

RE - BUILD

*Circular transformation
extension Palace of Justice, Arnhem*

Introduction

Personal interest



Lifespan & Sustainability

Introduction

Second Life Assignment



Lifespan & Sustainability

Introduction

Second Life Assignment



Multiple issues

1. Monofunctional
2. Low architectural value
3. Old technical installations
4. High energy demand

Introduction

Second Life Assignment



Multiple issues

1. Monofunctional
2. Low architectural value
3. Old technical installations
4. High energy demand

Introduction

Transformation



Extension Palace of Justice, Arnhem

Introduction

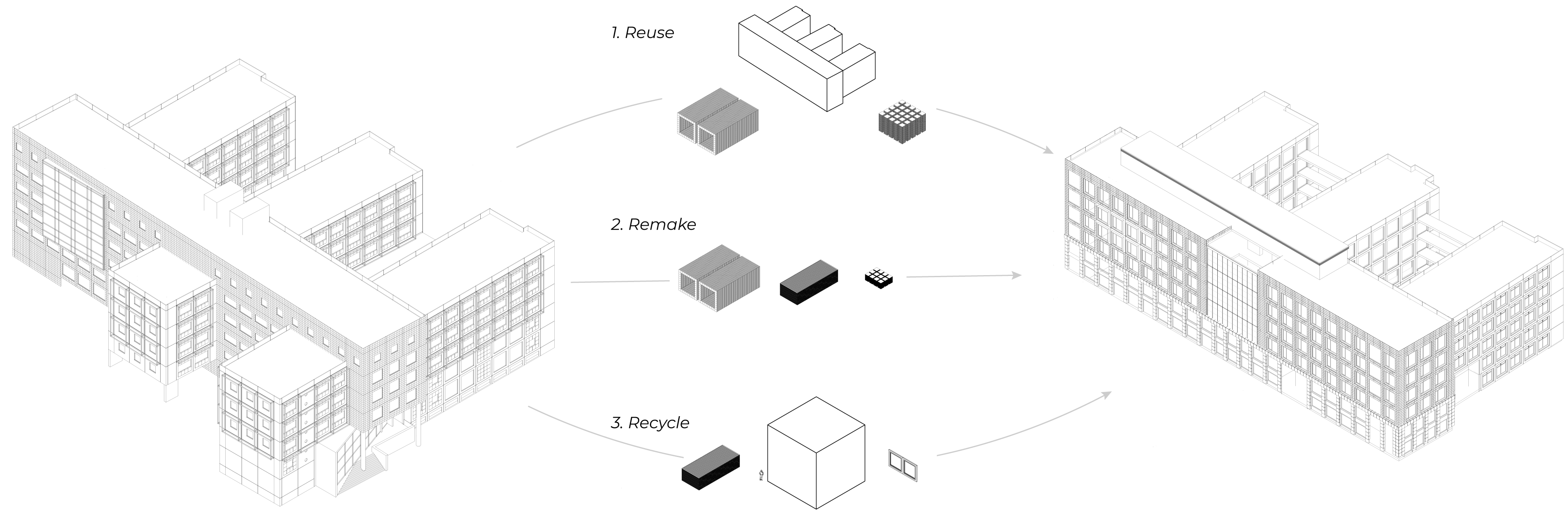
Transformation



Design proposal

Introduction

Circular material strategy



Introduction

Presentation content

1. Palace of Justice, Arnhem

2. Circular material strategy

3. Design

4. Conclusion & reflection

1. Palace of Justice



*Extension building
Completed : 1997
Architect: J.D. Peereboom Voller*



*Main building
Completed : 1963
Architect: F. Sevenhuijsen*

Palace of Justice

Urban setting



'Bestuurskwartier'
Government district

Palace of Justice

Urban setting

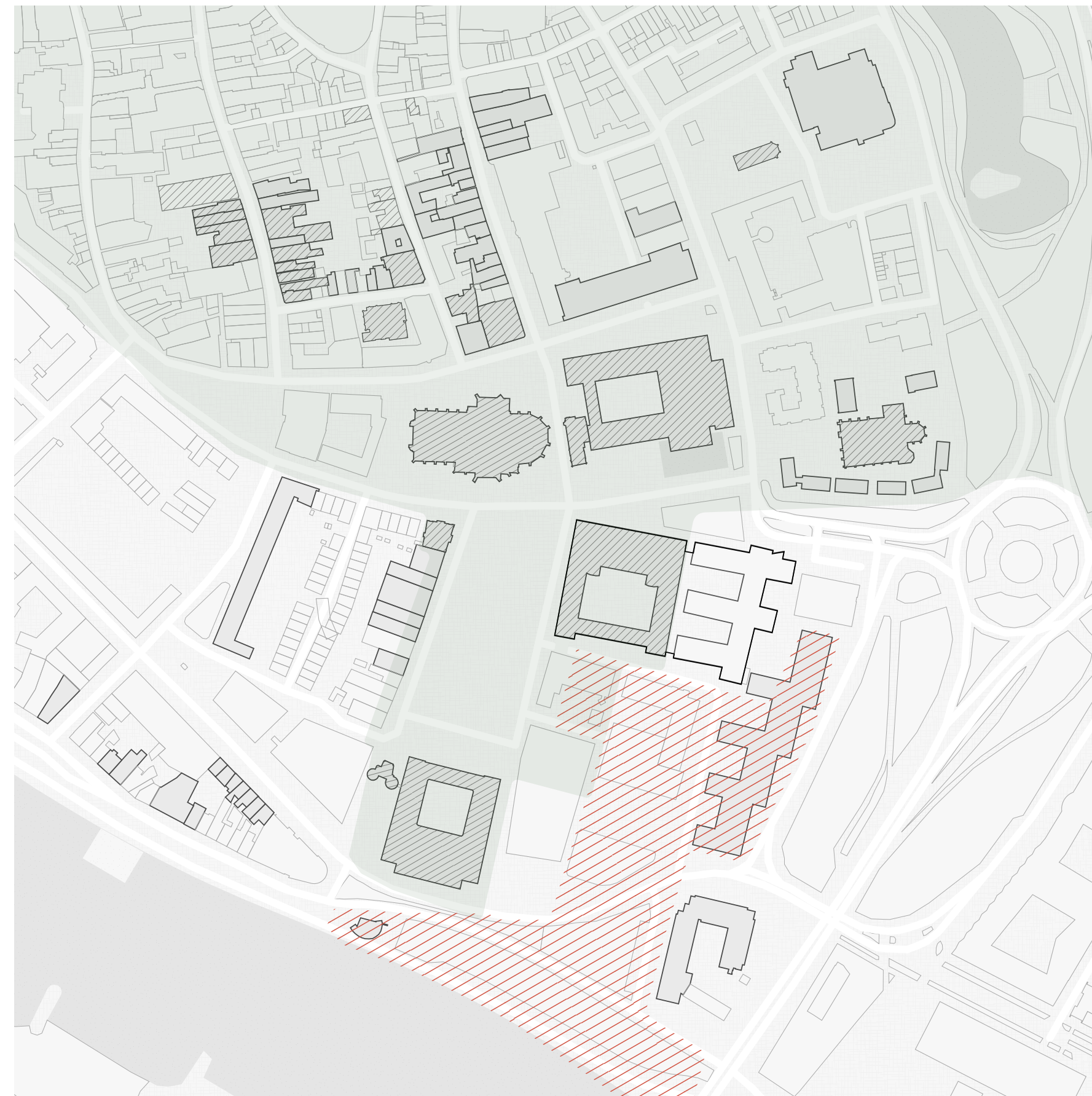


Typical plot size
Historical city centre ■ 120 m²
Reconstruction period ■ 1500 m²

Reconstruction period: Upscaling
of urban fabric

Palace of Justice

Urban setting

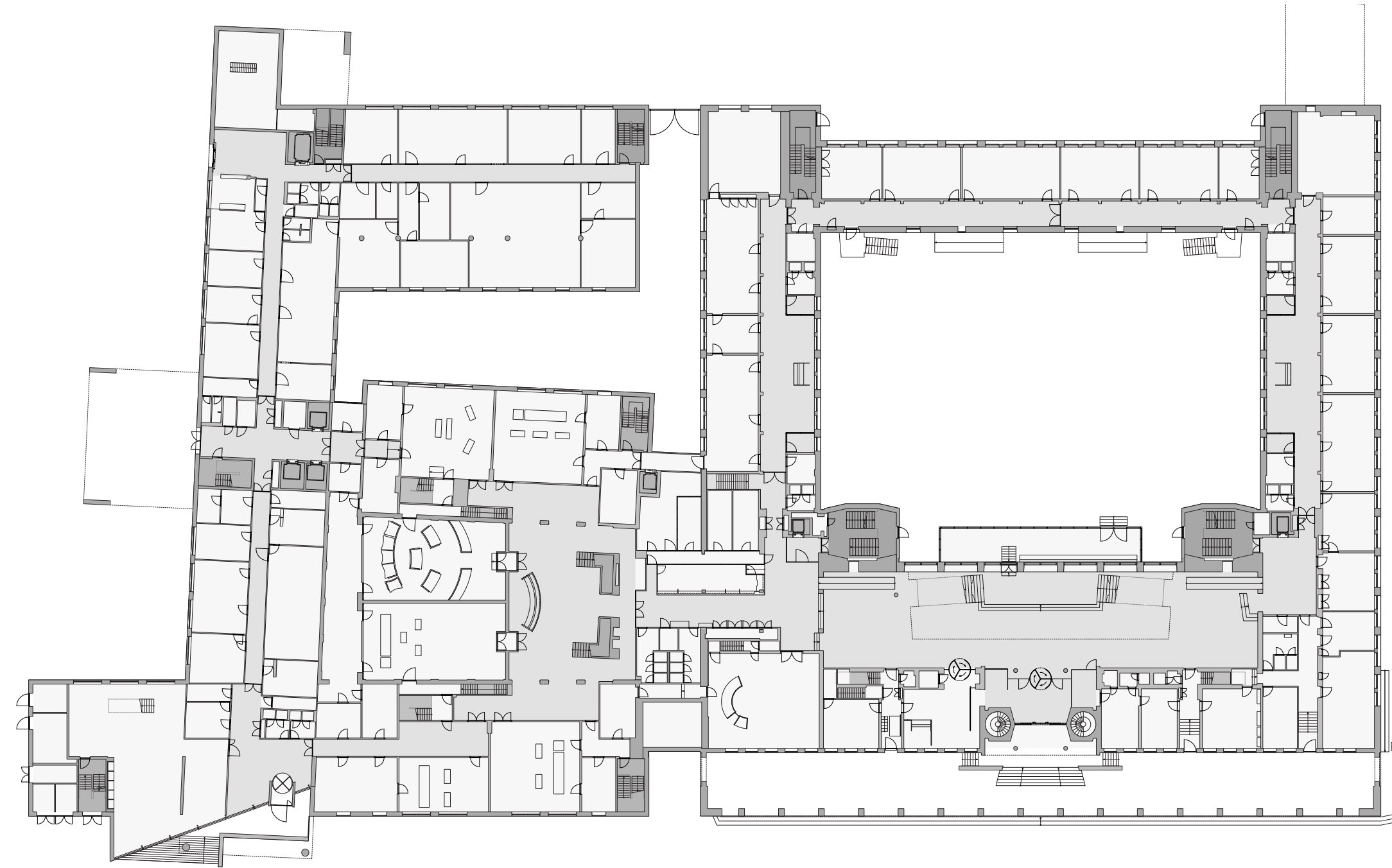


Highly valued area
vs
Monotonous 'Prinsenhof'

