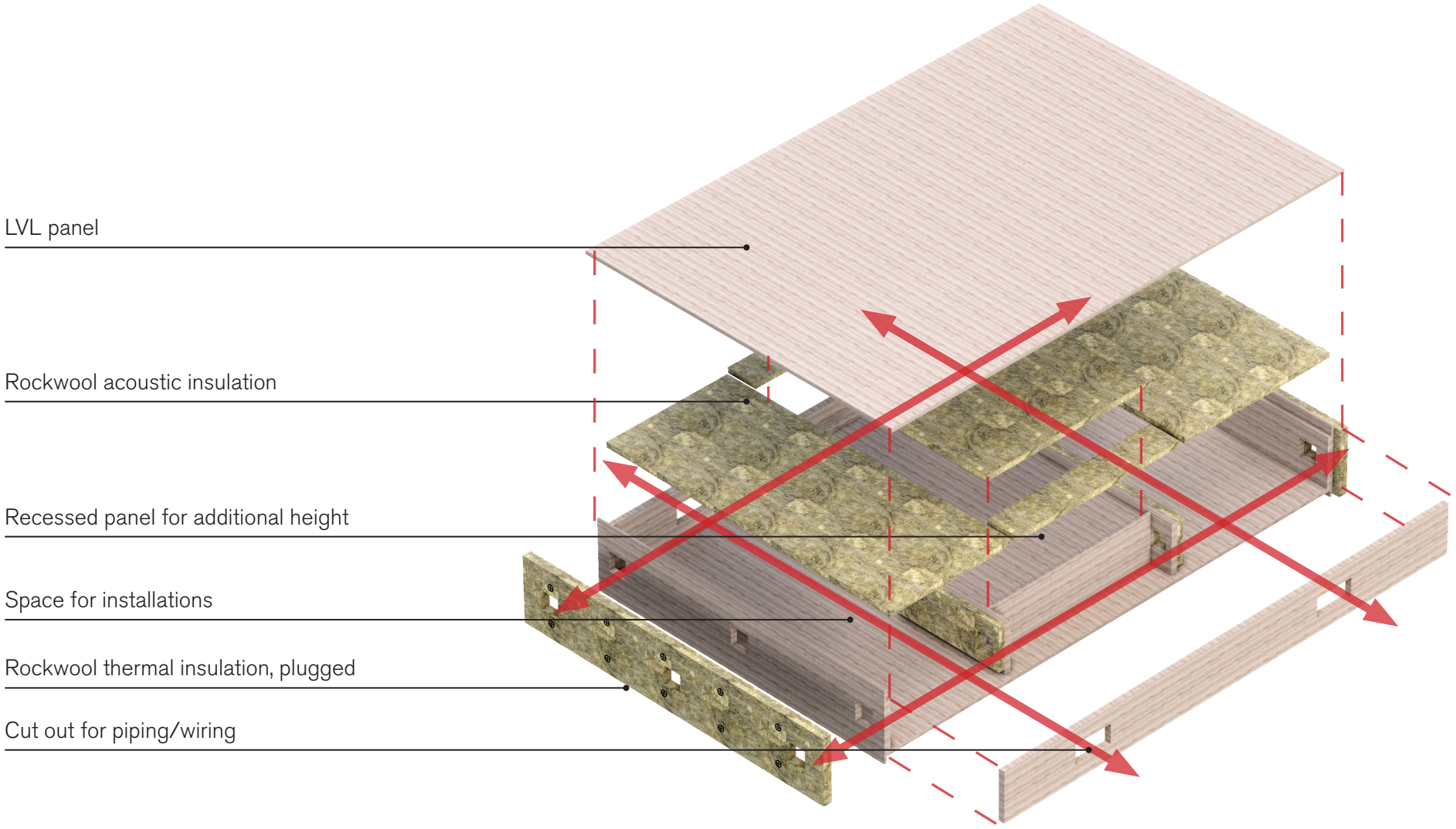
Columns, beams and nodes



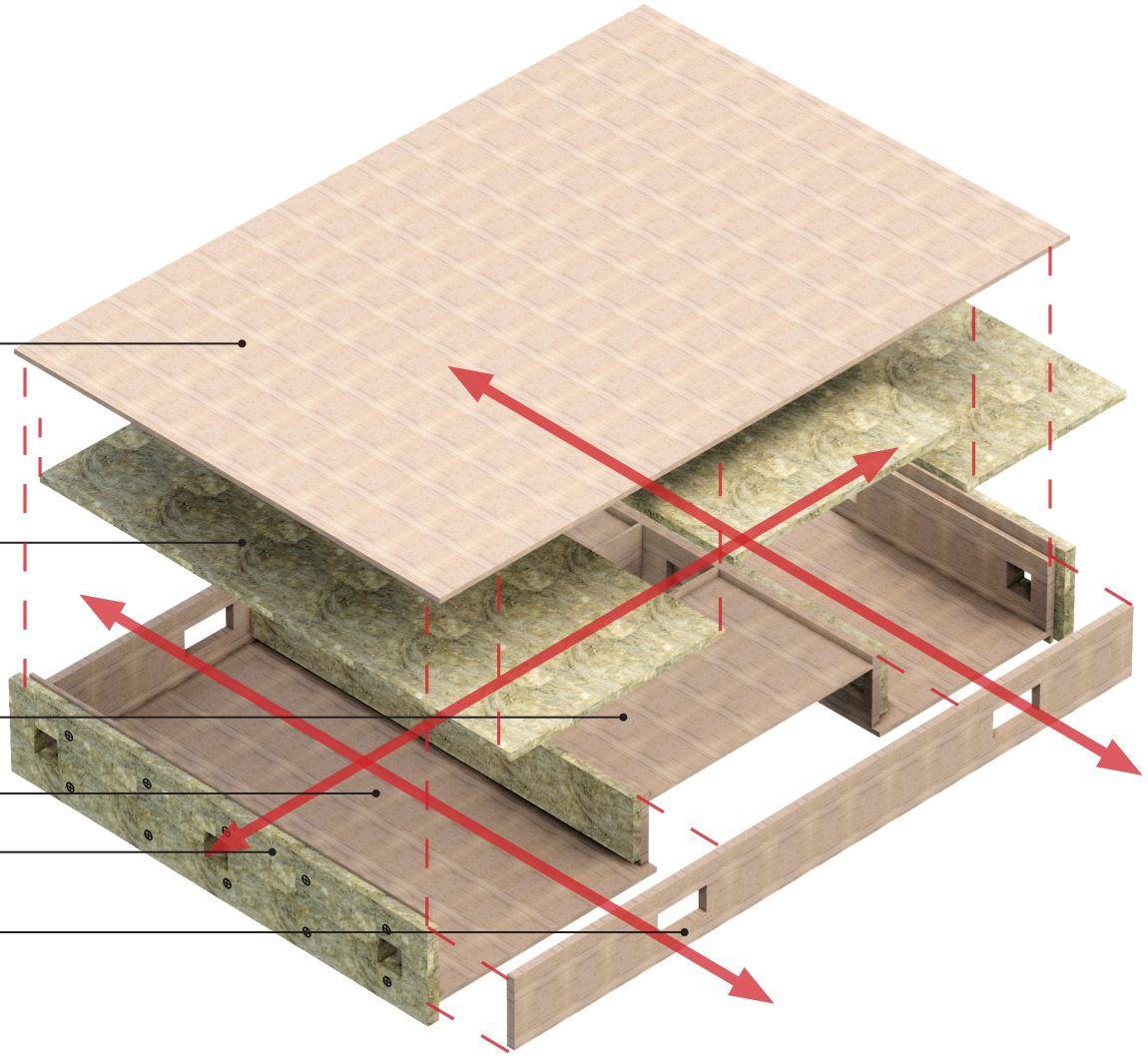
Floor elements



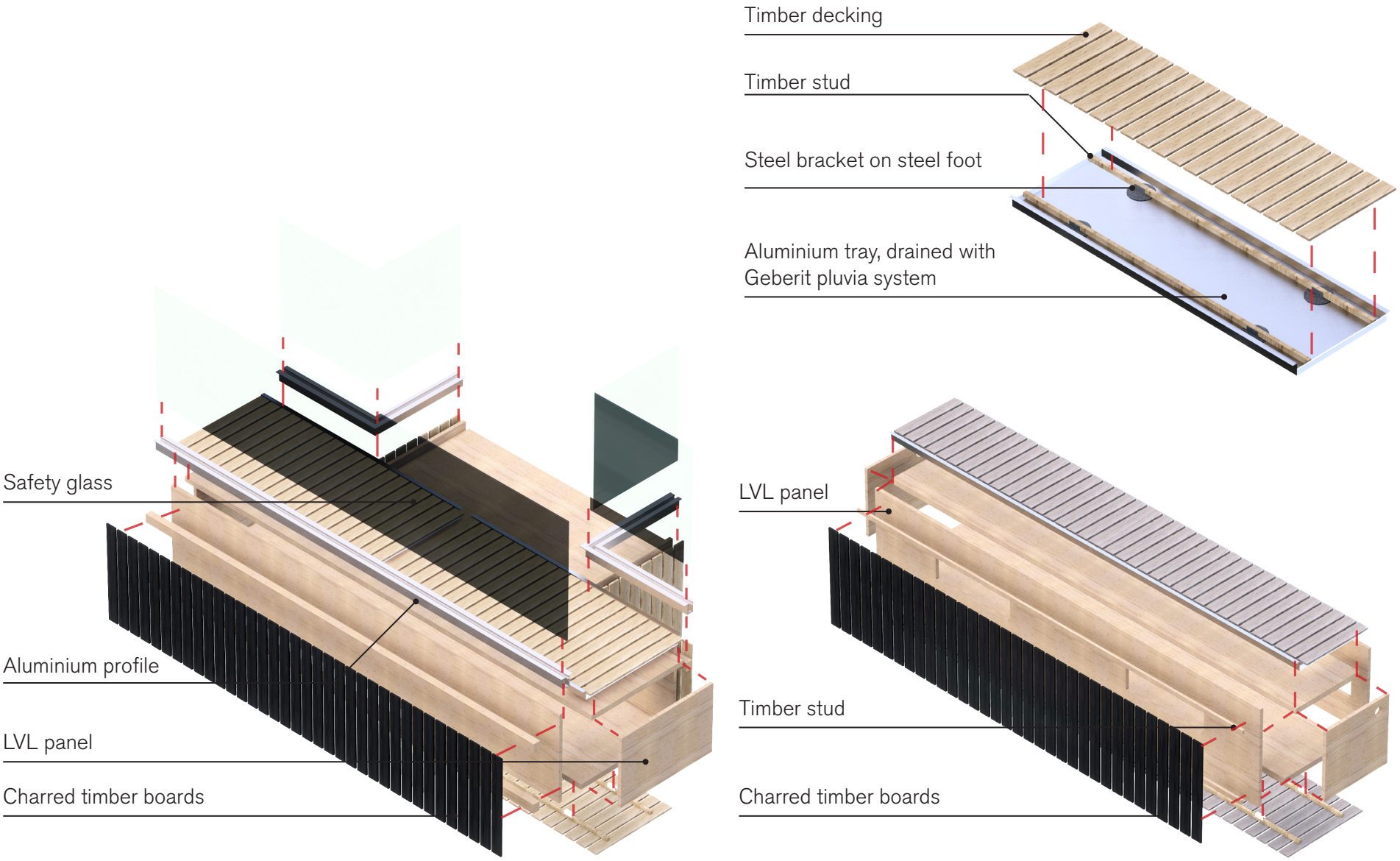
