

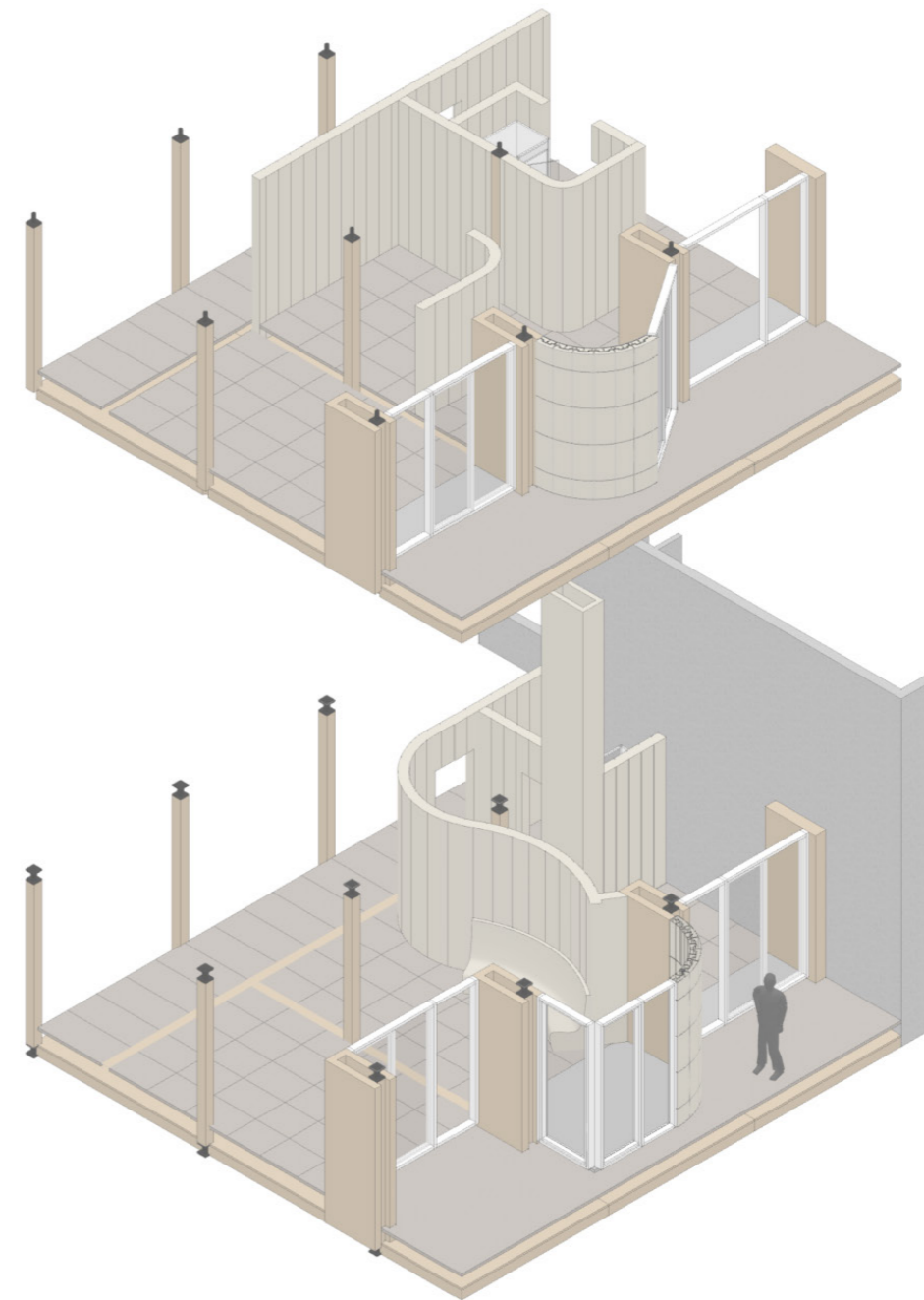
# Evolving Urban Housing

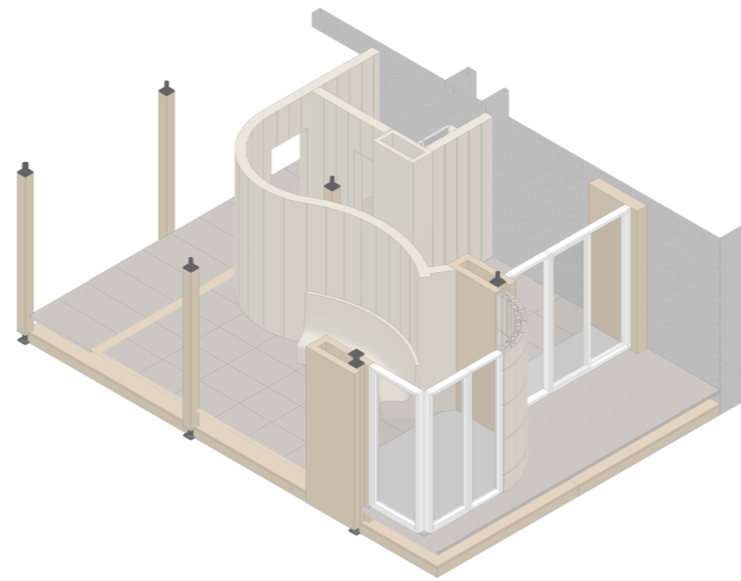
A prefabricated system for urban mix-used housing which could adapt over time

Wen Hsuan Huang

Architecture Engineering Studio  
Faculty of Architecture and the Built Environment  
Delft University of Technology

Anne Snijders  
Pieter Stoutjesdijk





**An evolving platform rather than a fixed product for mix-used housing**

**01 Problem Statement**

# 01 Problem Statement



## 01 **Problem Statement**

Construction sector faces the worst labour shortage

In The Netherlands,

**80%** of businesses in the construction sector indicated that they are experiencing staff shortages

**50 %** of all new residential buildings are expected to use prefabricated system by 2030

## 01 **Problem Statement**

Construction sector faces the worst labour shortage

In The Netherlands,

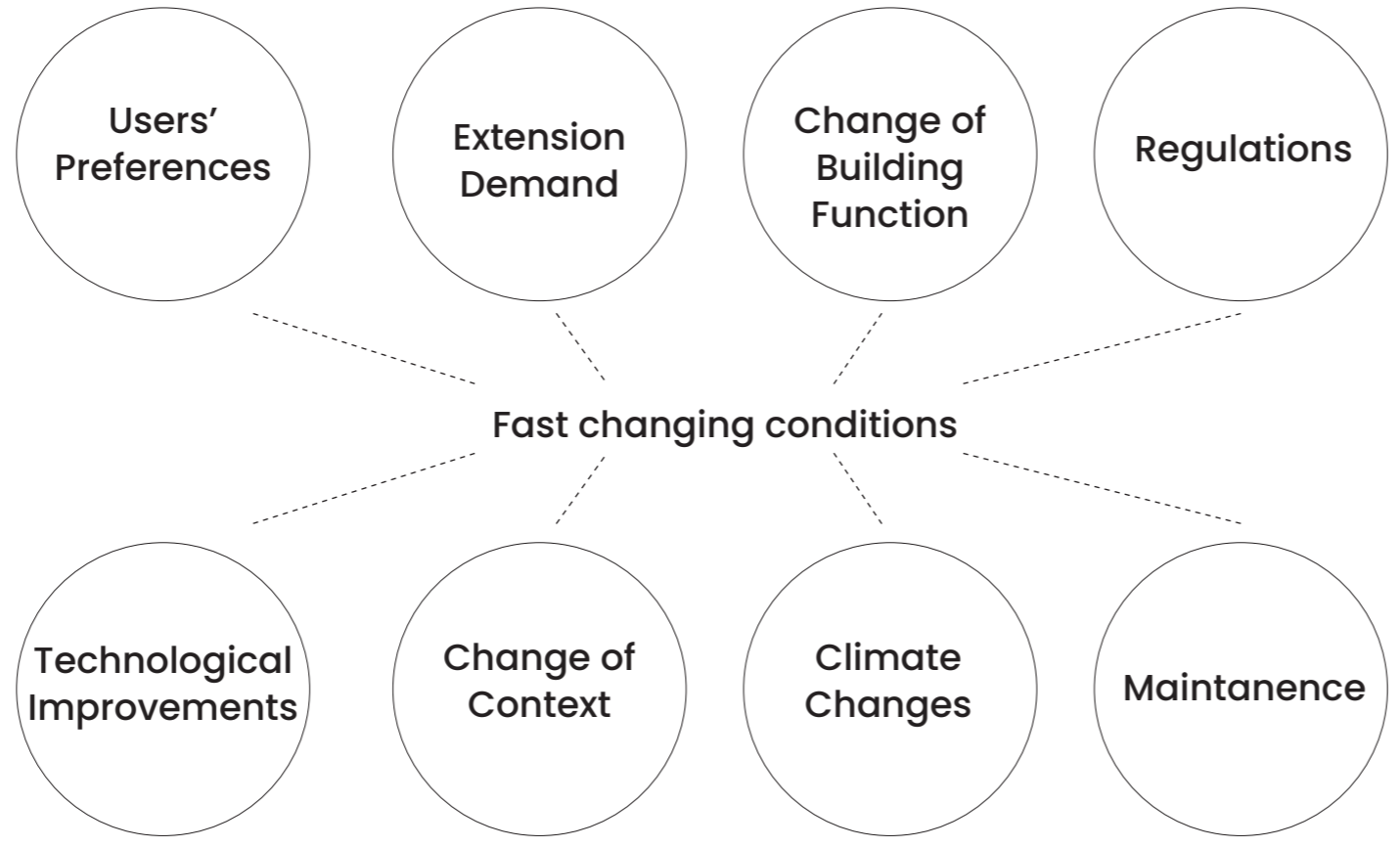
**80%** of businesses in the construction sector indicated that they are experiencing staff shortages

**50 %** of all new residential buildings are expected to use prefabricated system by 2030

**Prefabricated System & digital fabrication**

# 01 Problem Statement

Reduced Building Life Span

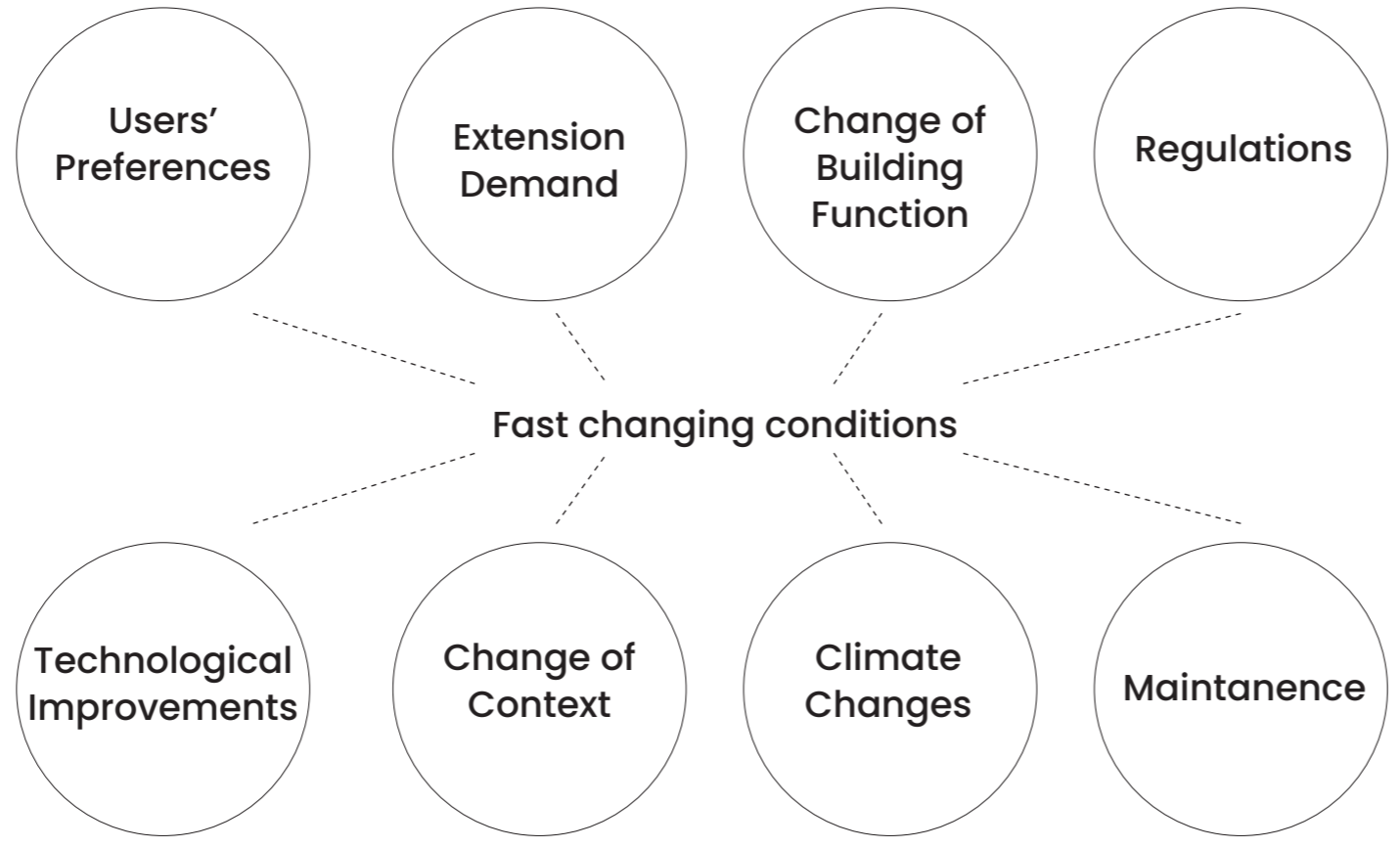


*Large amount of waste*



# 01 Problem Statement

Reduced Building Life Span



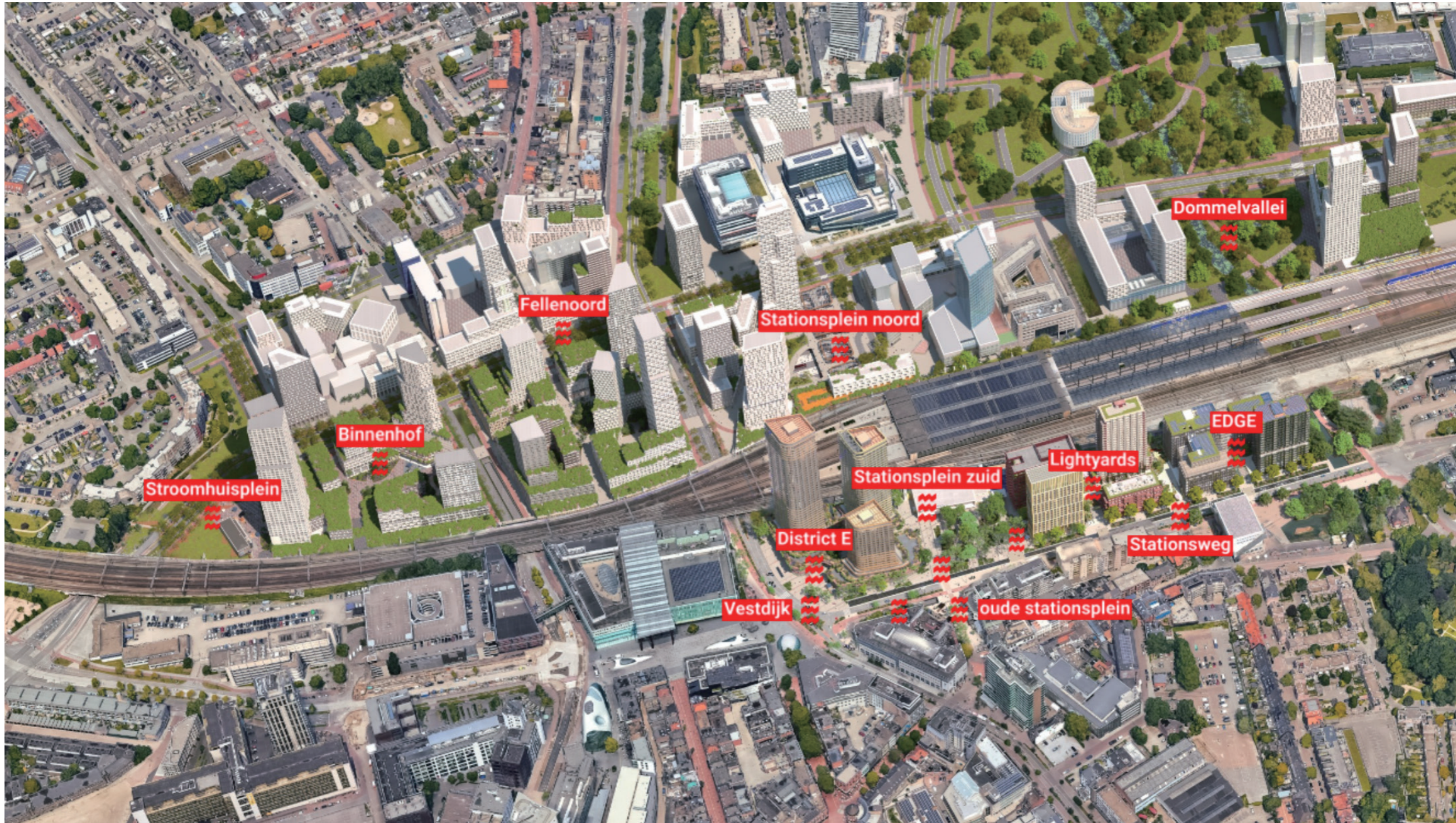
*Large amount of waste*



**Adaptable building: moveable kit of parts during "use"**

# 01 Problem Statement

## Future Population Growth in Eindhoven

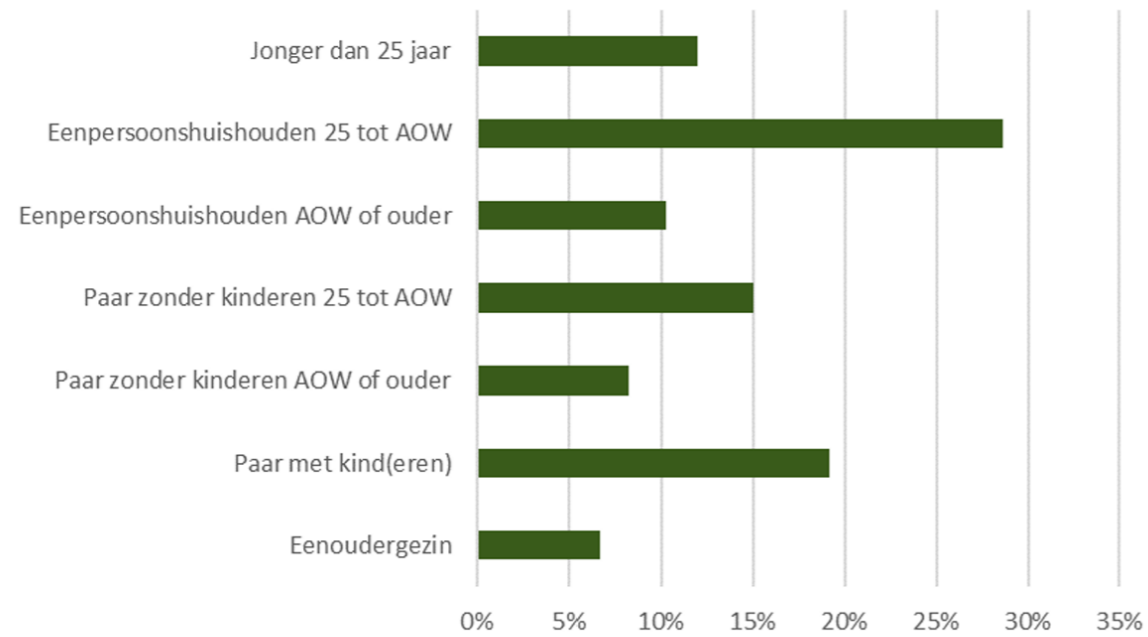


*Developments in the high-tech industry are bringing an influx of employees.*

# 01 Problem Statement

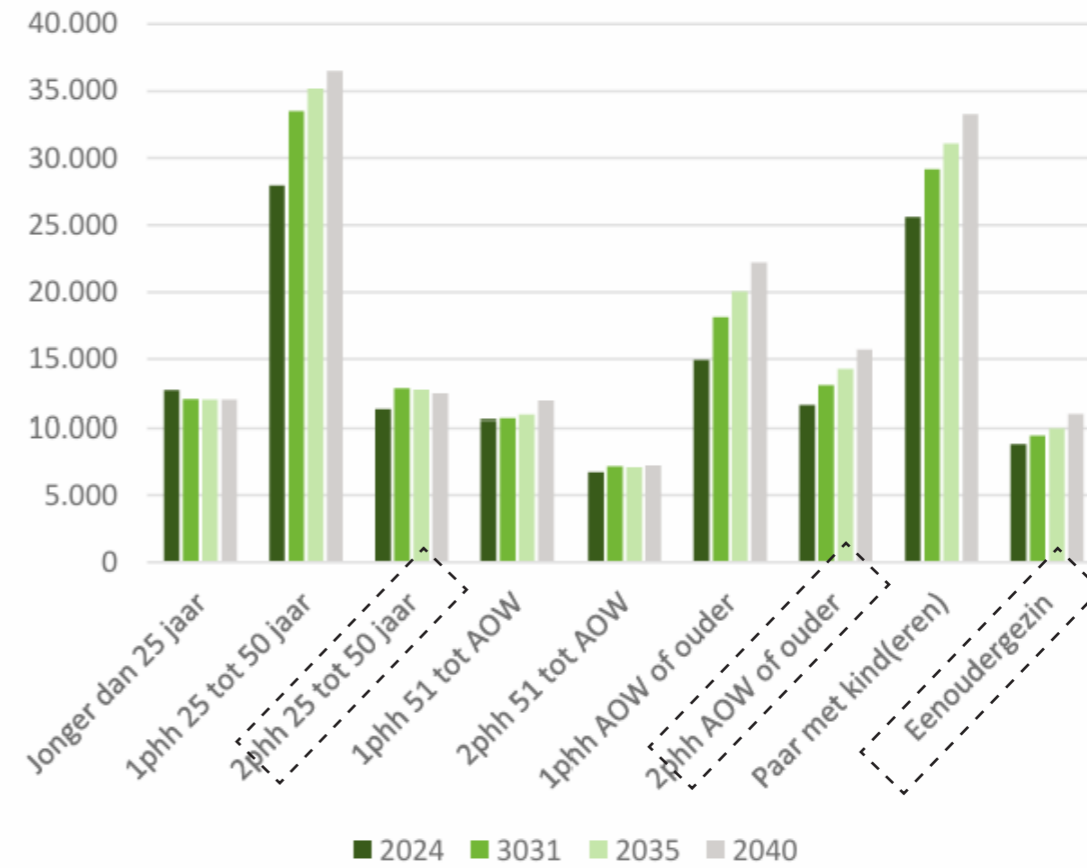
## Future Population Growth in Eindhoven

Figuur 3.1: Gemeente Eindhoven. Huishoudens naar leeftijd en samenstelling, 2023



Bron: CBS.

