# MATERIAL LAB

## MUIDE MEULESTEDE - MATERIAL&WASTE

Climate Design &
Sustainability

KULeuven - Department Architecture
2021
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## TEAM & CONTENT

### 1. TEAM

- Achet Walling - Urban Councilor
- Yasemin Okumuş
- Ekin Başkentli
- Emre Seyran
- Jiefei Ma

### 2. FUNCTION

- Material Production
    - production spaces
    - material storage
    - office

- Education Facilities
    - material school
    - learning spaces
    - library
    - individual working space
    - meeting spaces
    - multi-purpose areas

- Workshop
    - atelier/ studio
    - labs

- Accomodation
    - housing units
    - sport facilities
    - shared spaces

### 3. BASIC DATA

| | |
|---|---|
| - Inhabitants | app. 700 |
| - Apartments | 480 |
| - Production zone | 7000 $m^2$ |
| - Shared/flexible space | 6000 $m^2$ |
| - Housing area | 16 800 $m^2$ |
| - Train stops | 1 |

## INDEX

## GENERAL OVERVIEW

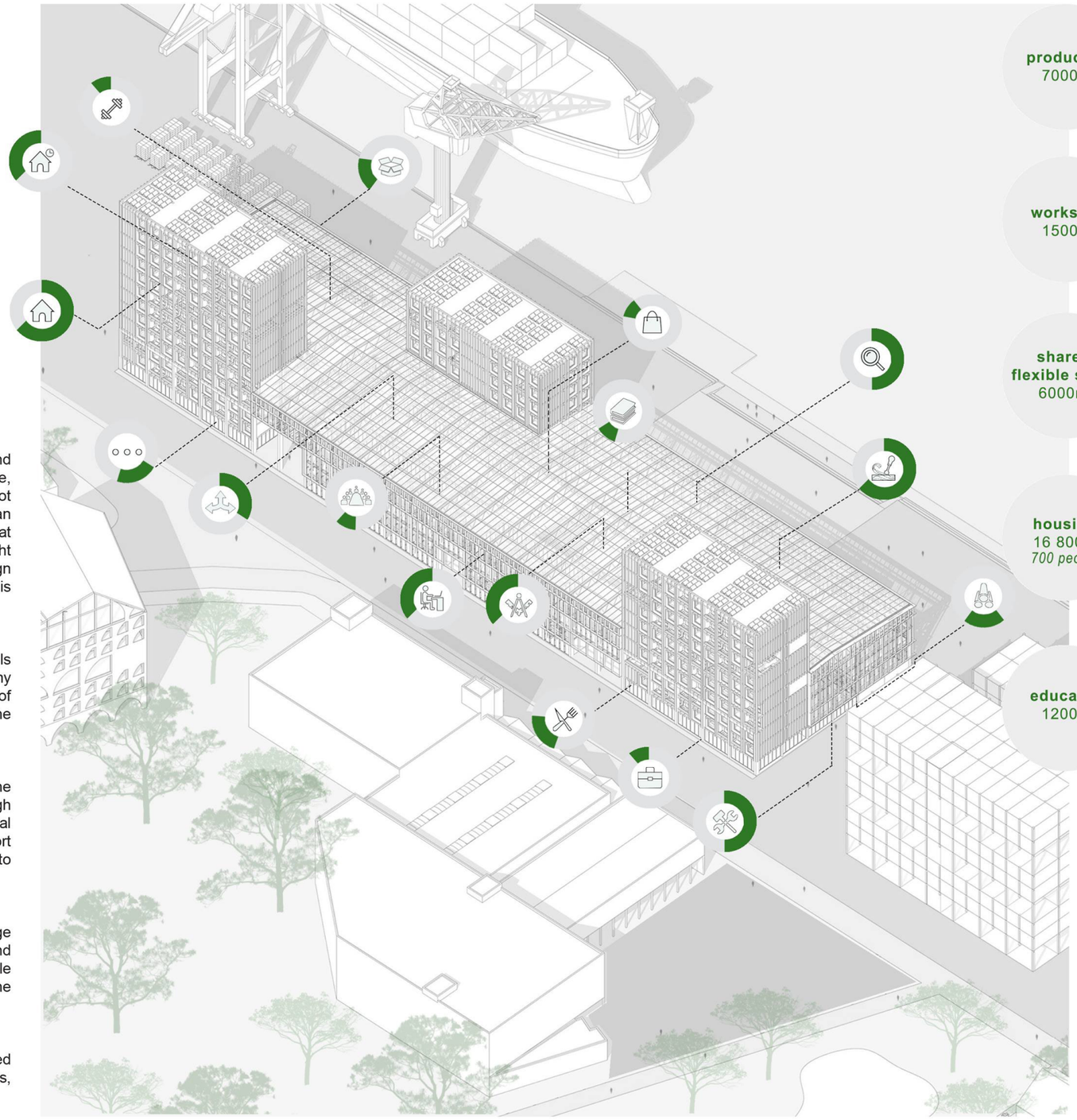
It can be claimed that terms as “sustainable”, “circular” and “resilient” re-shape and affect the world of architecture, urbanism and landscape in the 21st century. While a lot of cities are redesigned within these concepts, as an architects of future cities, we have a responsibility of that transformation to be archived in its best way. In the light of these concepts and the with support of Climate Design and Sustainability course the project of “Material Lab” is developed by Material&Waste Group.

Having main concerns as exploring sustainable materials and ways of using them, contribute to the circular economy of the village and the city and support zero waste policy of the village, we are designing two buildings located in the industrial neighborhood of the Gent city.

As a Material&Waste group we forsee the future of the village constructed from only sustainable, local and high performance materials. Having concentrated on material cycles, we aimed to propose materials that will support the short-chain economy in the village and contribute to the material and waste flows in Gent.

We foresee Material Lab project as well as Material Village in a continuous process of production, construction and consumption. So, we proposed the design that is flexible and open for various transformations and changes in the future.

Lastly, we aimed to develop Material Lab project based on three main concepts; sustainable and local materials, short chain economy and positive waste.



**production** 7000m²
- production spaces **50%**
- material library **20%**
- storage **20%**
- office **10%**

**workshop** 1500m²
- atelier / studio **70%**
- labs **30%**

**shared/ flexible space** 6000m²
- multi-functional spaces **40%**
- other facilities **20%**
- cafe / food-spaces **20%**
- shopping spaces **10%**
- sport facilities **10%**

**housing** 16 800m² *700 people*
- permanent accomodation **70%**
- temporary accomodation **30%**

**education** 1200m²
- learning spaces **50%**
- library **10%**
- individual working spaces **30%**
- meeting spaces **10%**

## OUR AMBITIONS

The aim of the “material and waste” group is to explore sustainable local materials and the way of use them. We aimed to contribute to the circular and local economy both on village and city scale.

We see the village as a whole and we propose material and waste design management that is supported by various disciplines of the village. In other word, our aim is to colloborate with other teams to design a sustainable village.

We envision 2040 in a process with three different phases; pre-construction phase, construction of the village, production/living/working stage.

## 4 RULES

### 1. SHORT CHAIN MODEL

Designing a sustainable business model and infrastructure in building material production and consumption on site.

### 2. SUSTAINABLE LOCAL MATERIALS

All materials that will be used on-site for construction should be local and sustainable. We propose wood-based, earth-based, fiber-based materials and existing site materials to be used in the village construction.

Wood-based: GLT, CLT
Earth-based: Rammed earth
Fiber-based: Hempcrete, mycellium and hemp insulation, straw
Existing materials: Concrete, steel, brick, metal sheets

### 3. POSITIVE WASTE

To make the village a positive waste area, all waste generated on-site goes under a short-chain reuse cycle. The mycelium from agricultural waste, bricks, and earth from construction waste will be used in our village to support the positive waste idea.

### 4. DESIGN FOR DISASSEMBLY

To support sustainability during the construction we should maximize the reusability by the strategy of dissembling in which we are going to use screws and bolts instead of glue and sealers.


## SYSTEM OF THE MATERIAL VILLAGE

Our village system is based on a cycle comprising of four primary sectors namely construction, accomodation, business, education. Each sector has its own cycle which contributes the system loop that we are creating.

We wanted to design a way of life in this village that the material becomes a central part of the whole ecosystem by facilitating the production of materials in the warehouses in Gent, and also designing a short-chain cycle model to make our own materials.

We created four cycles in order to shape sustainability concept as well as to support circular economy. These four cycles are connected to and depend on each other.

With the need to establish a sustainable and circular approach for materials production, infrastructure construction, management, and the way of life in this village which will transcend economic social and environmental considerations. We introduce the educational aspect to this village, while keeping material as the central core in our education. It will be used to work on material research, production, and to share knowledge of sustainable living, working with materials, and a sustainable way of learning to the community. Our economy based on the renting system of the accommodation units as well as the renting system of the materials we are producing on our site.

**MATERIAL CONCEPT**

We envision Material Village to be constructed from only sustainable, local and high performance materials. Production of these materials will support the short-chain economy in the village as well as contribute to material and waste flows in the city.

At the first stage of the design we explored existing structures, elements and materials on the site and define what will be protected, reused, recycled or removed.

After a wide research on materials within their cycles, we prepared a material list for the whole village that is consist of sustainable and local materials. So during this phase we concentrated on questions: which? (materials, products), why? (material cycles, characteristics) and how? (...to produce, to deliver, to reuse).

We are designing our spaces in relation to the full cycle of materials' life by thinking about their production, use, and disposal. Warehouse is the place for re-manufacturing, assembling/disassembling and storing of the materials. Circulation in the project is shaped by both human and material movements.

Workshop spaces contribute to the development of materials and their engagement with people.

Although for some existing materials which have no specific function or second life scenario, these materials will be stored in our material library after being recycled or repaired in Material Lab and can be used by residents of the village.

*material lab warehouse and waterfront area*

## THE SITE & THE CITY

Muide-Meulestede located on the north of Ghent city. The district that is stretched between the city center and the harbor.

Material Village sited in the heart of the district. The village is surrounded by water from the west side, and the east side which serves for heavy goods transportation. It can be said that, warehouses, the canal and wide range of raw materials are main elements of the site while residences, offices and shops, which are mostly located on the west part of the village, are secondary elements.

Material Lab project is mainly consist of two buildings; the concrete warehouse that has direct connection with the canal and located in the north east of the village and the old brick building with warehouse additions that is facing central green space of the village and main warehouse.