Floor elements



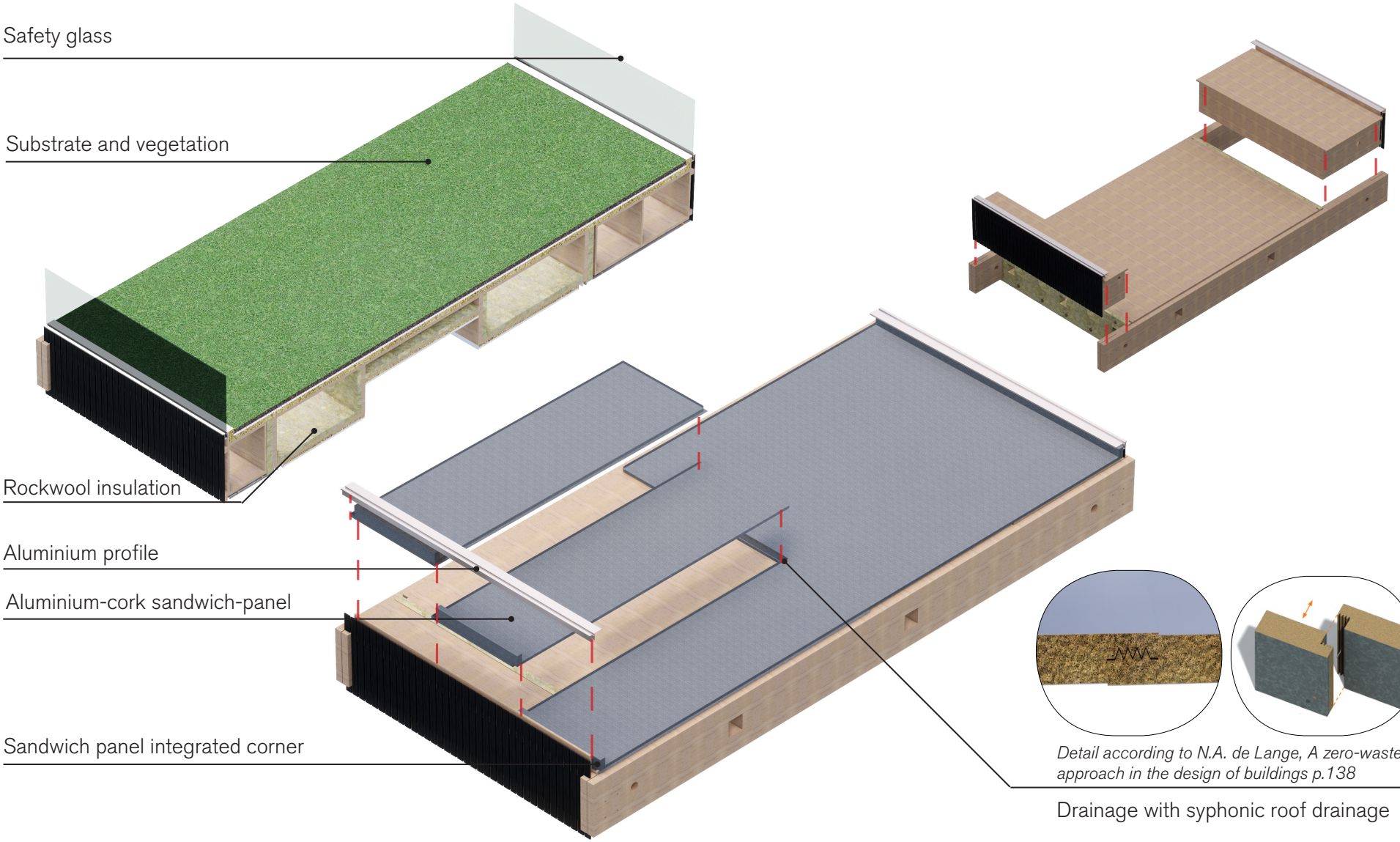
Floor elements



Balcony & Gallery element



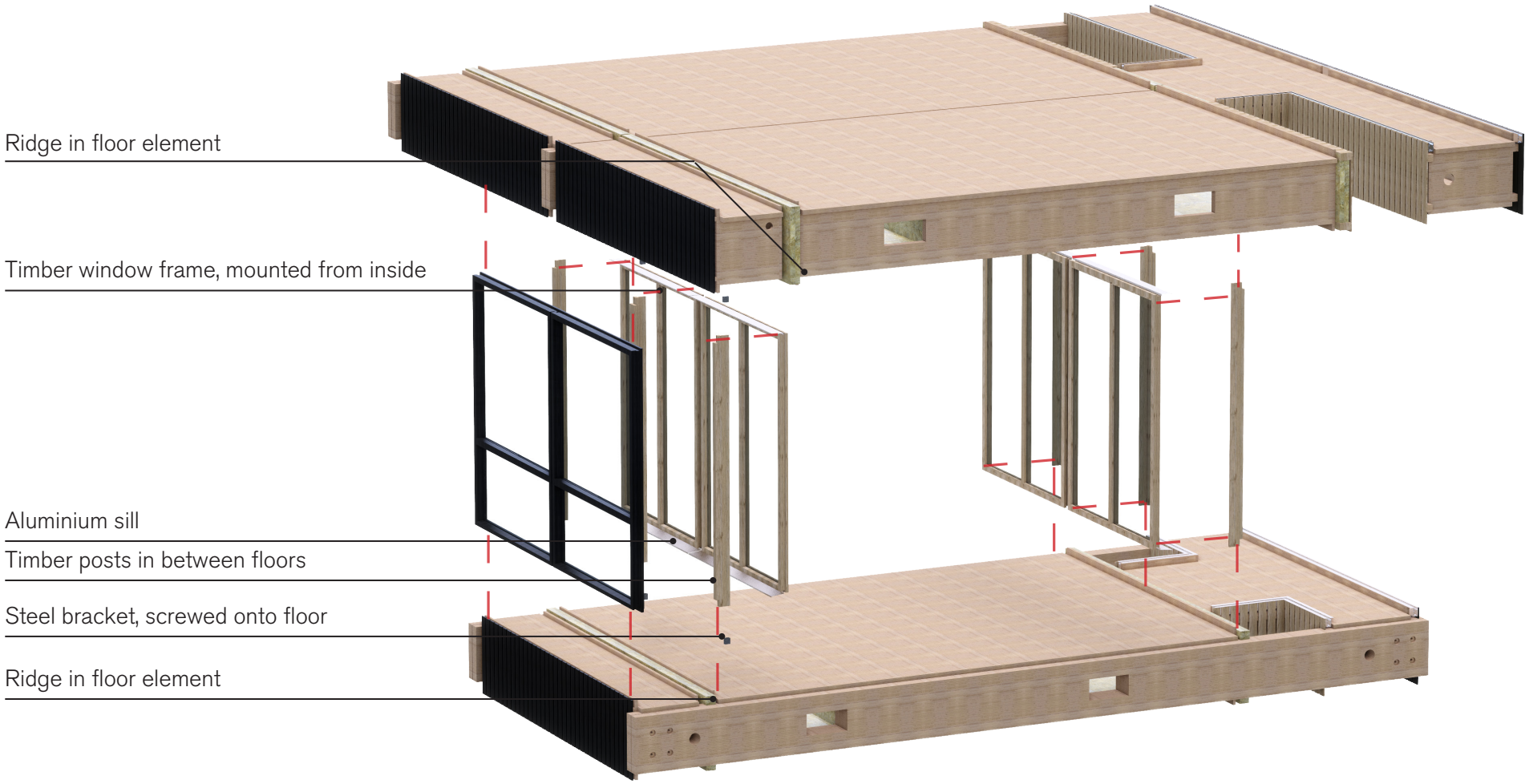