Figuur 4.1: Gemeente Eindhoven. Huishoudensontwikkeling naar leeftijd en samenstelling volgens de provinciale prognose, 2024 - 2040



Bron: Provincie Noord-Brabant.

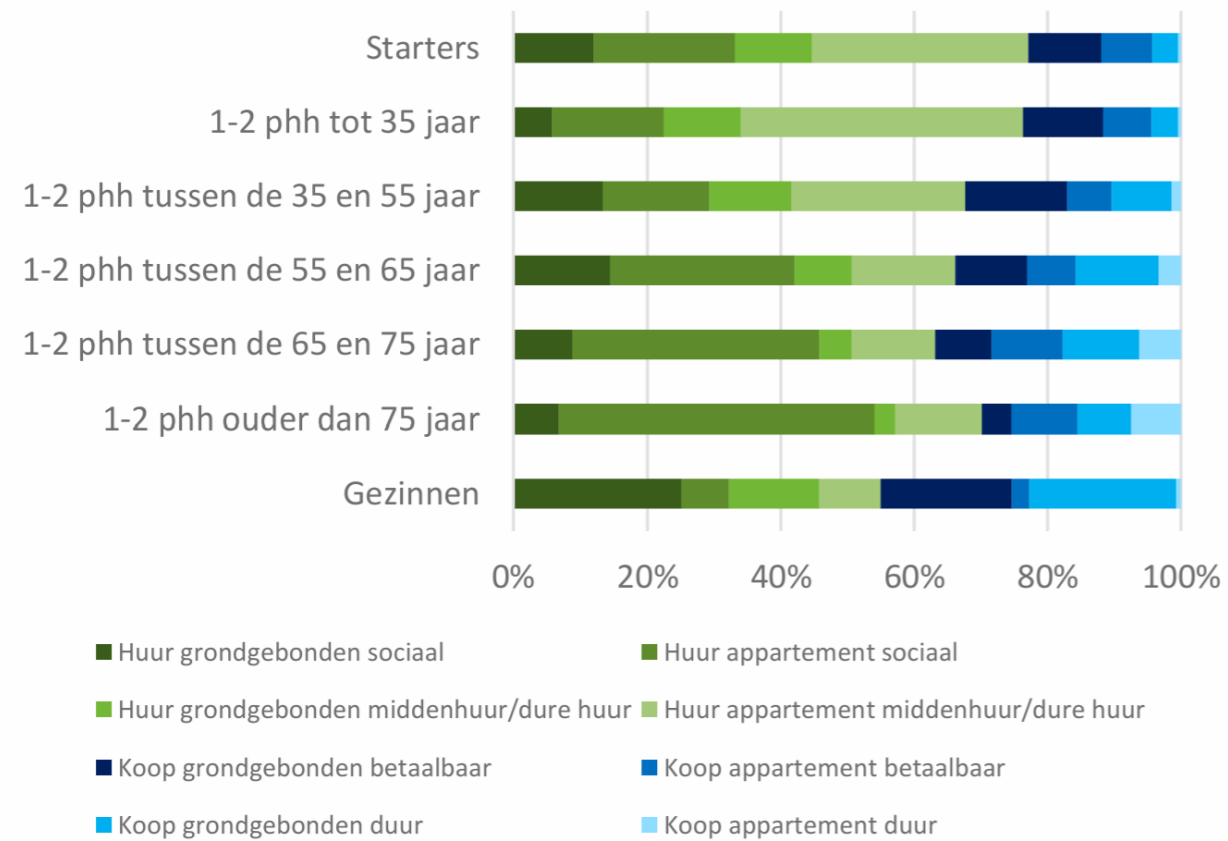
Around **75%** are 1-2 people households.

A household consists on average of **1.4** people in the center.

# 01 Problem Statement

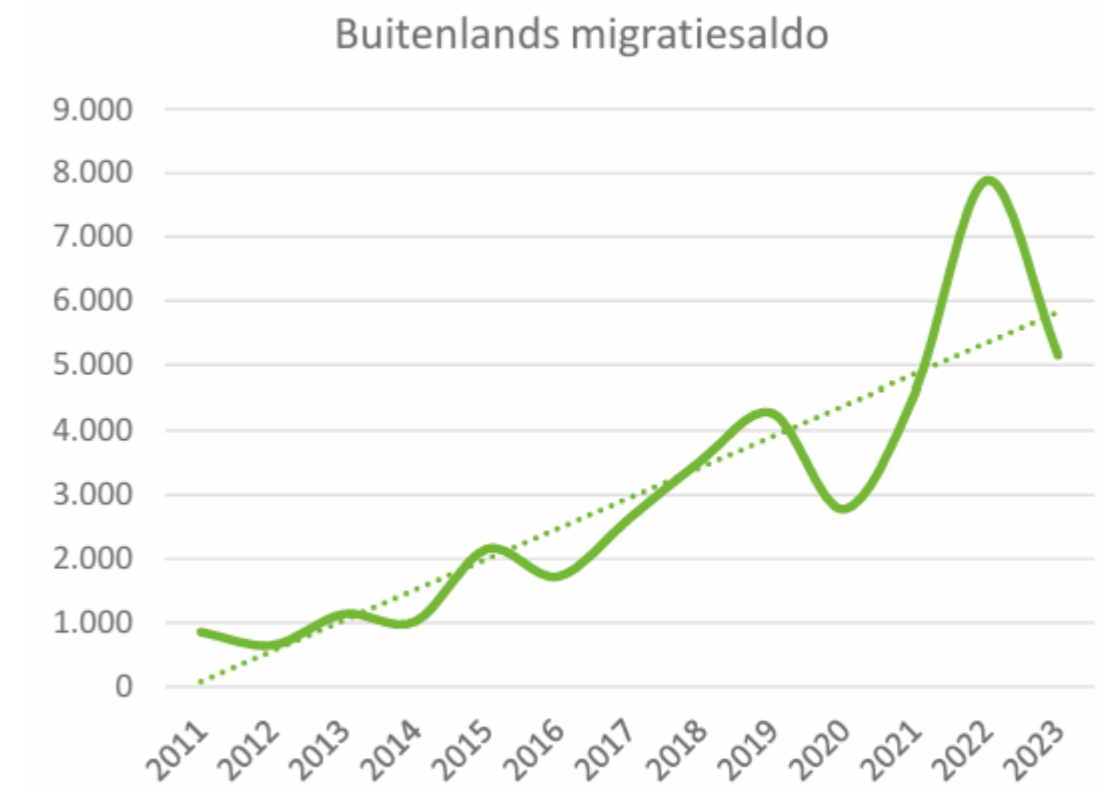
## Future Population Growth in Eindhoven

Figuur 4.4: Gemeente Eindhoven. Gerealiseerde verhuizingen, 2017 - 2022



Bron: CBS-Microdata.

Figuur 3.7: Gemeente Eindhoven. Ontwikkeling buitenlands migratiesaldo, 2010 - 2023



Bron: CBS.

*Of all the homes almost **60%** are rental homes.  
Increasing need for shared facilities in housing.*

# 01 Problem Statement

Future Population Growth in Eindhoven

## Fact

City center

Developments in the high-tech industry

## Trend

Single or small household

Different groups:  
Starters/ Expats/ Academic Researchers/  
Seniors/ Young parents

Shared facilities

## Change factor

Rental apartment & Short  
length of stay  
2-4 years

Various space requirements

**Flexible small size rental apartment & Co-housing**

# 01 Problem Statement



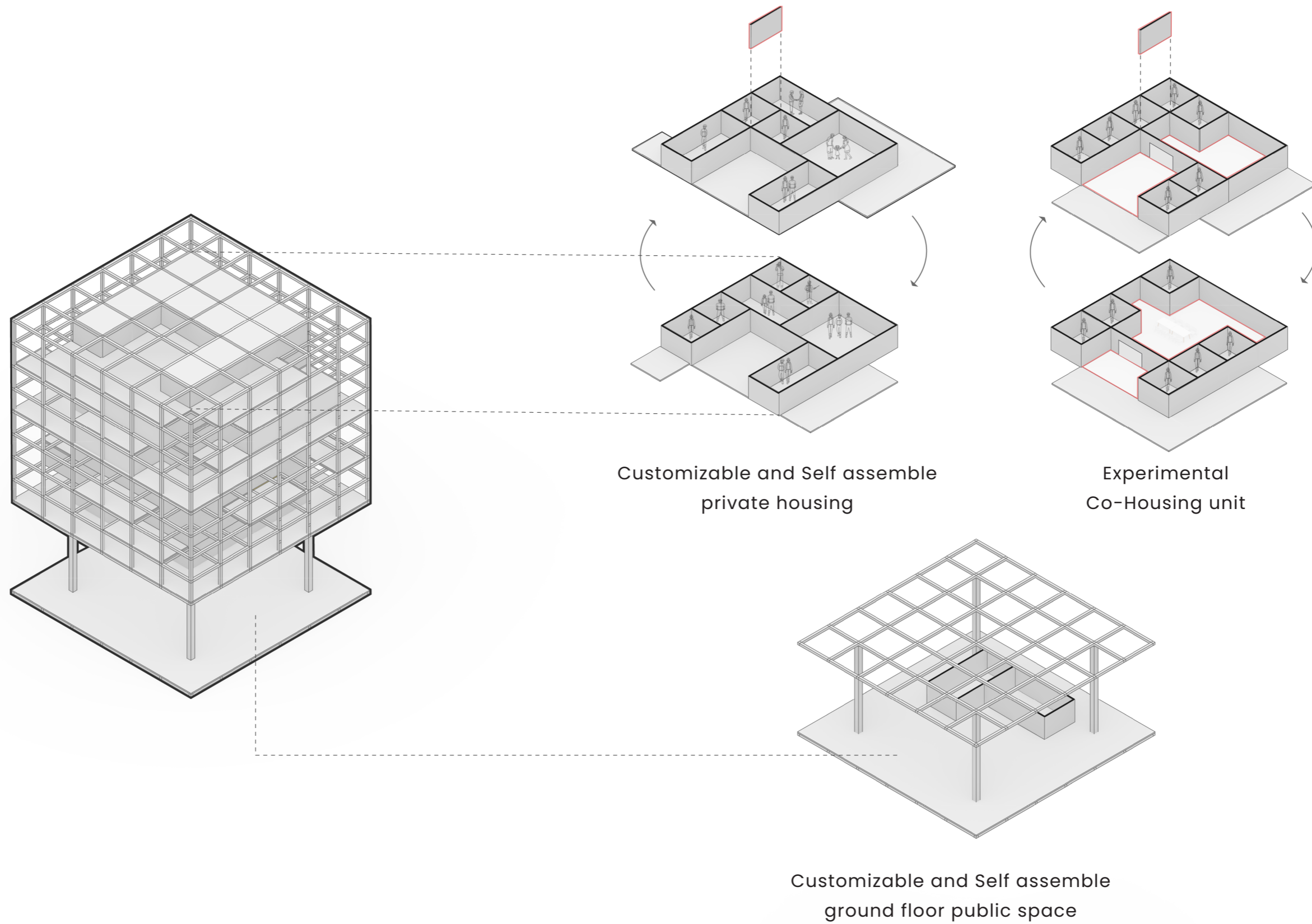
Prefabricated  
System &  
Digital  
Fabrication

Moveable kit of parts  
during "use"

Co-Housing  
&  
Flexible Small-size  
Rental Apartment

## 02 **Vision**

## 02 Vision



## 03 **Strategies**

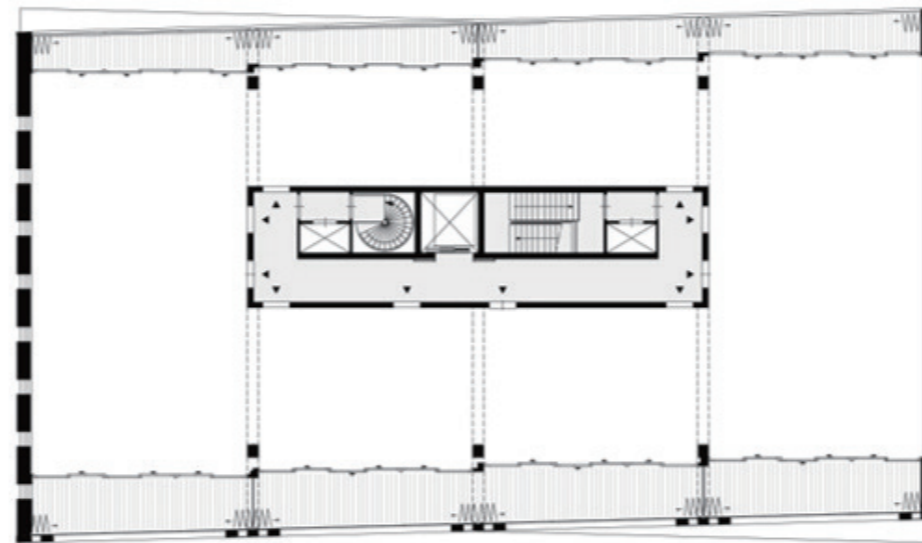
### 03 Strategies: Open Building Research

Support/ Fixed

Open structure system

Arrangement of vertical circulation

Arrangement of service shaft



Patch 22

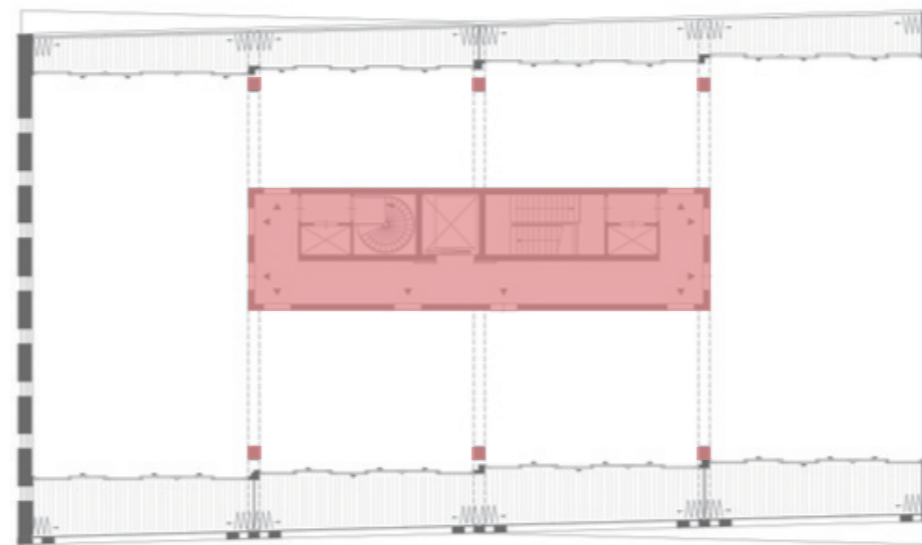
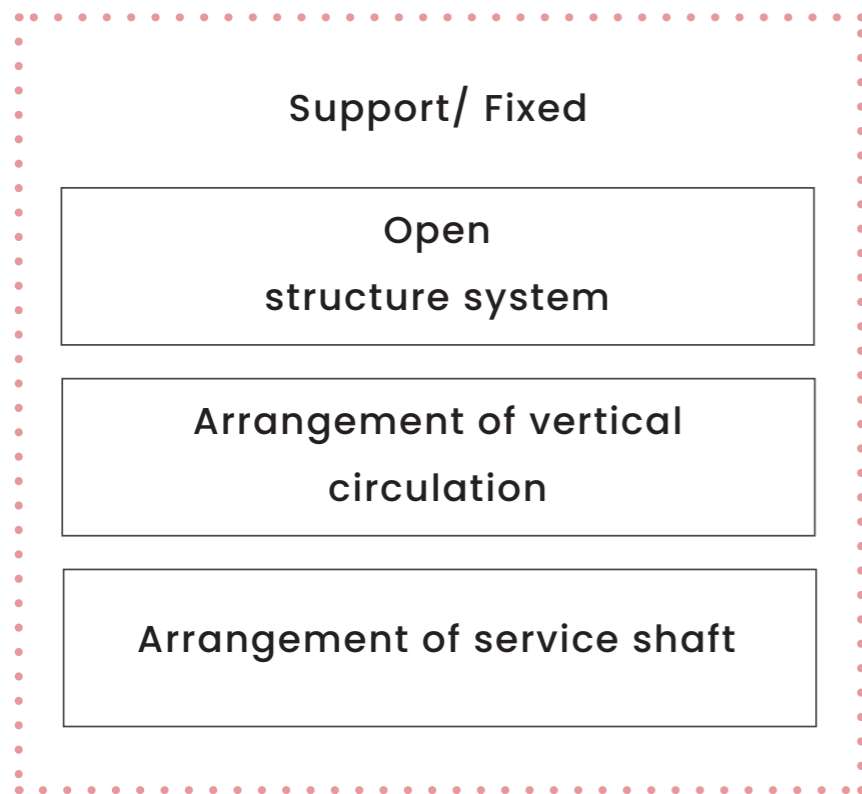
Infill/ Changeable

Movable partition wall

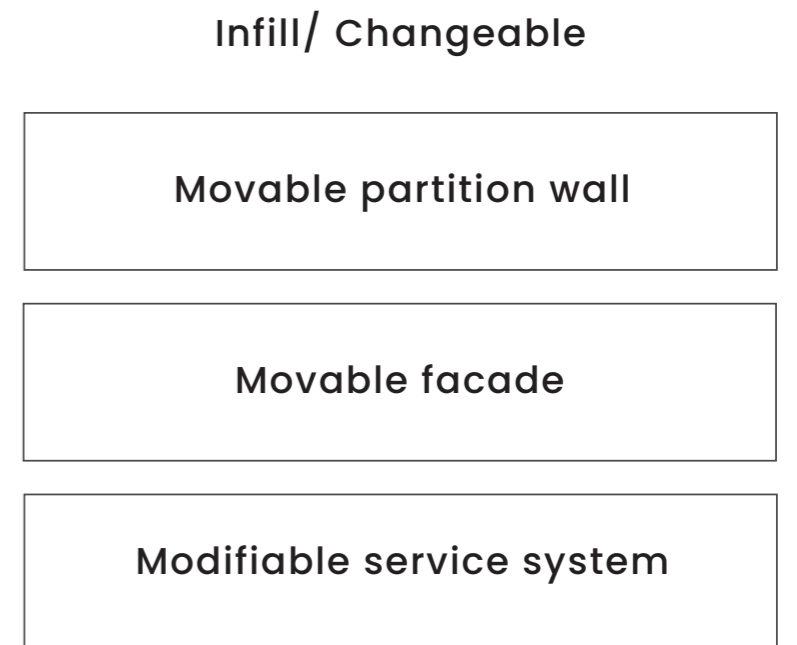
Movable facade

Modifiable service system

# 03 Strategies: Open Building Research



Patch 22



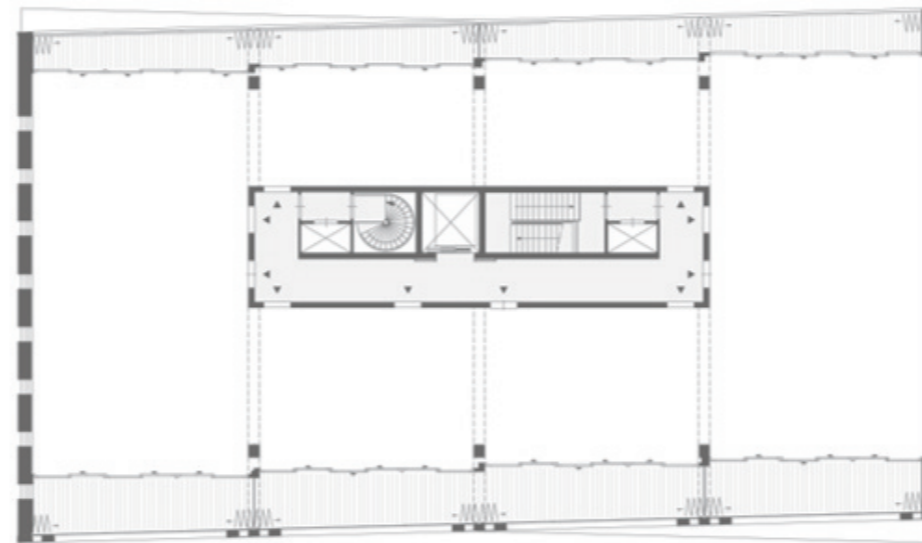
### 03 Strategies: Open Building Research