Palace of Justice

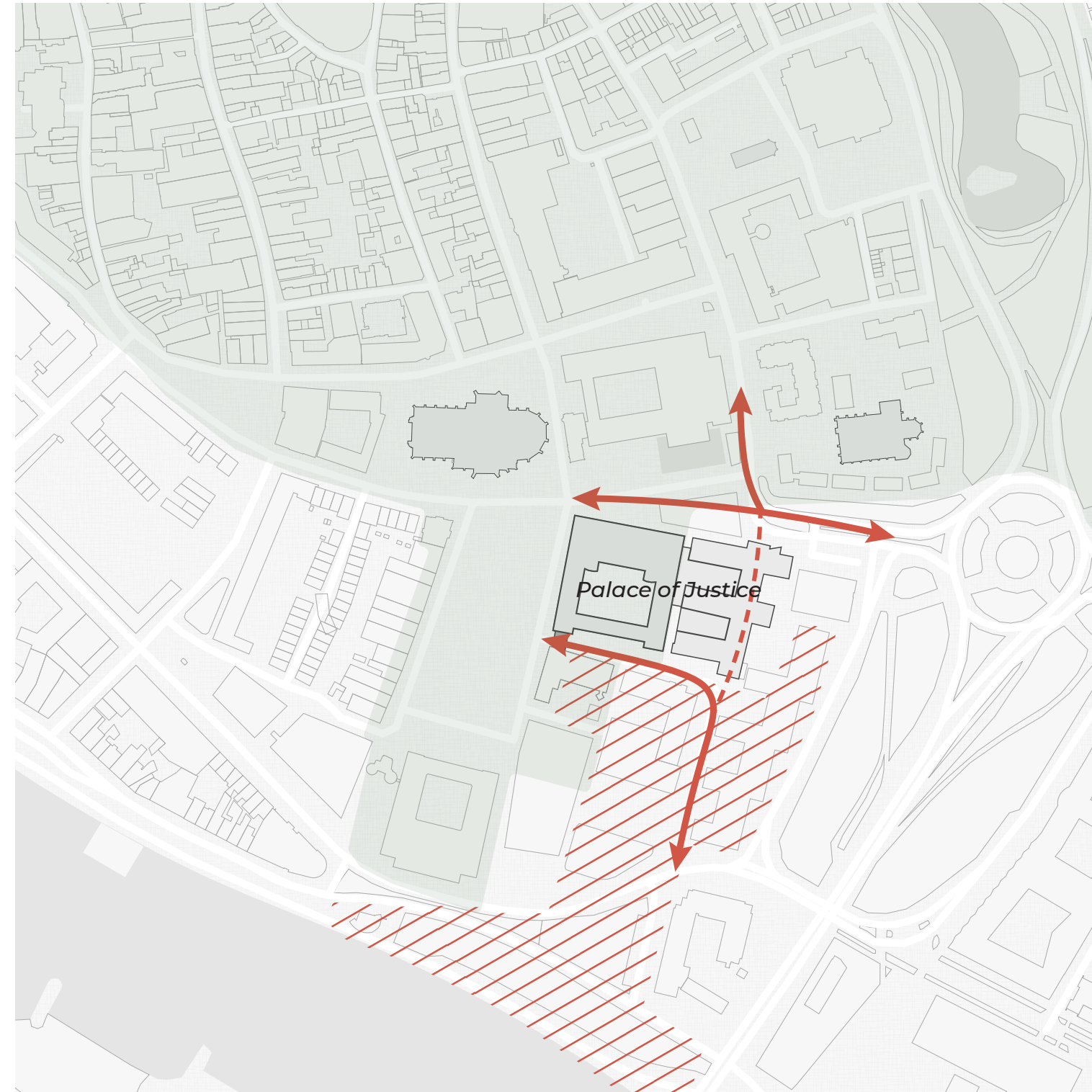
Building analyses

Facades



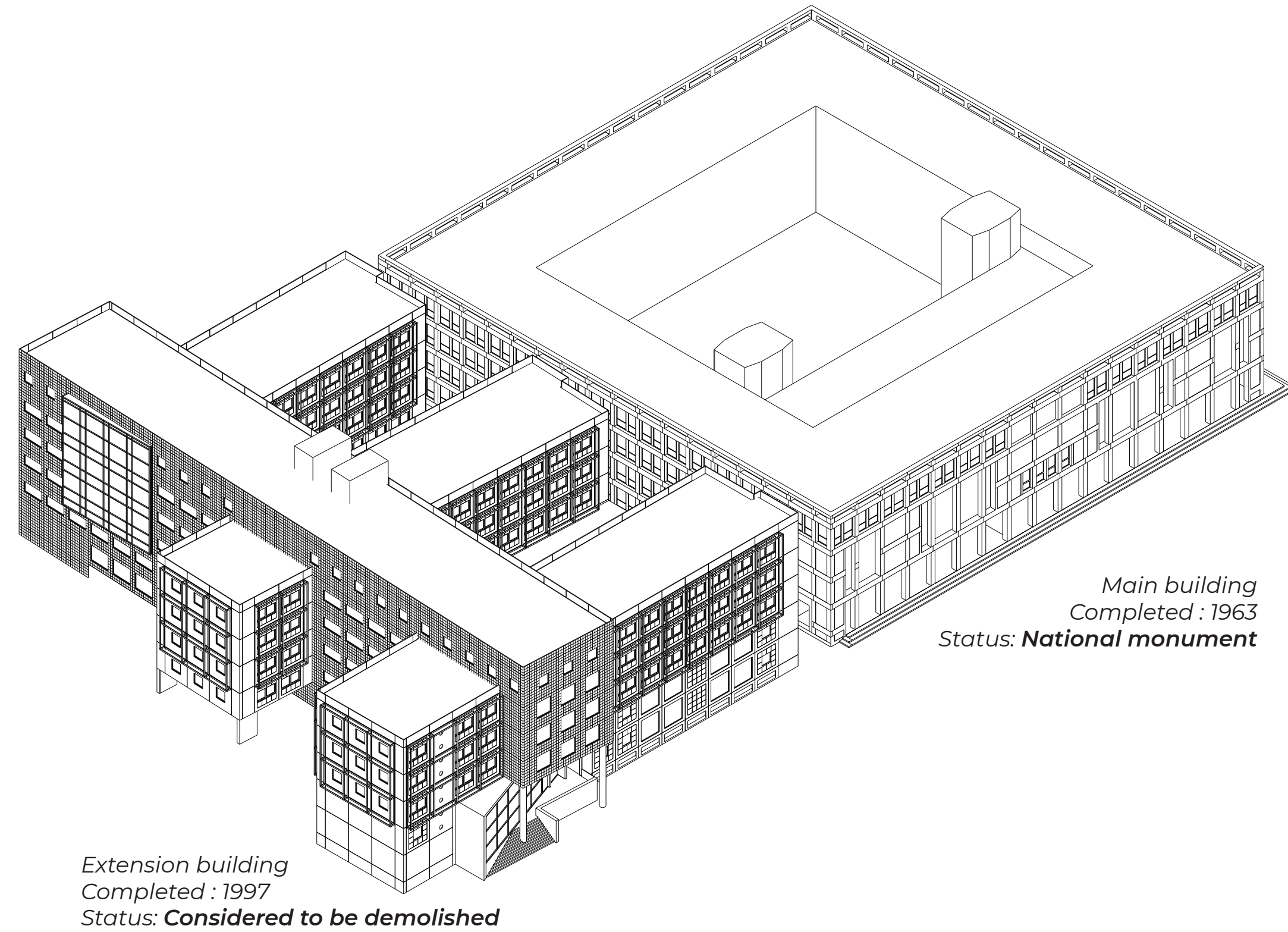
Palace of Justice

Current situation



Municipal vision

“Waarom heeft het ene gebouw een monumentale status en wordt de andere na amper 20 jaar gesloopt?”



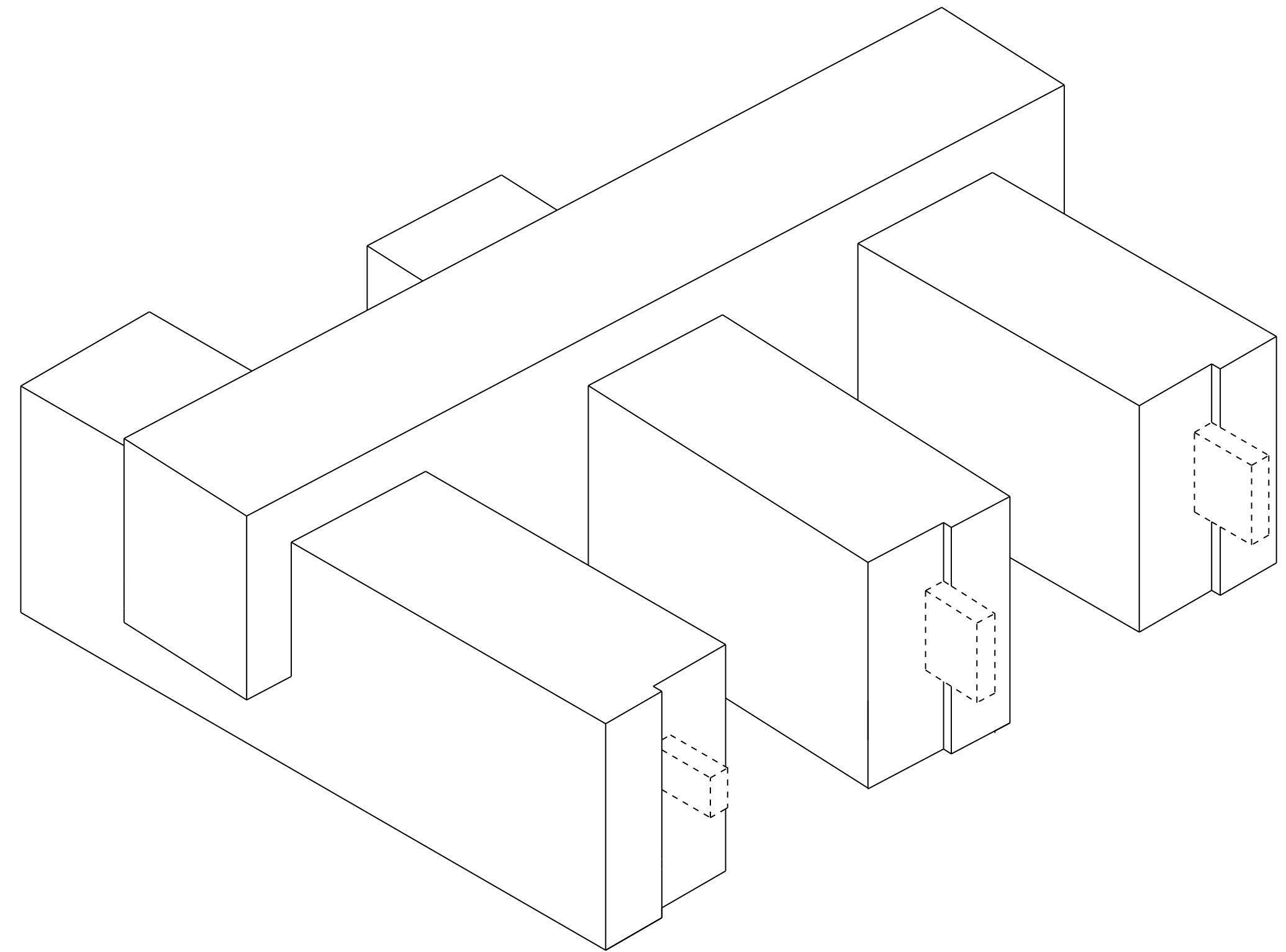
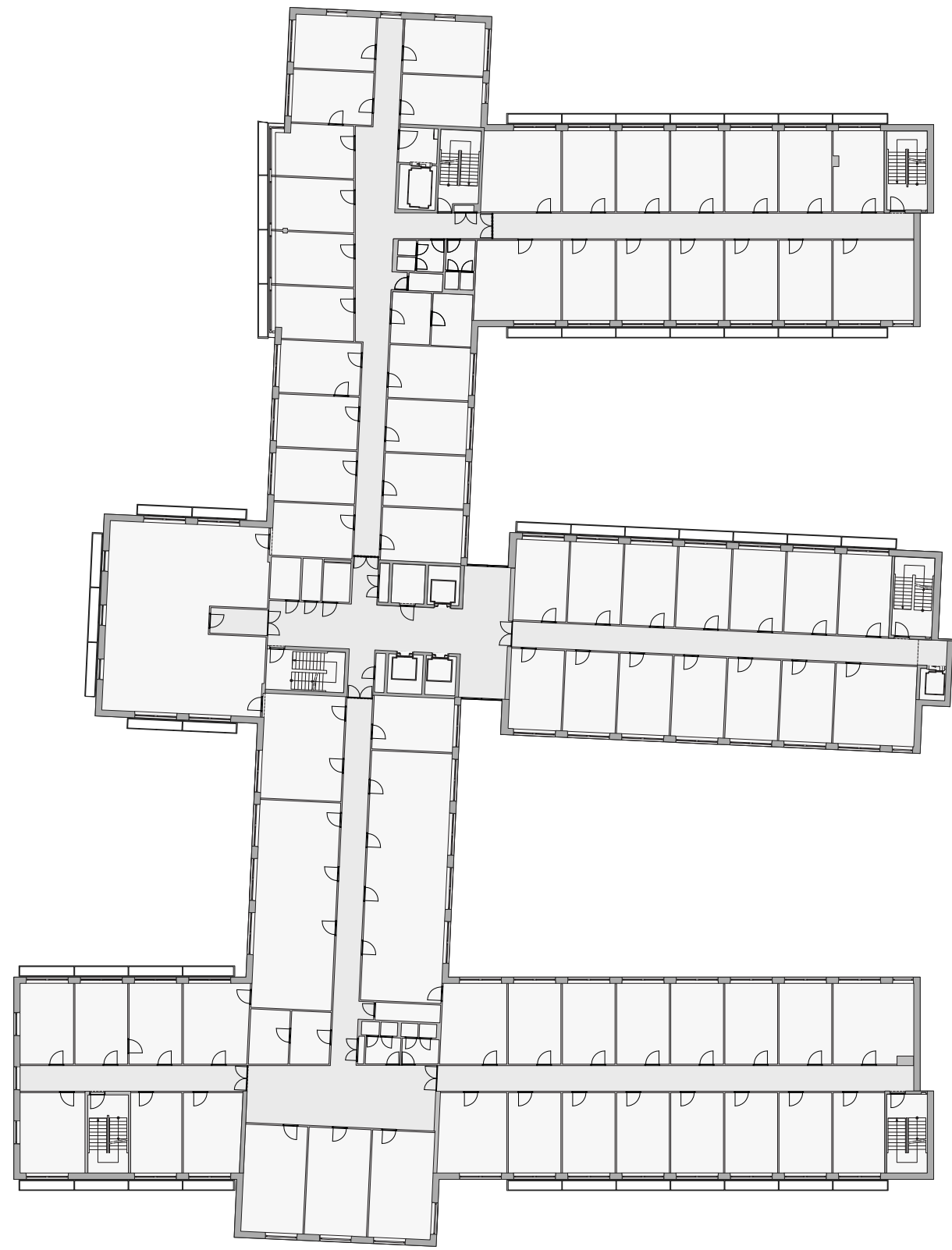
Main building
Completed : 1963
Status: **National monument**