Roof elements



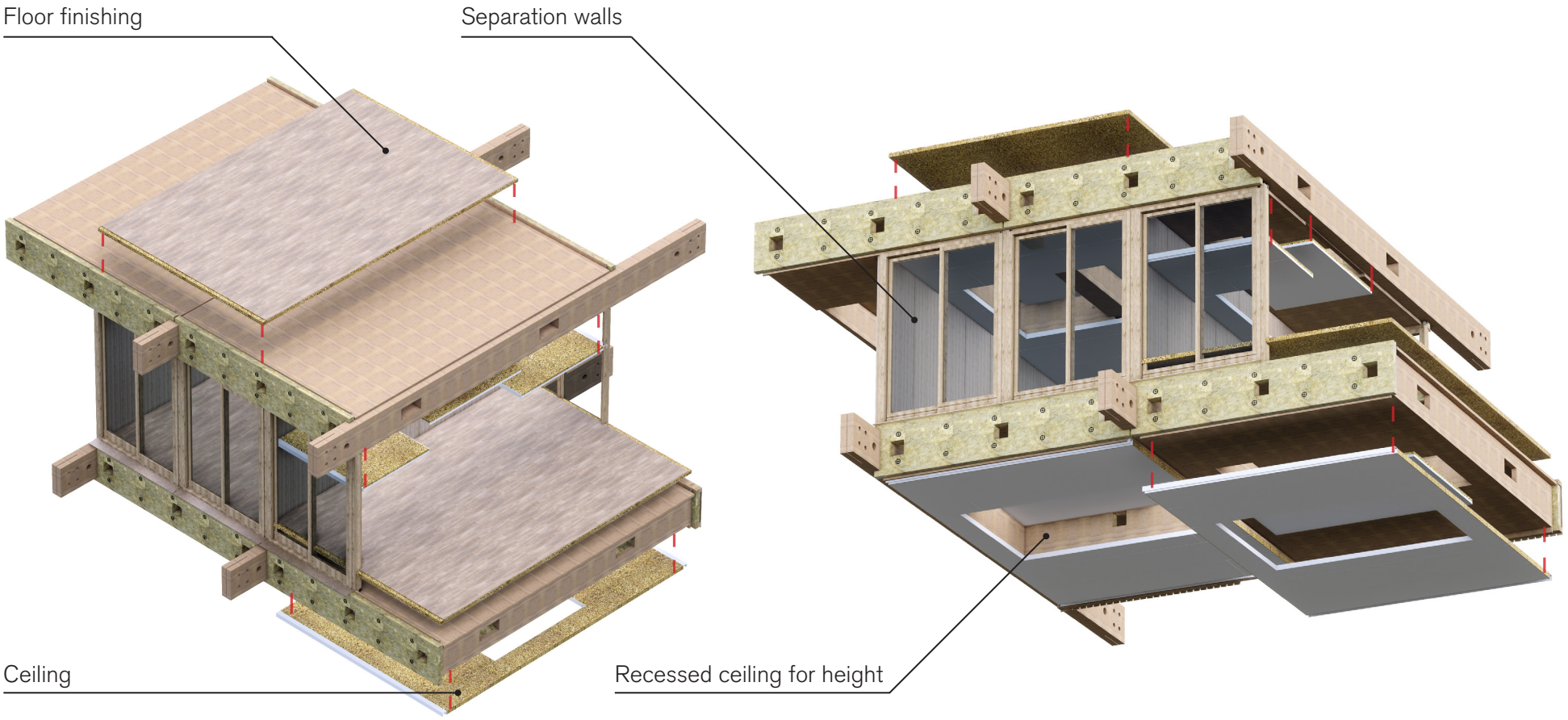
Detail according to N.A. de Lange, A zero-waste approach in the design of buildings p.138