Support/ Fixed

Open  
structure system

Arrangement of vertical  
circulation

Arrangement of service Shaft



Patch 22

Infill/ Changeable

Movable partition wall

Movable facade

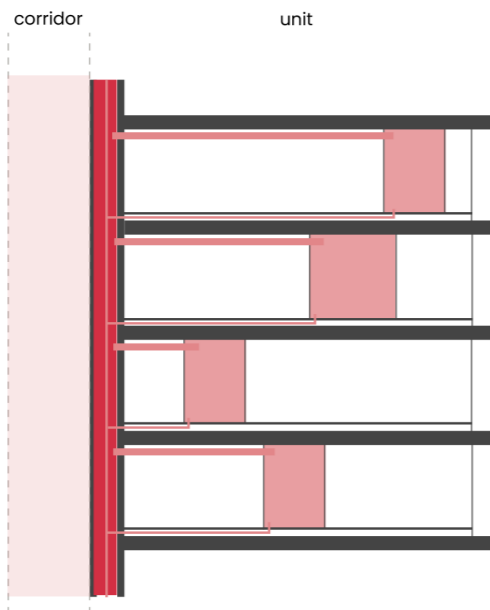
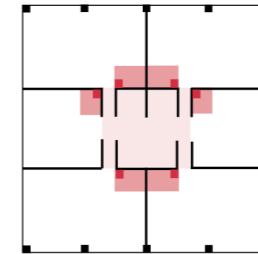
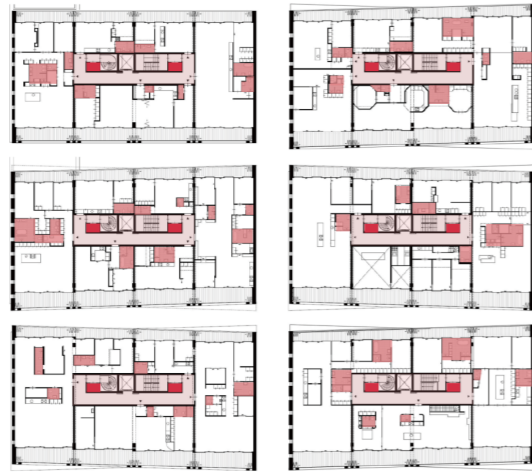
Modifiable service system

# 03 Strategies: Open Building Research

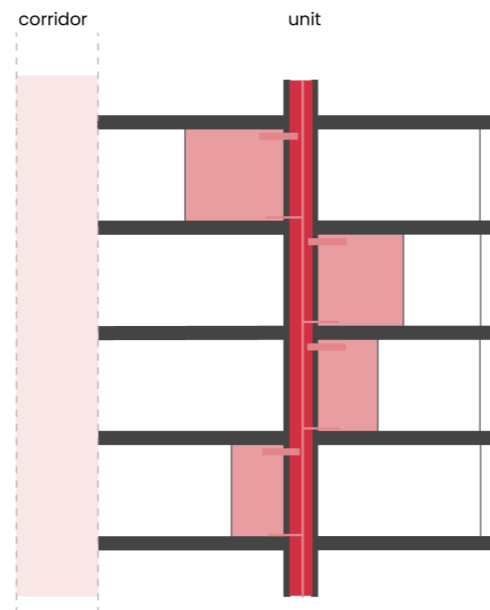
More  
Adaptable



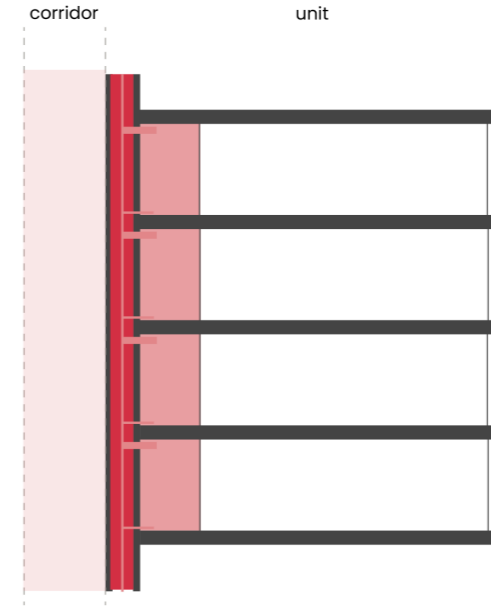
Less  
Adaptable



Adaptable with raised floor but with exposed ventilation



Initially customizable but not adaptable

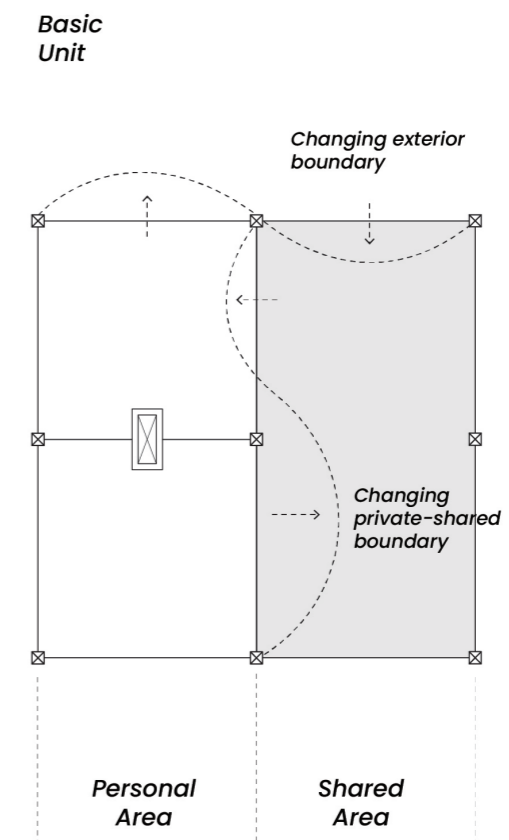
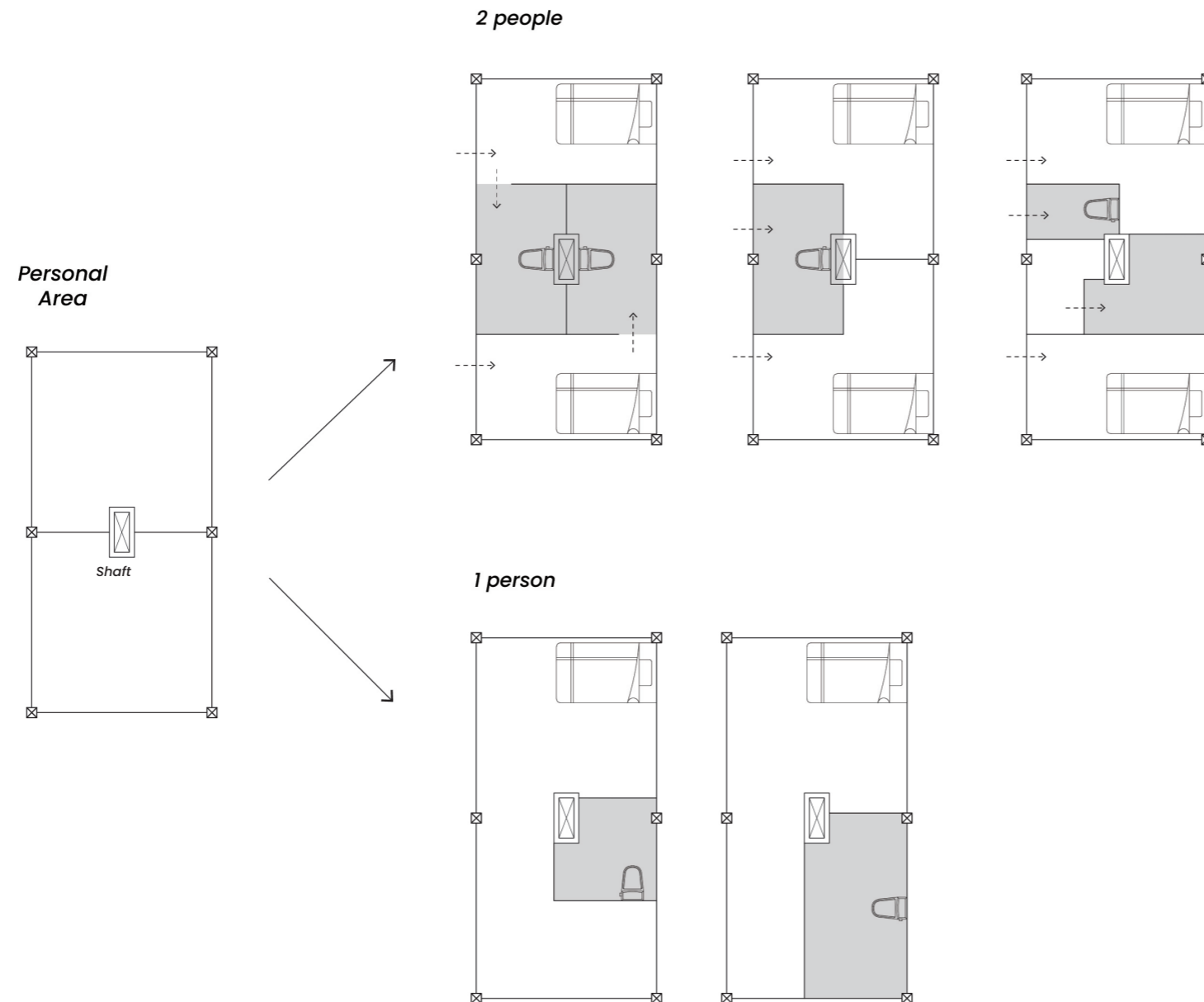
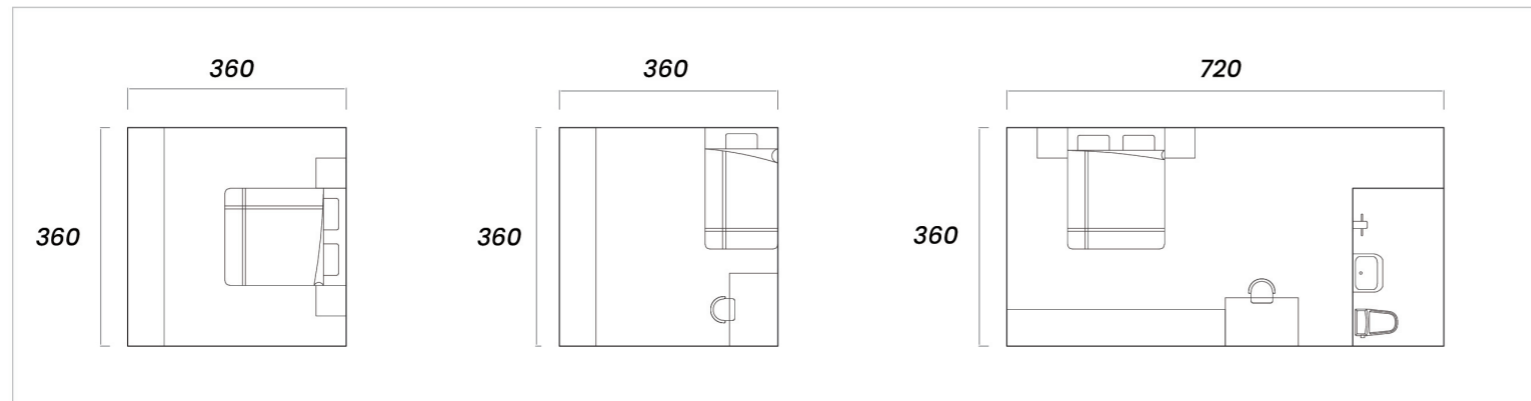


Fixed

## **04 Housing System Design**

# 04 Housing System Design

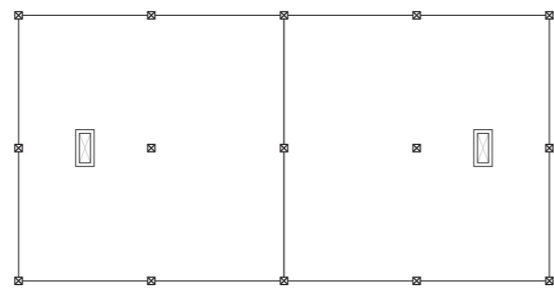
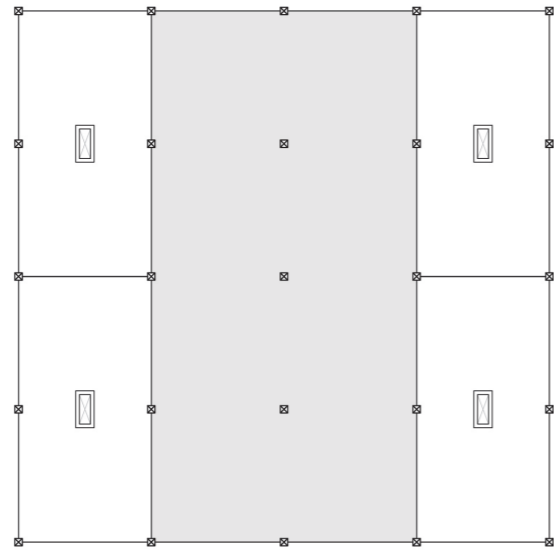
## Basic unit of housing



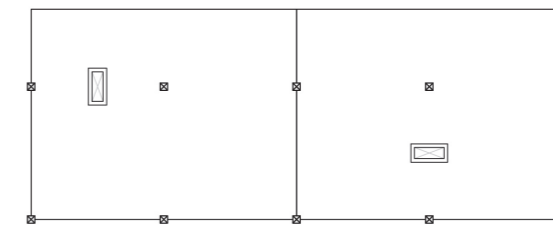
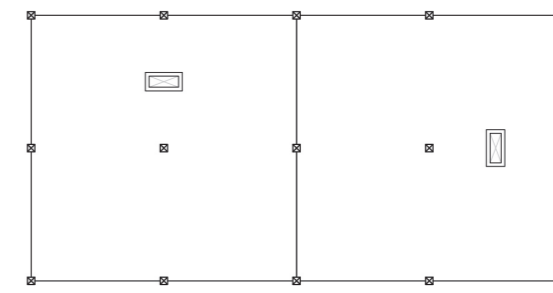
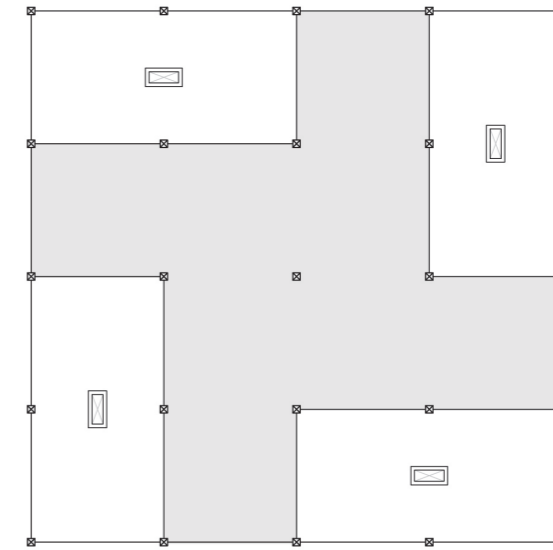
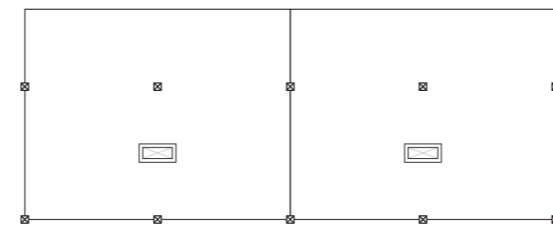
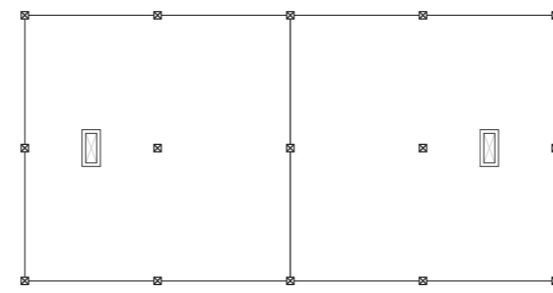
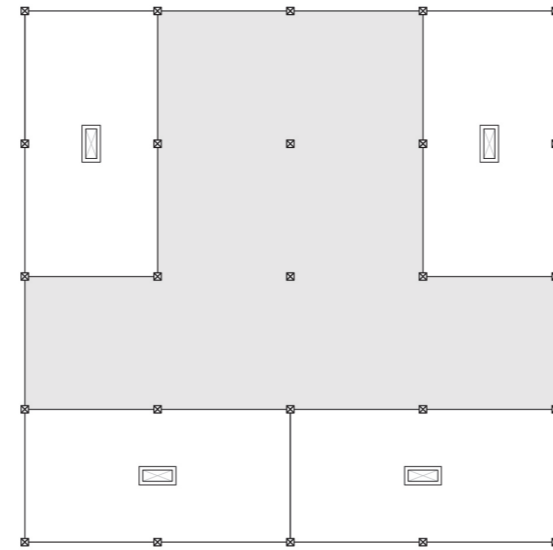
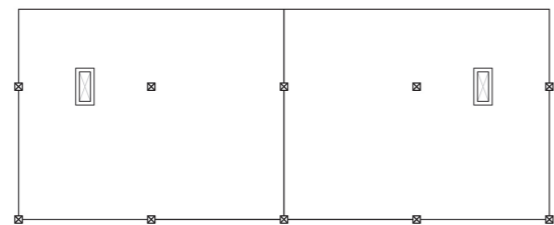
# 04 Housing System Design

## Basic unit of housing

Co-Housing



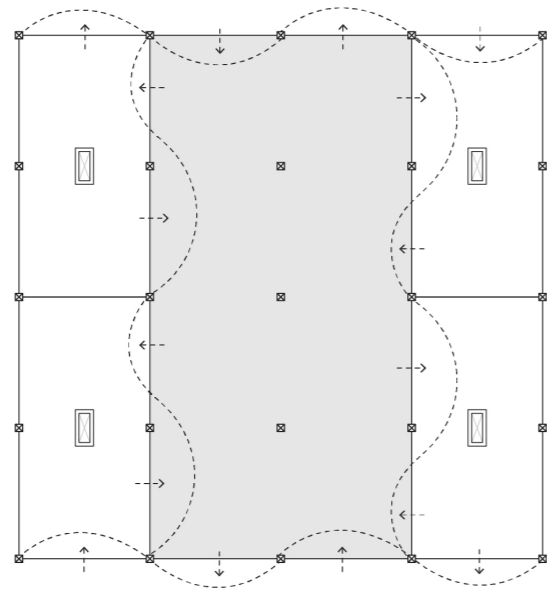
Private Housing



# 04 Housing System Design

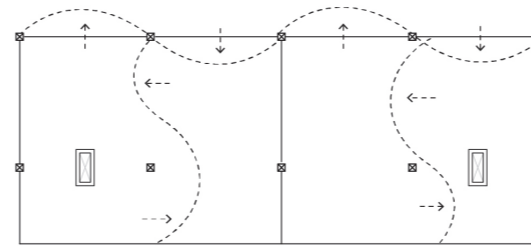
## Basic unit of housing

Co-Housing

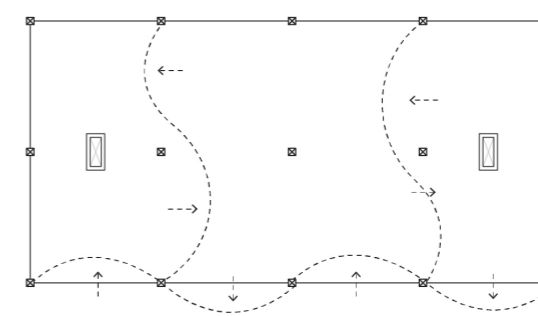
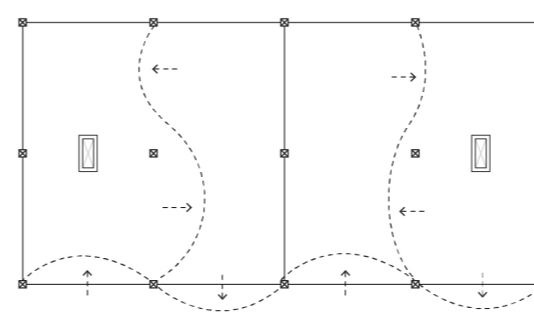
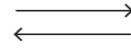
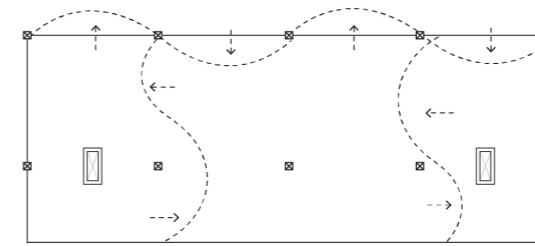