Extension building
Completed : 1997
Status: **Considered to be demolished**

Building ensemble

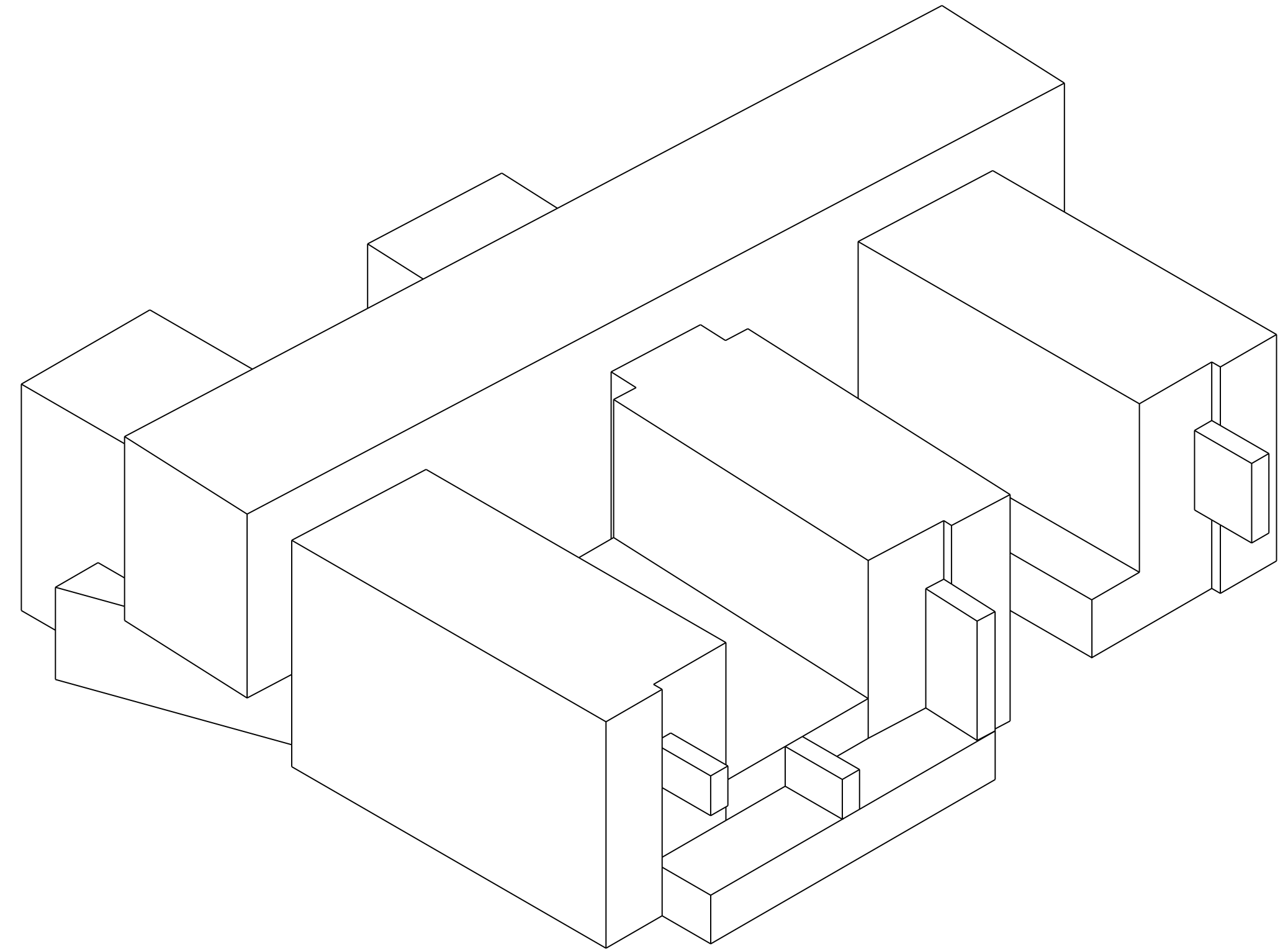
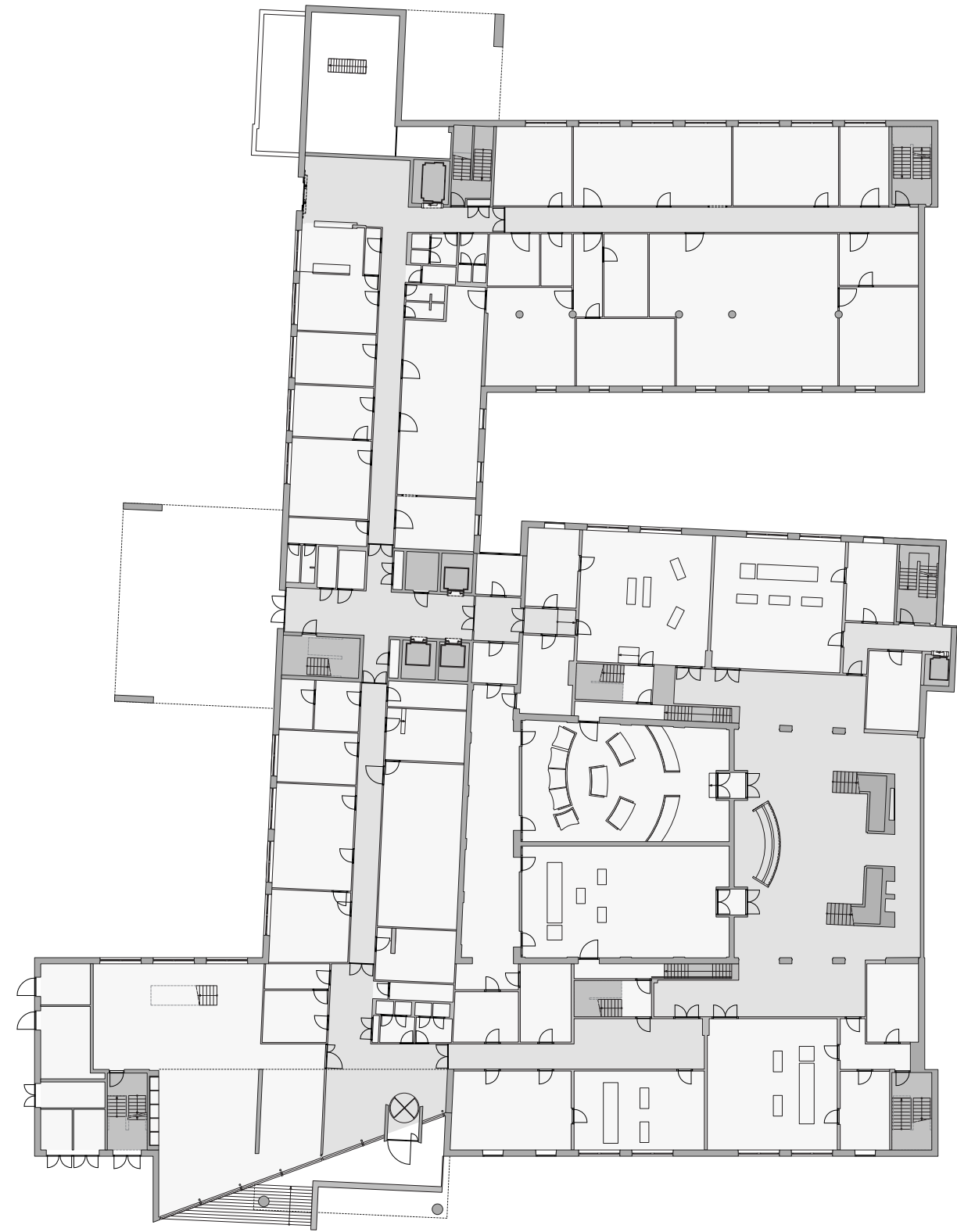
Palace of Justice