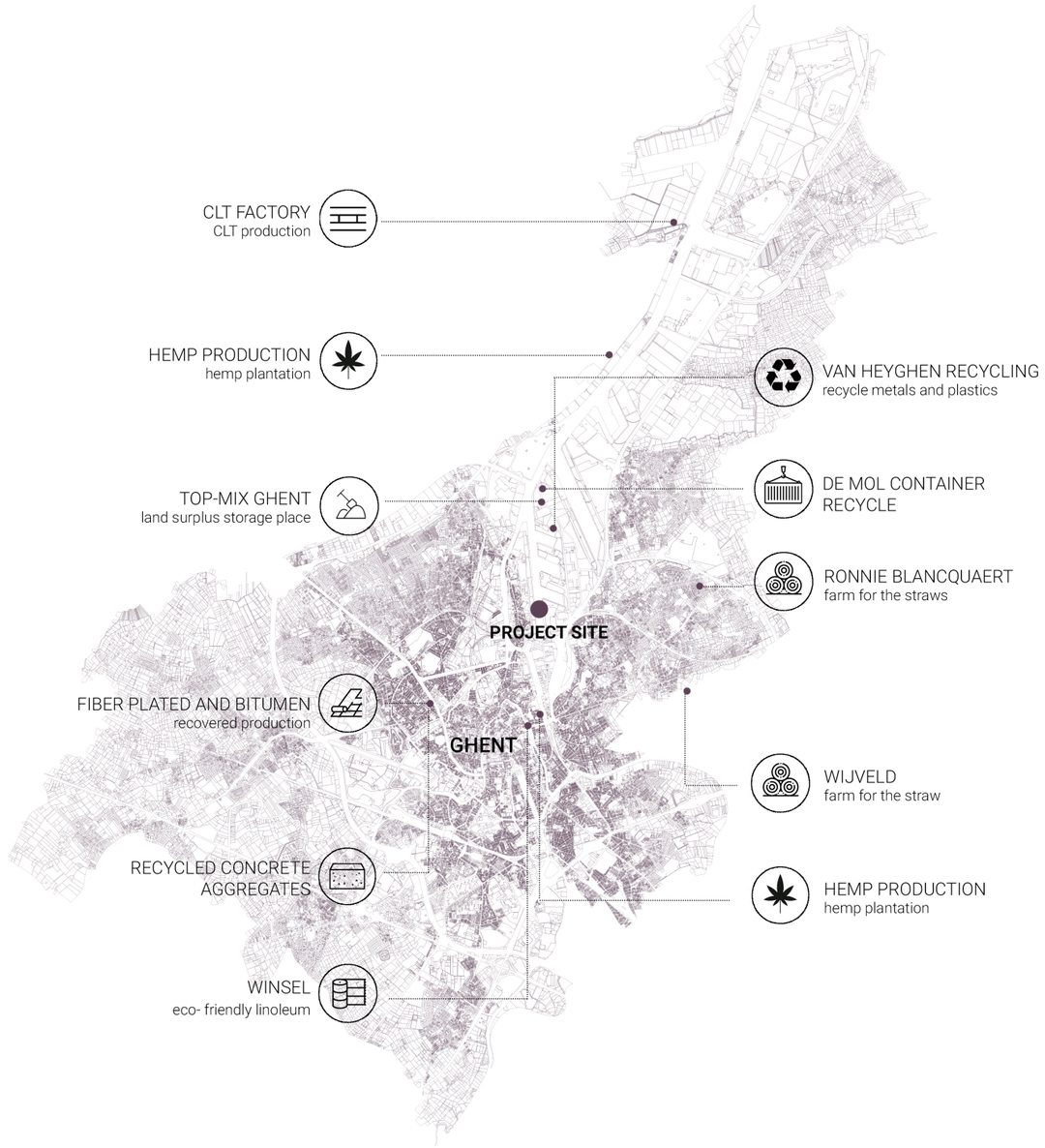

## GHENT MATERIAL SUPPLY MAPPING

Ghent city has a rich material production network. As a material team we explored wide range of materials and their production sites.

While our aim is to maintain the short chain economy by closing material cycles in the vllage, we perceive city material network as a supportive supply system.

The mapping shows material production network in the city of Ghent.

We export wood-based materials via the canal by taking the advantage of being in the harbour area. In order to contribute to the existing network, we export materials that are produced in the village as as hempcrete, mycellium and hemp insulation to the city trough the canal and railway.

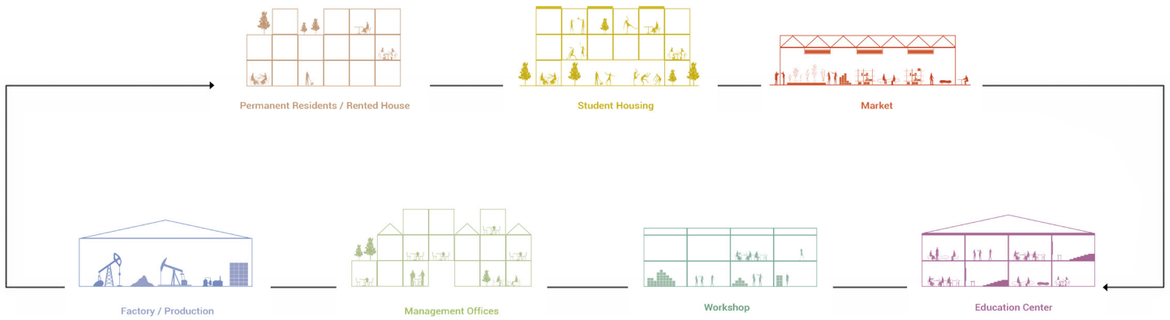


## INFRASTRUCTURE SYSTEM FOR MATERIAL VILLAGE

In developing a community-based living environment with the concept of a sustainable village in Meulestede, we wanted to establish an ecosystem where all aspects are co-dependent and mutually beneficial across people, the resources they provide each other creates the very essence of our village.

The village requires several social infrastructures in order to create a working society which includes education center, workshop, management offices, production spaces, market, and housings for temporary and permanent use.

As a material team of the material village, we established this integrated network system since we aim to strengthen the commons of the community. This infrastructure system provides jobs and livelihood to the people of the village while it also encourages a collective vision of living.



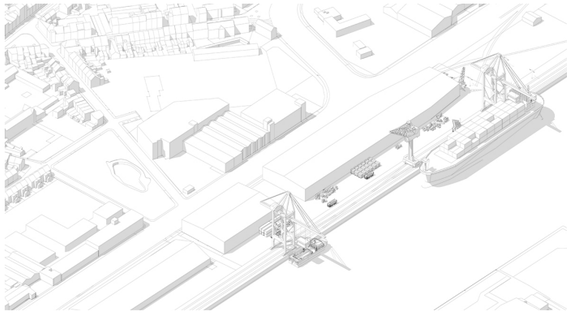

***short-chain economy:*** it is a business model which supports local production and aims to close the material life cycles inside of the specific site.

## PROJECT PHASES

**1st phase** pre-construction-storage

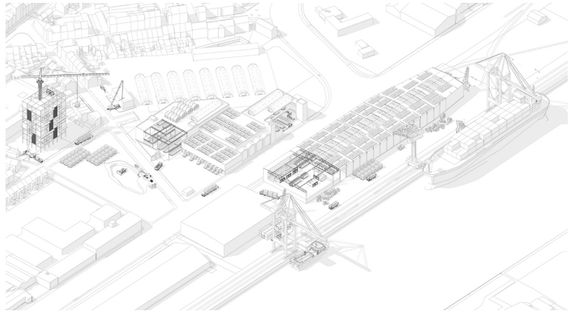
During the first phase, as part of the adaptive use initiative, we will be using the existing buildings and warehouse with additional retrofitting, change of materials for the building other than the structure.

The function of the space at this phase will be for storage of materials forged from the site as well as additional materials from outside.



**2nd phase** village construction

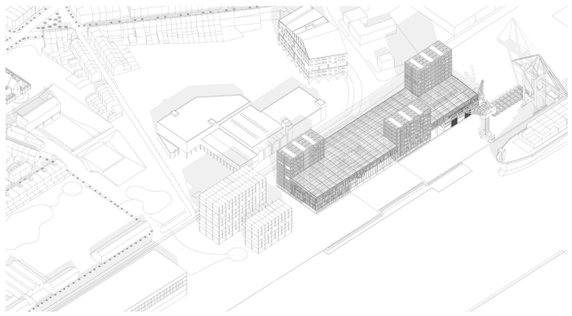
During the second phase, parts of the buildings will be developed into workshops with specific programs needed to make materials on site. Materials are processed, assembled and transported to the site for construction. This process will continue until the whole village is constructed.