Private Housing

Type A: Studio small

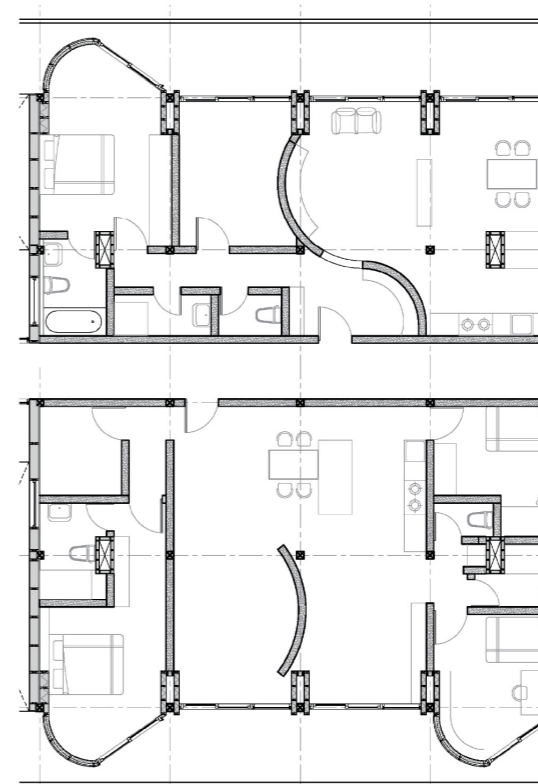
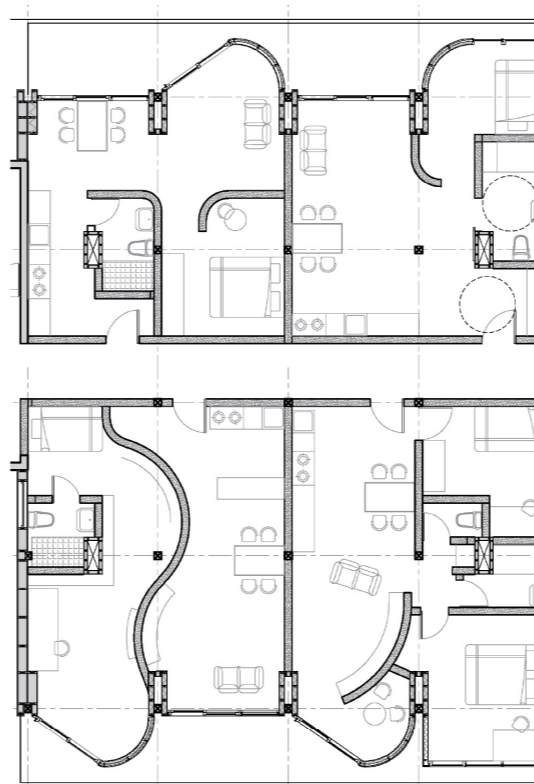
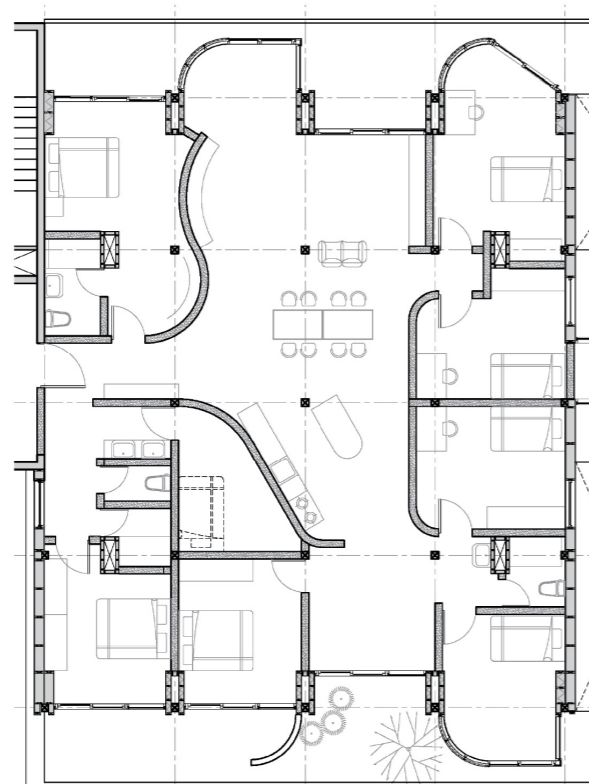