Current situation



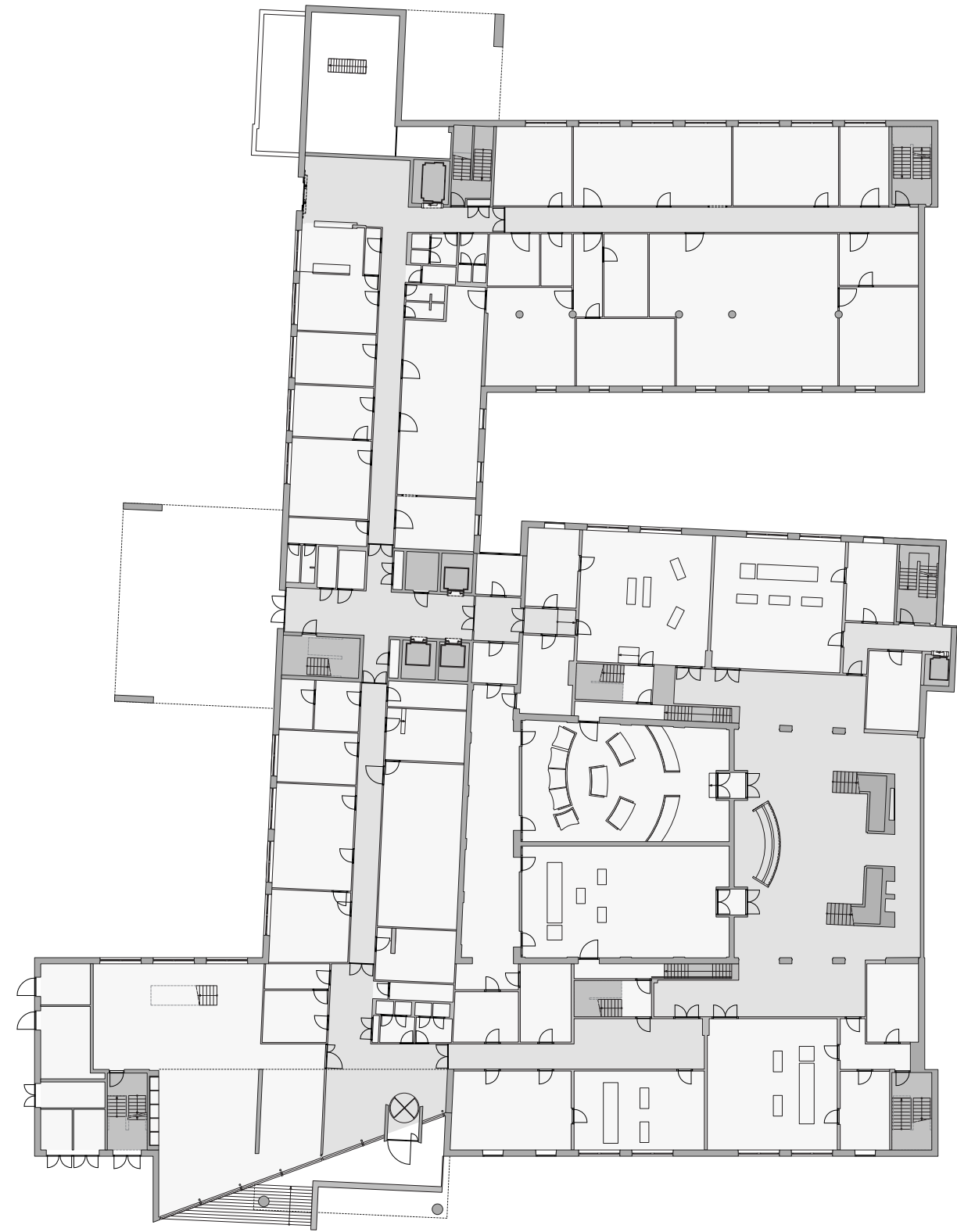
Palace of Justice

Current situation



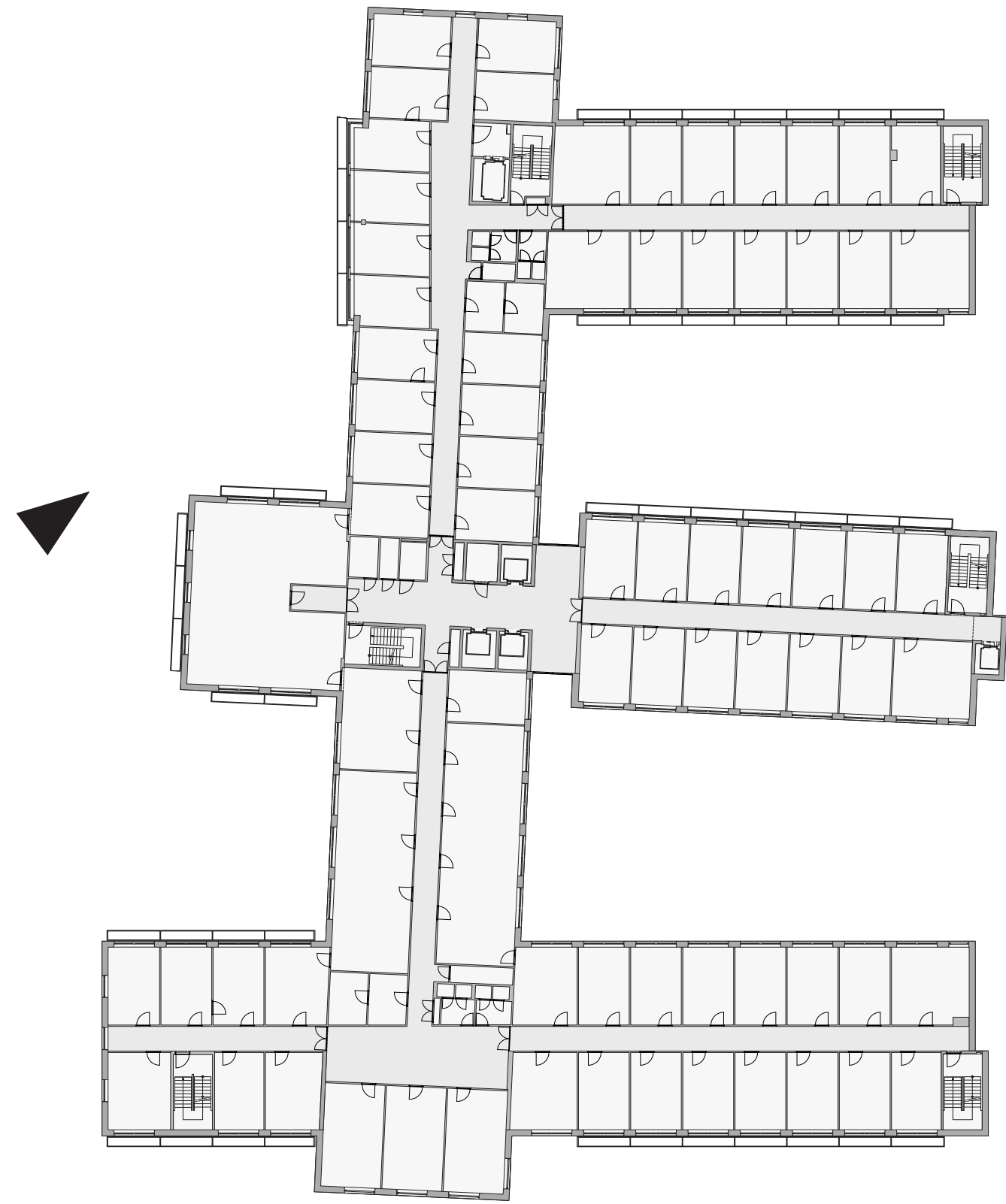
Palace of Justice

Problem statement



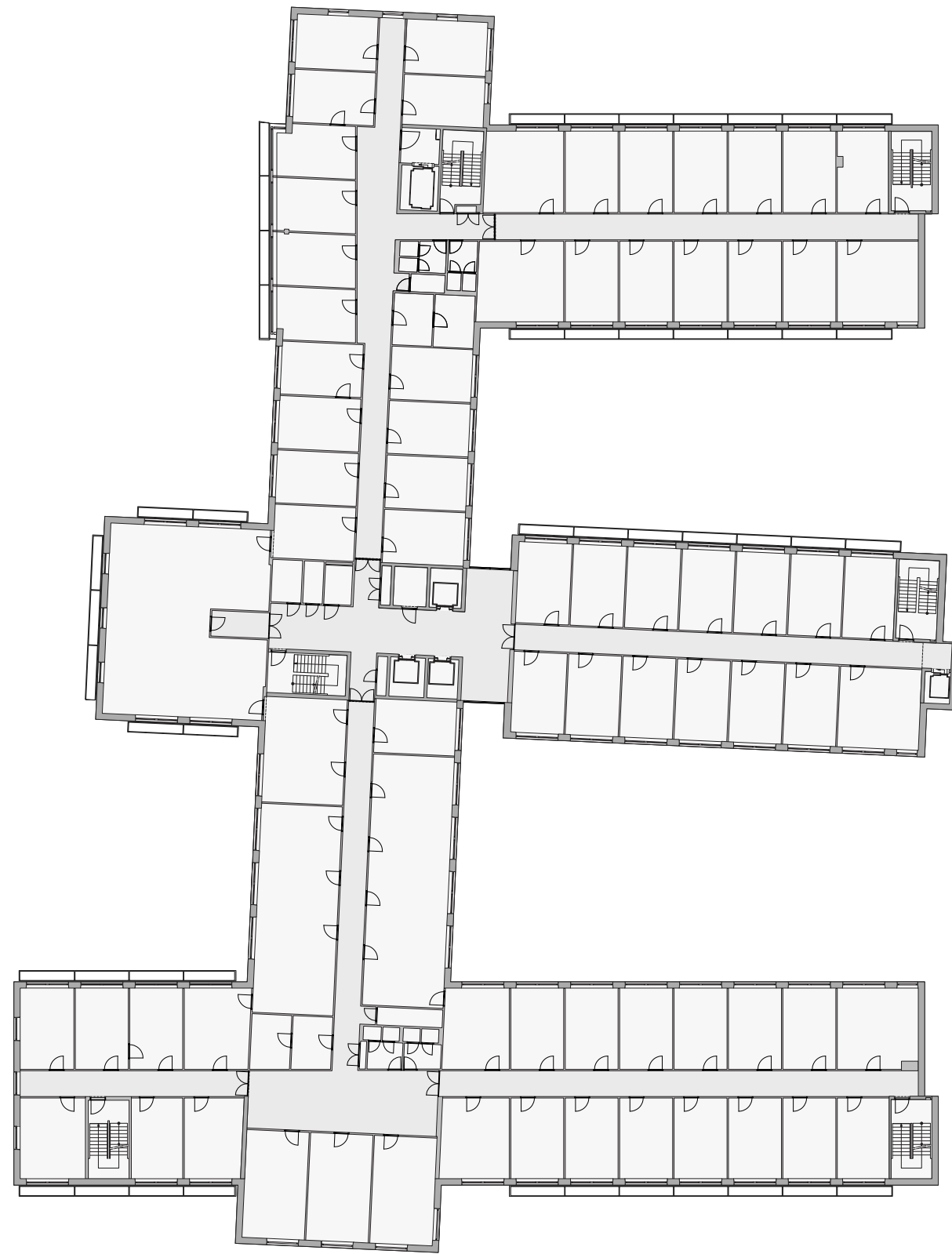
Palace of Justice

Problem statement



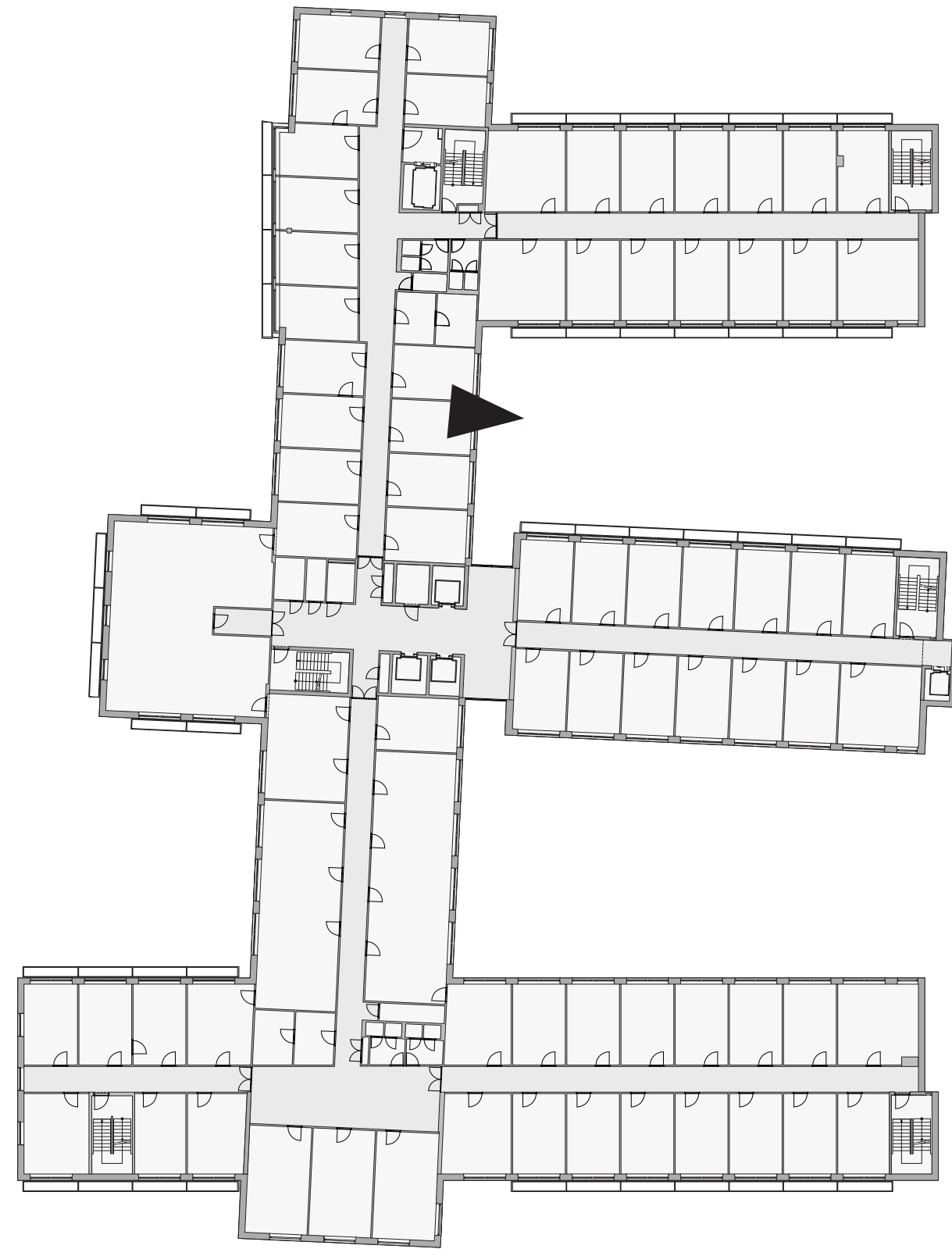
Palace of Justice

Problem statement



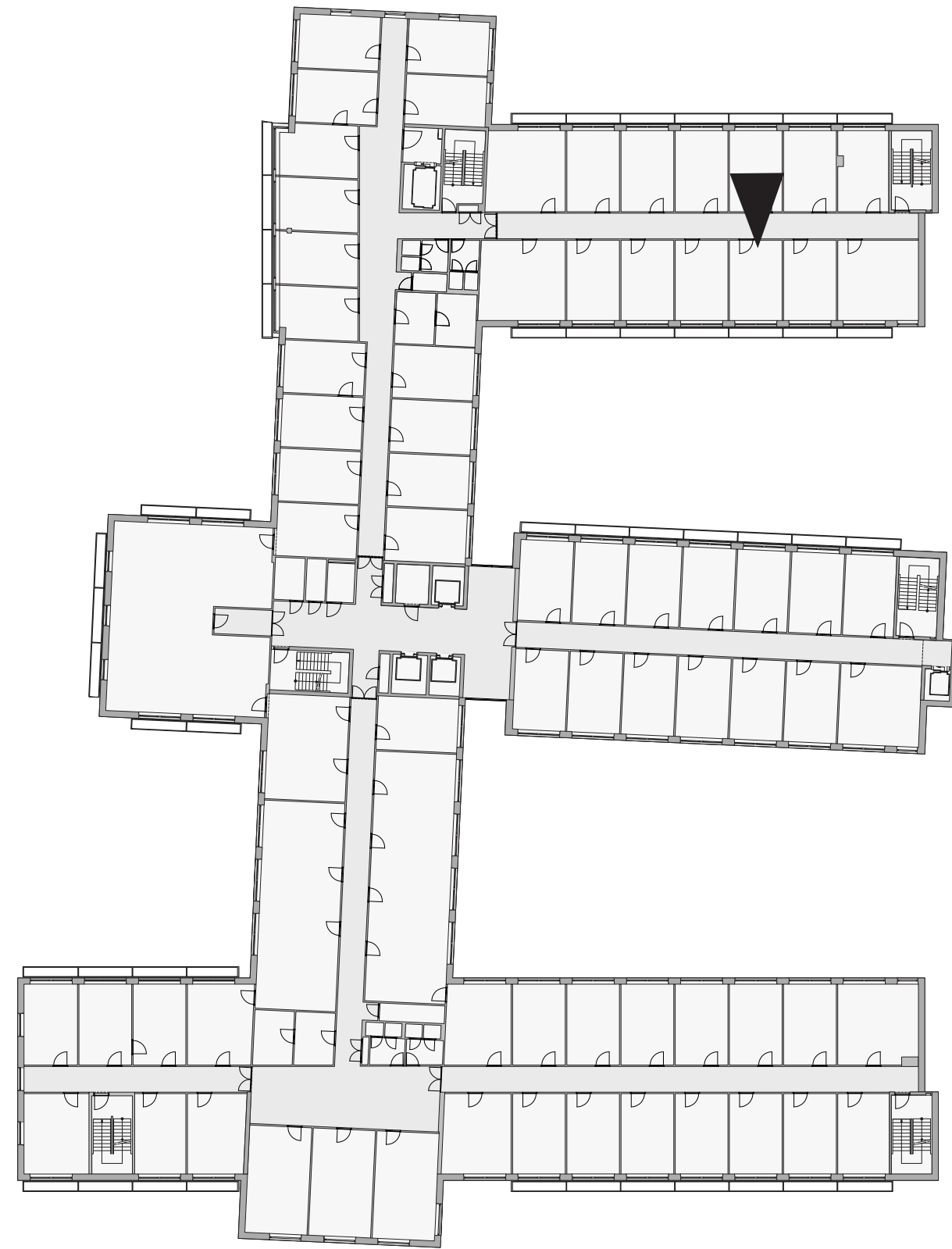
Palace of Justice