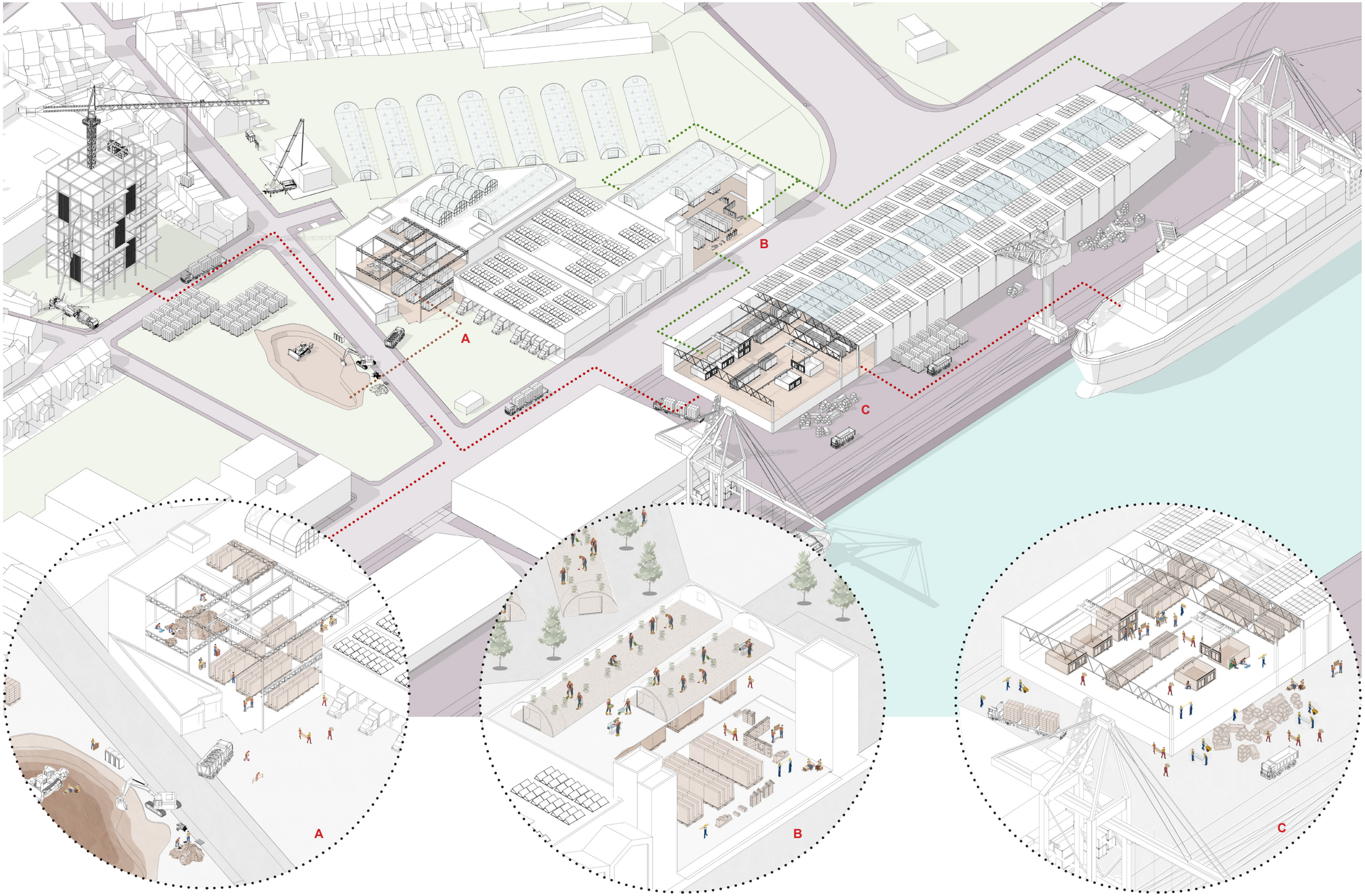
**3rd phase** 2040

During the third phase after the village is developed and built, the existing buildings will undergo a space transformation. The buildings will be adaptive reused into public centric spaces such as offices, production spaces, workshops, education facilities and recreation.

Dock area will also be transformed into a waterfront development and will be integrated into the public space and port area.



## SECOND PHASE - VILLAGE CONSTRUCTION



## MATERIAL LIBRARY

CLAY/SAND

CONCRETE

ALIMINIUM

WOOD TIMBER

BRICK

WATERPROOF MEMBRANE

TIMBER STRUCTURE

TIMBER/ CONCRETE

CORRUCGATED STEEL

STEEL FRAME

## MATERIAL LIST

### Wood-Based Materials

#### Glued Laminated Timber

Properties

| | |
|---|---|
| DENSITY | 650 kg/m³ |
| WOOD MOISTURE PERCENTAGE | 10% ± 2% |
| THERMAL CONDUCTIVITY | 0,14 W / (m.K) |
| CARBON FOOTPRINT | - 1t~ $CO_2$-e/m³ |
| SPECIFIC HEAT CAPACITY | 1300 J / (kg.K) |

Natural, renewable and 100 % recyclable
High load-carrying capacity with low density
Fast and dry construction method
Positive effects on climate protection due to storage of CO2
High fire resistance and chemical resistance
High thermal insulation properties

#### Cross Laminated Timber

Properties

| | |
|---|---|
| DENSITY | 450 kg/m³ |
| WOOD MOISTURE PERCENTAGE | 10% ± 2% |
| VAPOR DIFFUSION RESISTANCE | 20-50 µ |
| THERMAL CONDUCTIVITY | 0,11 W / (m.K) |
| CARBON FOOTPRINT | - 1-1.5 $CO_2$-e/m³ |
| SPECIFIC HEAT CAPACITY | 1600 J / (kg.K) |

Supply of CLT plates along the Canal
Cut down replant - Cycle
Construction time is ~35%
than concrete and steel
Moisture regulation & Insulation material

### Existing Site Materials

#### Brick

Properties

| | |
|---|---|
| DENSITY | 1900 kg/m³ |
| THERMAL CONDUCTIVITY | 0,6 W (m.K) |
| CARBON FOOTPRINT | 437 kg $CO_2$-e/m³ |
| SPECIFIC HEAT CAPACITY | 800 J / (kg.K) |

Energy efficient.
Low maintenance.
Weatherproof.
Time consuming construction.

#### Steel

Properties

| | |
|---|---|
| DENSITY | 8000 kg/m³ |
| THERMAL CONDUCTIVITY | 50~ W (m.K) |
| CARBON FOOTPRINT | 1.8 ~ t $CO_2$-e/m³ |
| SPECIFIC HEAT CAPACITY | 480 J / (kg.K) |

Steel is 100% recyclable.
steel never loses any of its strength
during recycling.
Steel production produces large amount of $CO_2$.

#### Concrete

Properties

| | |
|---|---|
| DENSITY | 2400~ kg/m³ |
| THERMAL CONDUCTIVITY | 0,263 W / (m.K) |
| CARBON FOOTPRINT | 350 ~ kg $CO_2$-e/m³ |
| SPECIFIC HEAT CAPACITY | 1000 J / (kg.K) |

Economical than steel.
Versatile construction material.
Resistant to extreme environmental conditions.
Formwork is required.
Concrete produces large amount of $CO_2$

### Earth-Based Materials

#### Rammed Earth (250mm wall)

Properties

| | |
|---|---|
| DENSITY | 1540 kg/m3 |
| SPECIFIC HEAT CAPACITY | 1260 J/kg.K |
| CARBON FOOTPRINT | 0+- |
| THERMAL CONDUCTIVITY | 1.2 W (m.K) |

low embodied energy
local material
environmentally friendly
unlimited source
great sound absorbing

### Fiber-Based Materials

#### Hempcrete

Properties

| | |
|---|---|
| DENSITY | 275 kg/m³ |
| AIRBORNE SOUND INSULATION | 37-45 Rw |
| VAPOR DIFFUSION RESISTANCE | 24.2 µ |
| THERMAL CONDUCTIVITY | 0,06 W / (m.K) |
| CARBON FOOTPRINT | - 130 kg $CO_2$-e/m³ |

Local production
Thermoacoustic quality
Fire resistant
Resistant to mold and insects
Carbon negative
Light and porous

#### Mycelium Insulation

Properties

| | |
|---|---|
| DENSITY | 57–99 kg/m3 |
| AIRBORNE SOUND INSULATION | 56 Rw |
| THERMAL CONDUCTIVITY | 0.024W/(m.K) |
| CARBON FOOTPRINT | 0 kg $CO_2$-e/m³ |

Grow from waste
Strong fire behavior
Local and fast growing
No carbon emission
After use,can be composted

#### Straw

Properties

| | |
|---|---|
| DENSITY | 63-123 kg/m³ |
| AIRBORNE SOUND INSULATION | 45 Rw |
| VAPOR DIFFUSION RESISTANCE | 2µ |
| THERMAL CONDUCTIVITY | 0,059-0.064 W (m.K) |
| CARBON FOOTPRINT | |

It is possible to produce in site.
Straw bales have a low-embodied energy.
Always available locally. / Easily sourced.
Cost efficient.
Eco-friendly.