Type C: 2 people



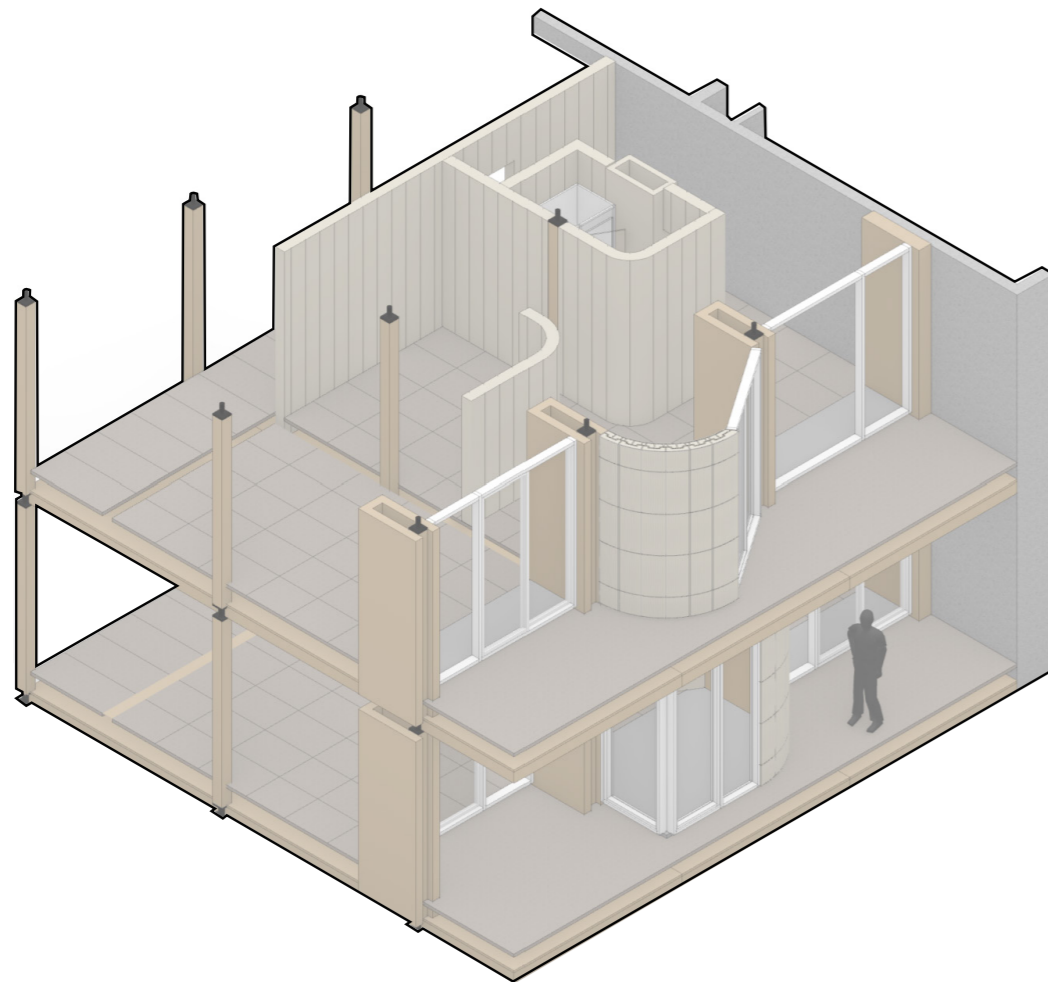
Type B/C: Studio large

Type D: 3 people

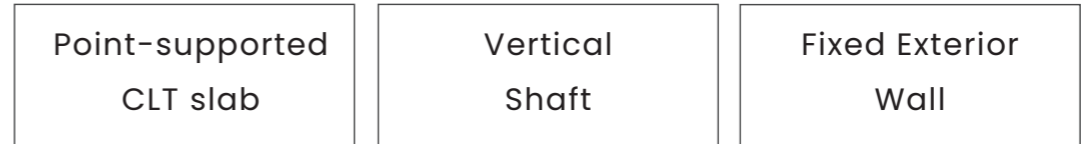


# 04 Housing System Design

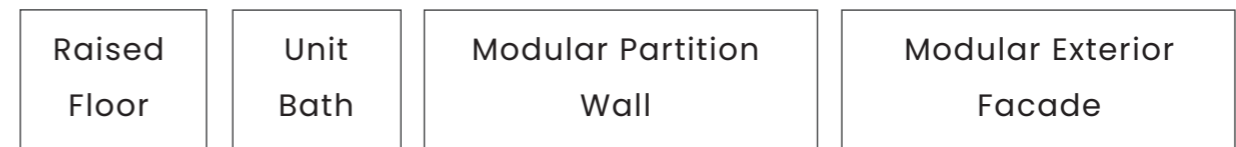
## System overview



### Fixed

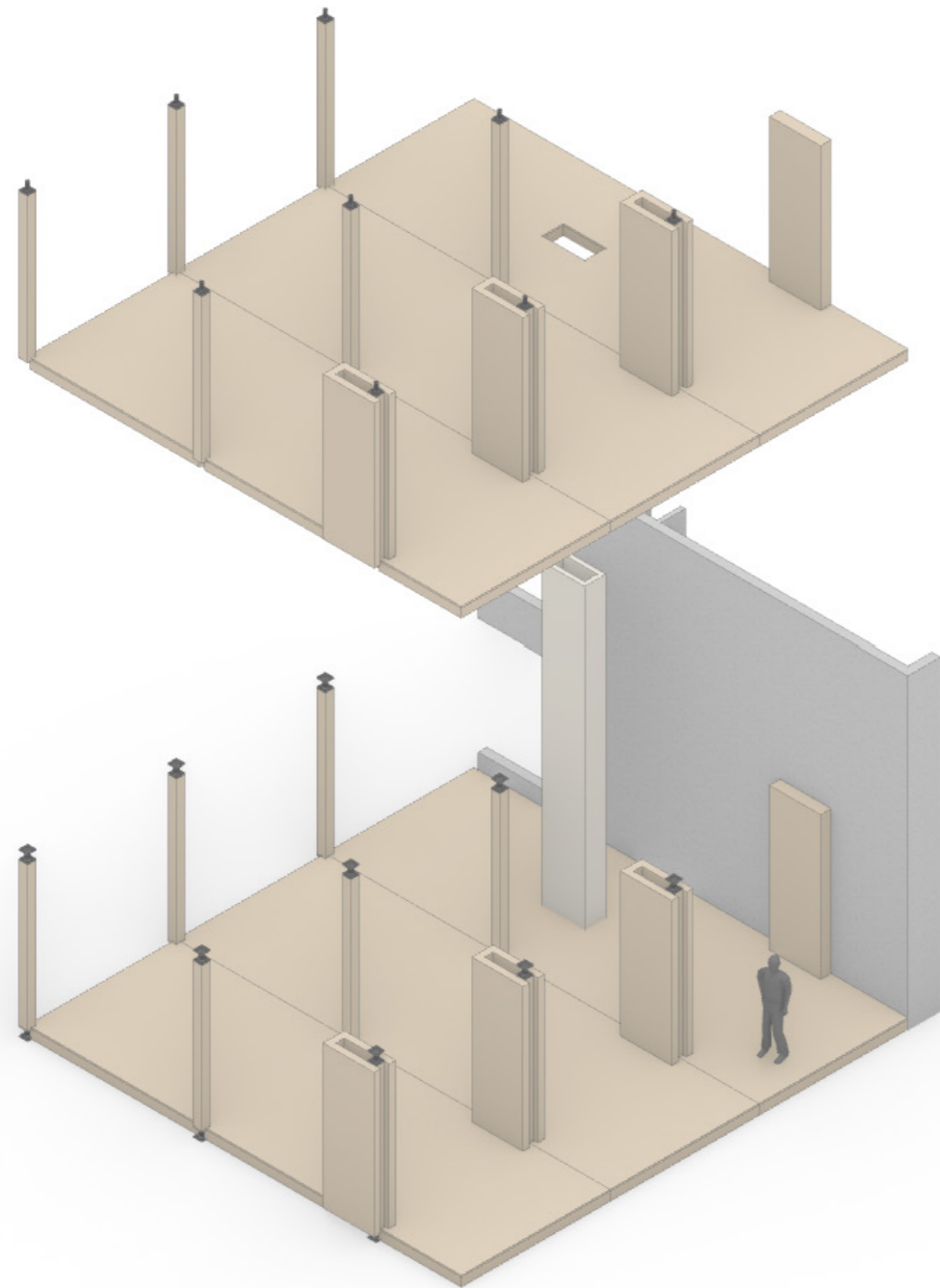


### Changeable



# 04 Housing System Design

System overview



Fixed

Point-supported  
CLT slab

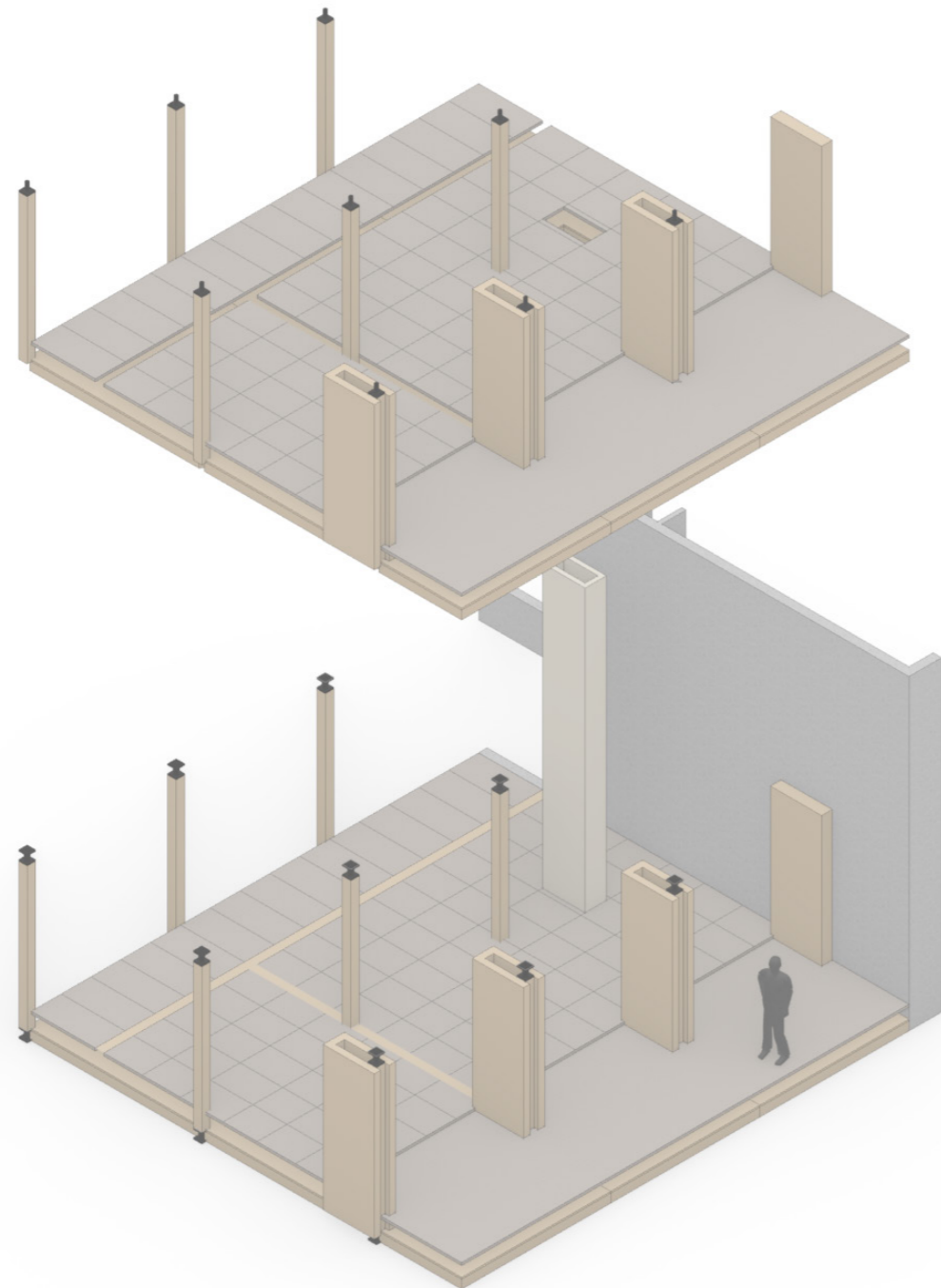
Vertical  
Shaft

Fixed Exterior  
Wall

Changeable

# 04 Housing System Design

## System overview



Fixed

Point-supported  
CLT slab

Vertical  
Shaft

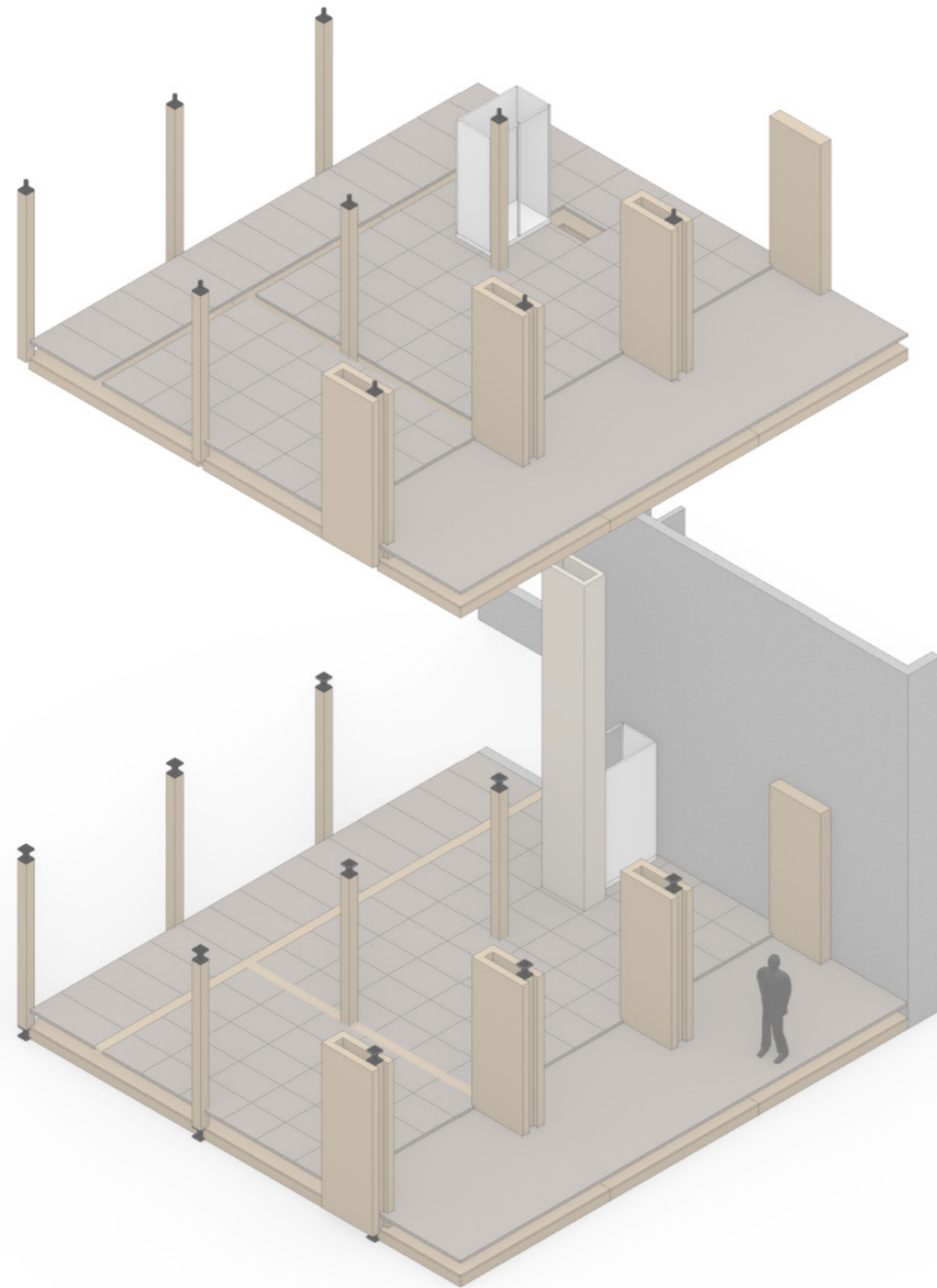
Fixed Exterior  
Wall

Changeable

Raised  
Floor

# 04 Housing System Design

## System overview



### Fixed

Point-supported  
CLT slab

Vertical  
Shaft

Fixed Exterior  
Wall

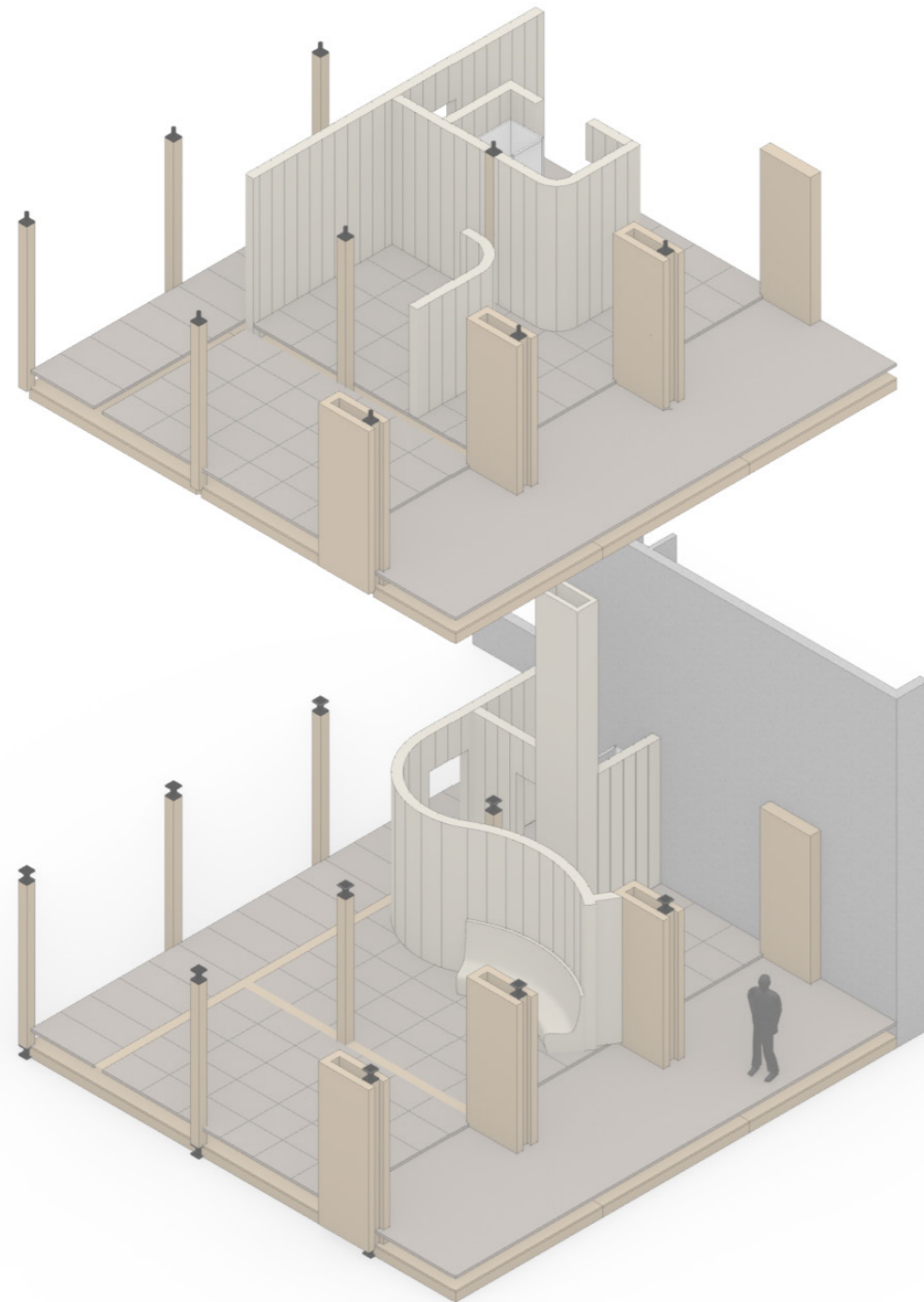
### Changeable

Raised  
Floor

Unit  
Bath

# 04 Housing System Design

## System overview



### Fixed

Point-supported  
CLT slab

Vertical  
Shaft

Fixed Exterior  
Wall

### Changeable

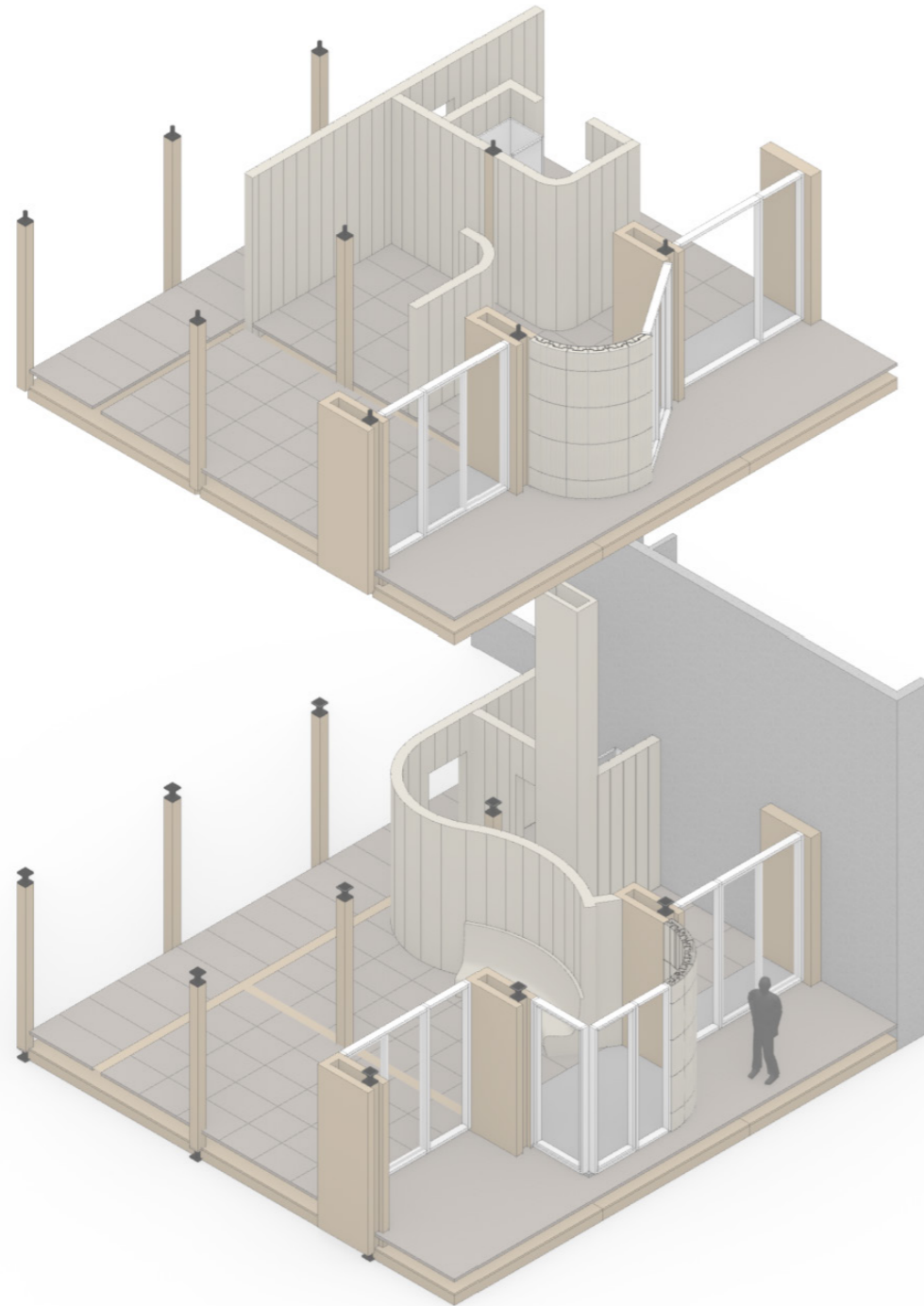
Raised  
Floor

Unit  
Bath

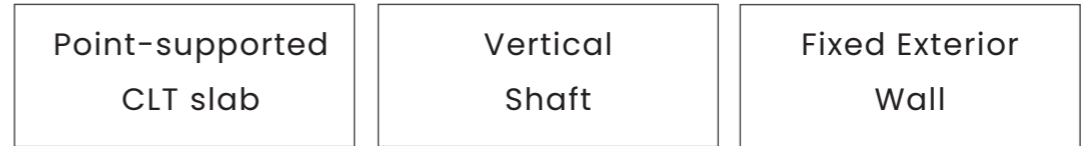
Modular Partition  
Wall

# 04 Housing System Design

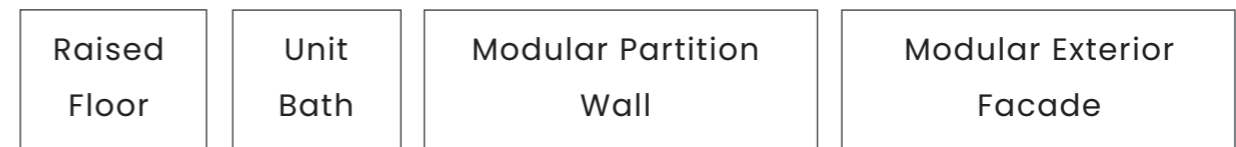
## System overview



### Fixed

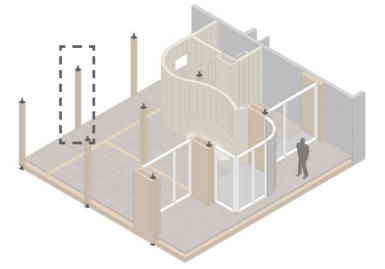


### Changeable



# 04 Housing System Design

Structure system



Column and Beam

Span: 6-8m

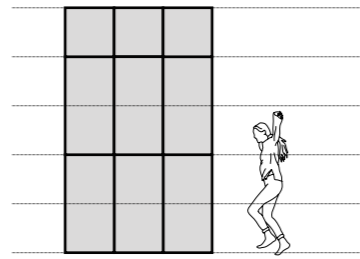
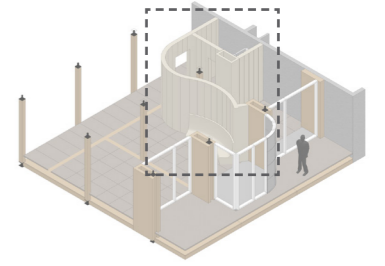


Point-supported  
CLT slab

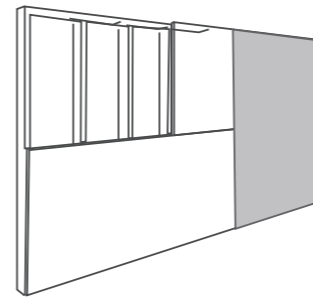
Span: 2.4-3.6m

# 04 Housing System Design

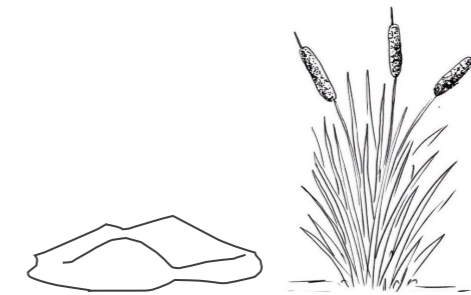
Modular partition wall



Manually demountable



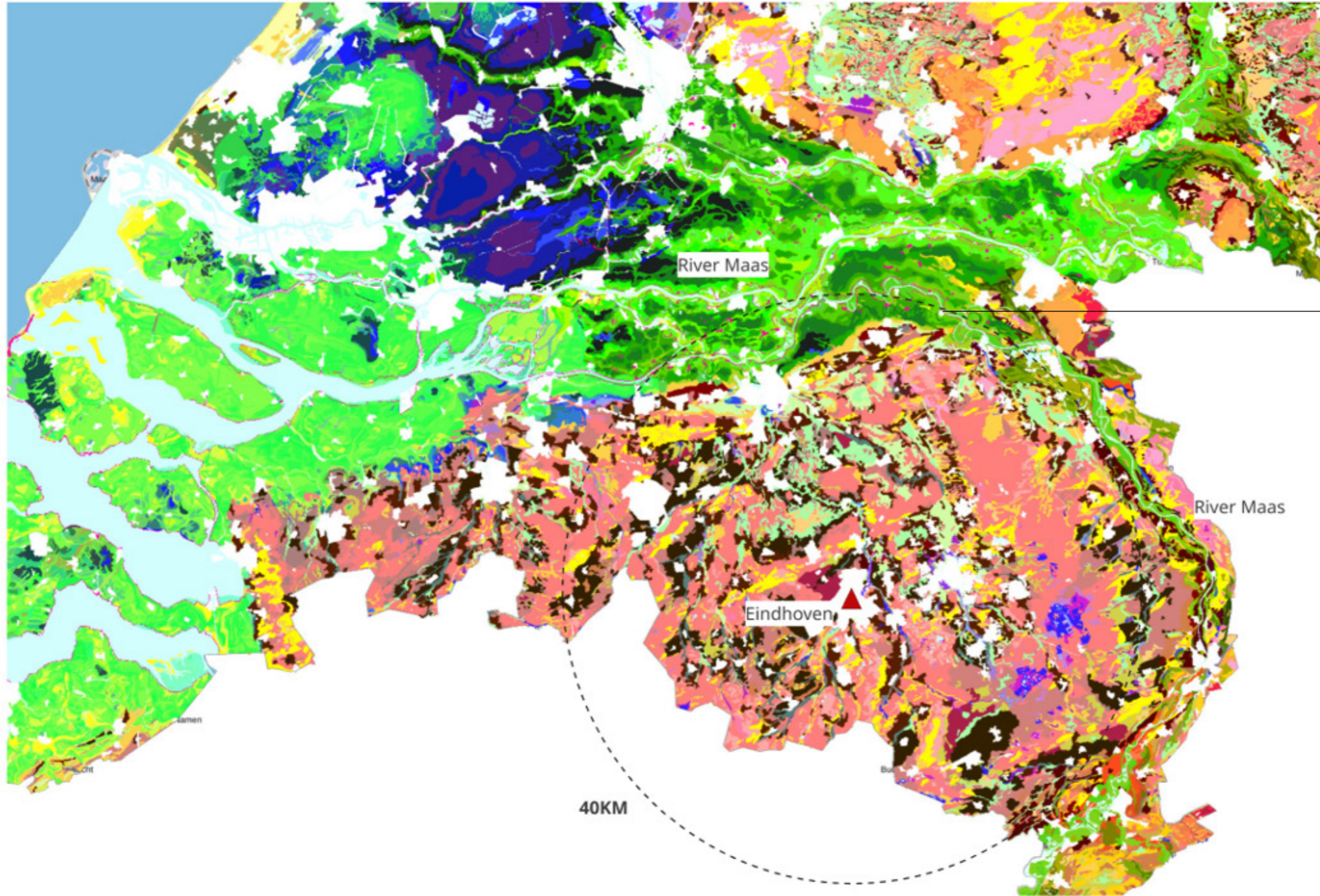
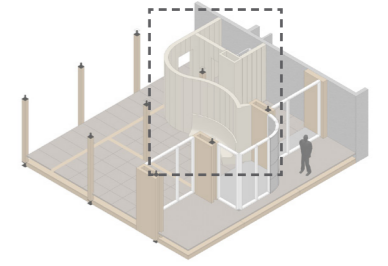
Mono material



Bio-material

# 04 Housing System Design

Modular partition wall: earth based brick



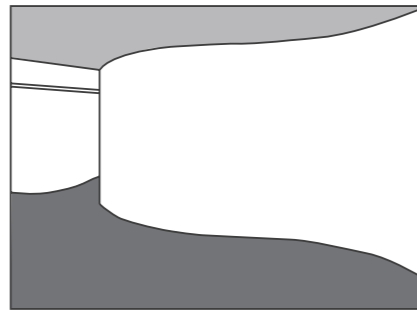
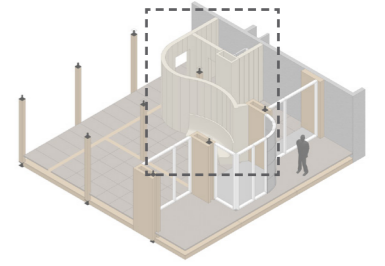
River Maas:  
Constant supply of clay



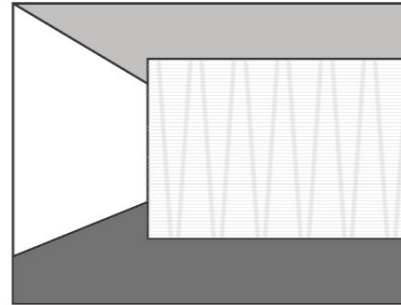
Earth based material

# 04 Housing System Design

Modular partition wall: 3D printed earth based brick



Free form



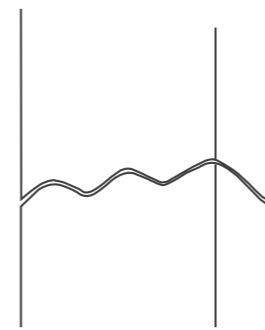
No finishing needed



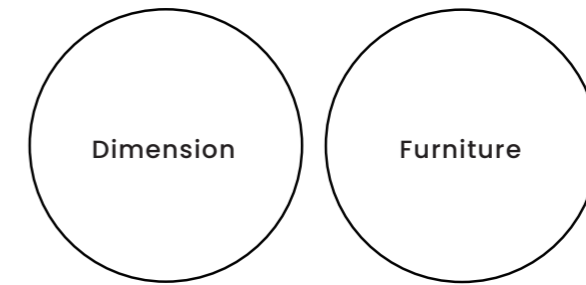
Recyclable & No-waste production



Light weight



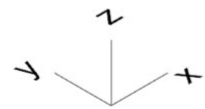
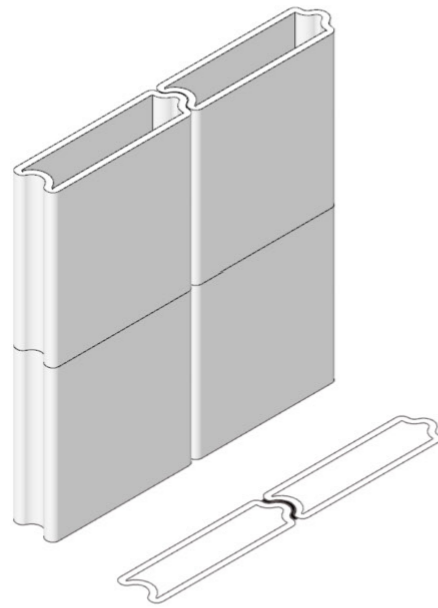
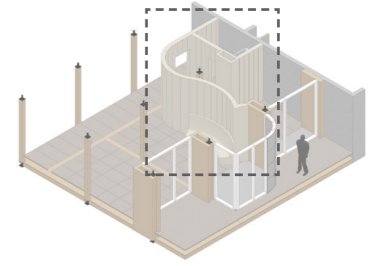
Interlock connection with mono material



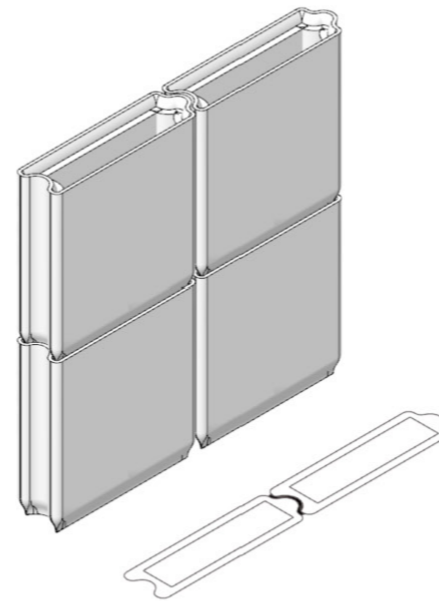
Customizable On site digital fabrication

# 04 Housing System Design

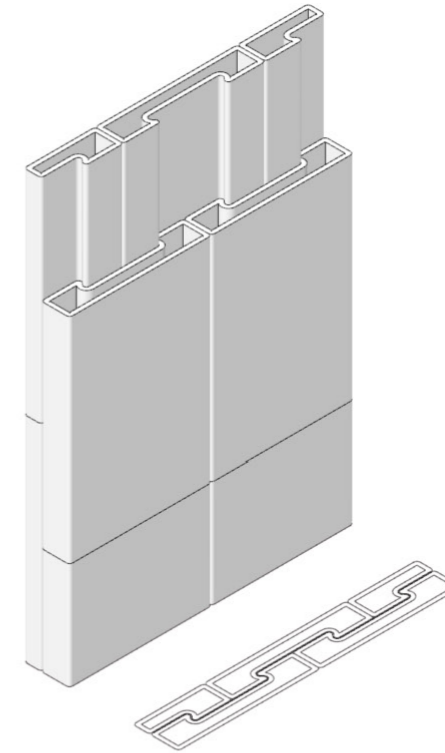
3D printed earth based brick: Brick composition



Unstable



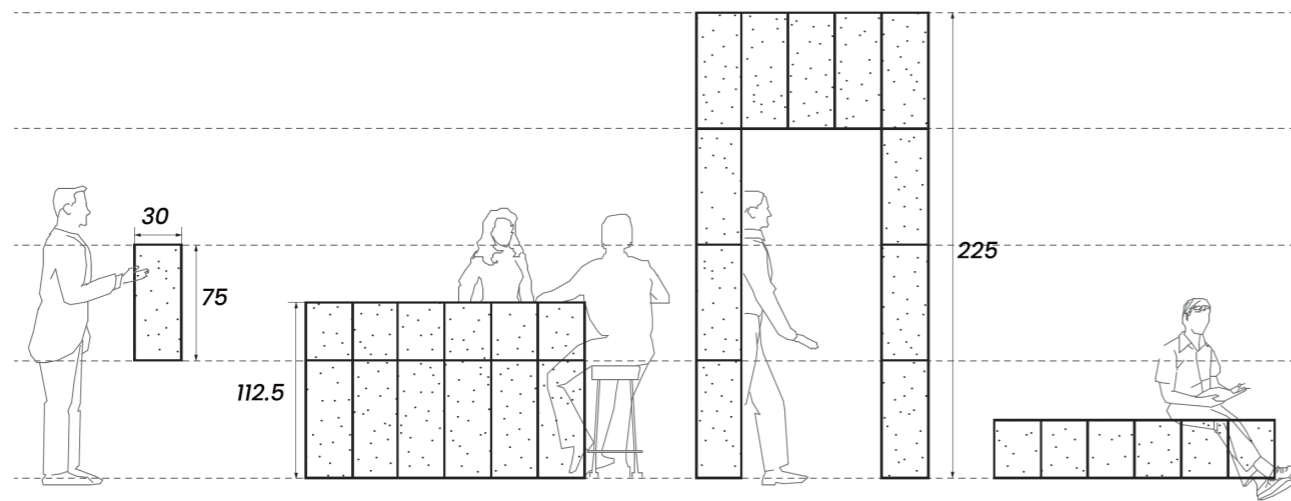
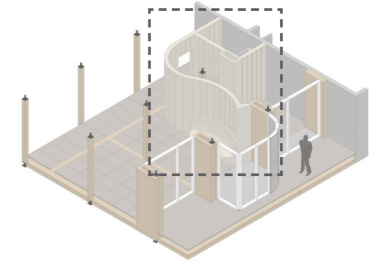
Stable/ Not Printable