Problem statement



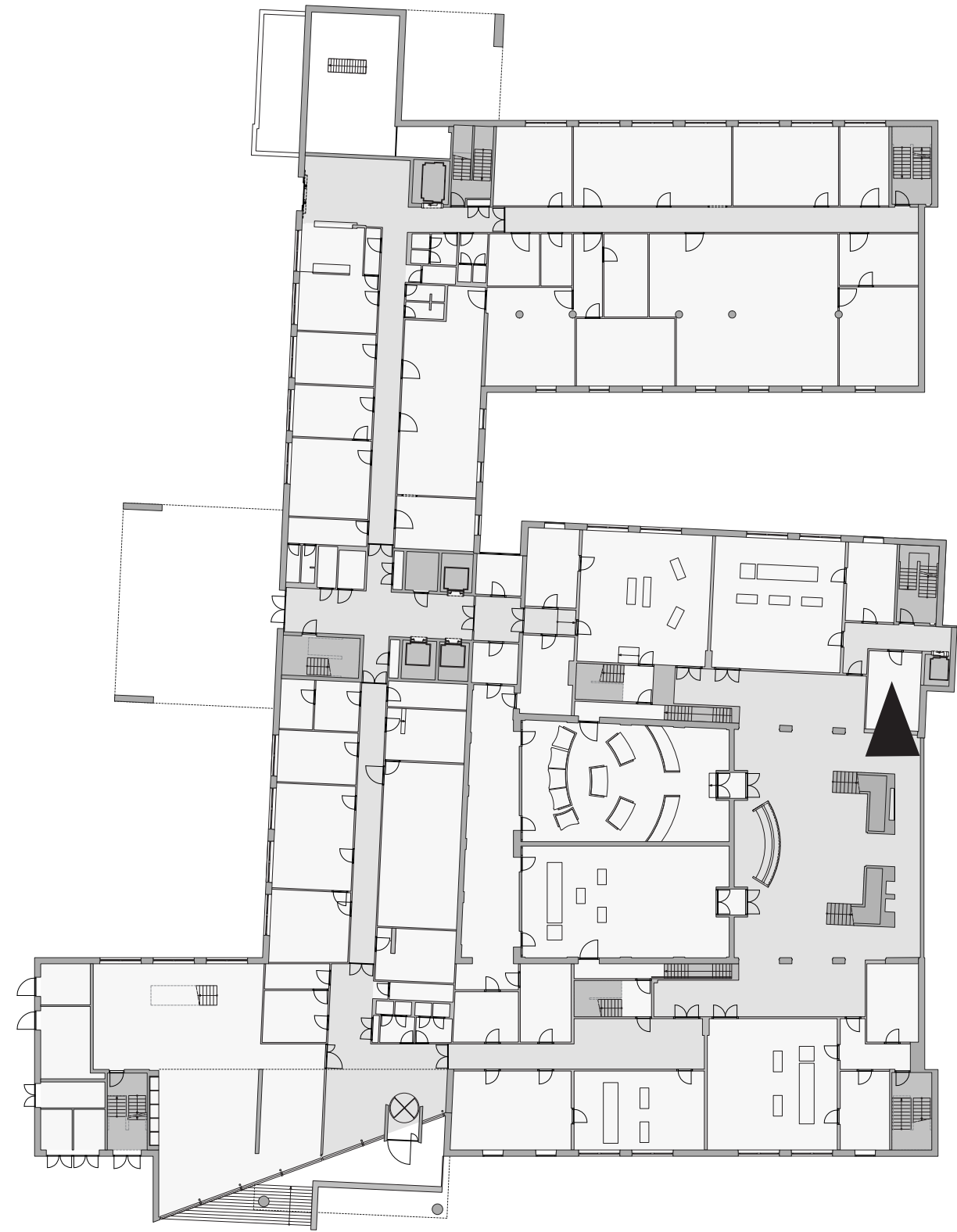
Palace of Justice

Problem statement



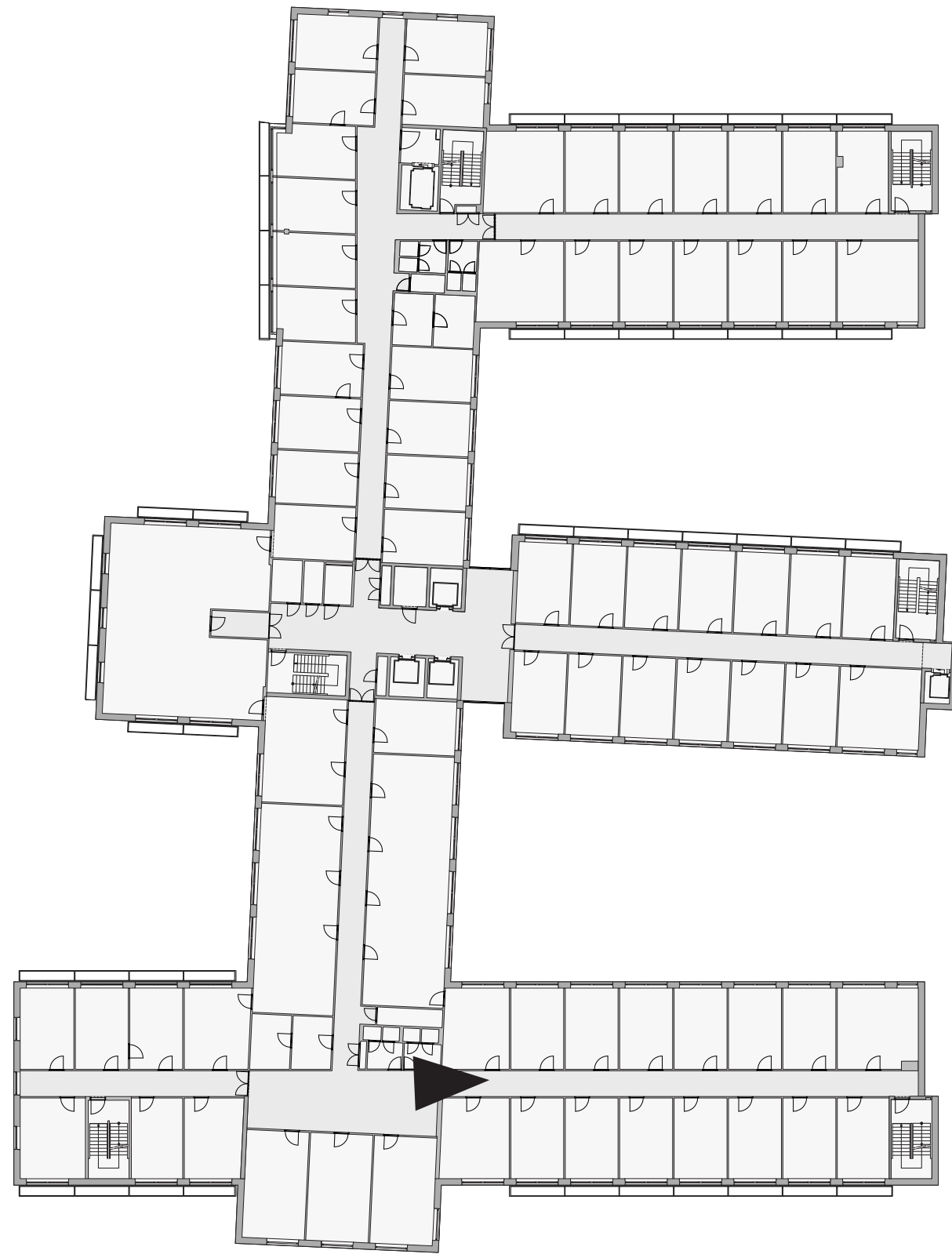
Palace of Justice

Problem statement



Palace of Justice

Problem statement



Palace of Justice

Problem statement



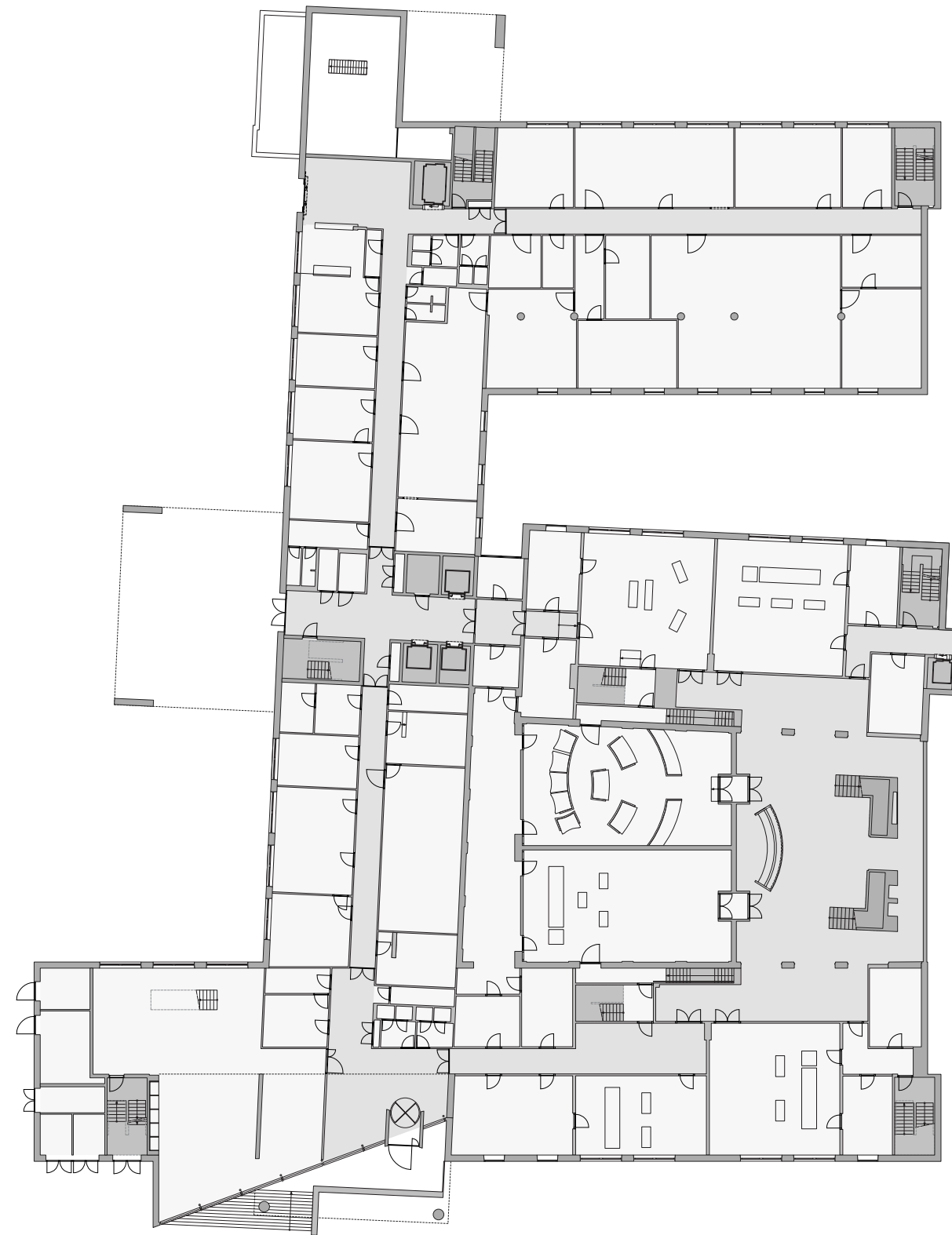
1. Monofunctional

2. Uncomfortable

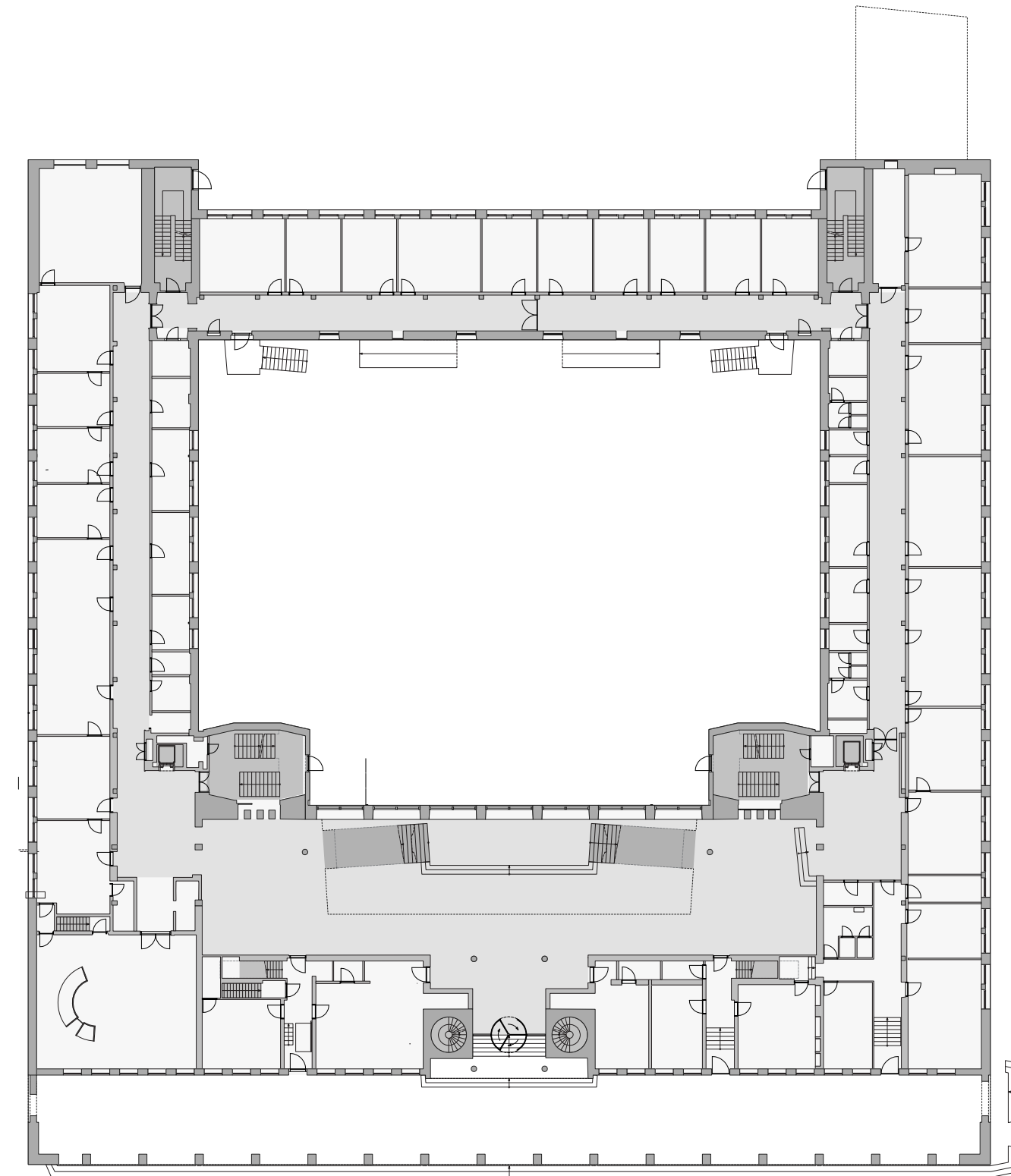
3. Low architectural value