Drainage with syphonic roof drainage

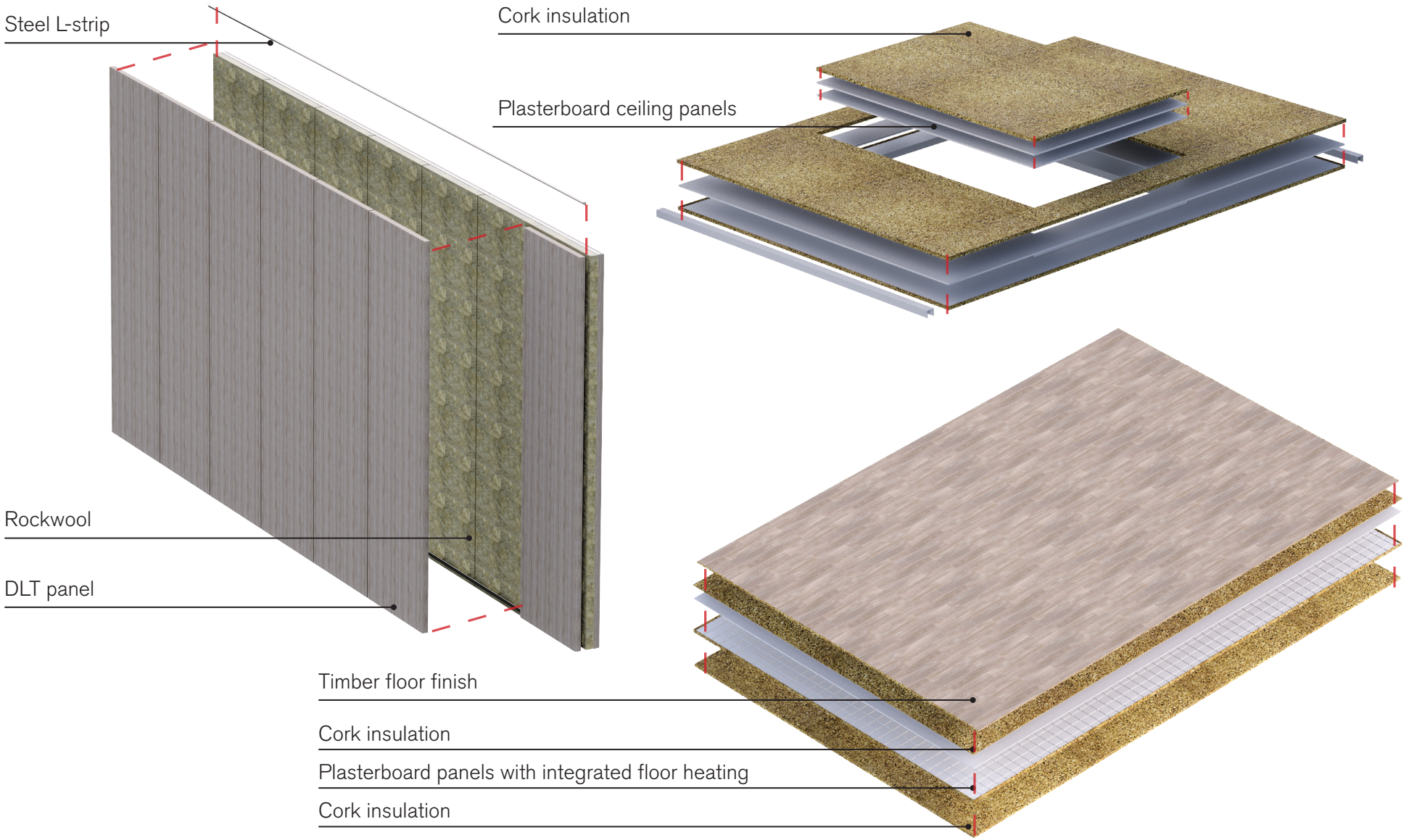
Window frames



Walls, ceilings, floor finishings



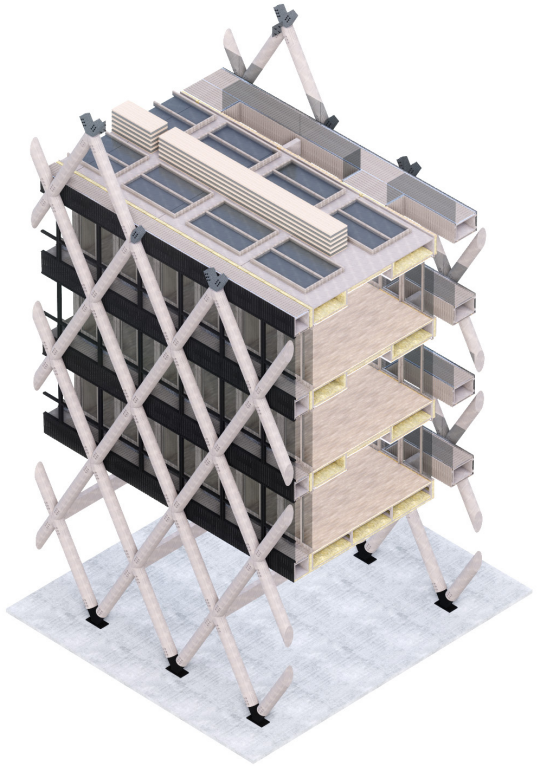
Walls, ceilings, floor finishings



Build order

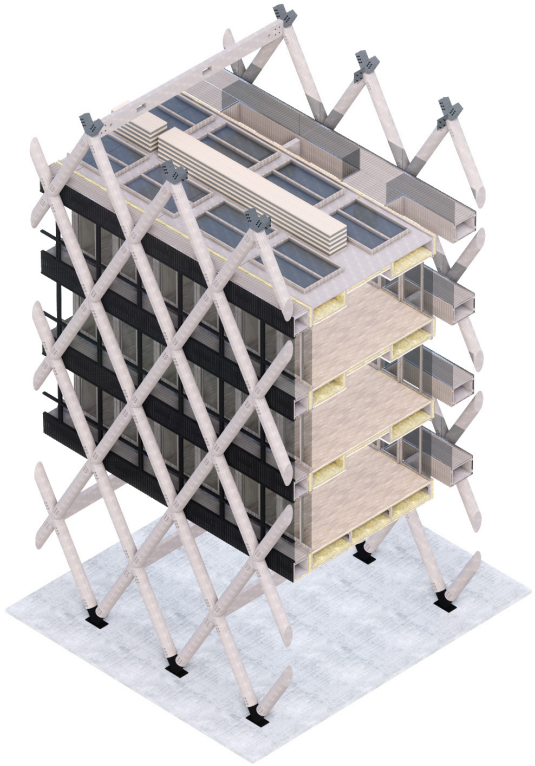
1.

Lifting wall elements and window elements to floor
Extend the diagrid with columns and nodes



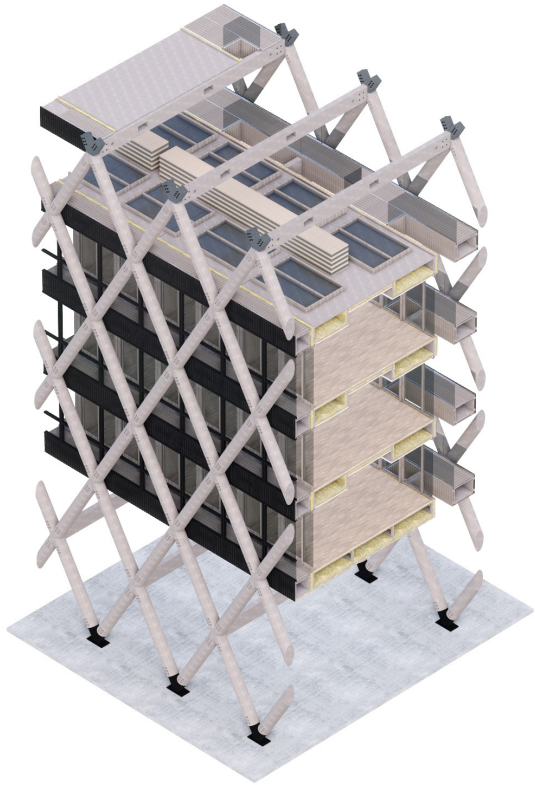
2.

Connect beams to nodes



3.