Stable/ Self Interlocking

# 04 Housing System Design

3D printed earth based interior wall: Dimension study



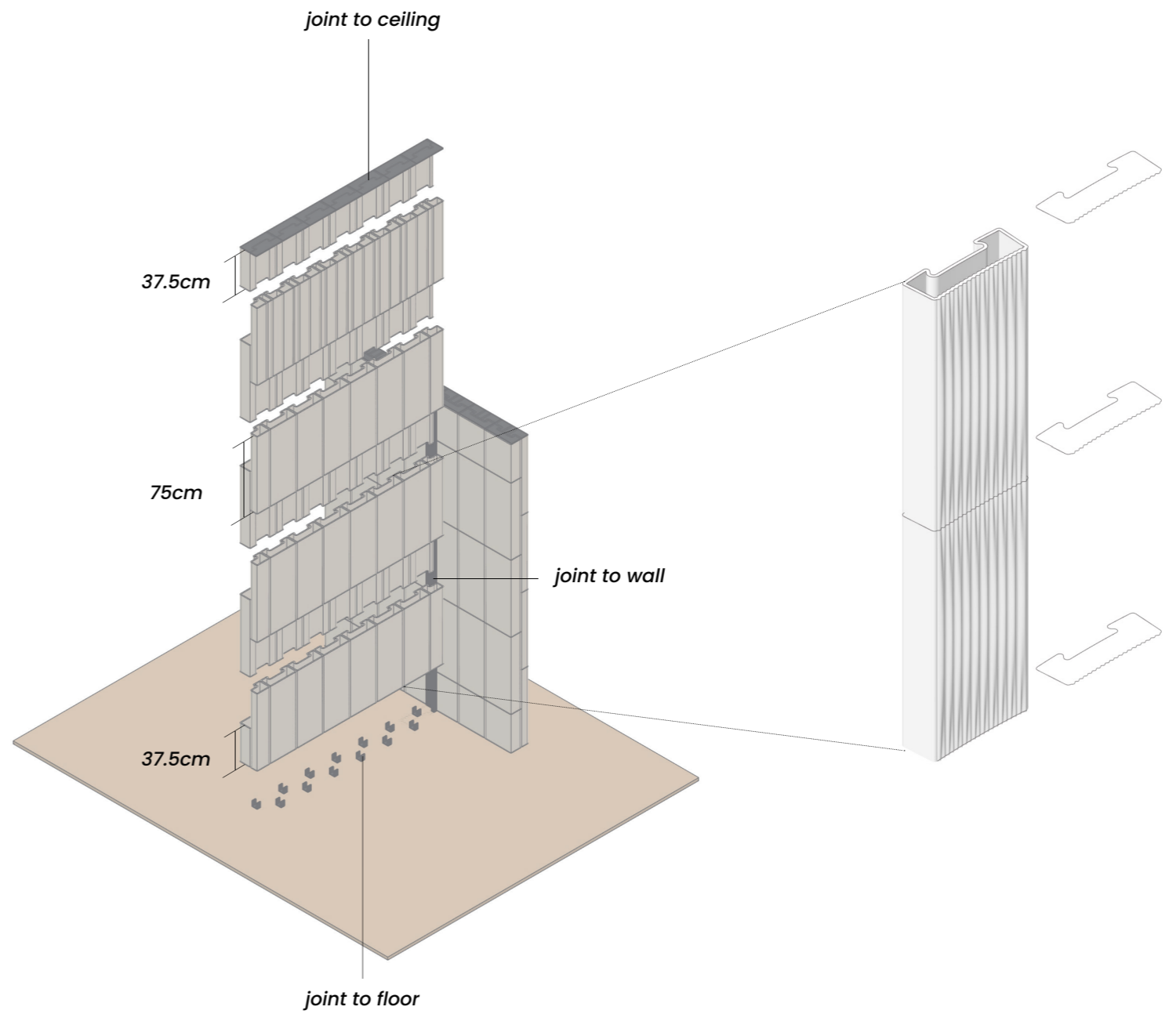
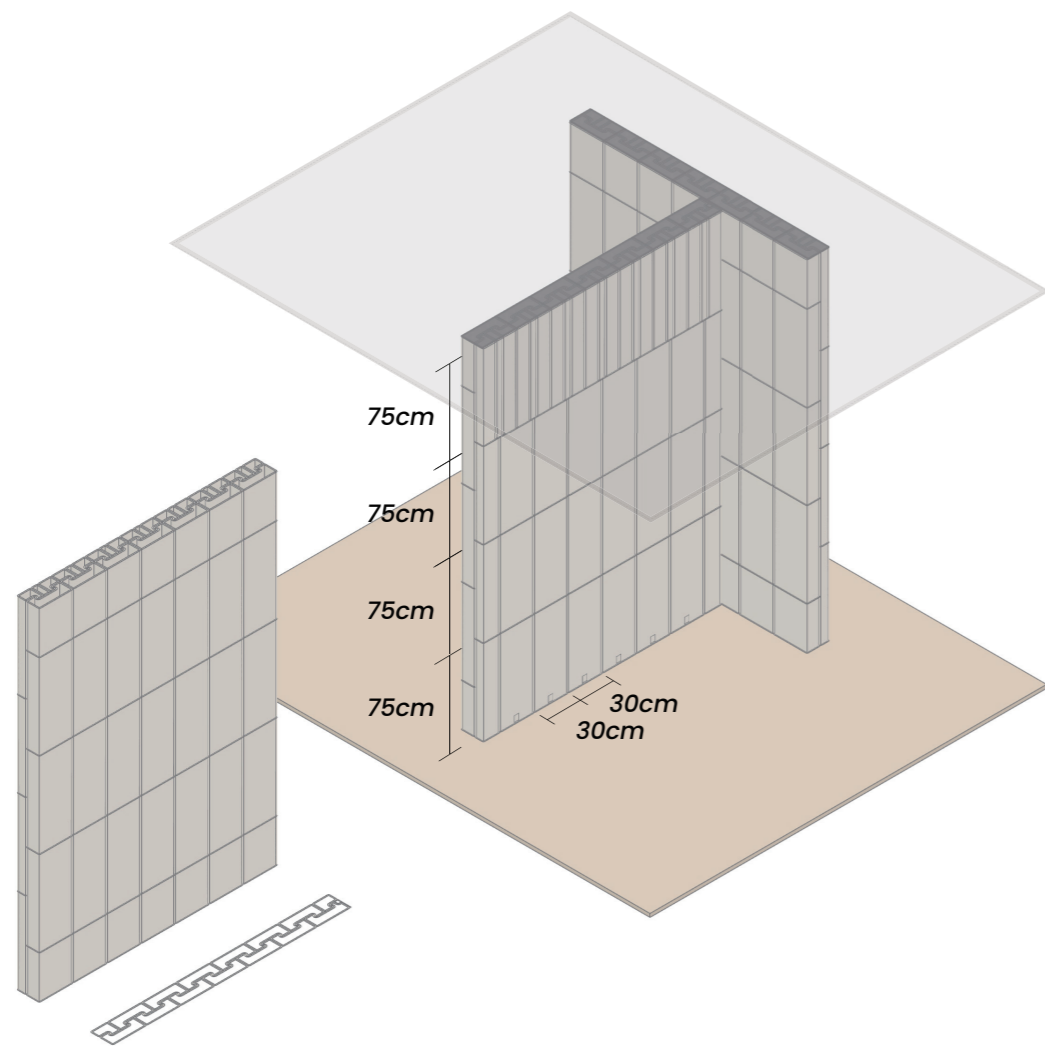
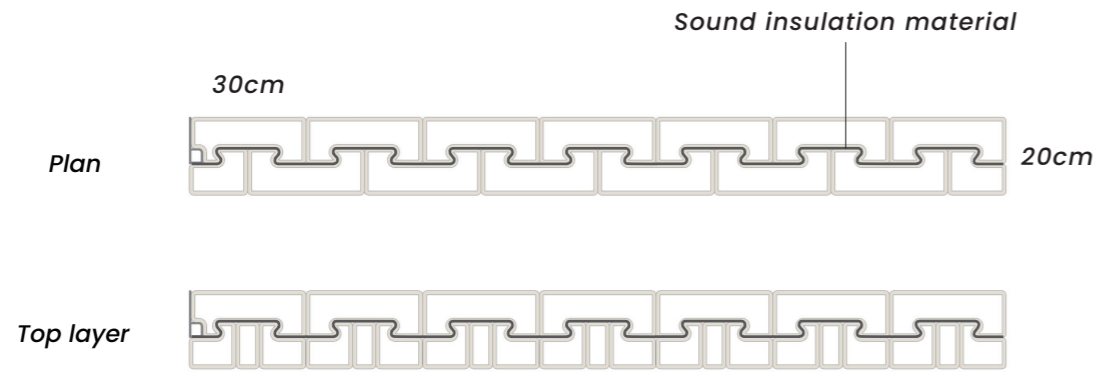
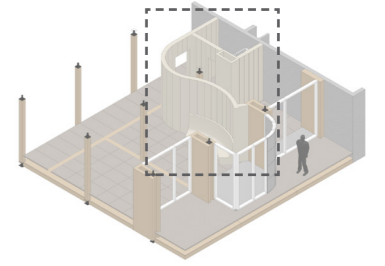
Height

Material	Unit weight(kg/m <sup>2</sup> )
Brick, 12cm	220
Gypsum Block Wall (10cm), 1/2" Gyp Board Each Side	85
ALC (10cm), 1/2" Gyp Board Each Side	76
Wood Studs, 2x4, Plastered Two Sides	98
Wood or Steel Studs, 1/2" Gyp Board Each Side	39
Designed system (20cm), 1.5cm thickness	131
Designed system (20cm), 1cm thickness	88

Thickness

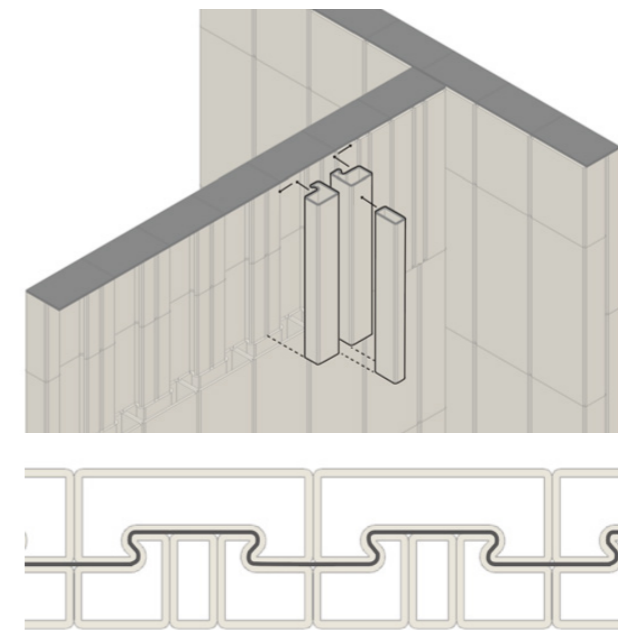
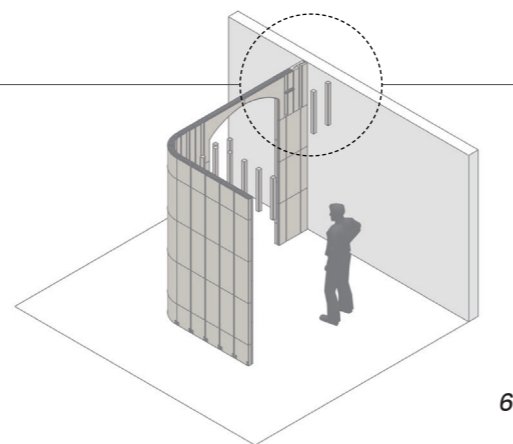
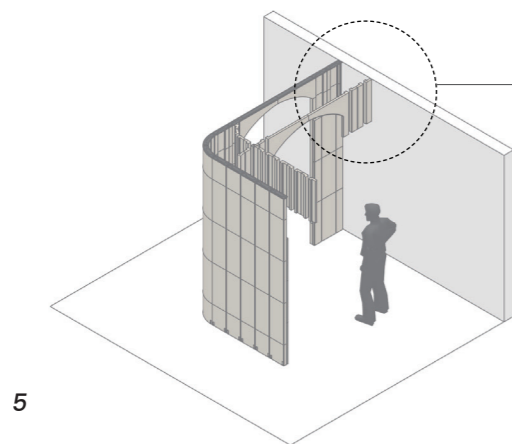
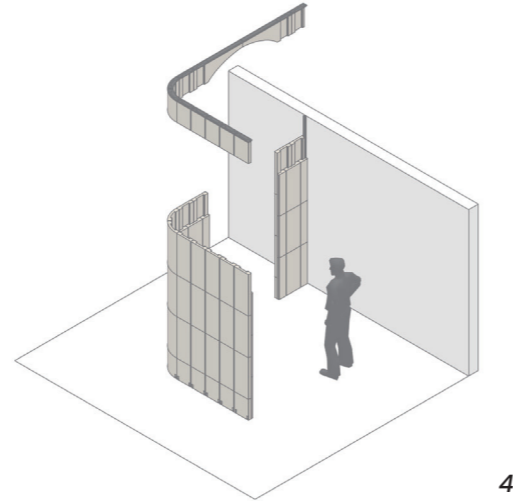
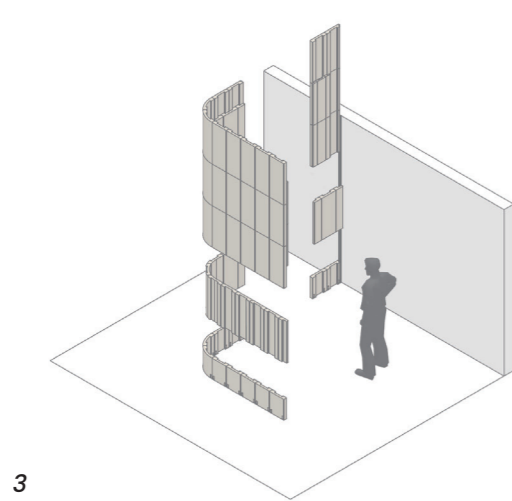
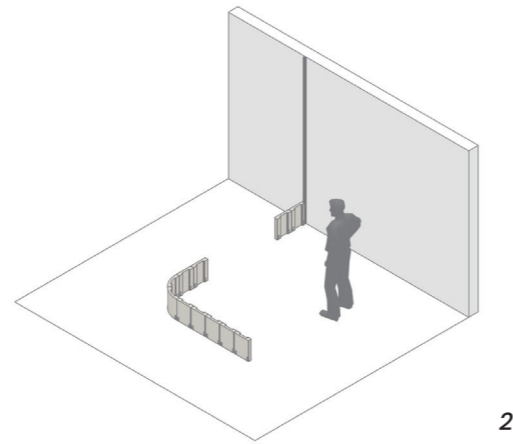
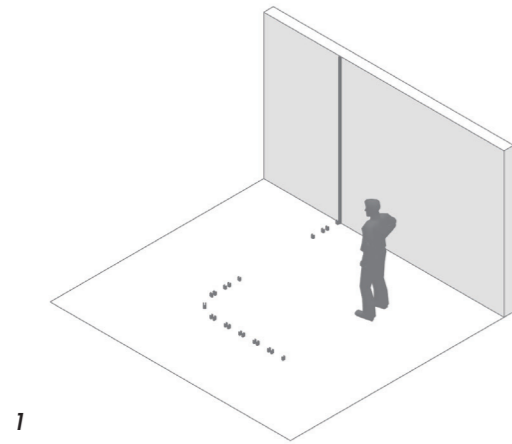
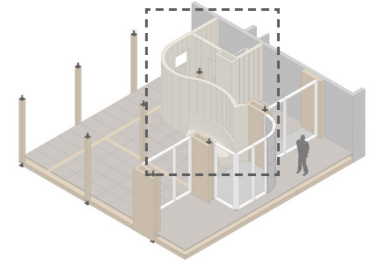
# 04 Housing System Design

## 3D printed earth based interior wall: Basic module



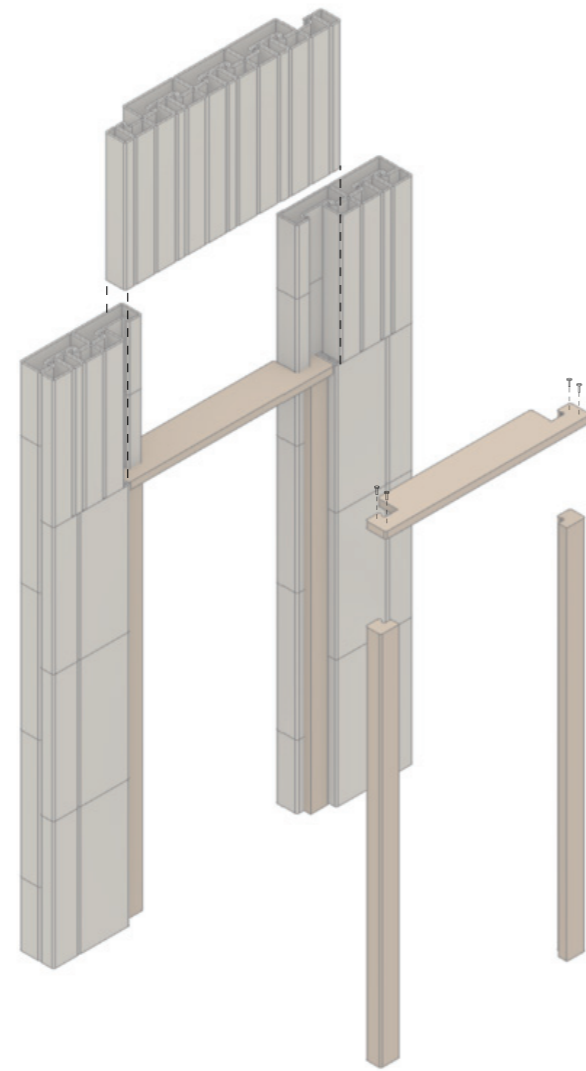
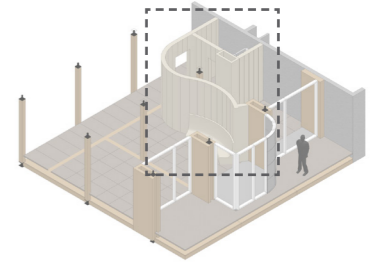
# 04 Housing System Design

3D printed earth based interior wall: Assembly sequence

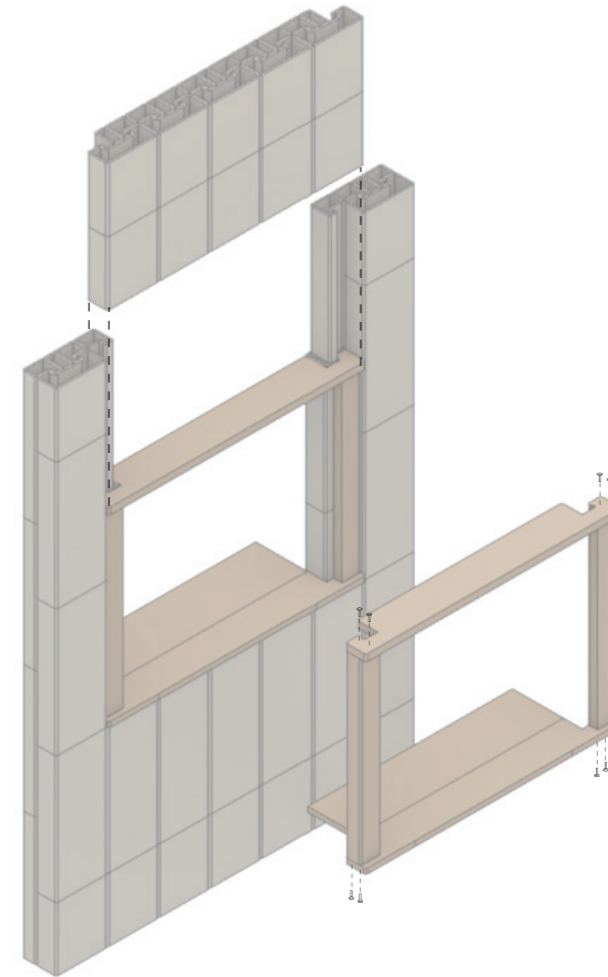


# 04 Housing System Design

3D printed earth based interior wall: Type



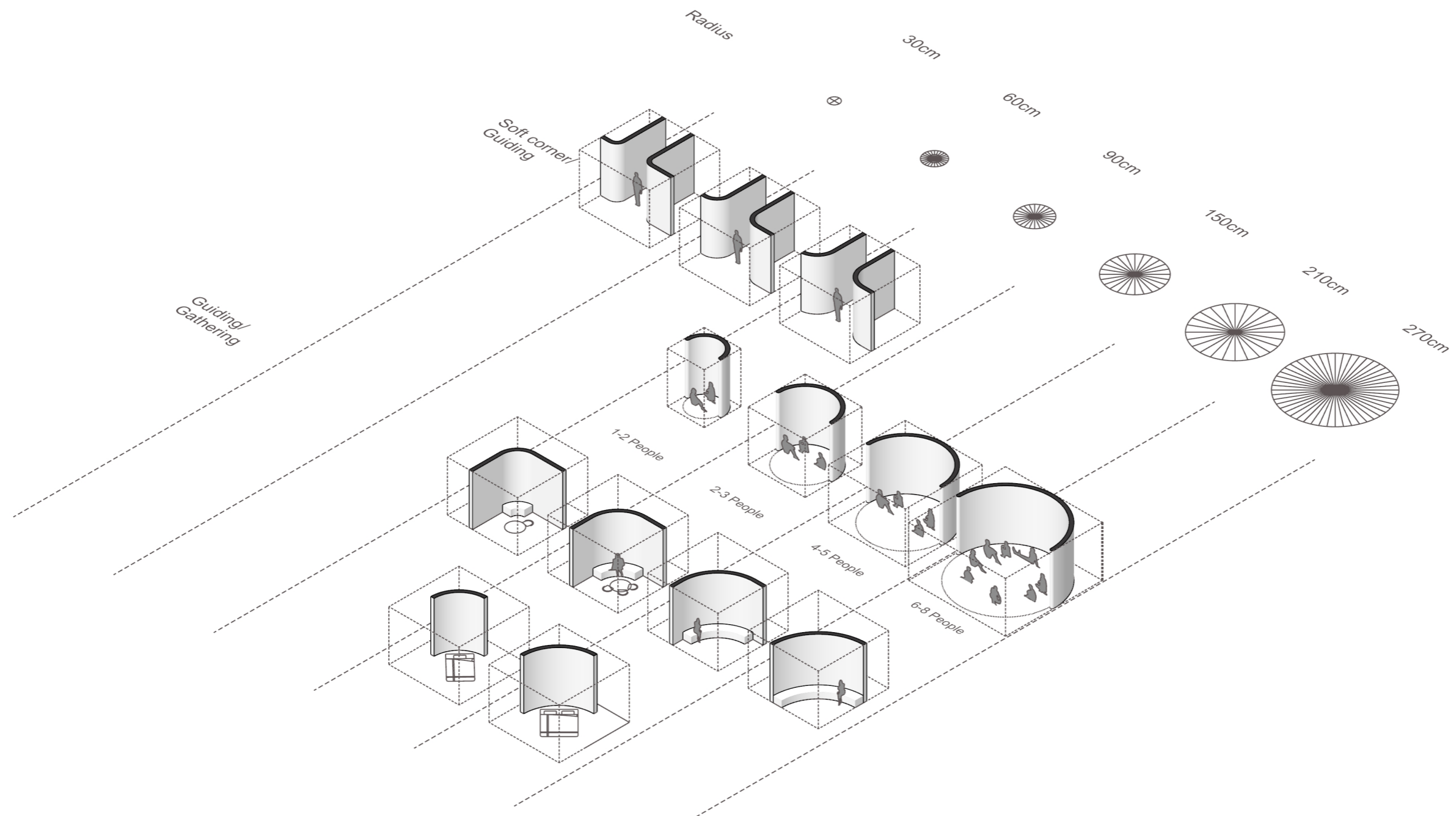
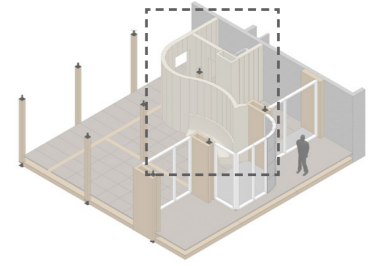
Door