Design

Future scenario



Function independently



Restored into original status

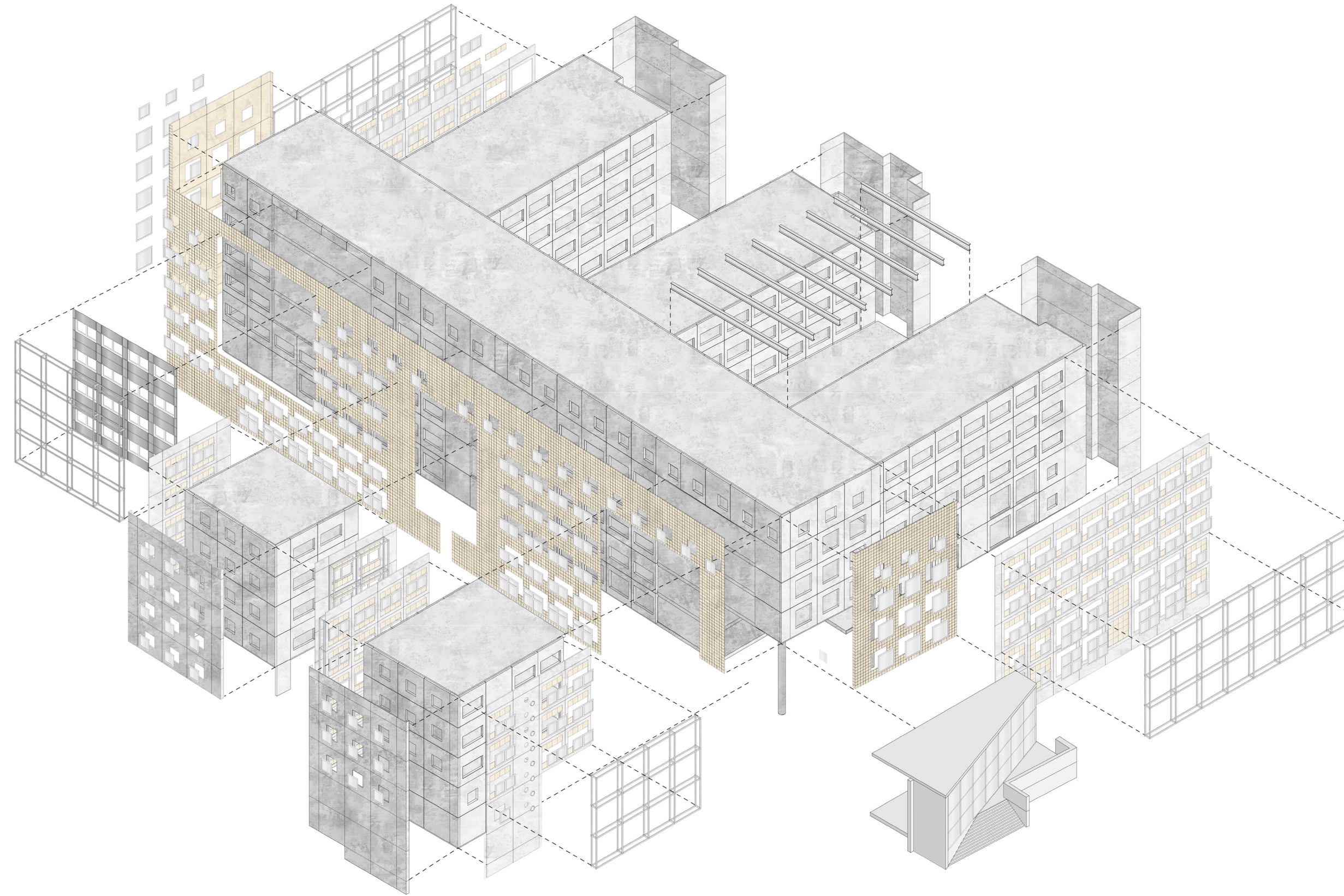
Design

Objective

Design question:

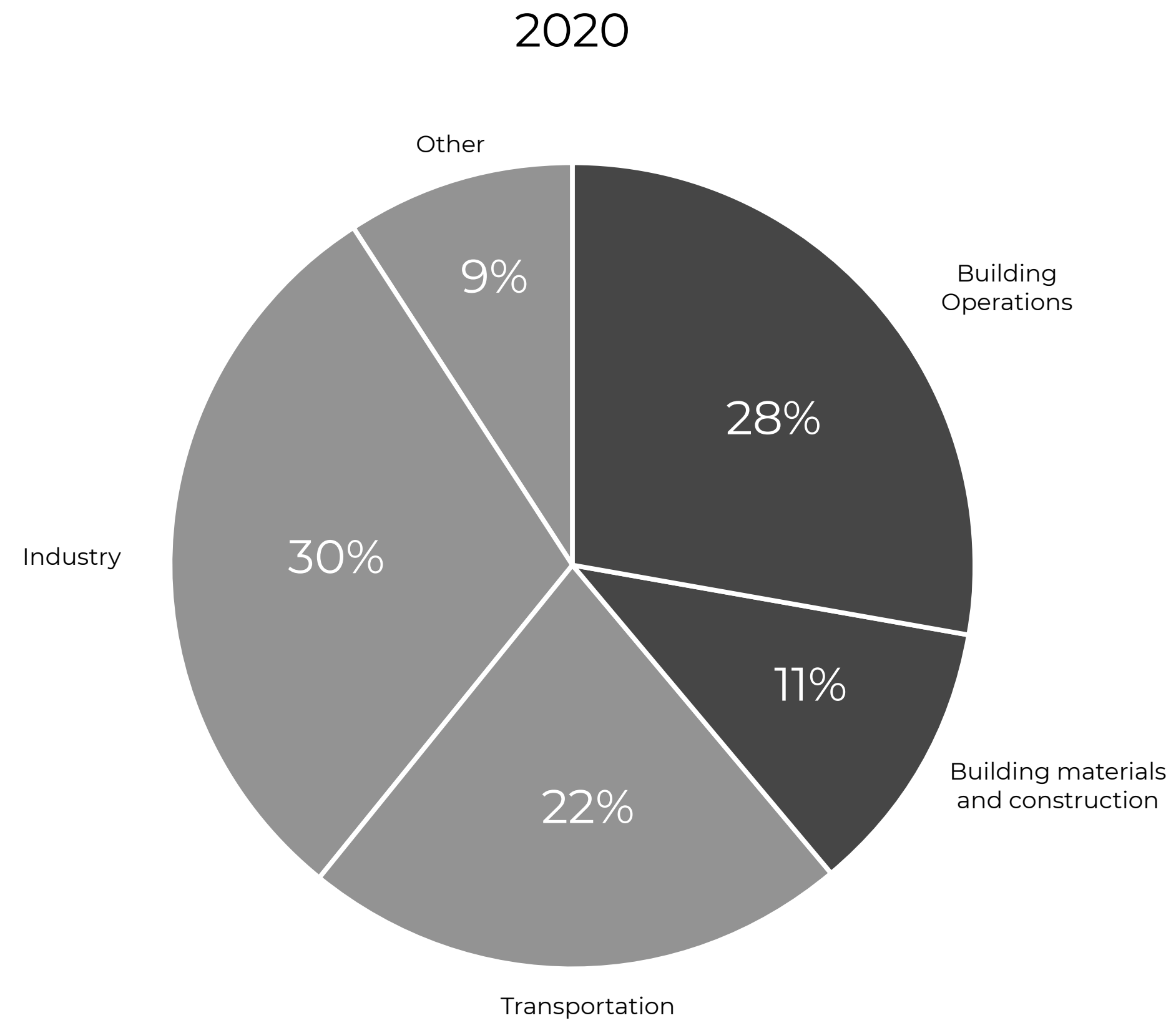
'How to transform the extension building into a qualitative and flexible structure, with a uniform architectural expression, a clear organisation and a comfortable user environment to ensure a long lifespan?'