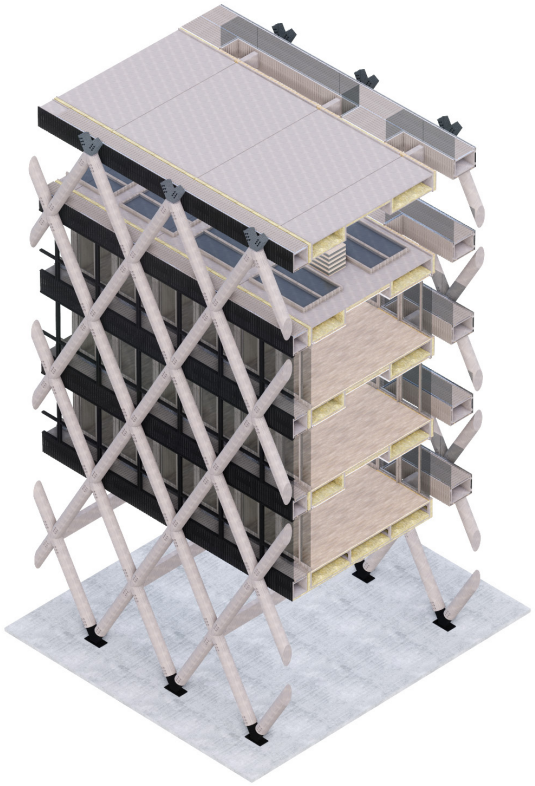
Lift floor elements onto beams



Build order

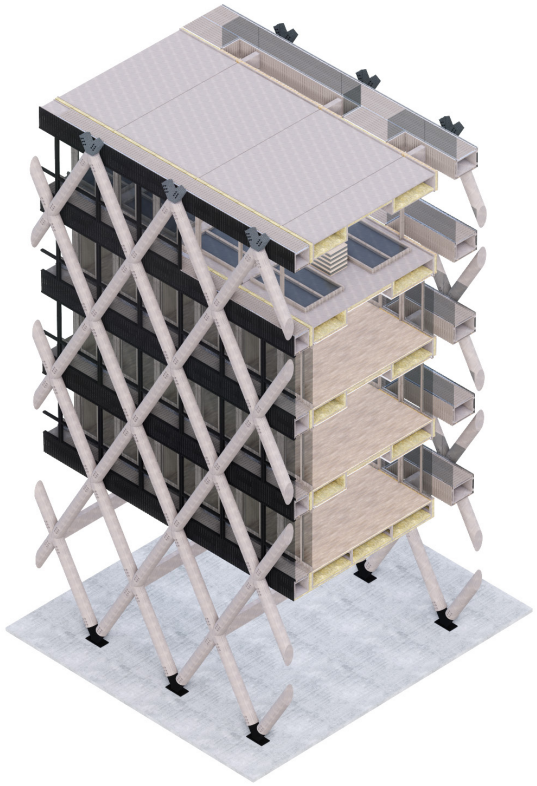
4.

Fasten all structural elements into position



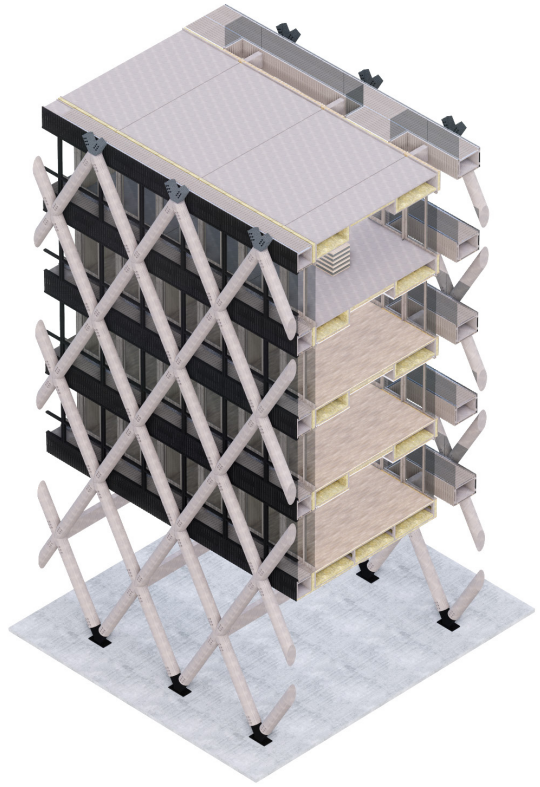
5.

Mount window frame supports and window frames



6.

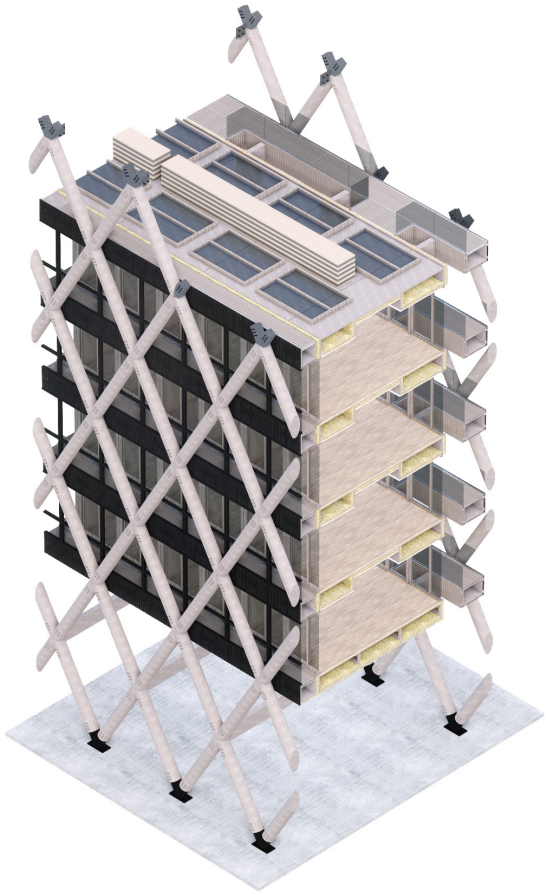
Fasten all window frames into position
Mount separation walls
Install floor and ceiling finishes



Build order

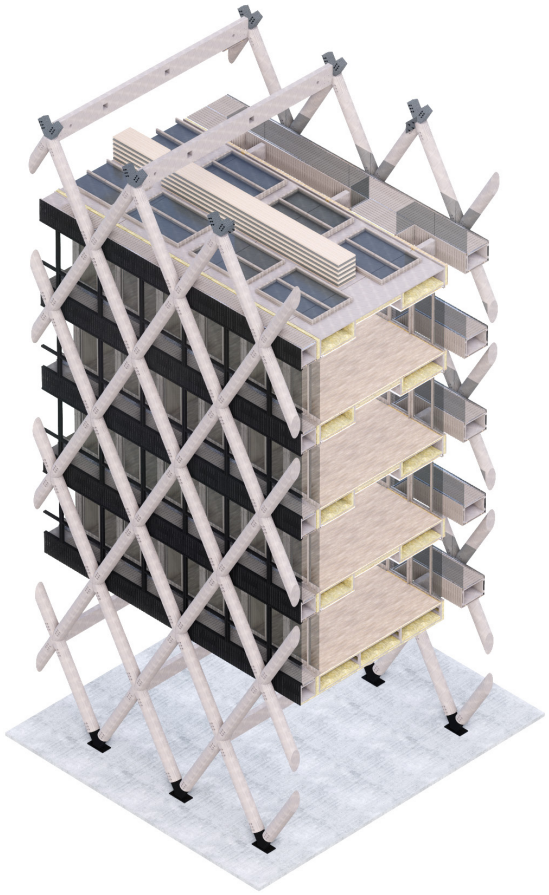
7.