#### Hemp Insulation

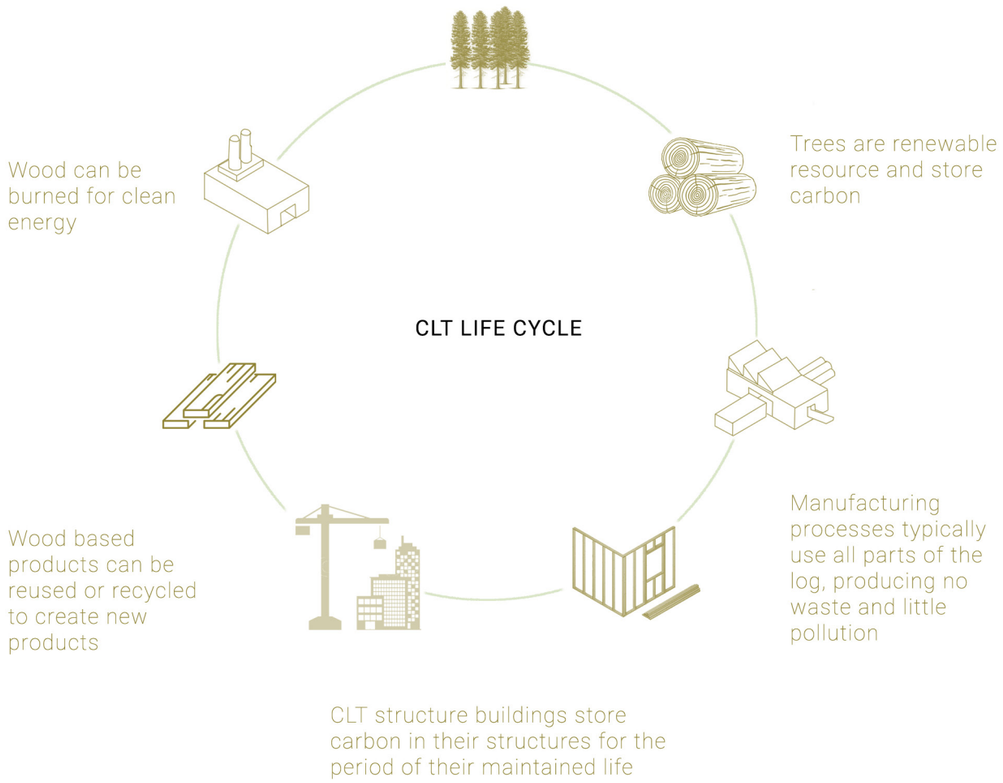
Properties

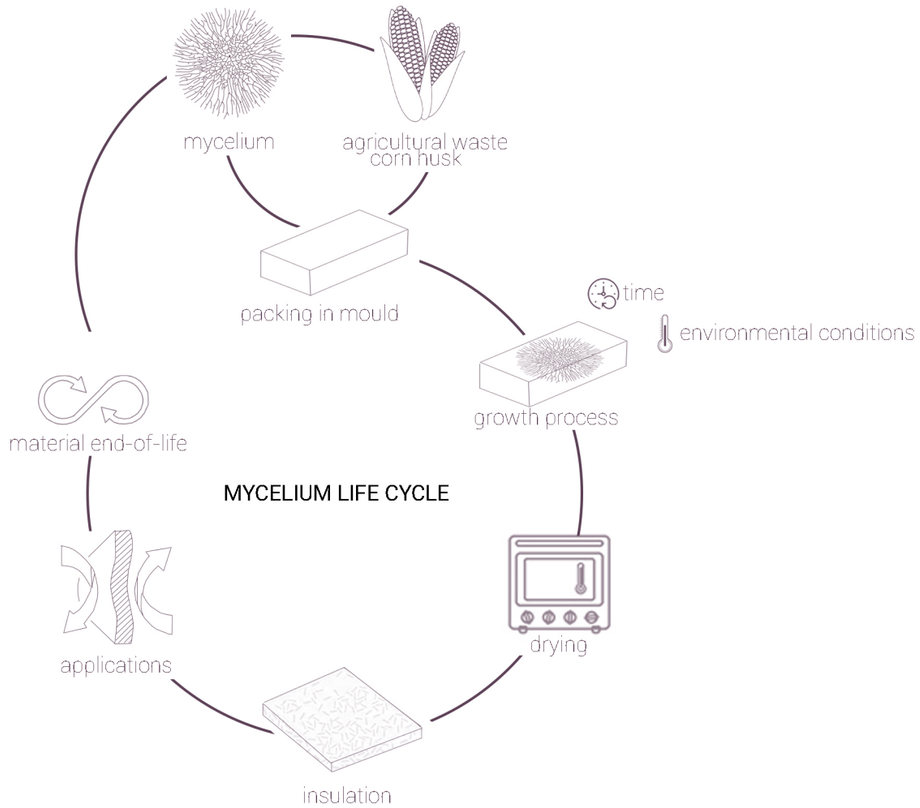
| | |
|---|---|
| DENSITY | 30 kg/m³ |
| AIRBORNE SOUND INSULATION | 56 Rw |
| VAPOR DIFFUSION RESISTANCE | 1µ |
| THERMAL CONDUCTIVITY | 0,1 W / (m.K) |
| CARBON FOOTPRINT | - 325 kg $CO_2$-e/m³ |

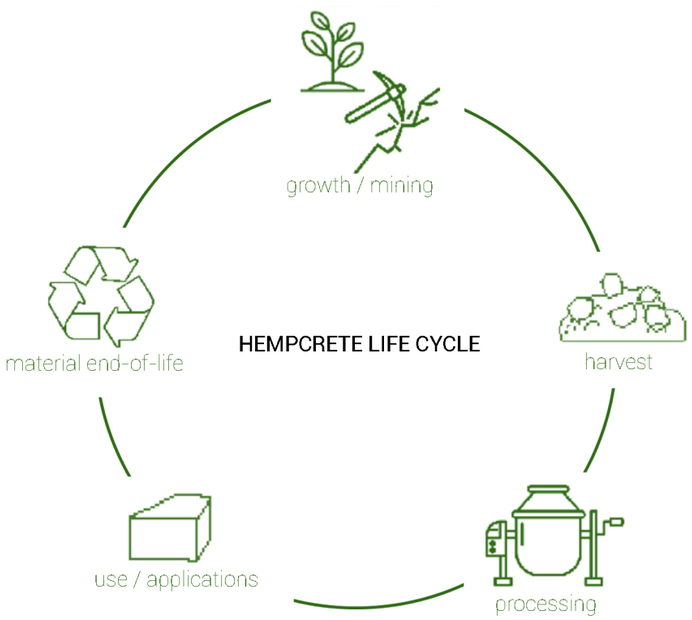
Grown in Belgium.
CO2 positive cultivation process.
Insulation mats are in the boxes
places & removed.
Does not irritate during processing.
Responsible use of raw materials
and production.