2. Circular material strategy



Circular material strategy

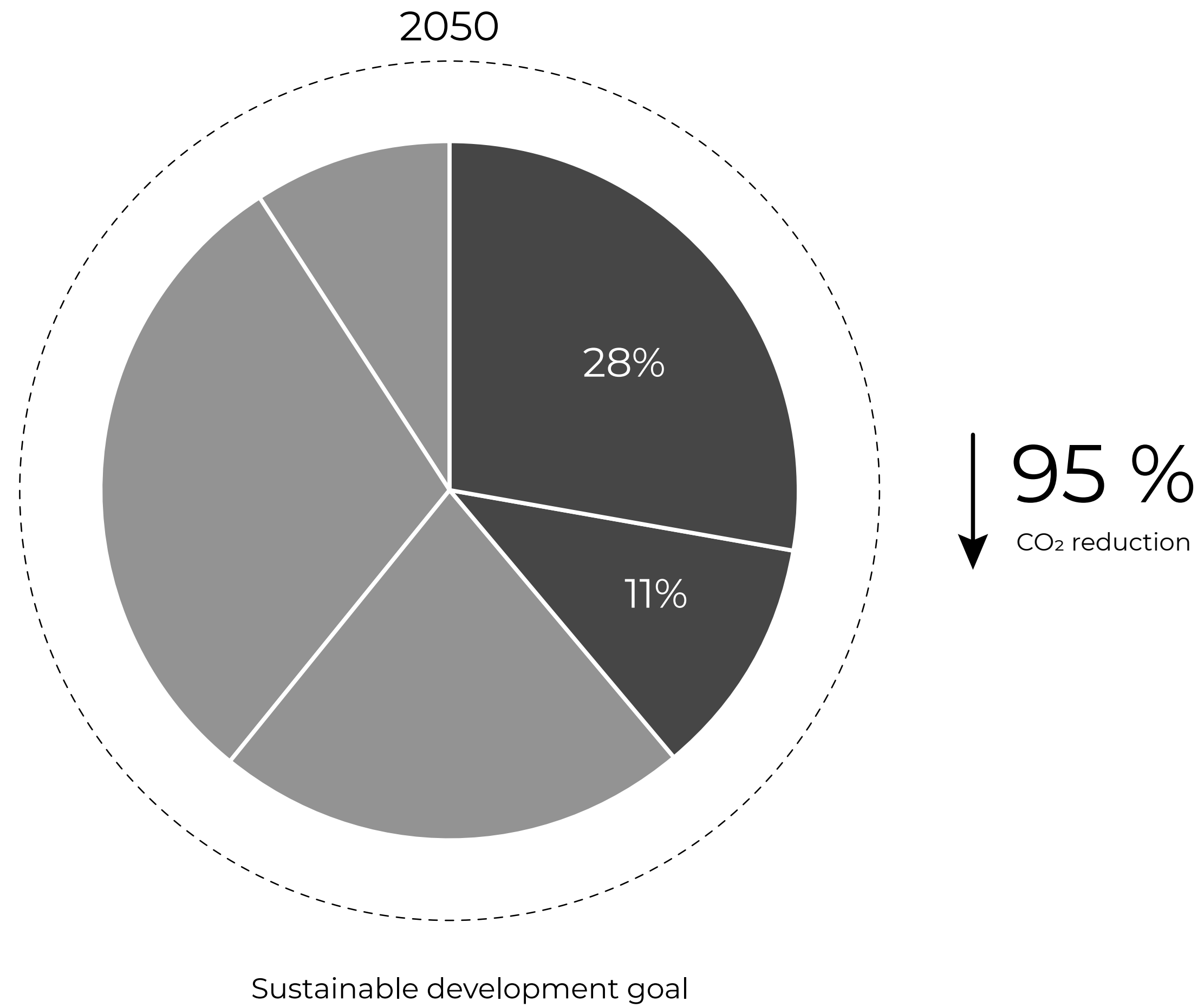
Sustainability in built environment



Global CO₂ emissions by sector

Circular material strategy

Sustainability in built environment

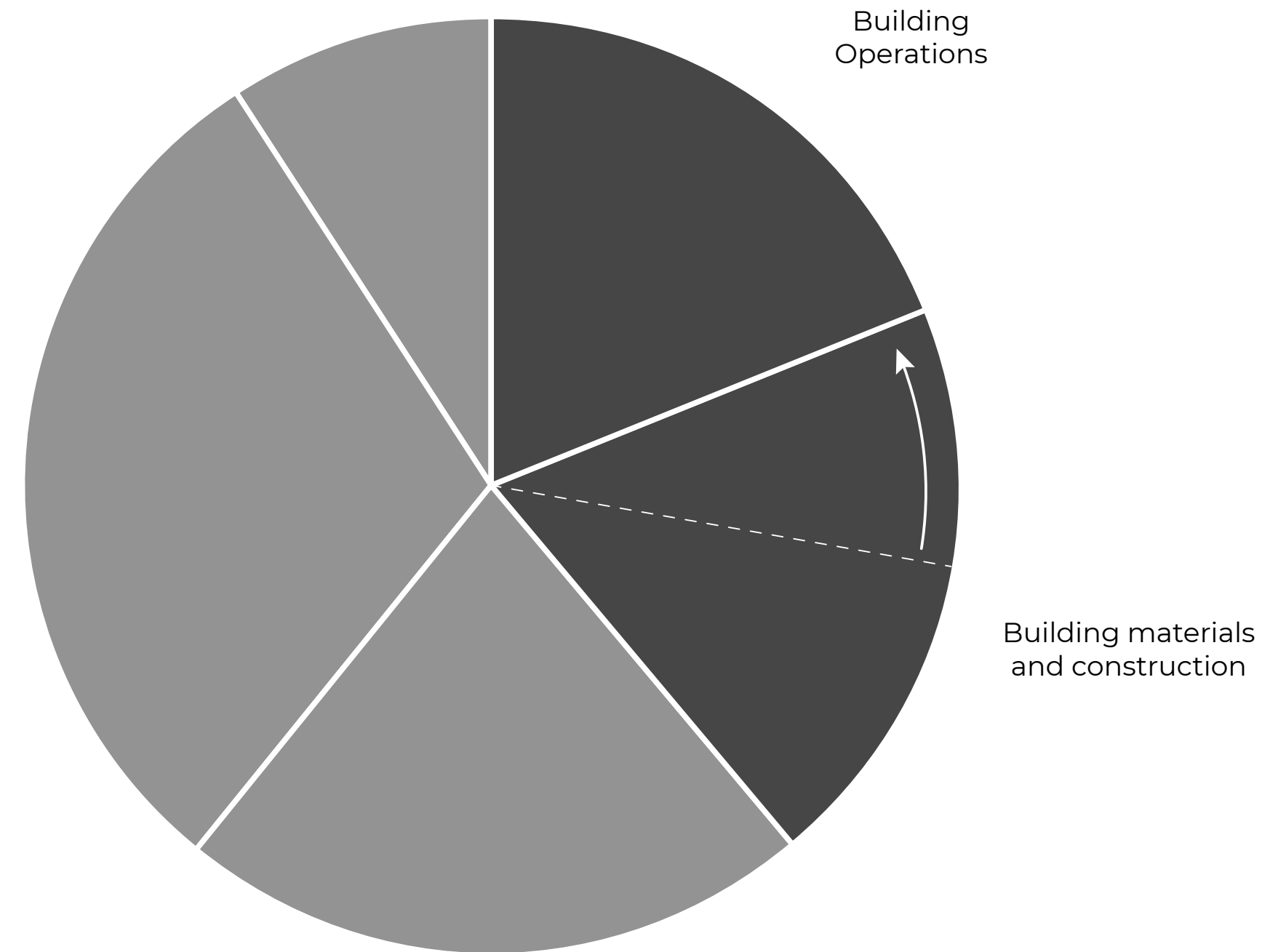


Source: 2015 Paris Climate Agreement

Circular material strategy

Sustainability in built environment

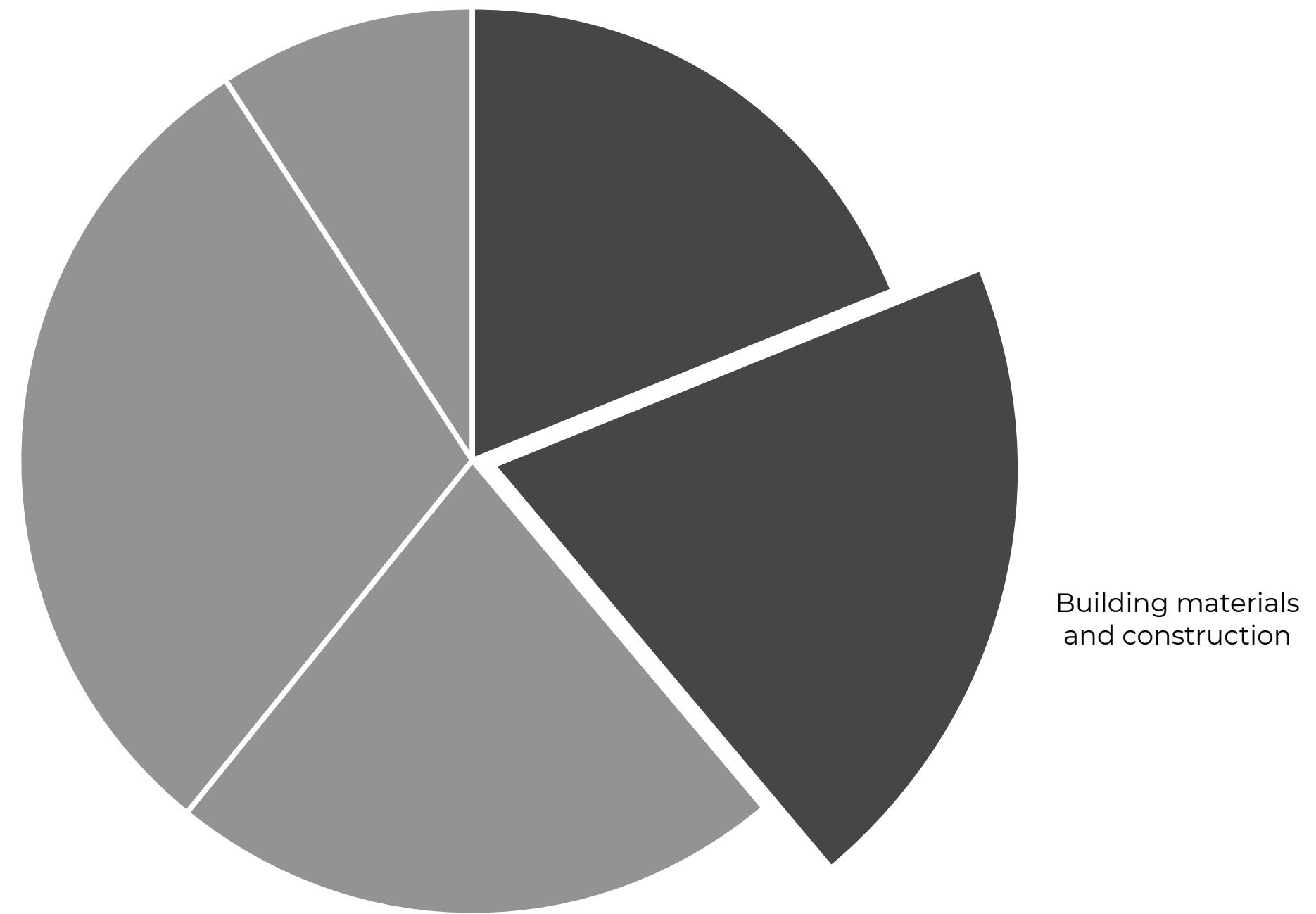
2050



Future scenario

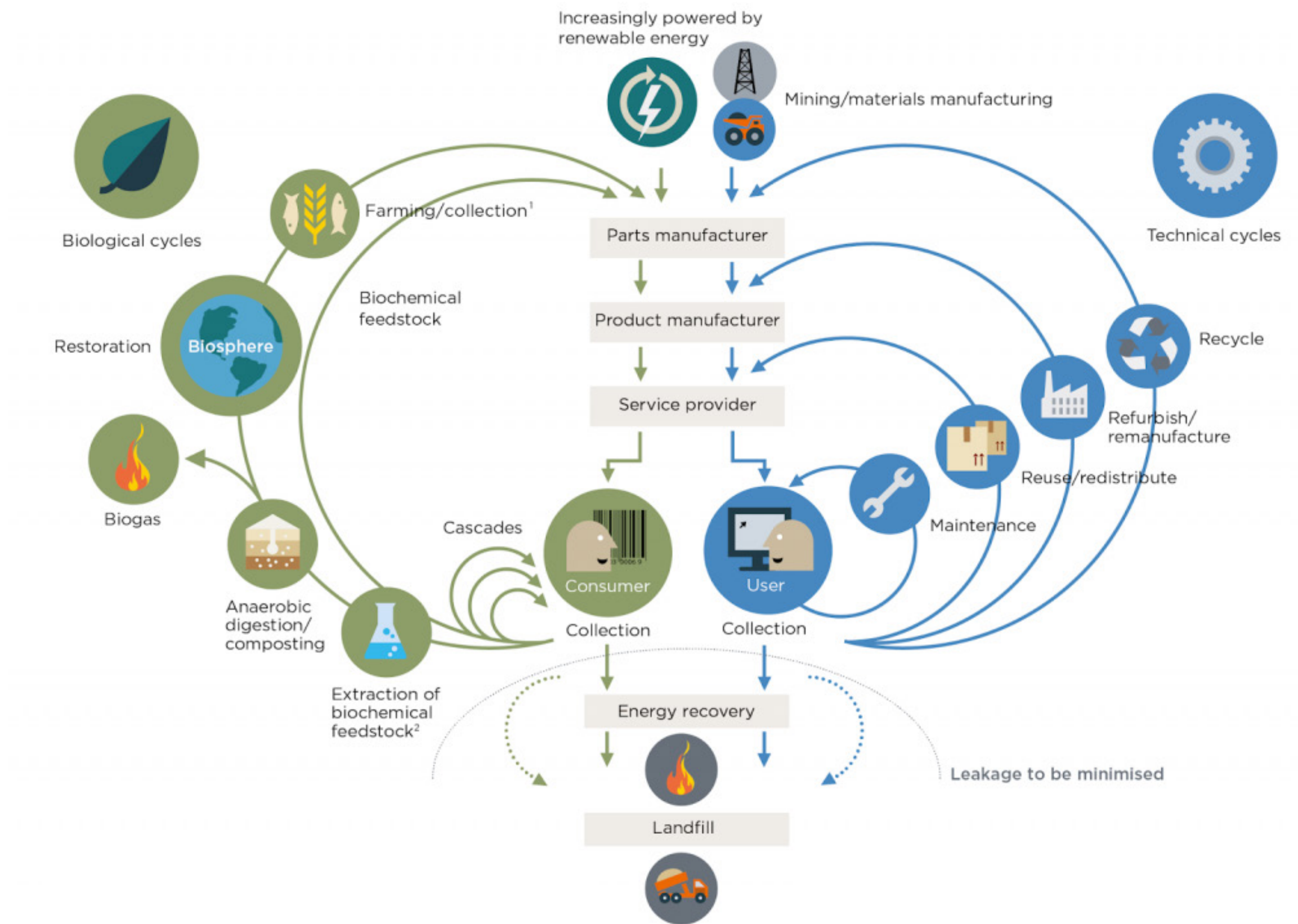
Circular material strategy

Sustainability in built environment



Circular material strategy

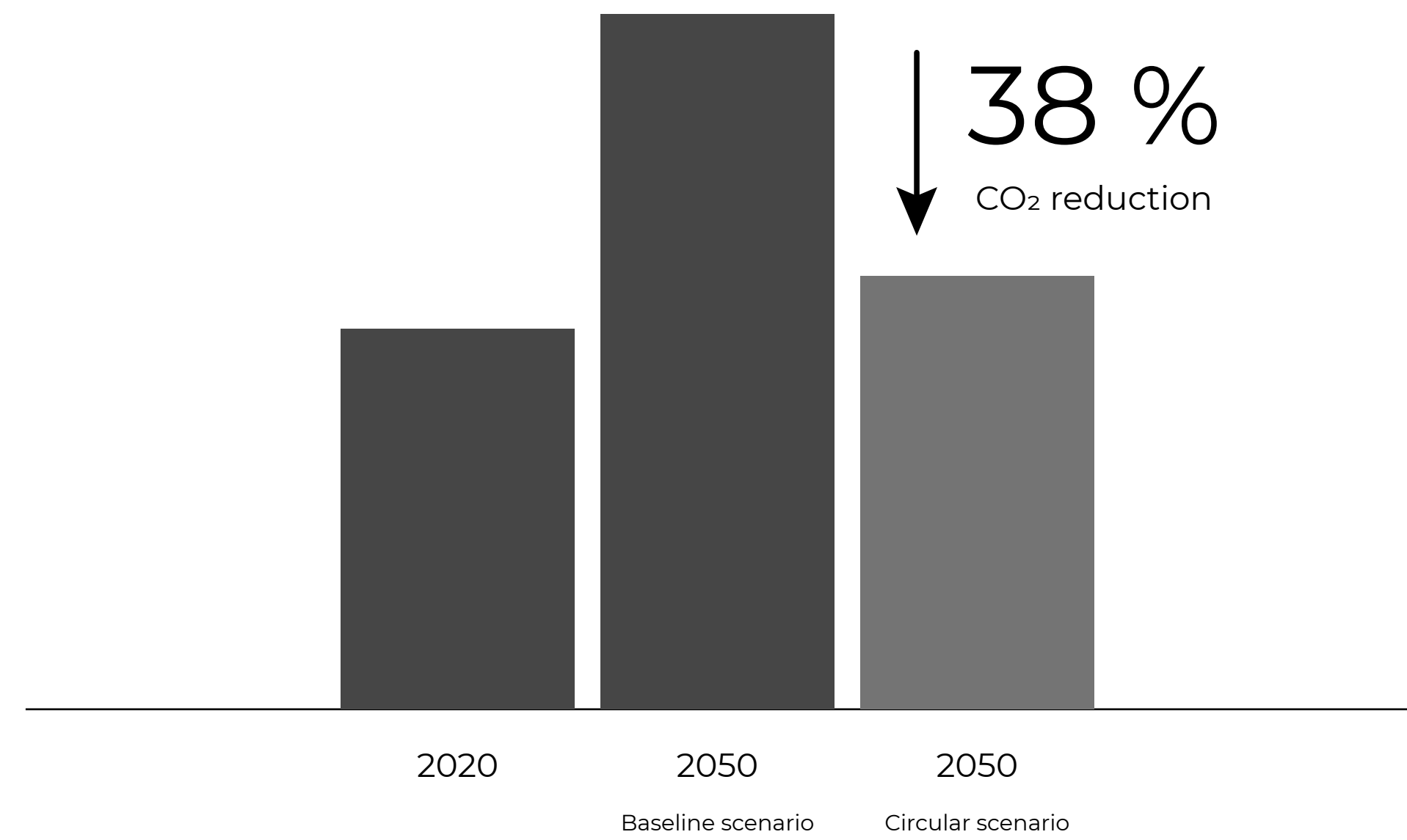
Circularity



Circular system diagram

Circular material strategy

Circularity in built environment



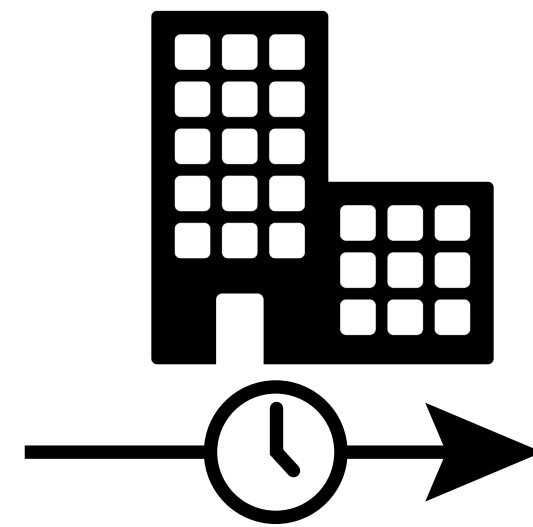
CO₂ emissions of building materials & construction