Lifting wall elements and window elements to floor
Extend the diagrid with columns and nodes



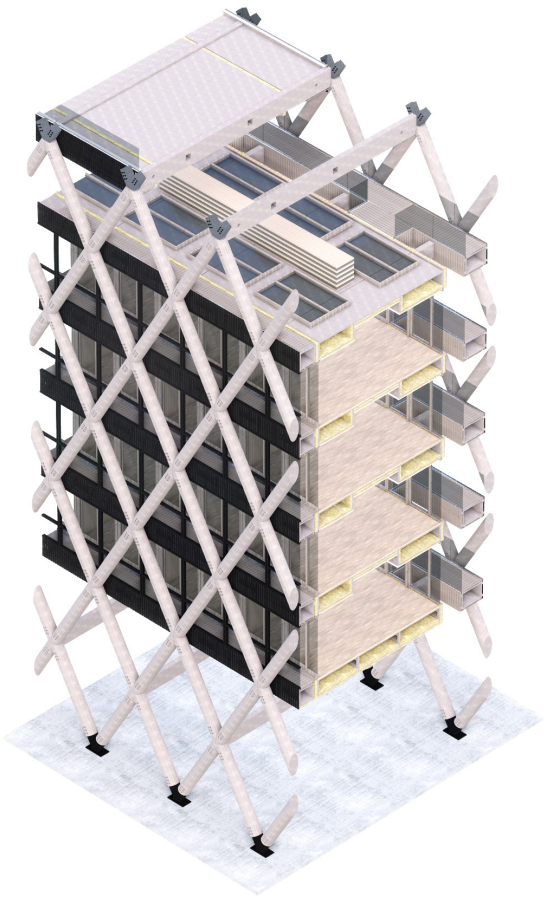
8.

Connect beams to nodes



9.

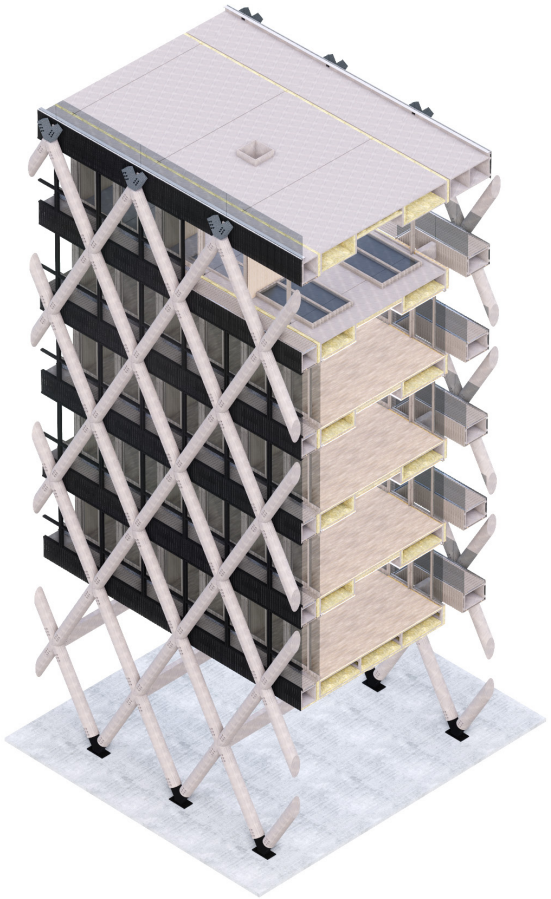
Lift floor elements onto beams



Build order

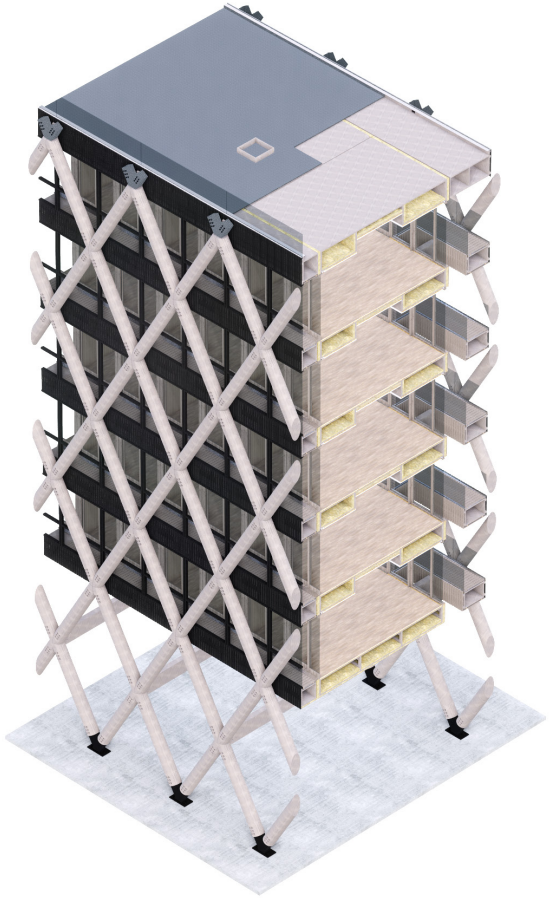
10.

Fasten all structural elements into position
Install window frames



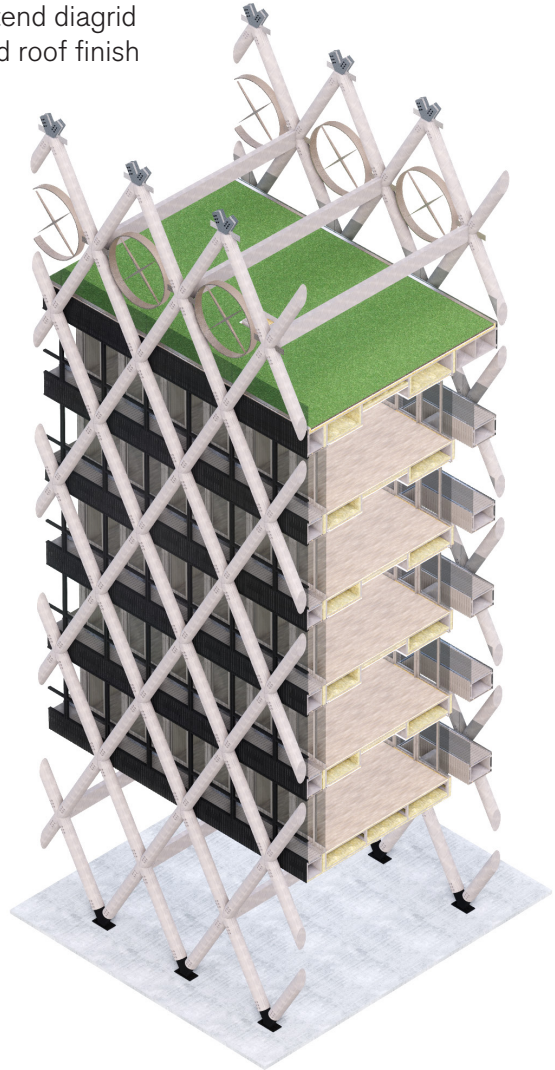
5.

Install roof elements



6.