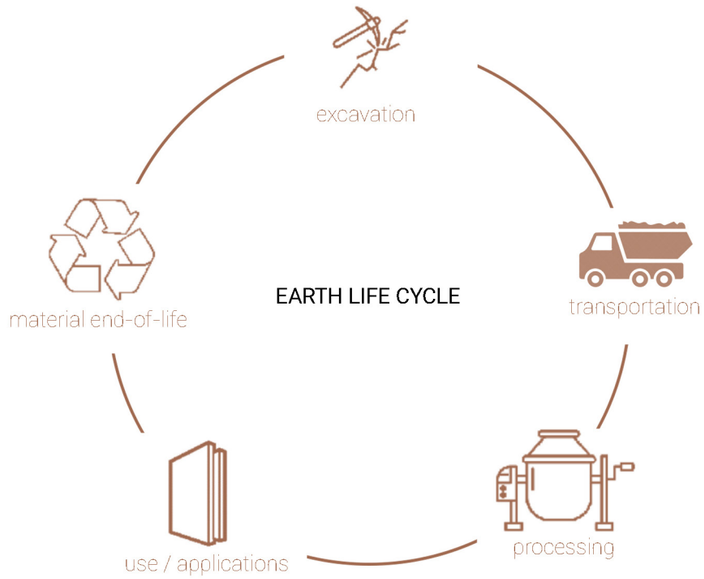
**MATERIAL LIFE CYCLE**

***flow:*** the movement of physical mass, energy or value per time unit.



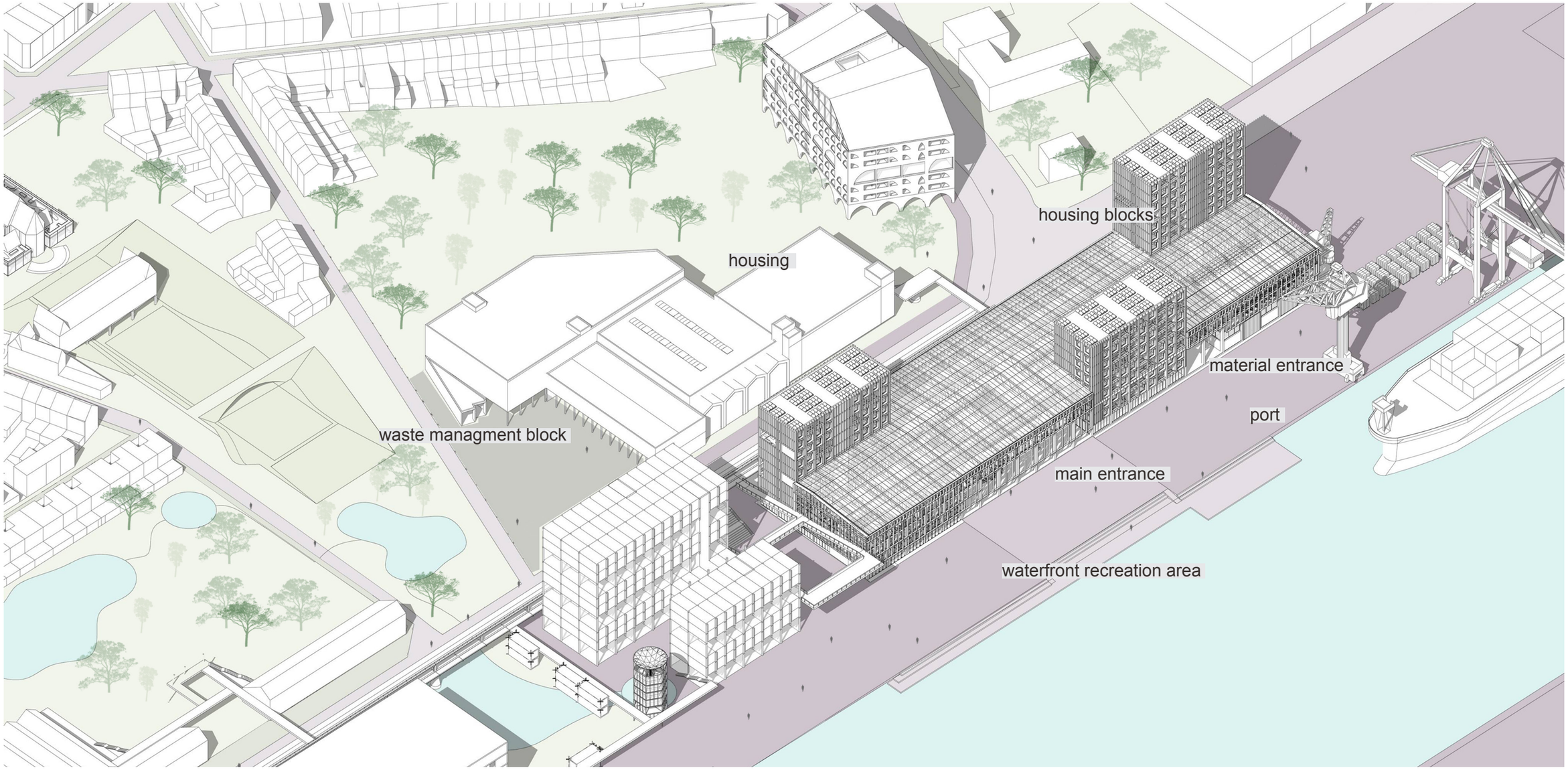



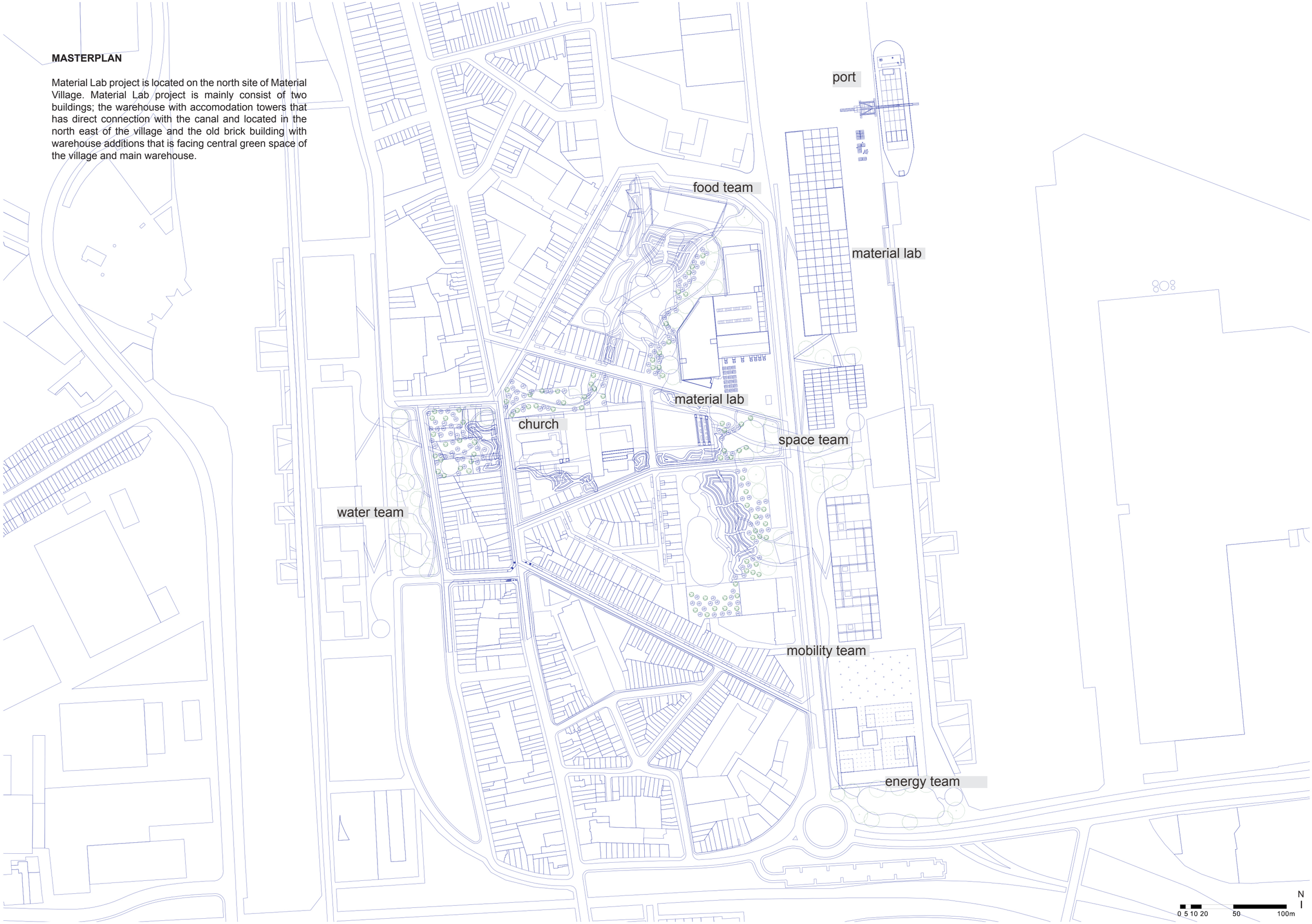
*material workshop area*

**THIRD PHASE - 2040**



**MASTERPLAN**

Material Lab project is located on the north site of Material Village. Material Lab project is mainly consist of two buildings; the warehouse with accomodation towers that has direct connection with the canal and located in the north east of the village and the old brick building with warehouse additions that is facing central green space of the village and main warehouse.



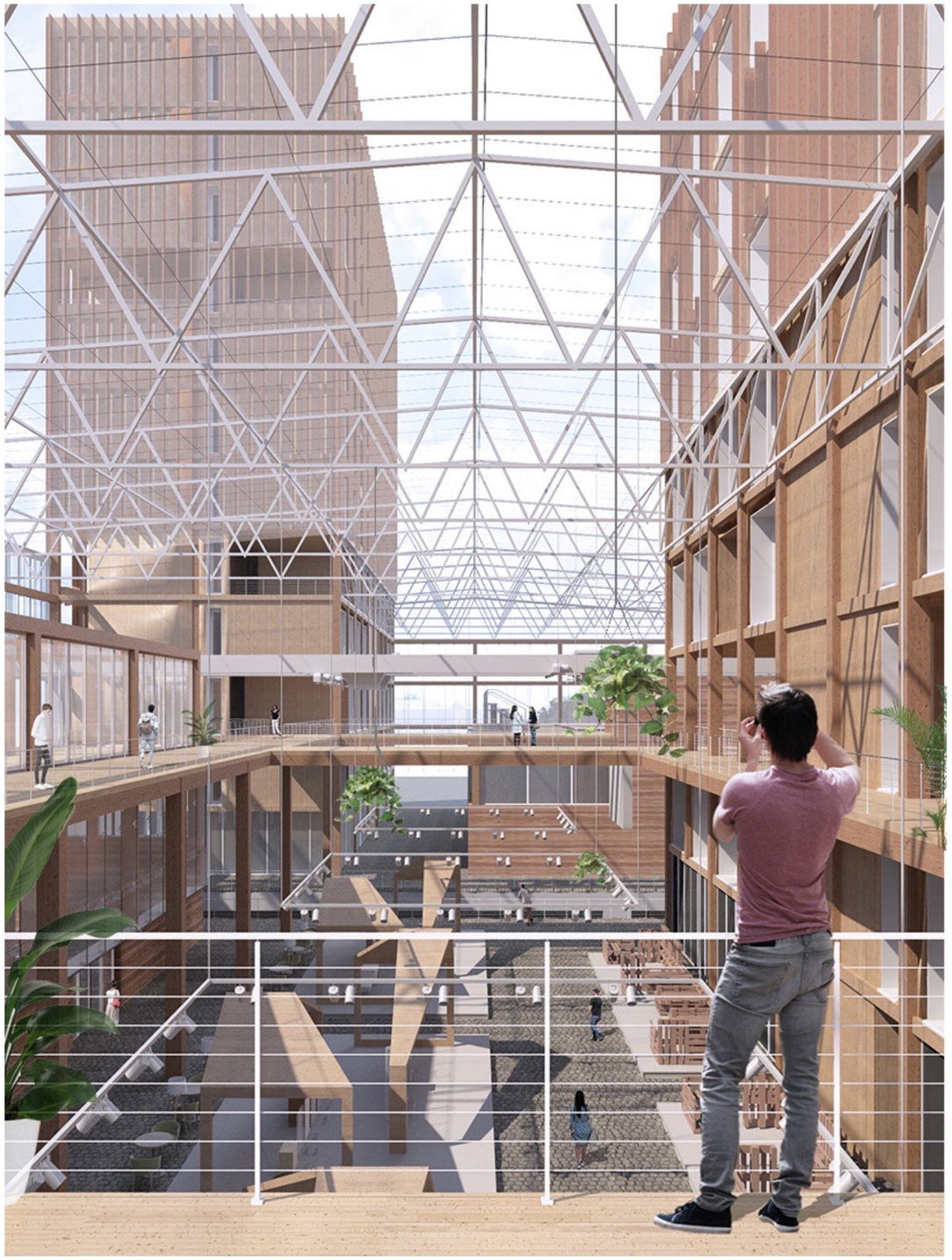
## PROGRAM

| | WHAT IS INSIDE? | FOR WHO? |
|---|---|---|
| **EDUCATION RESEARCH** | - learning spaces<br>- library<br>- individual working spaces<br>- multi purpose area<br>- cafeteria<br>- meeting spaces | - students<br>- adults<br>- kids |
| **WORKSHOP** | - atelier/studio<br>- labs<br>- material production studios | - students<br>- adults<br>- kids |
| **PRODUCTION** | - manufacture area<br>- offices<br>- material library<br>- storage | - professionals |
| **ACCOMODATION** | - housing units<br>- sport facilities<br>- shared spaces | - temporary accomodation will be used by individuals studying/working in education/workshop programs<br>- permanent accomodation for residents |

OPEN PLAN

FLEXIBLE SPACES

MODULAR CONSTRUCTION



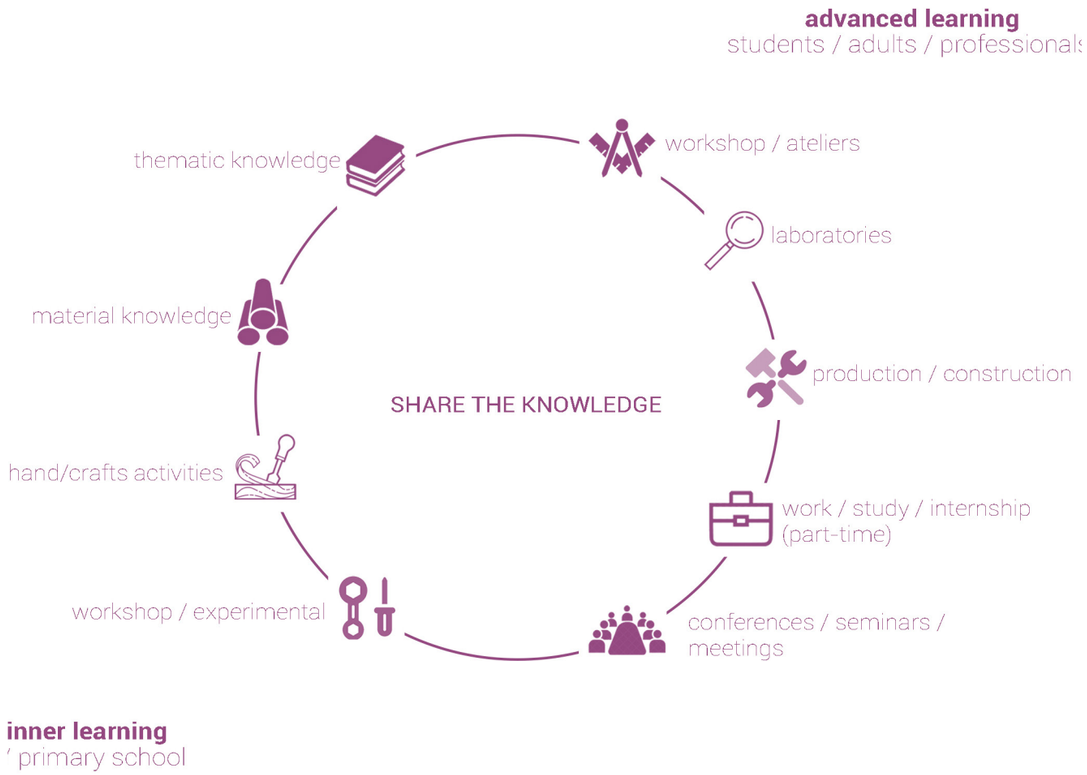
*view from walkway to the multifunctional space and material storage*

## EDUCATION CURRICULUM

With the material-based economic infrastructure, we also would like to introduce an education system based on the materials specific to Meulestede and Gent to promote and give back to the community.

We design an architectural program that is based on education aiming to develop more socially supported building processes that would benefit the village and the city. The identity of our system and building model is based on sharing the knowledge of materials with people in Gent and Belgium. To do this, we envision a material school that reflects our local identity. The material school and the village itself will construct frameworks of new forms of interaction among humans, material, technology, and nature.