Window

# 04 Housing System Design

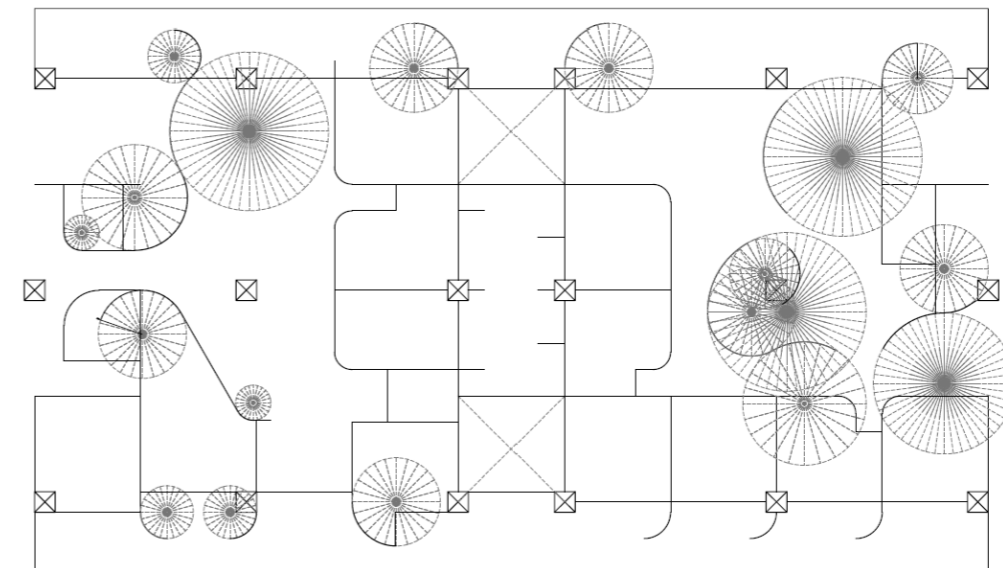
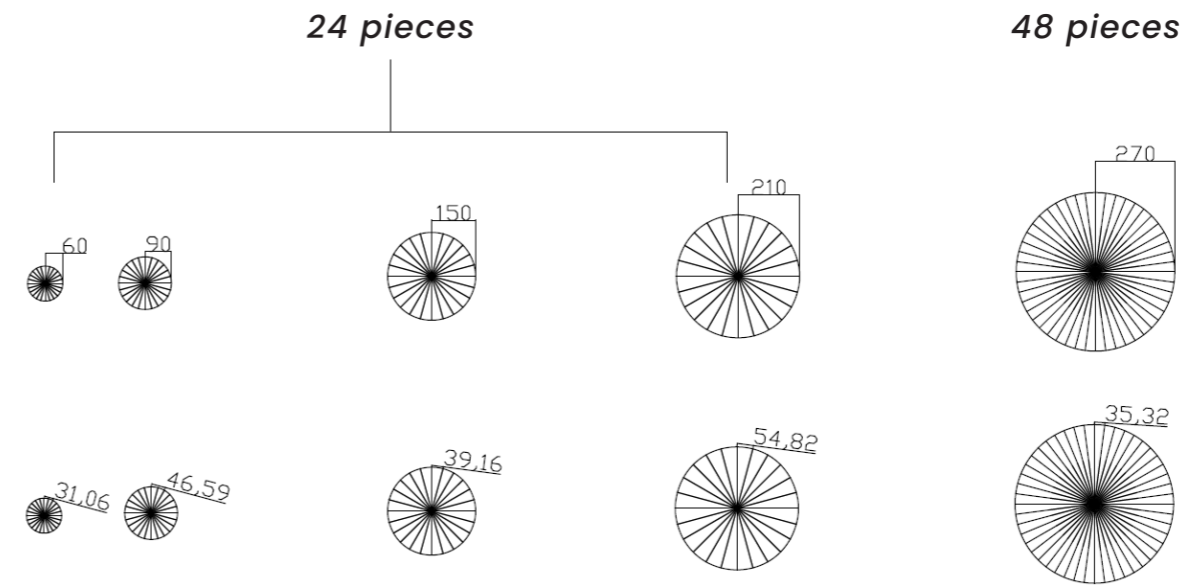
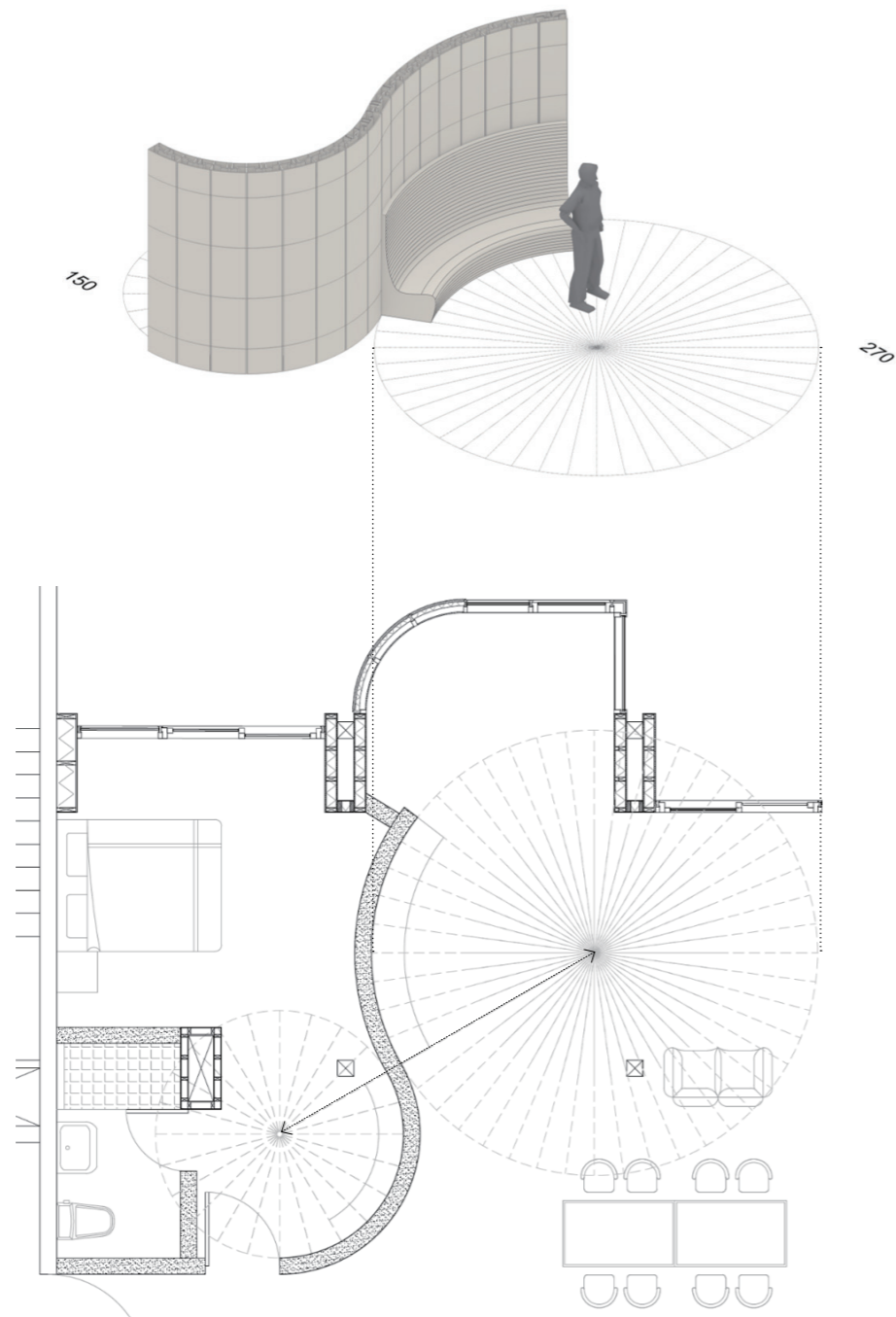
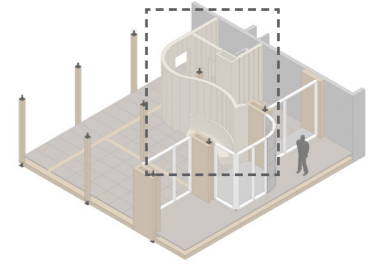
3D printed earth based interior wall: Type



Curved wall

# 04 Housing System Design

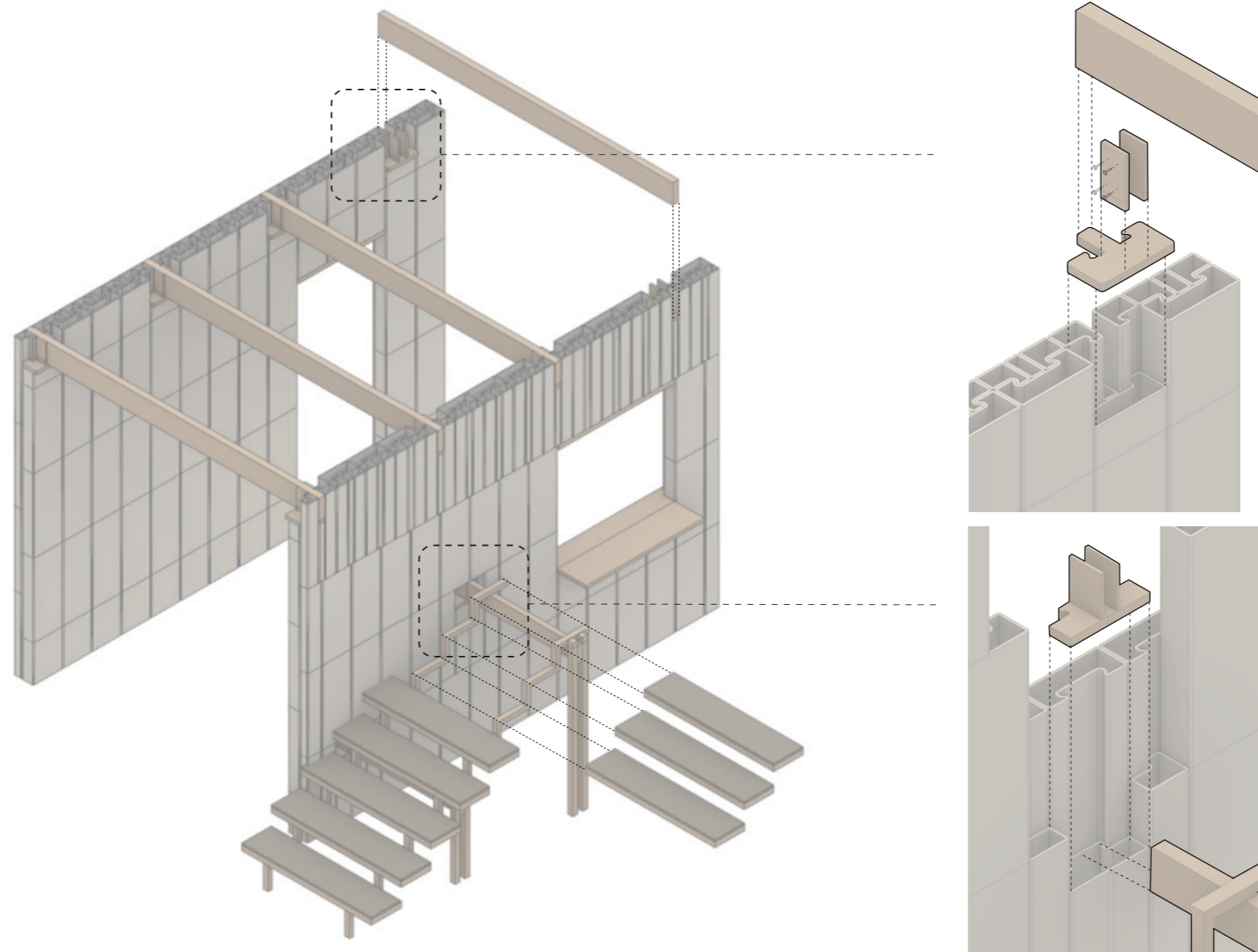
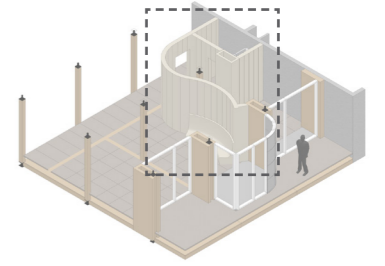
3D printed earth based interior wall: Type



Curved wall

# 04 Housing System Design

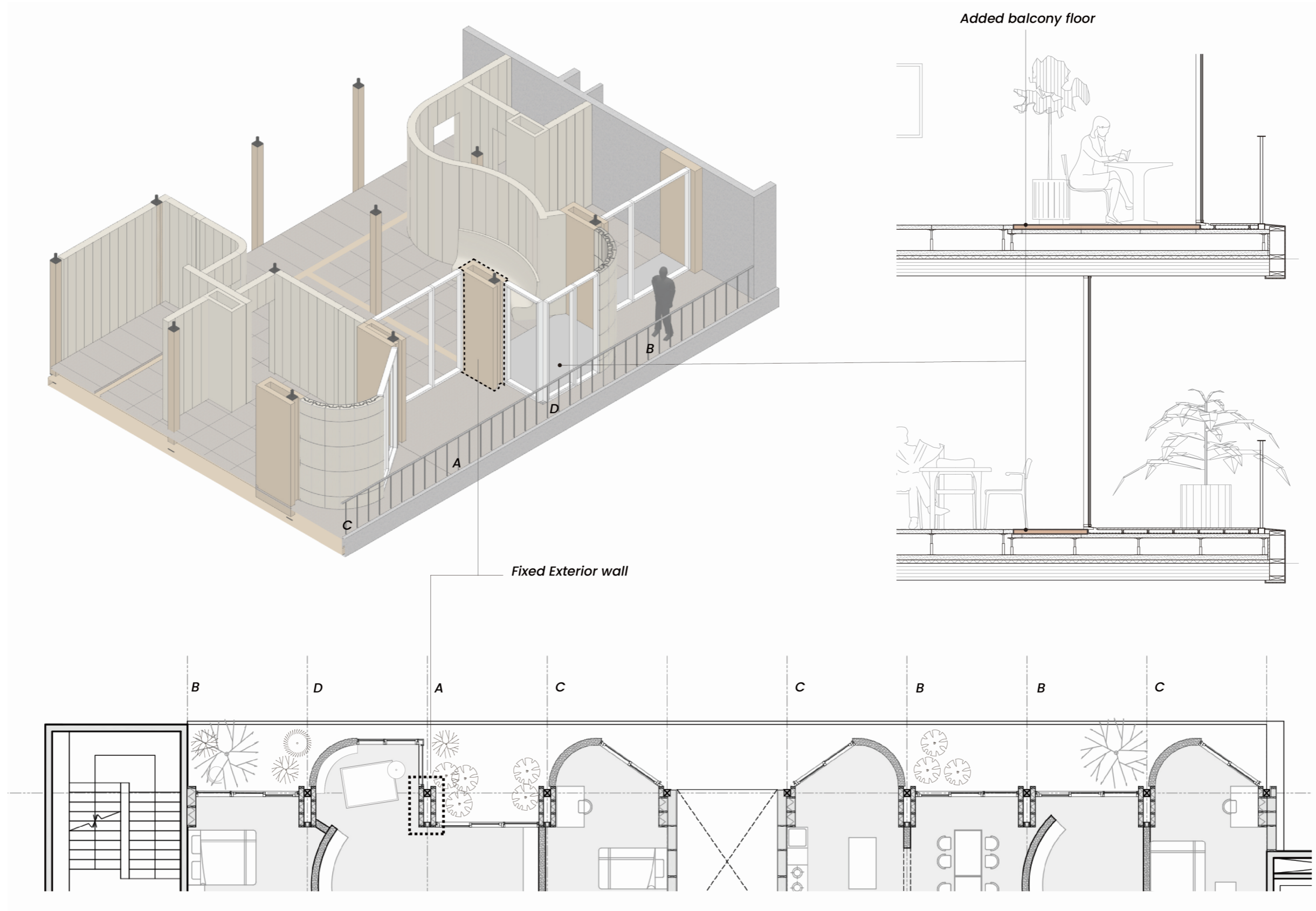
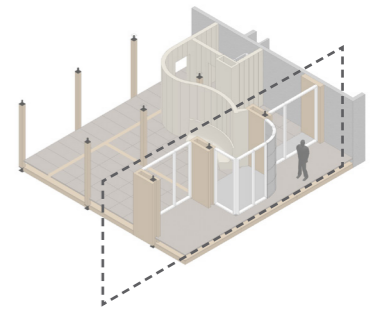
3D printed earth based interior wall: Type