Extend diagrid
Add roof finish



CONCLUSIONS

Conclusions - design

- The proposed design is not completely zero-waste
- Elements of the building can be reused and recycled
- The design increases floor space by a factor of 2
- Combination of increased density and public/collective spaces
- 7900 tonnes of CO2 stored in used timber

Conclusions - overall

- Mass-timber is a suitable material for extending existing buildings because of its lightweight properties
- These lightweight properties also provide structural challenges in high-rises
  - Prevent tipping over by spreading loads over a relative large footprint
  - Reduction of wind loads can provide architectural opportunities in the design
- Zero-waste design requires thoughtful design of all elements and materials

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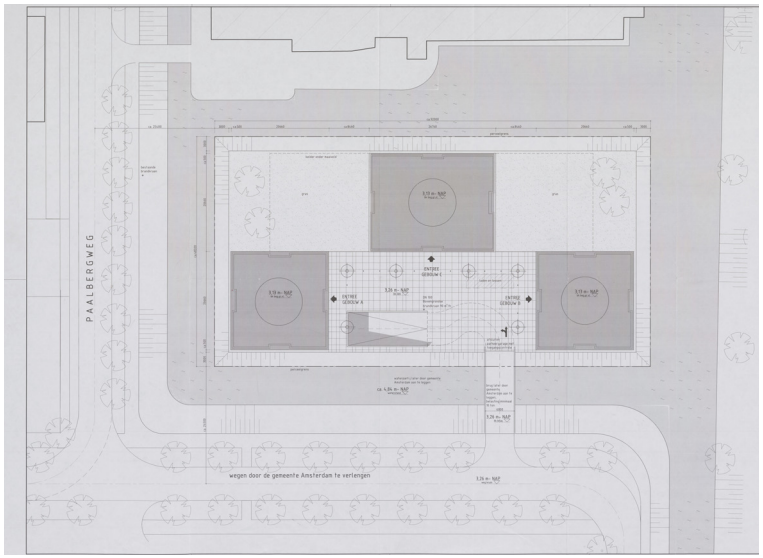
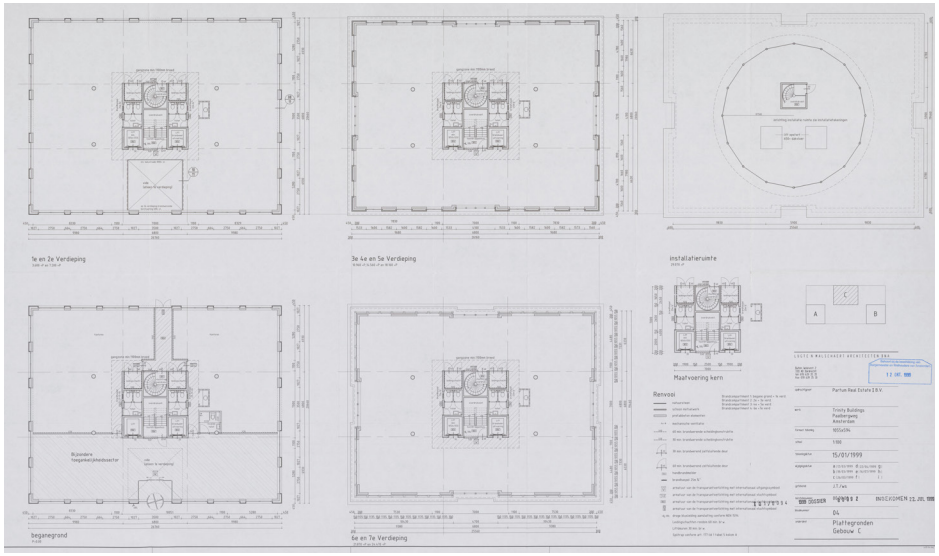
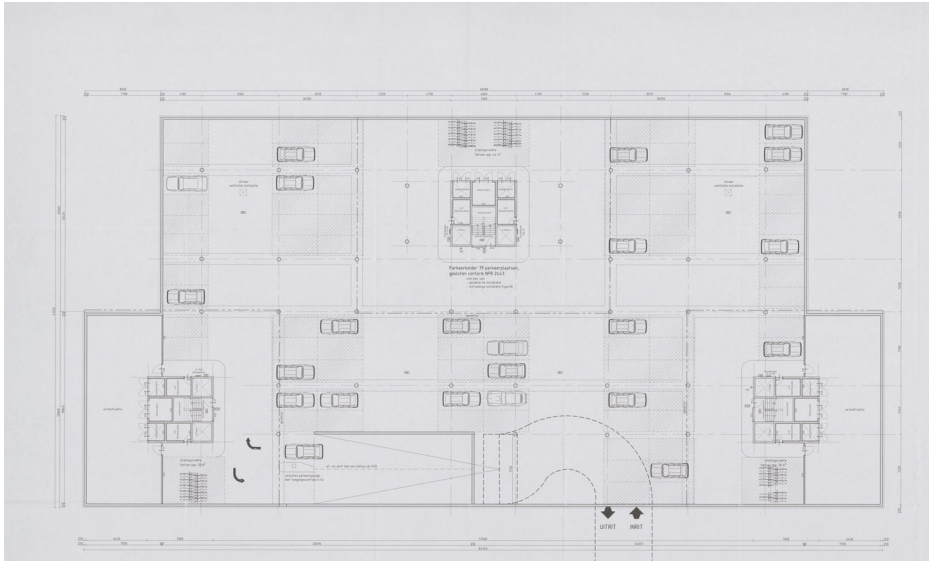