Conversions of some of the warehouses to education and co-living spaces, ateliers, and several workshops where there can be the exchange of knowledge, research, seminars, libraries, etc. will benefit interaction with the outside world and this community enriching both sides




1 wood fabrication, recycled timber, carpentry and wood works

2 earth, mud, compressed earth material-training

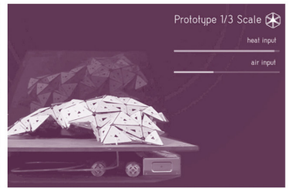
3 masonry works

4 hemp, mycelium

5 ceramic workshop

6 organic farming practices and composting

7 digital fabrication




8 high-tech material research

9 green jobs and waste management

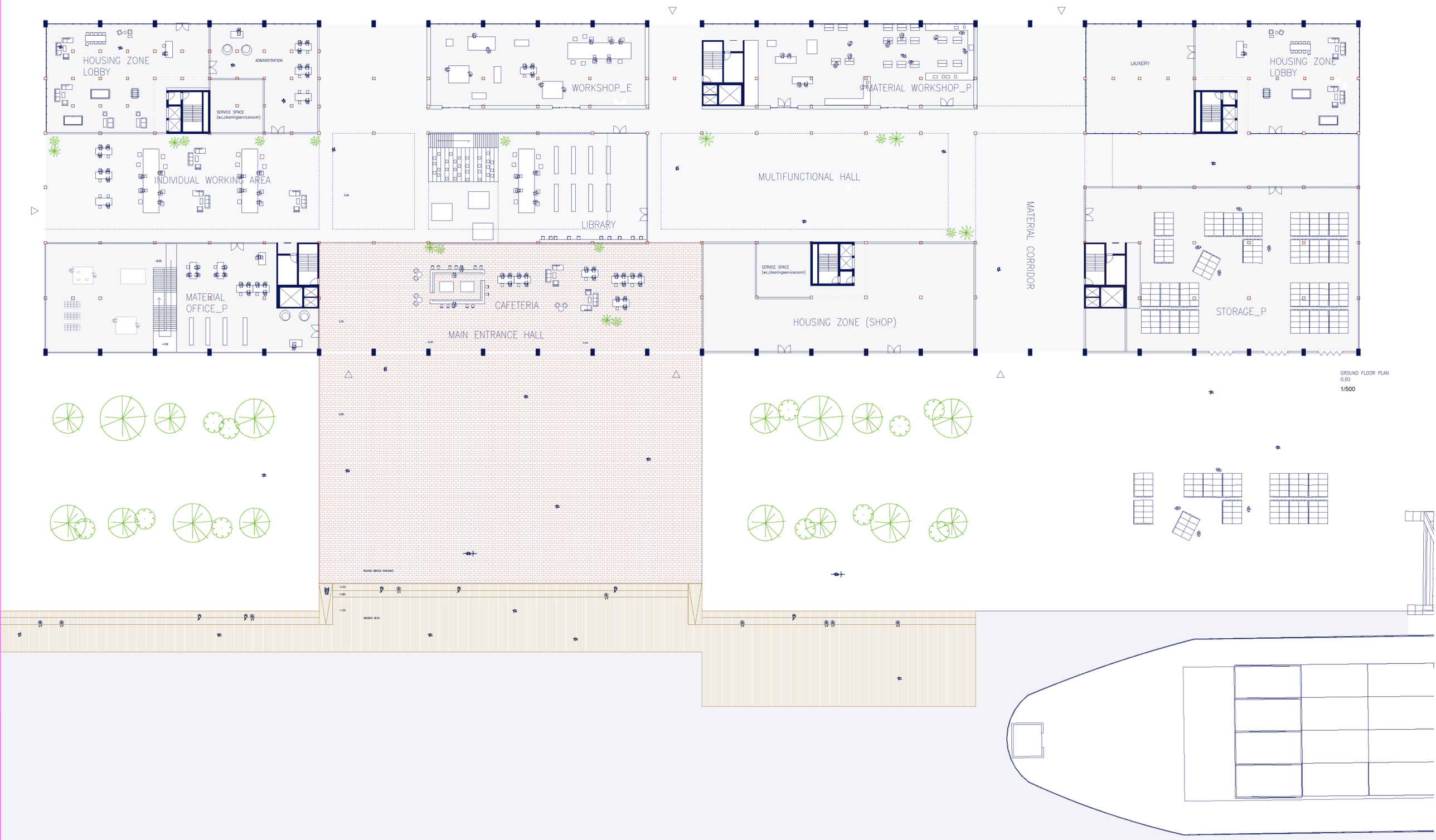
10 water as a circular resourse

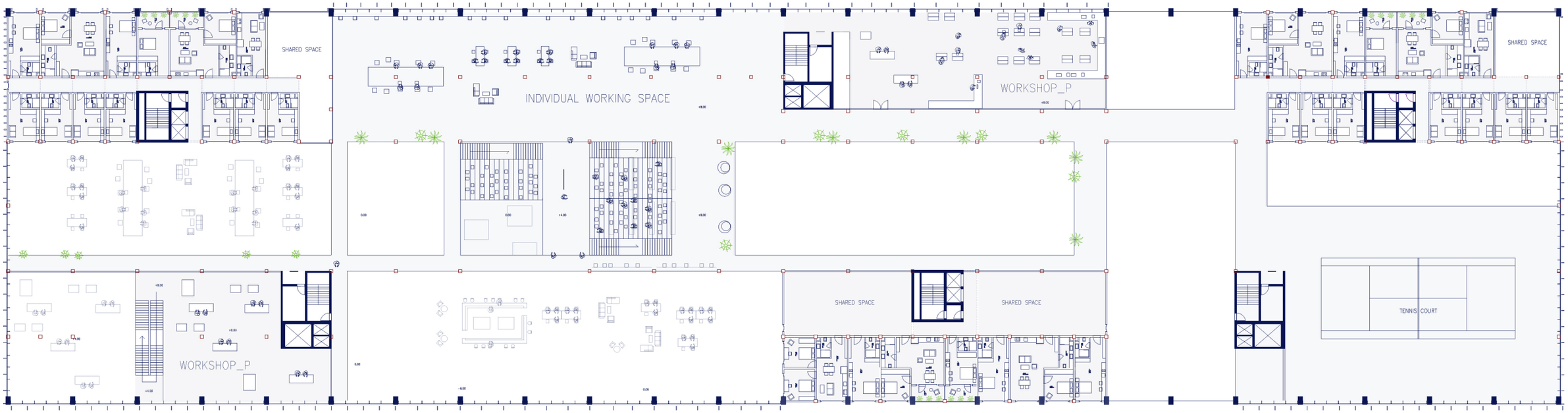
11 sustainable community living

***material school:*** a facility that provides exchange of material knowledge between professionals, students, children and residents of the village and the Gent city.

## SECTION DIAGRAM

***material workshop:*** is a workshop that contributes to material technology development and production.



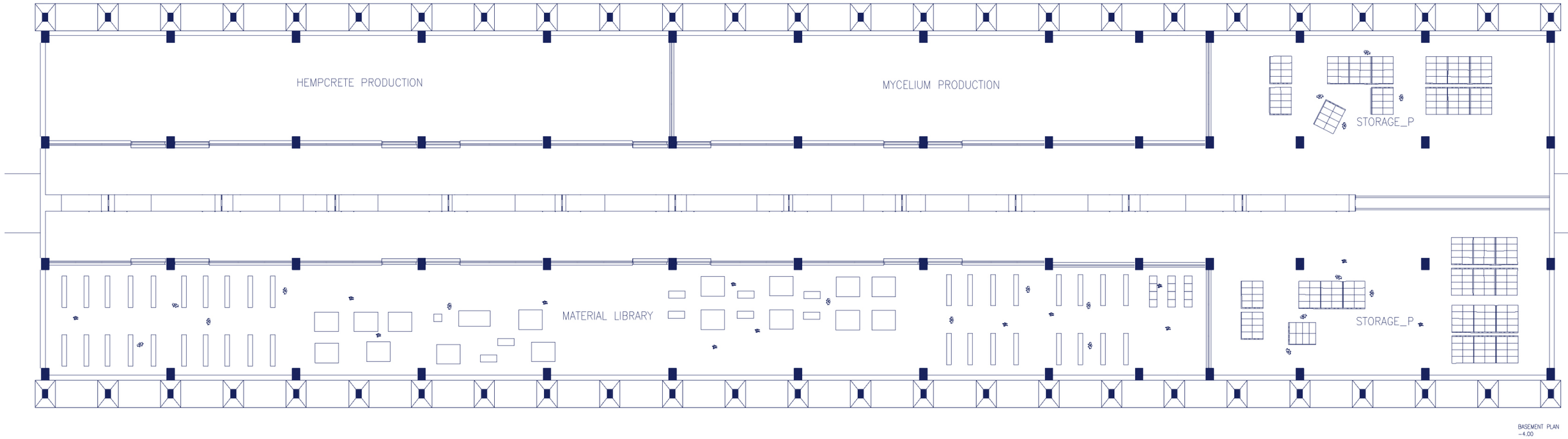



FLOOR PLAN
+8.00

1/500


EAST ELEVATION
1/500

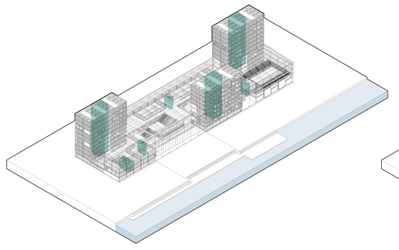
## BASEMENT FLOOR PLAN



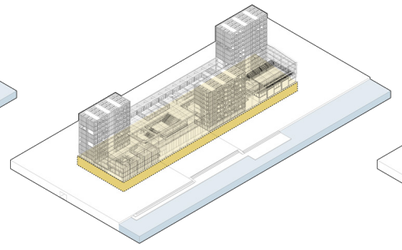

**material library:** it is a storage of waste materials that have potentials to be reused and recycled aiming to gain a second-life to the materials by the users.