Stairs & Mezzanine

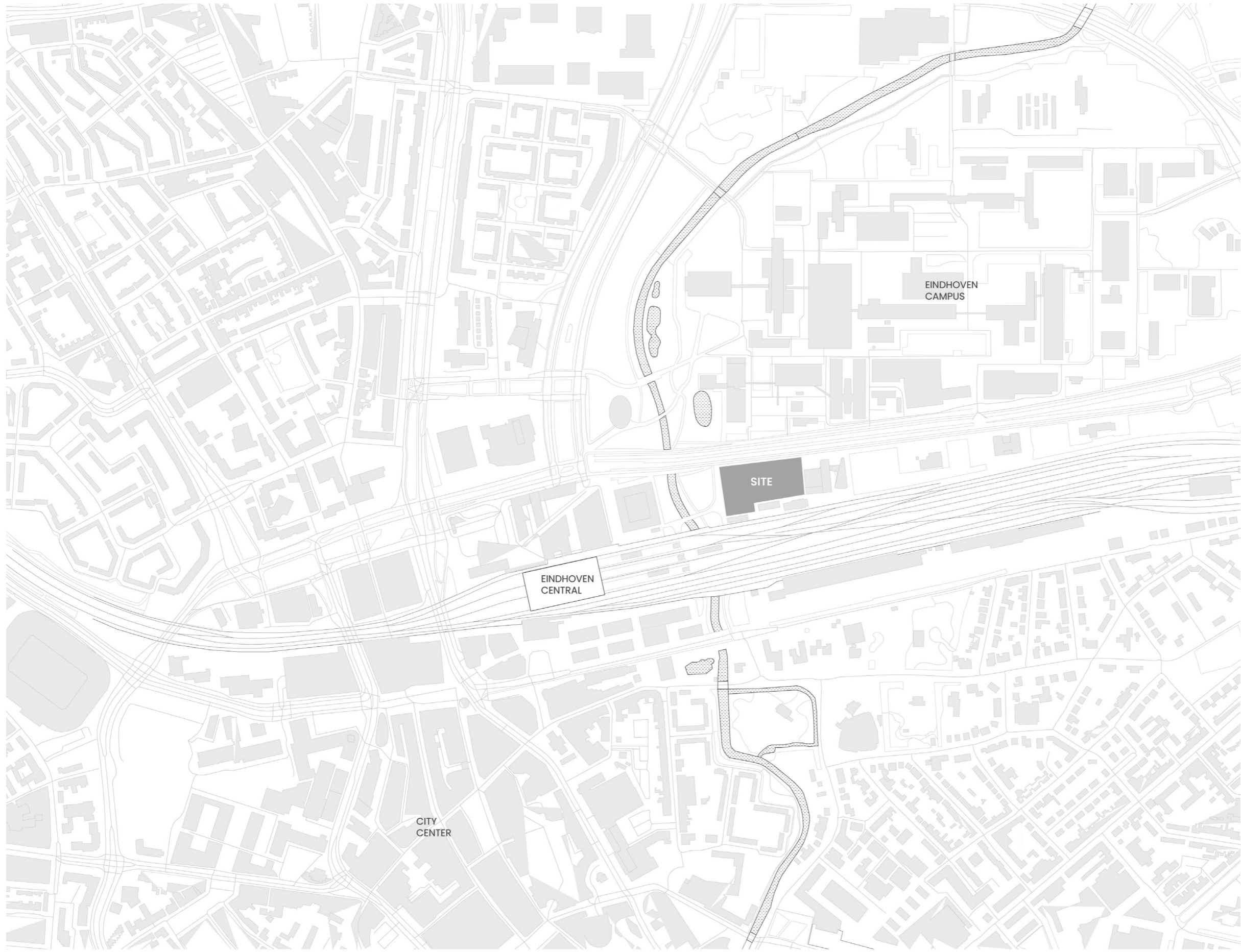
# 04 Housing System Design

Modular Exterior Facade: Changing boundary of in and out

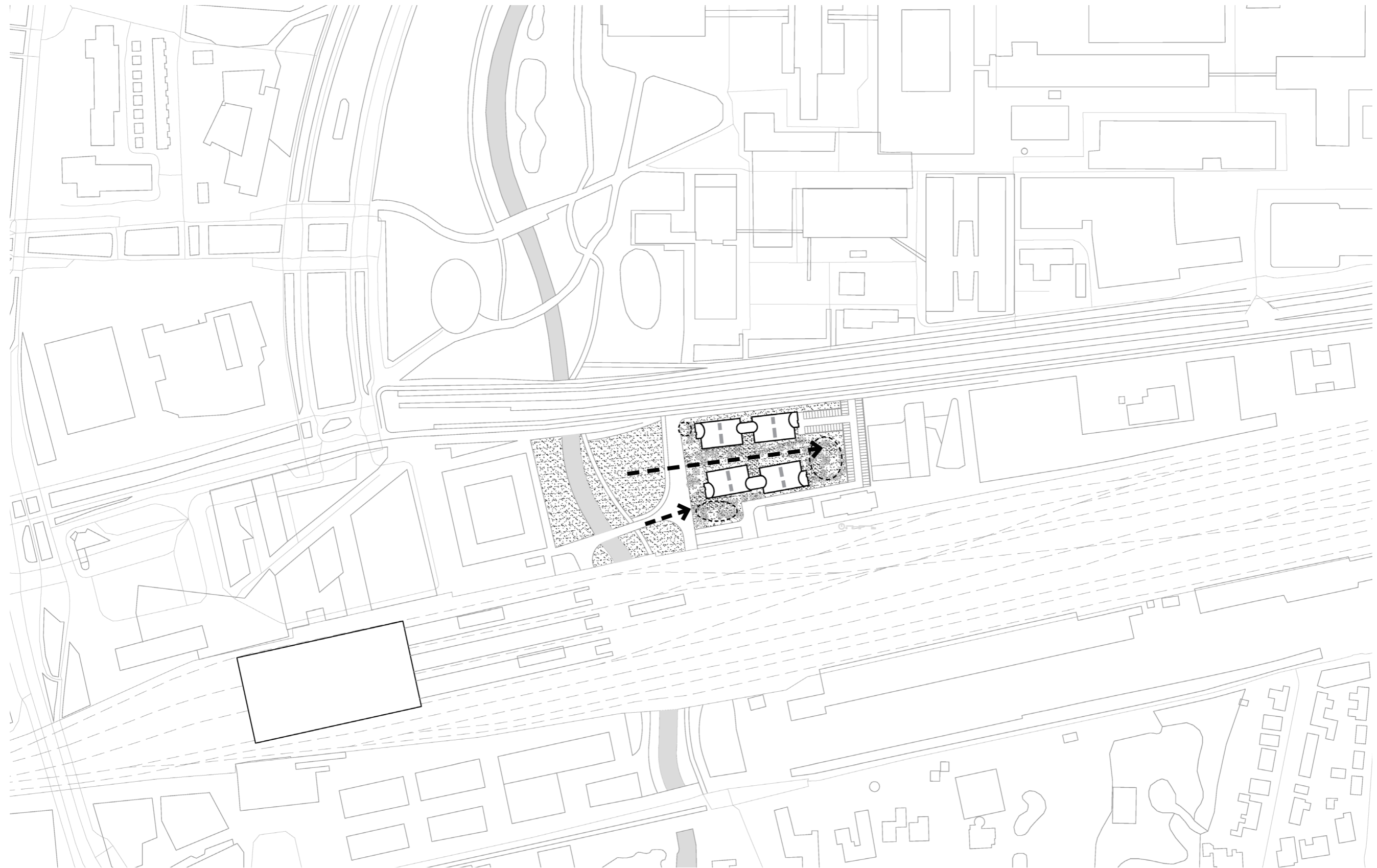


## **05 In context**

# 05 In Context



# 05 In Context

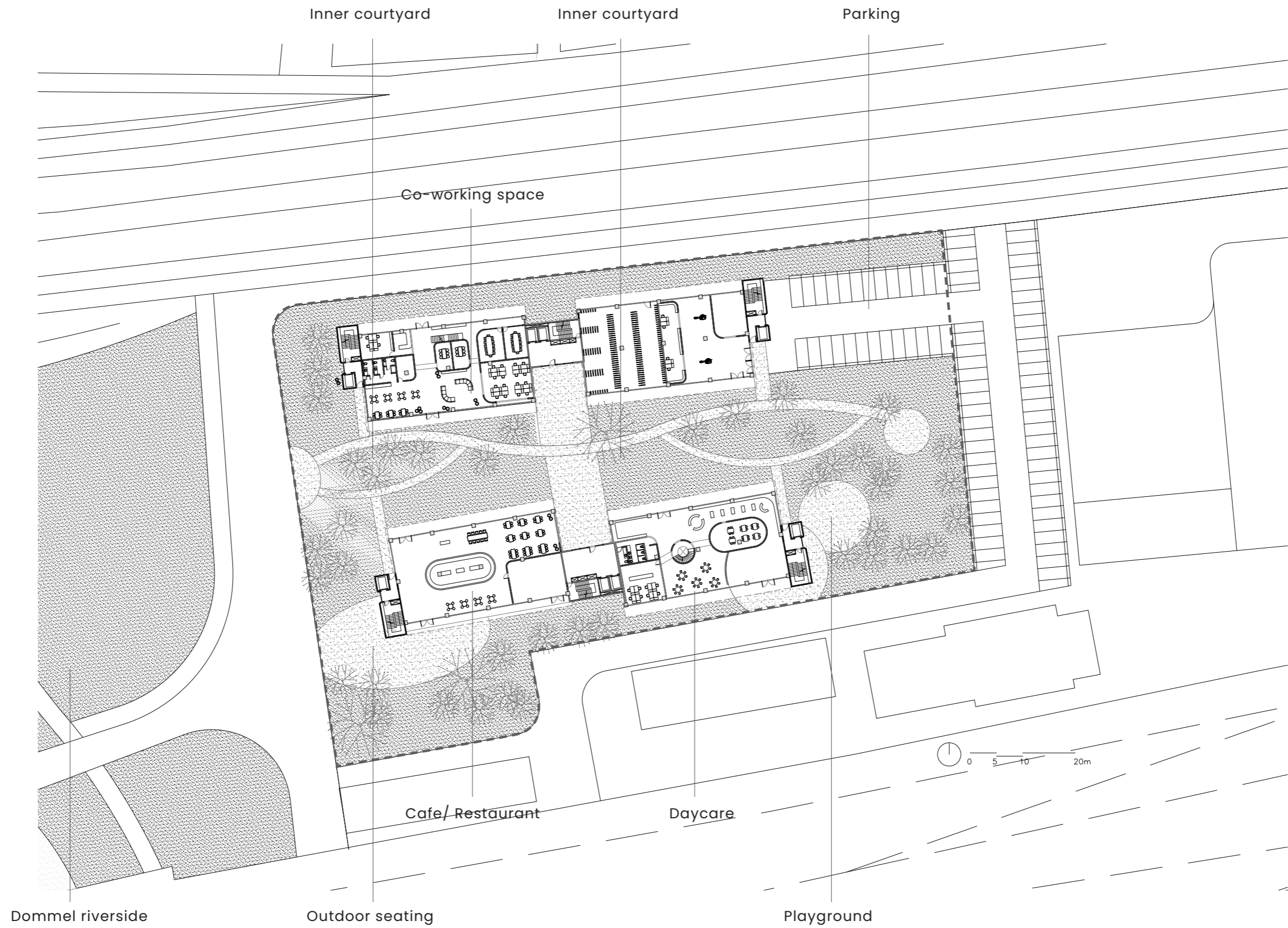


## 05 In Context



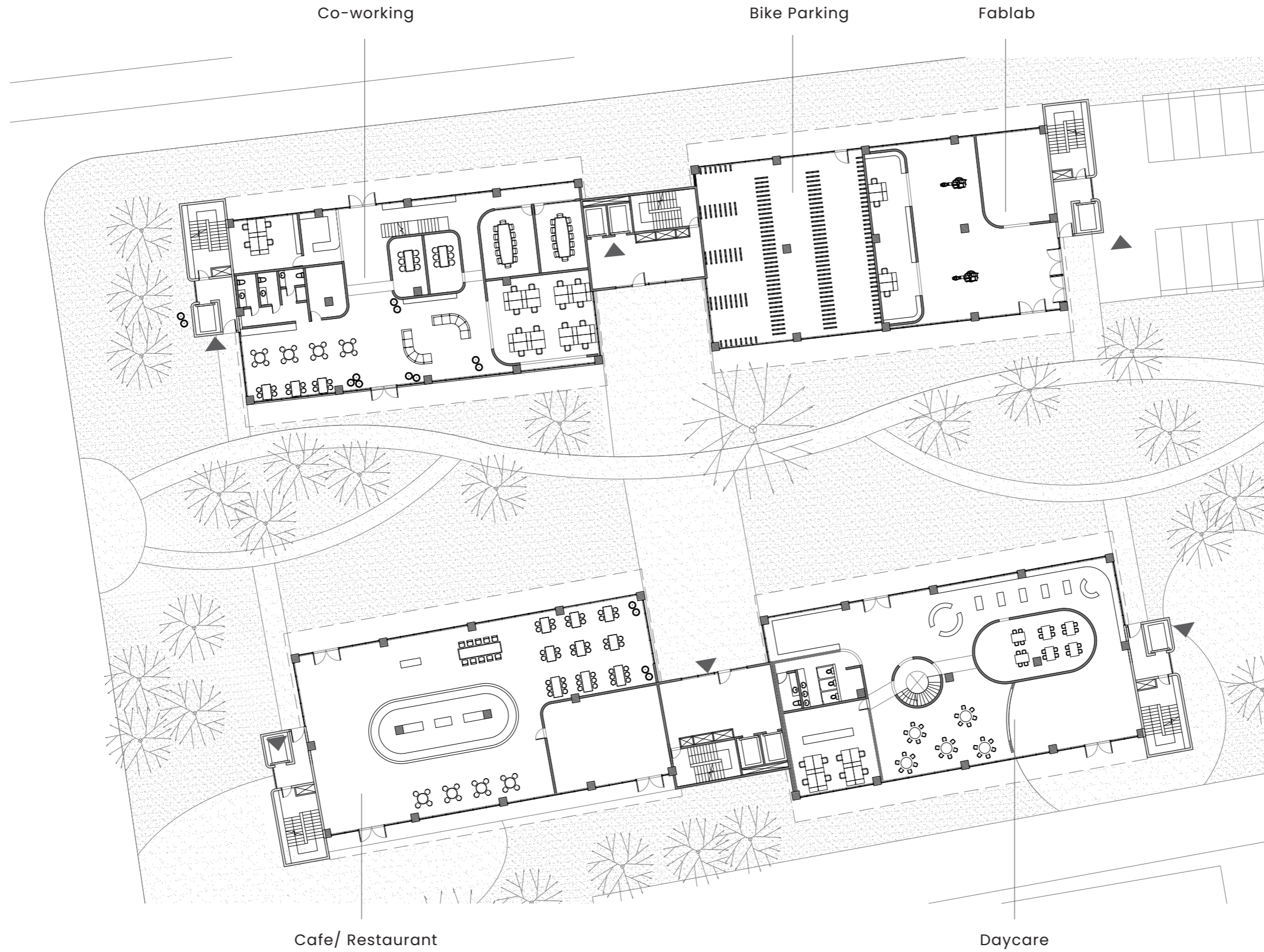
# 05 In Context

## Site plan



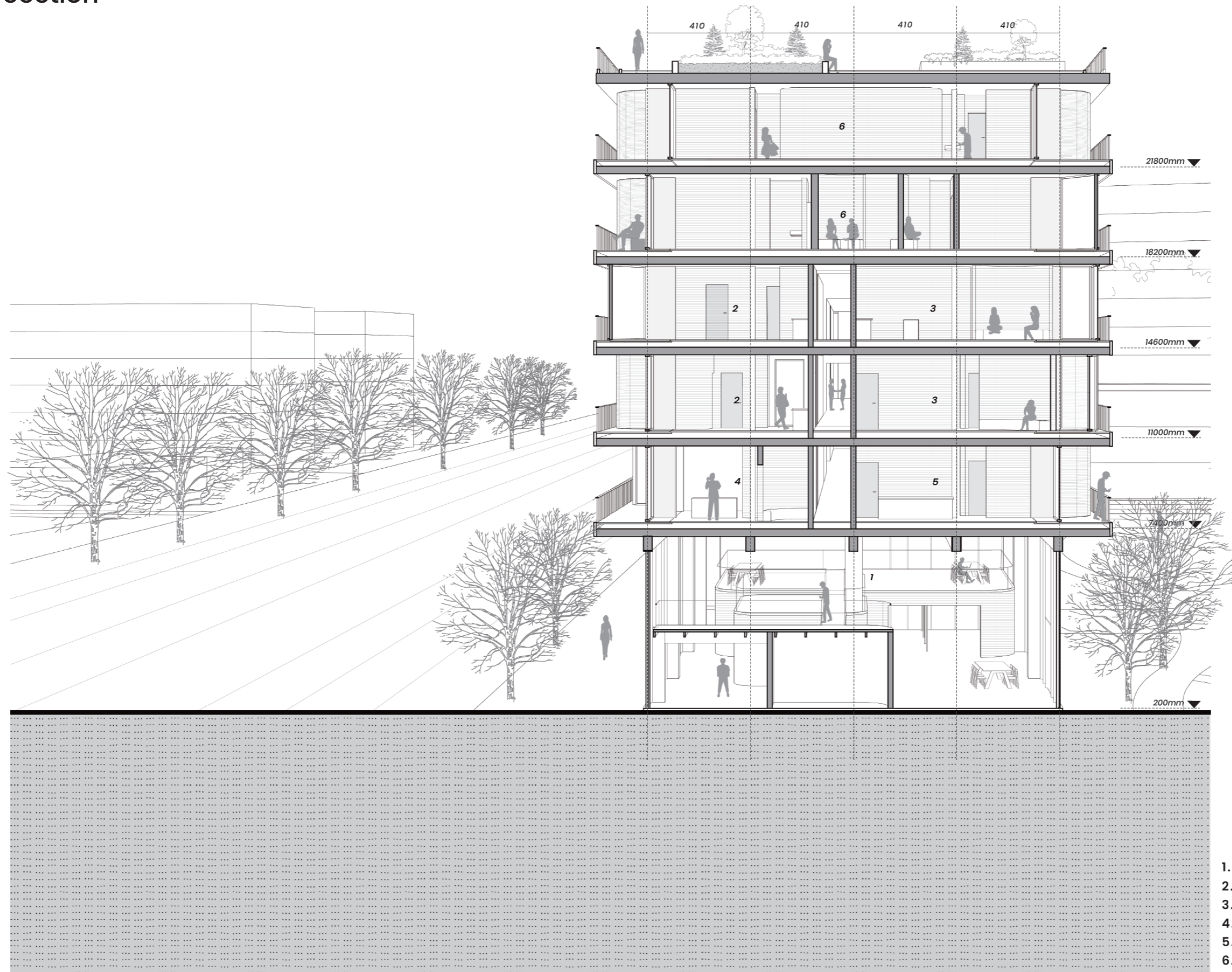
# 05 In Context

## Ground floor plan



# 05 In Context

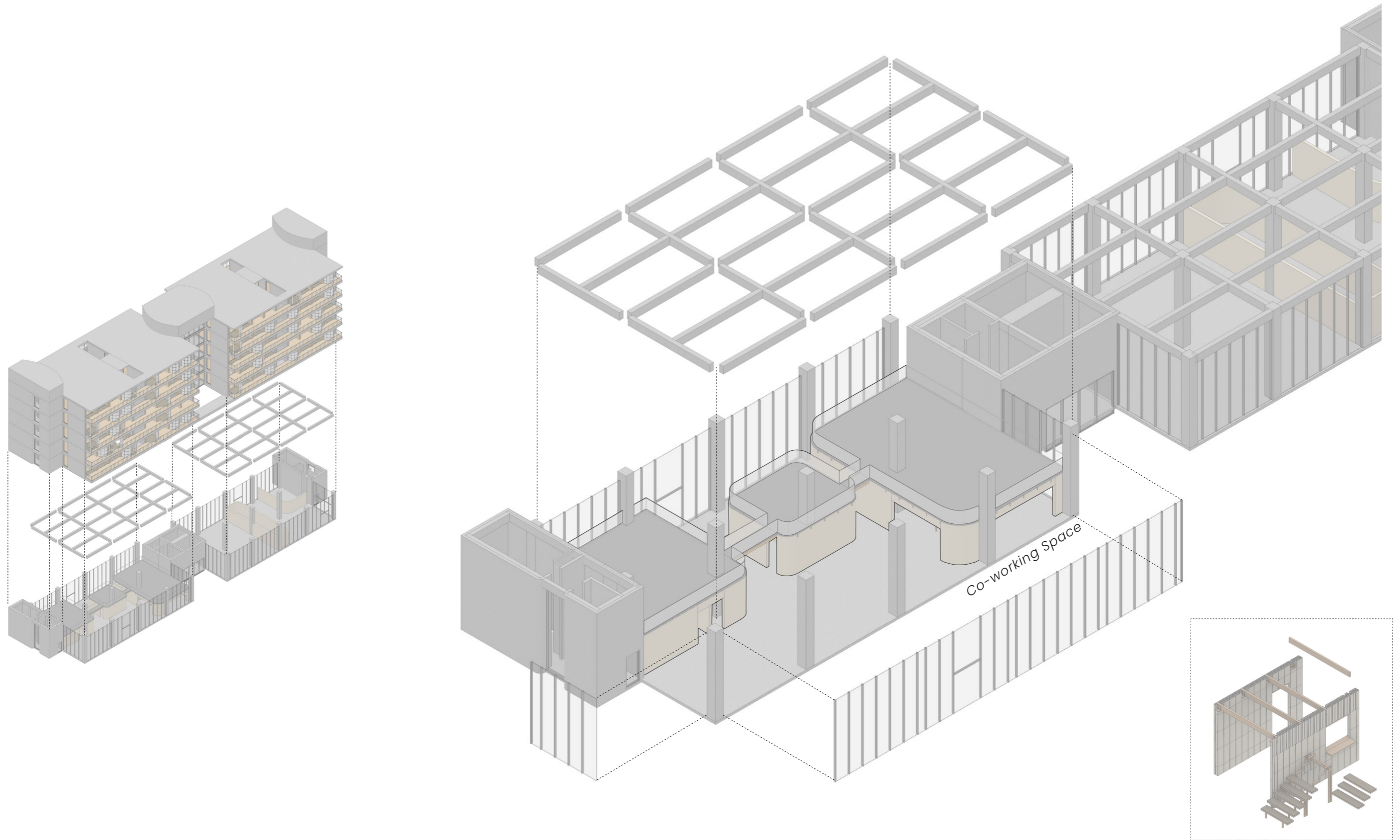
## Section



1. Co-working space
2. Type A housing
3. Type B housing
4. Type C housing
5. Type D housing
6. Type E housing

# 05 In Context

Ground floor



# 05 In Context

## Housing Floor plan

Type E : Co-housing

Type C : Combine small

Type A : small studio



Type B : large studio

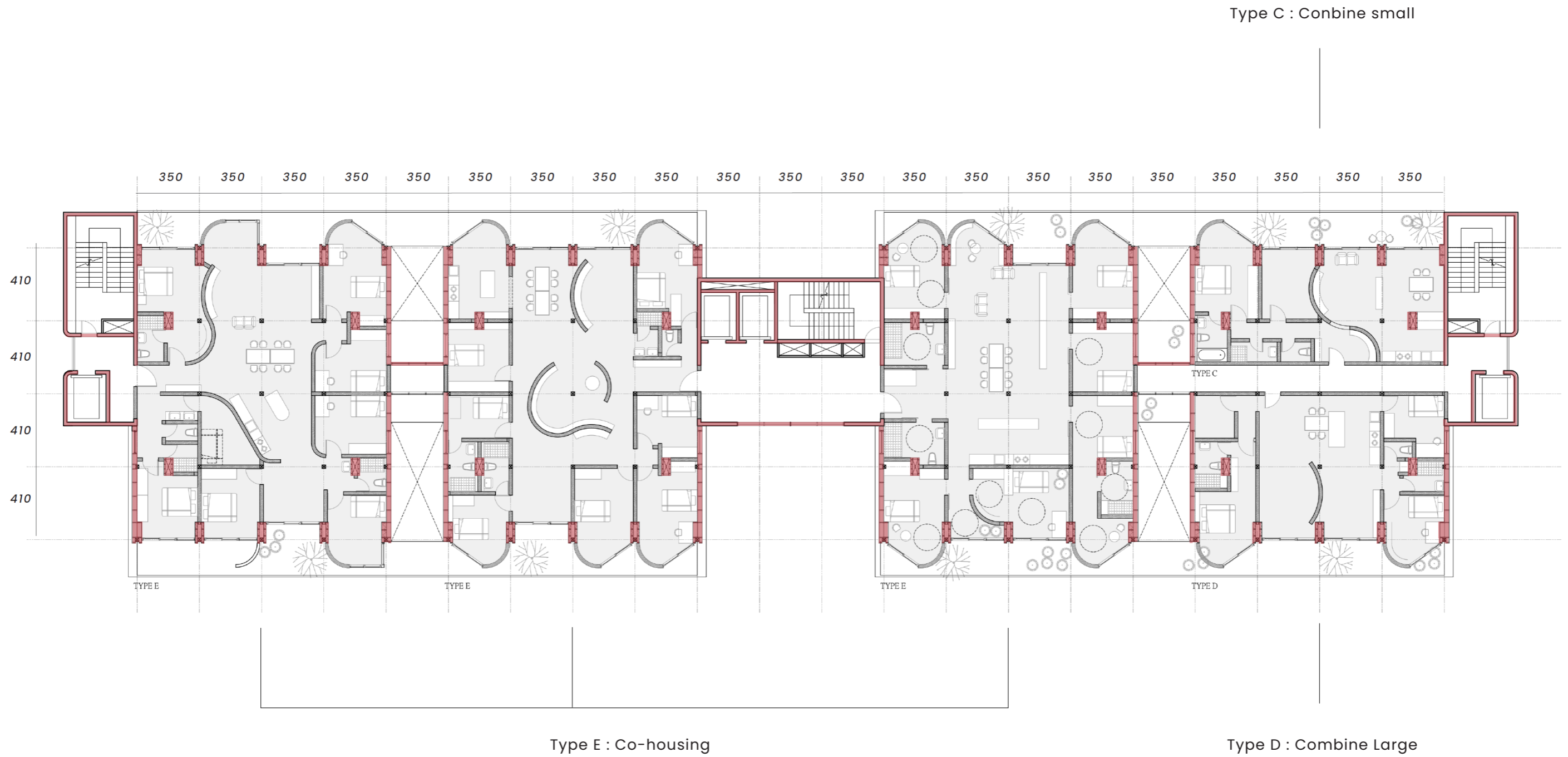
# 05 In Context

## Housing Floor plan



# 05 In Context

## Housing Floor plan



## 05 In Context



## 05 In Context