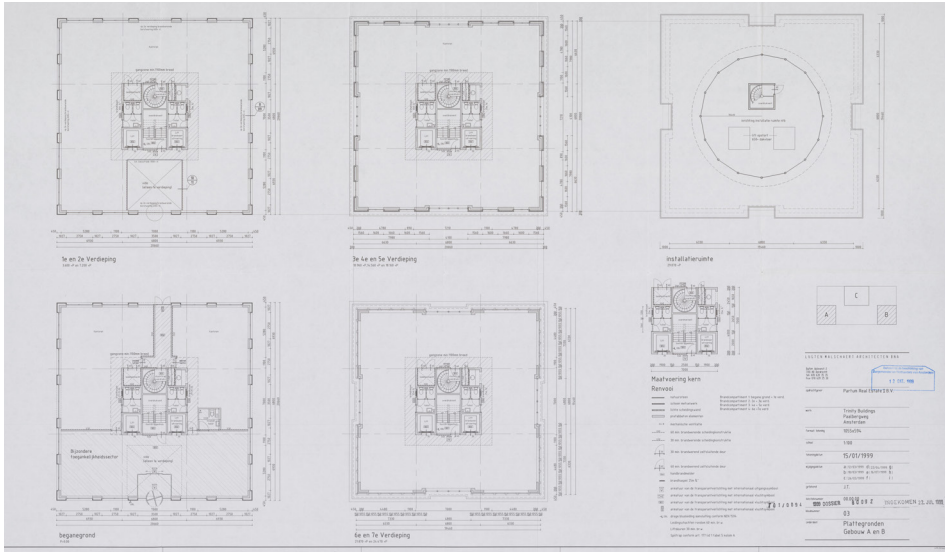
Site



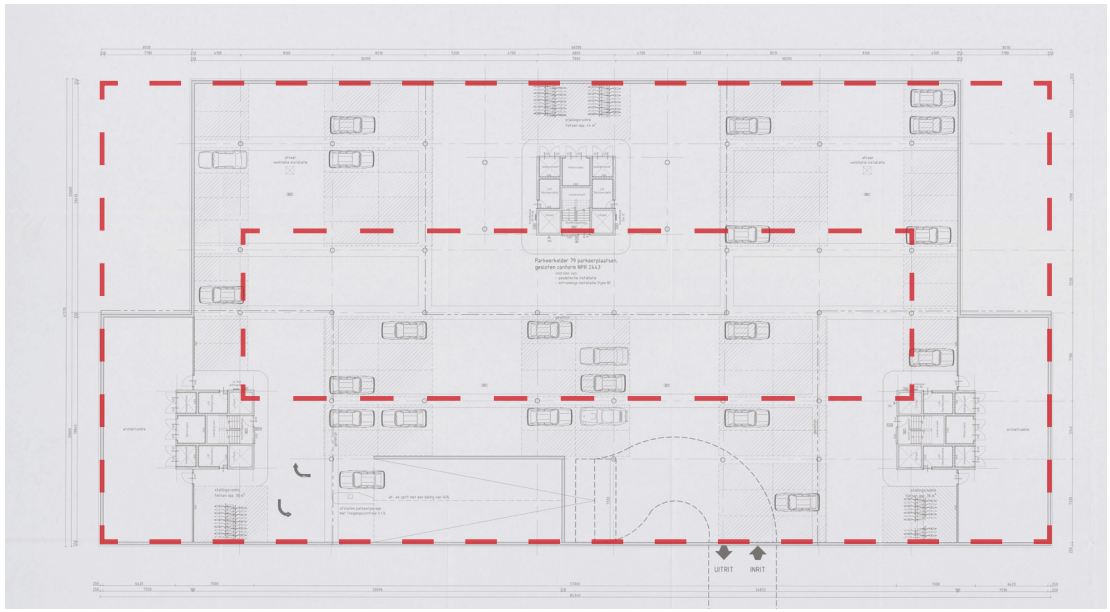
Tower C



Basement



Towers A&B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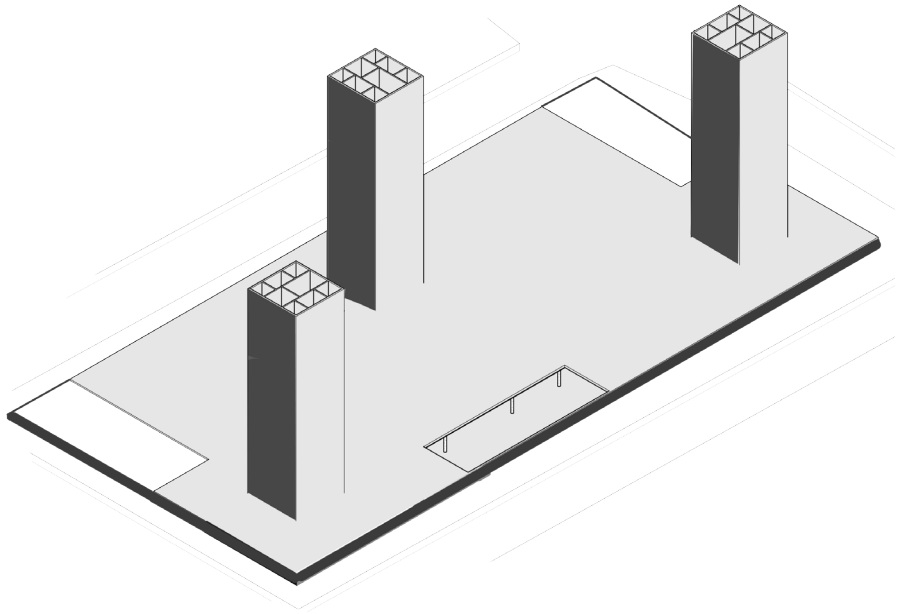

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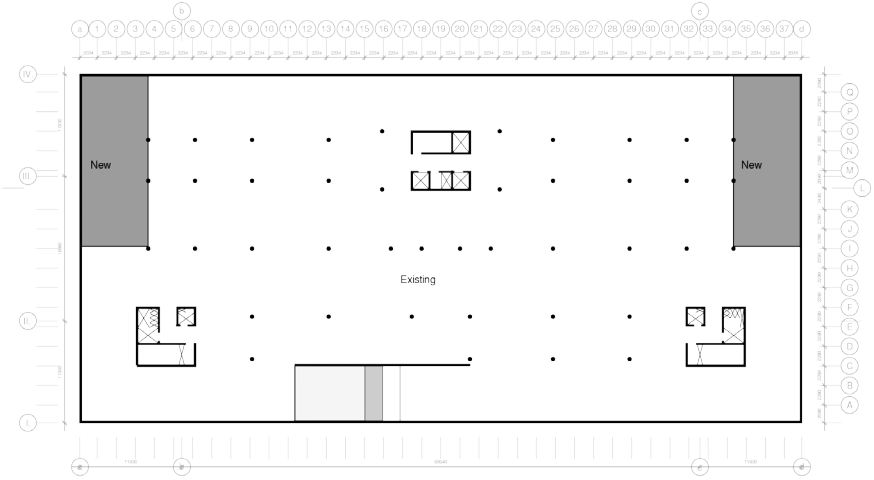
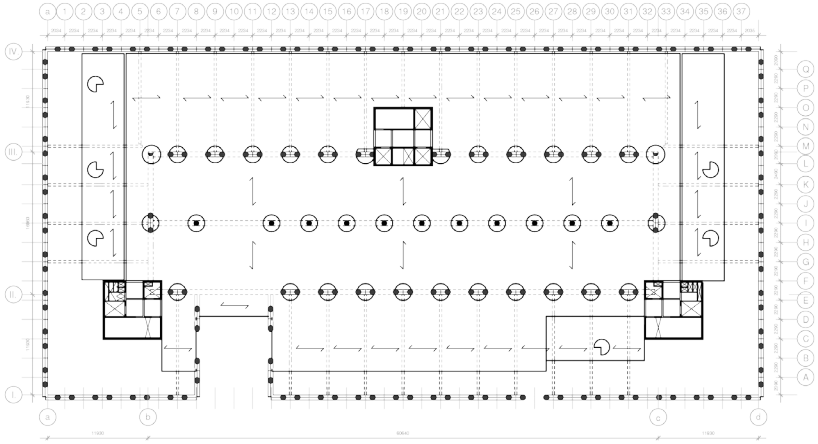
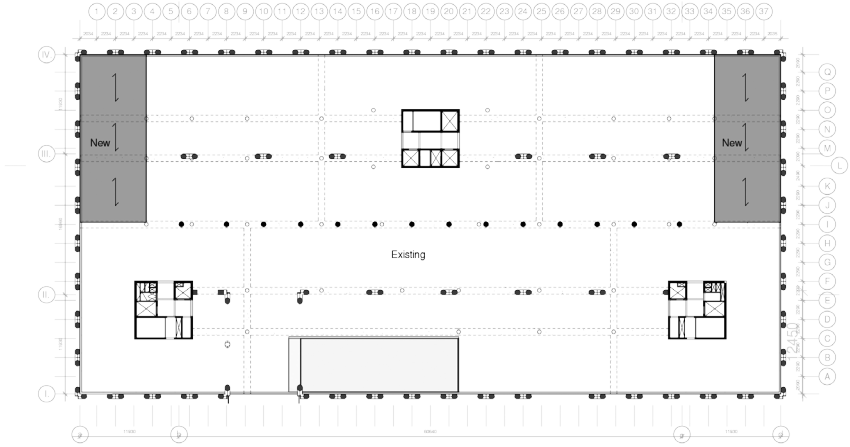


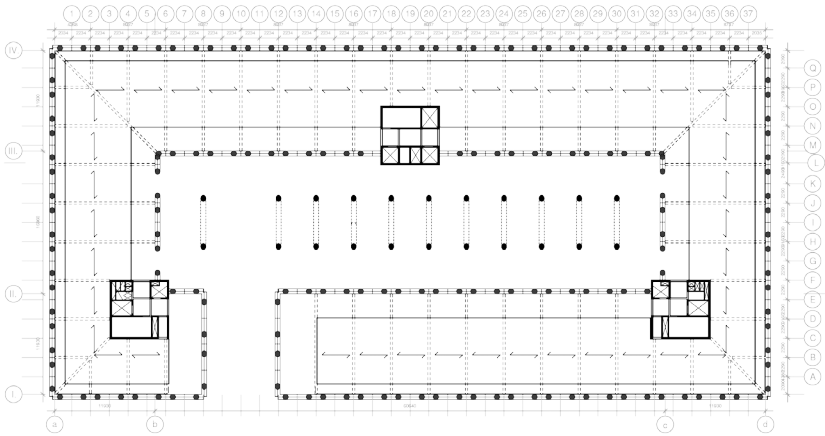
First floor



Ground level



Second floor



Reference buildings

79&park - BIG Architects

8 house - BIG Architects

The whale - Architekten Cie.

Via57 - BIG Architects

432 Park Avenue - Rafael Vinoly
& SLCE Architects