## CONCEPTUAL DIAGRAMS

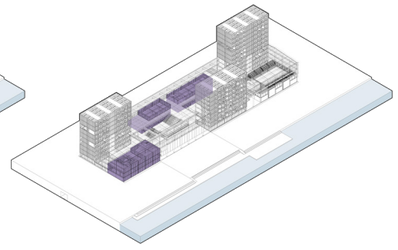
circulation



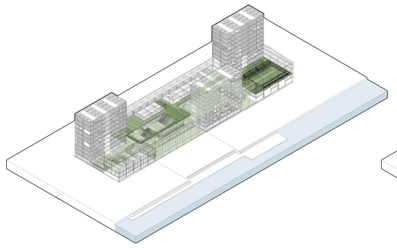
production area



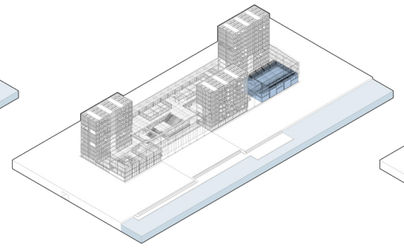
workshop area



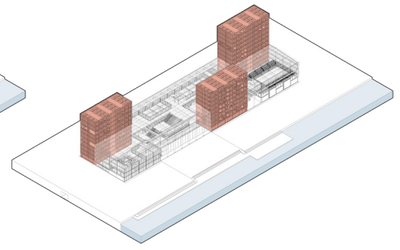
public area



storage



accommodation



## HOUSING MODULES

Building blocks consist of four different living modules and the core. Grid of for the building blocks is 4mx8m so all modules are shaped based on that grid.

Interior designs of modules designed to create maximum confort for its inhabitant. Each room receives natural light and each module has private bathroom and kitchenette. Modules B and C have their own balconies, for other two modules it is possible to add an additional balcony unit.

The core has two elevators, fire stair and shaft. Around the core there is circulation area.

Housing modules include group of proposed materials; hempcrete partition walls, CLT exterior walls with mycelium insulation, CLT slabs and concrete and GLT structure.

***co-living:*** it is concept of living where thinkers and creaters sharing same space for living.

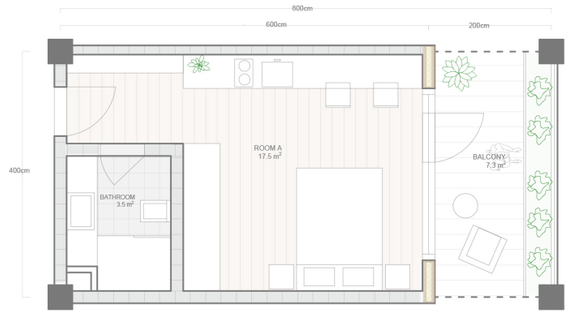

studio_A_1p


apartment_C_2p

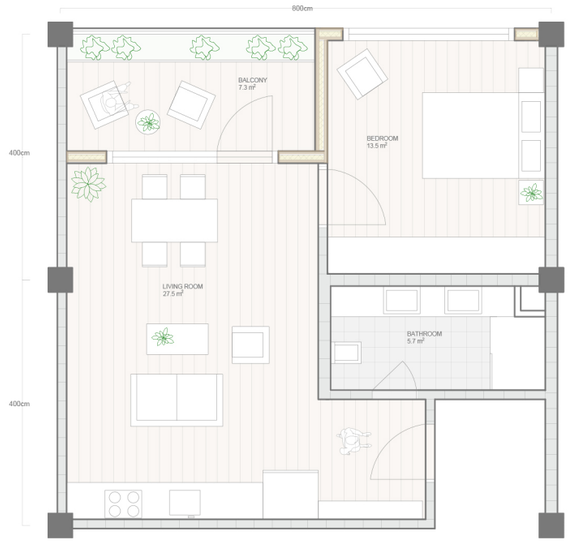
CLT walls with mycellium insulation

hempcrete walls

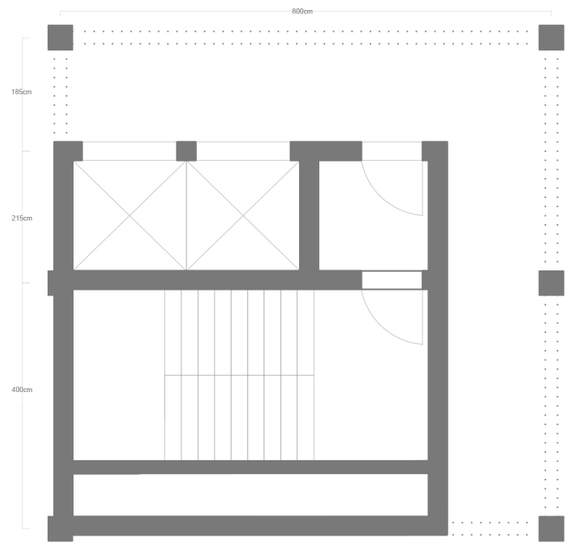
GLT columns




studio_B_1p

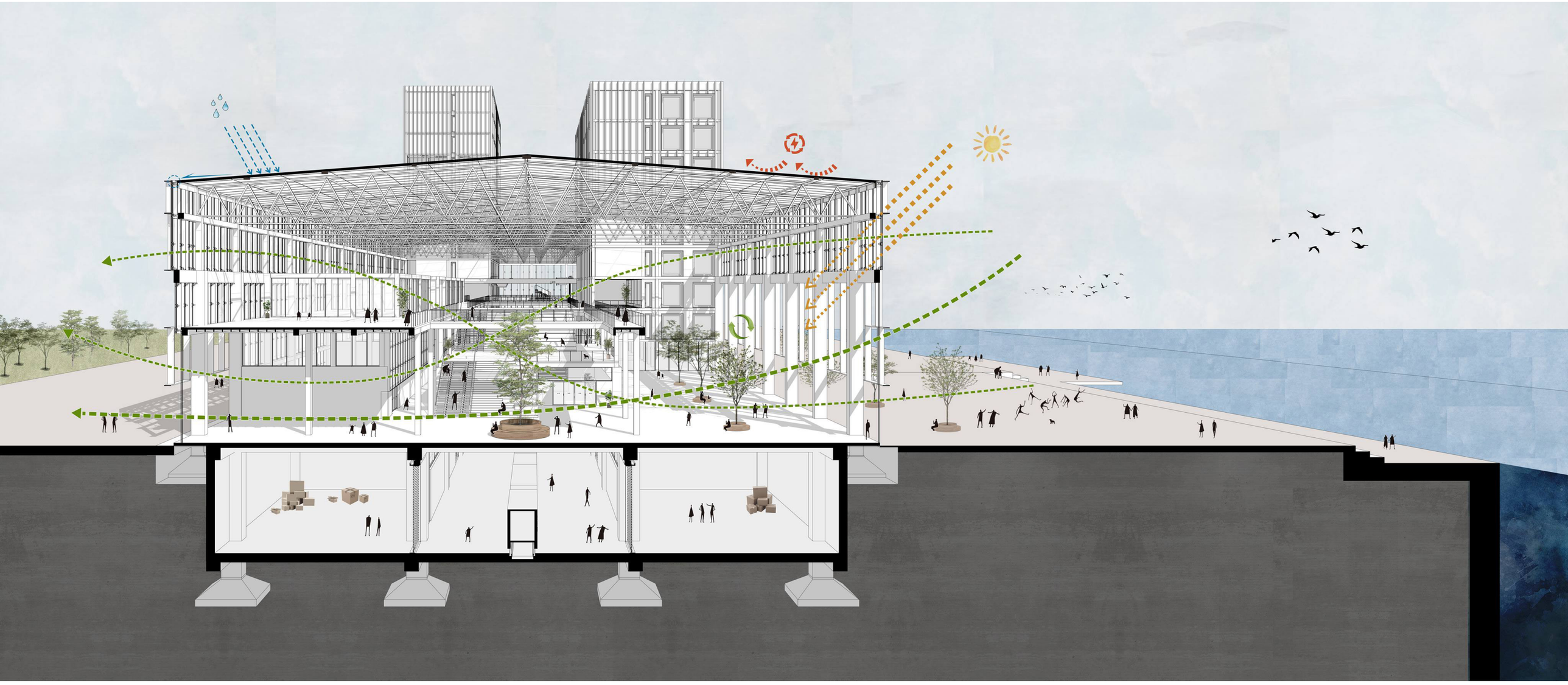



apartment_D_2p



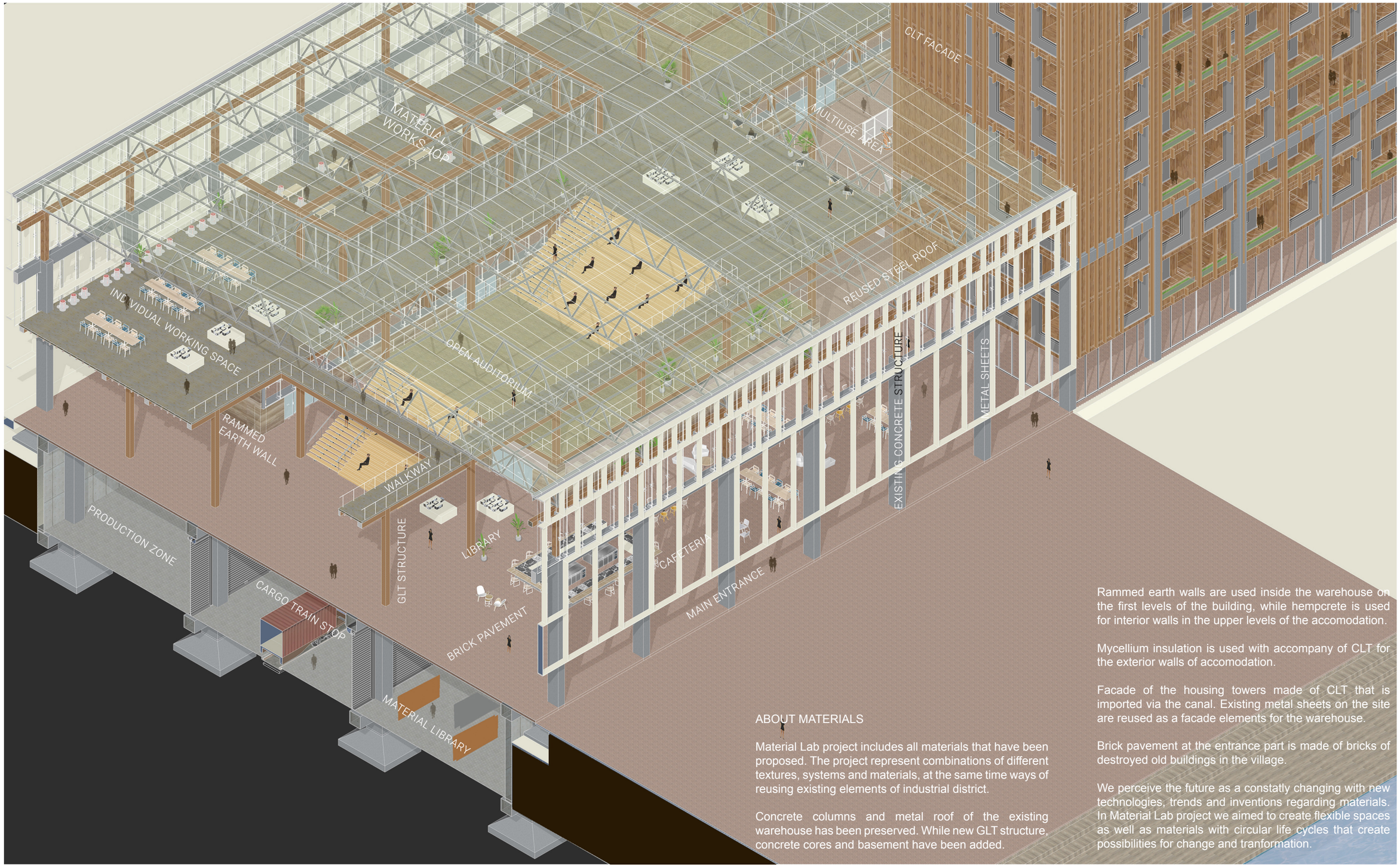

core

## SECTION DIAGRAM



*material workshop area*

**ISOMETRIC MATERIAL SECTION**




ABOUT MATERIALS

Material Lab project includes all materials that have been proposed. The project represent combinations of different textures, systems and materials, at the same time ways of reusing existing elements of industrial district.

Concrete columns and metal roof of the existing warehouse has been preserved. While new GLT structure, concrete cores and basement have been added.

Rammed earth walls are used inside the warehouse on the first levels of the building, while hempcrete is used for interior walls in the upper levels of the accomodation.

Mycellium insulation is used with accompany of CLT for the exterior walls of accomodation.

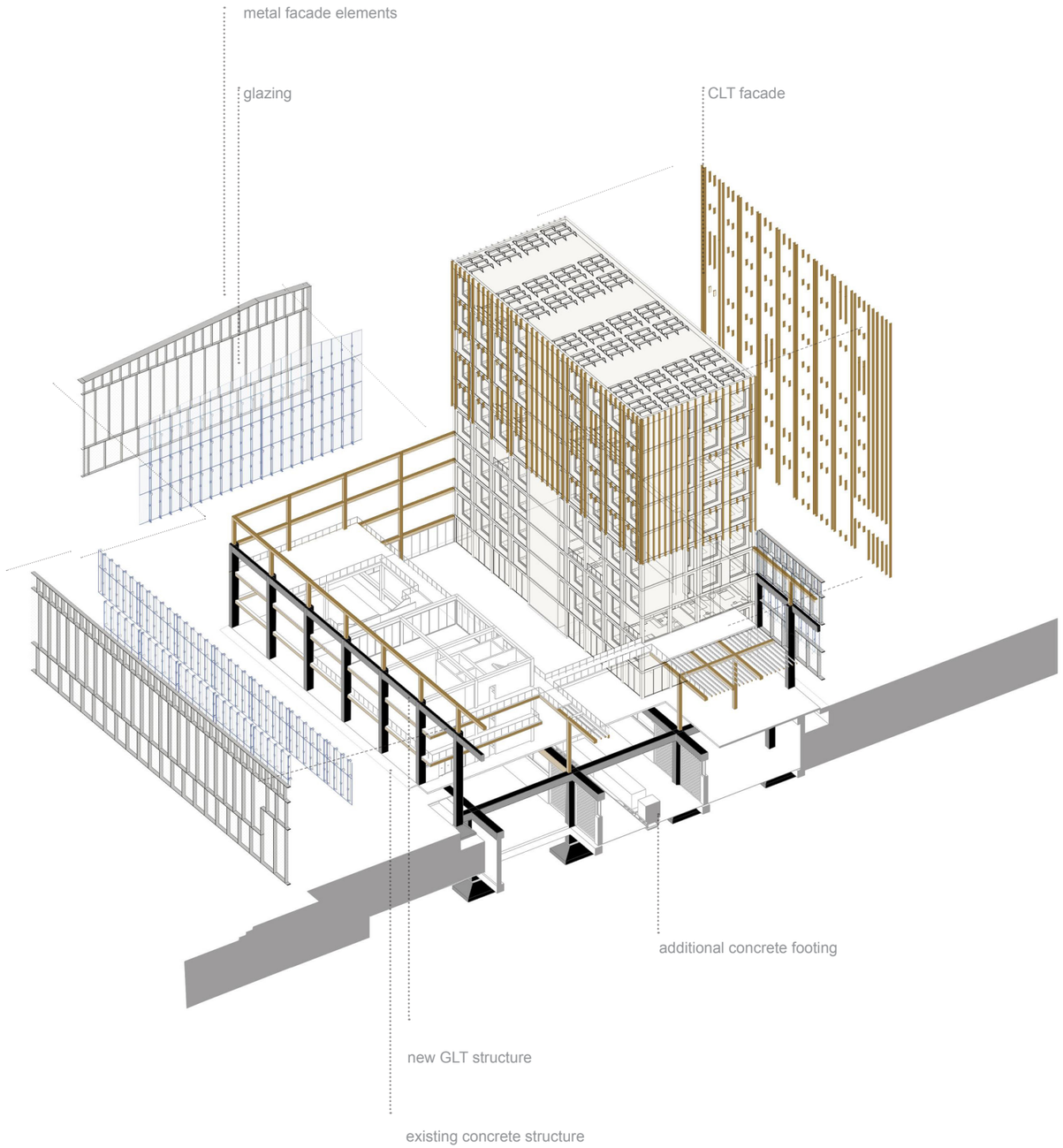
Facade of the housing towers made of CLT that is imported via the canal. Existing metal sheets on the site are reused as a facade elements for the warehouse.

Brick pavement at the entrance part is made of bricks of destroyed old buildings in the village.

We perceive the future as a constatly changing with new technologies, trends and inventions regarding materials. In Material Lab project we aimed to create flexible spaces as well as materials with circular life cycles that create possibilities for change and tranformation.

## DETAIL SECTION


## STRUCTURE DIAGRAM



## MATERIAL DIAGRAM OF HOUSING MODULES

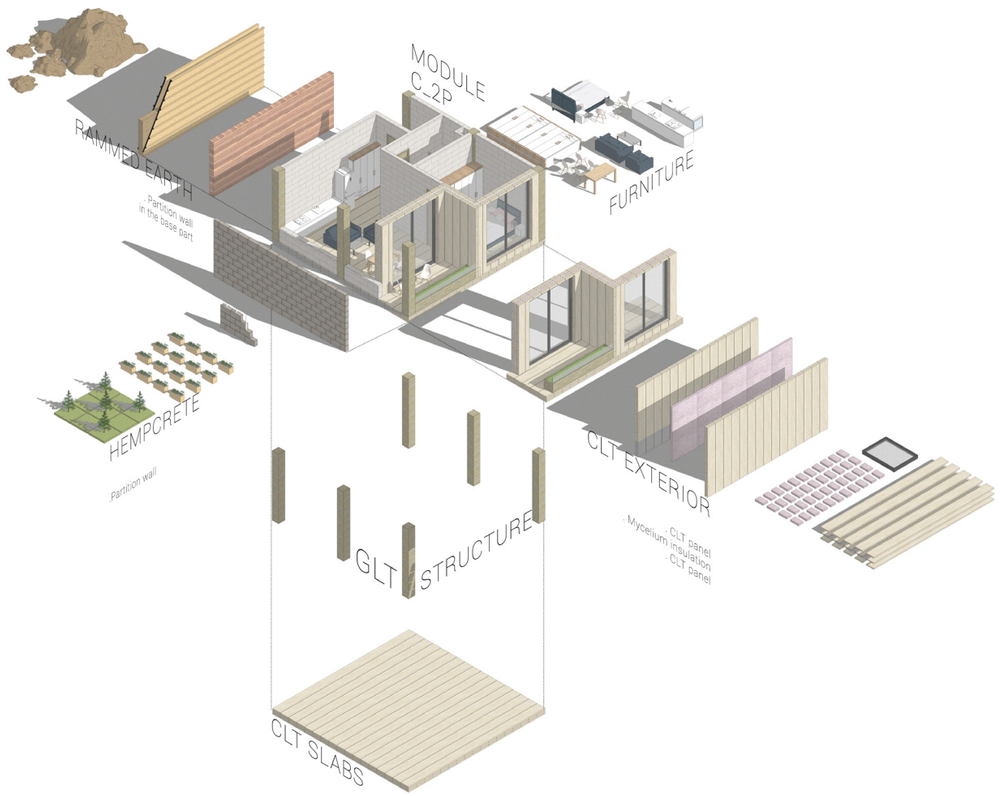
Building blocks consist of four different living modules and the core. Grid of for the building blocks is 4mx8m so all modules are shaped based on that grid.

GLT is used for structural elements.

Hempcrete is used for partition walls, provides natural sound and thermal insulation. Unique texture of hempcrete walls creates cozy atmosphere inside.

CLT panels are used with mycelium insulation for exterior walls. CLT is also used for flooring.

Rammed earth walls are an alternative material for walls in first levels of the building blocks.




## CONCLUSION

At the end of the semester, we mostly achieved the aims that we set. Material Lab project creates a healthy material ecosystem for itself as well as for the village. We designed a multifunctional building that not just includes but also connects production, workshop, education, and living spaces. Proposed materials have been integrated into different spaces and become one of the main determinants of their atmosphere.

The identity of our system and building model is based on sharing the knowledge of materials with people in Gent and Belgium. To do this, we envision a material school that reflects our local identity. The material school and the village itself will construct frameworks of new forms of interaction among humans, materials, technology, and nature. This education framework provides a living and working environment for professionals, students, kids, the local residents as well as for the people in the city.

This integrated system supports the local economy and closes the cycles of all materials, supporting our positive idea of waste.

According to our envision of 2040, we designed flexible spaces which are open to change in case of population and programmatic needs. We designed our spaces according to the identity and the life cycle of the materials. It was important for us to understand the life of the material and provide spaces accordingly. During the design process, we made some important changes in the form of our building. We have made these changes to meet our own goals and according to the decisions taken by other teams of the village. As a material team of the material village, we provide a material ecosystem that will always keep the growth and most importantly life inside.

*view from waterfront to the main entrance*