Circular material strategy

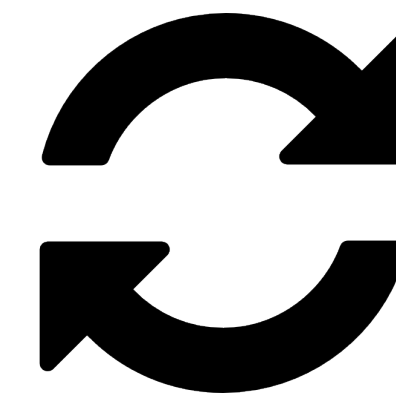
Circularity in built environment



1. Sharing business models; mixed use buildings



2. Prolong lifetime of buildings



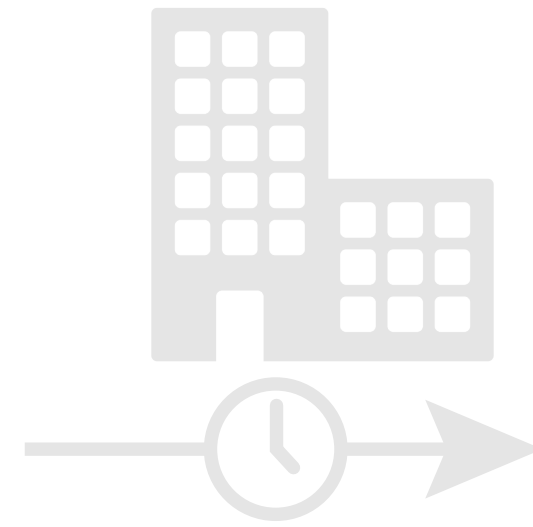
3 Reuse & recycling of building materials

Circular material strategy

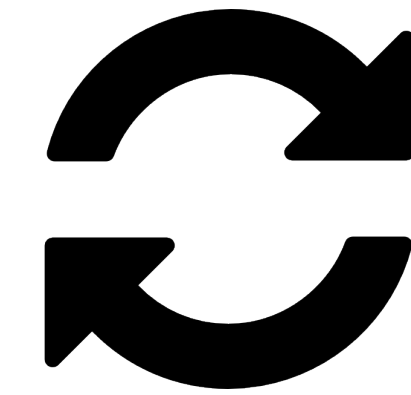
Circularity in built environment



1. Sharing business models; mixed use buildings



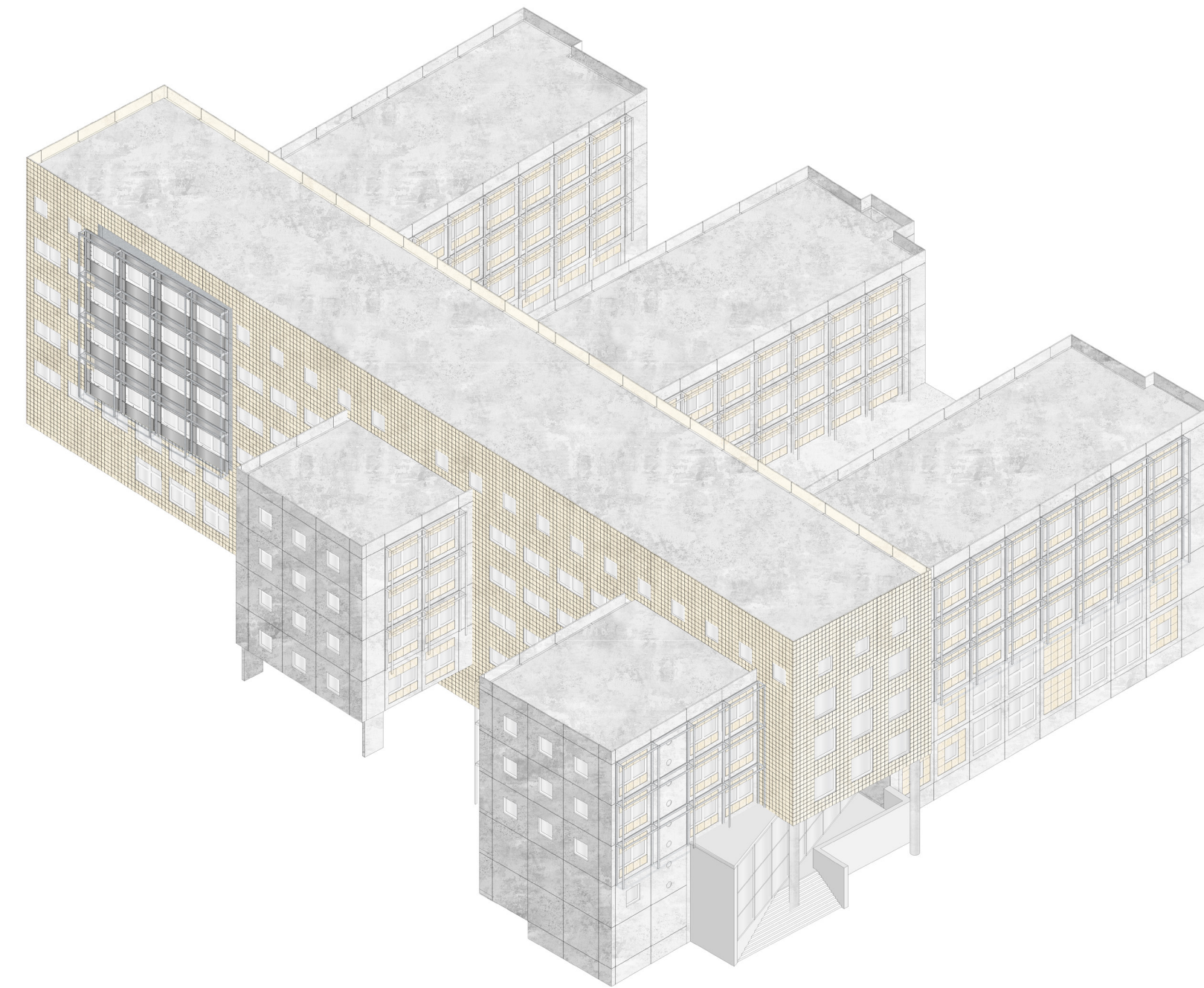
2. Prolong lifetime of buildings



3 Reuse & recycling of building materials

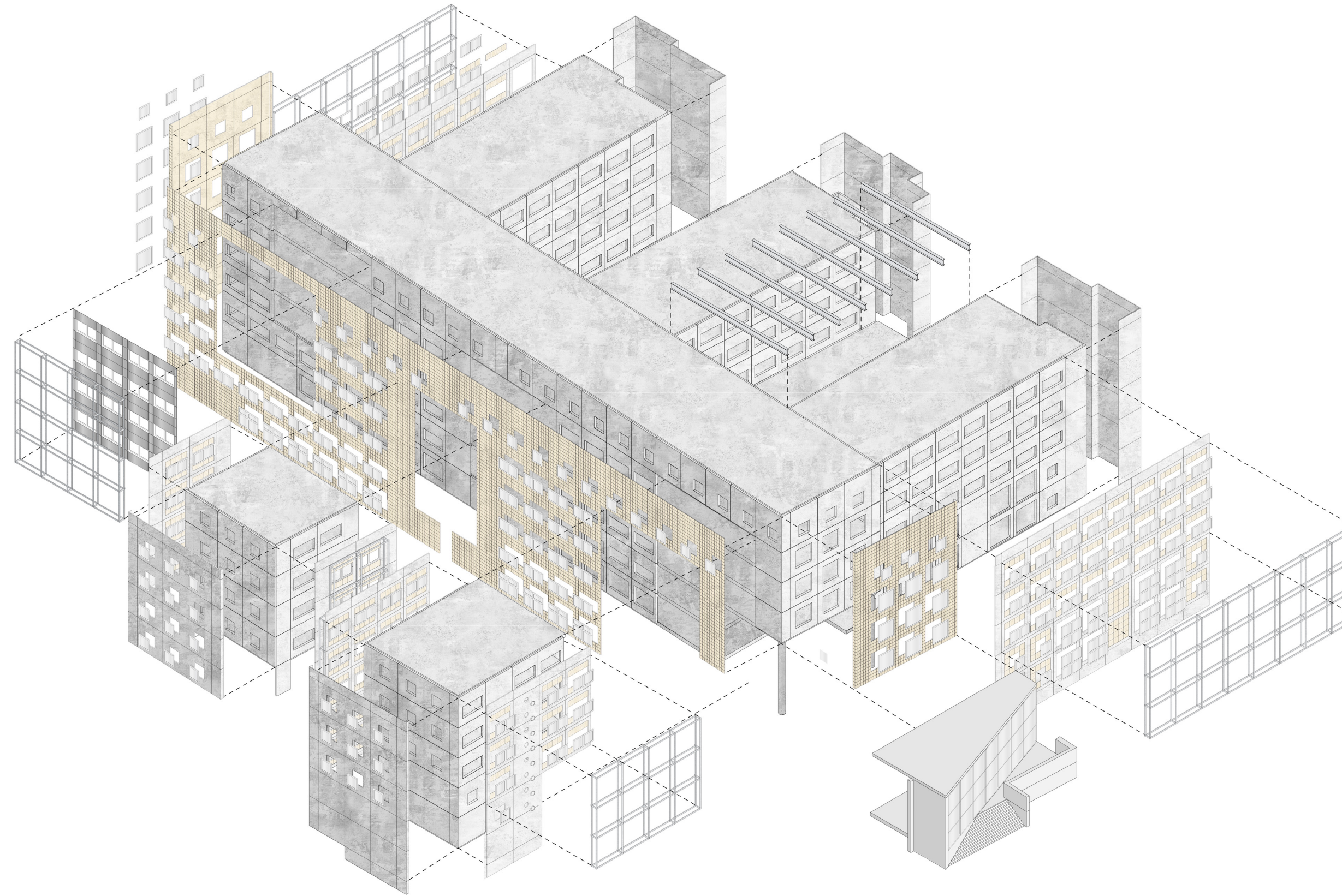
Circular material strategy

Material inventory



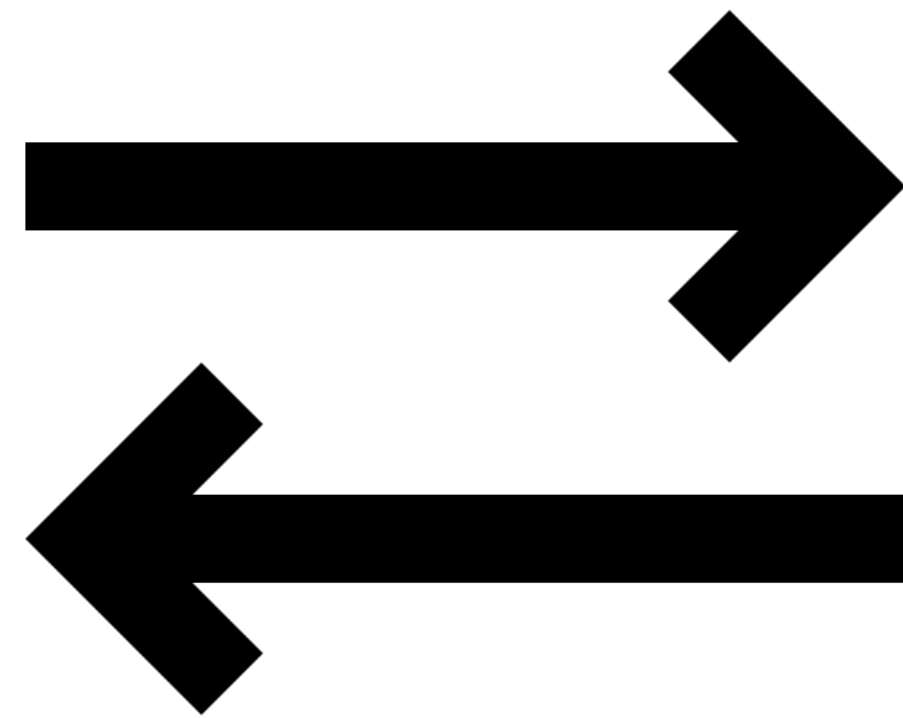
Circular material strategy

Material inventory

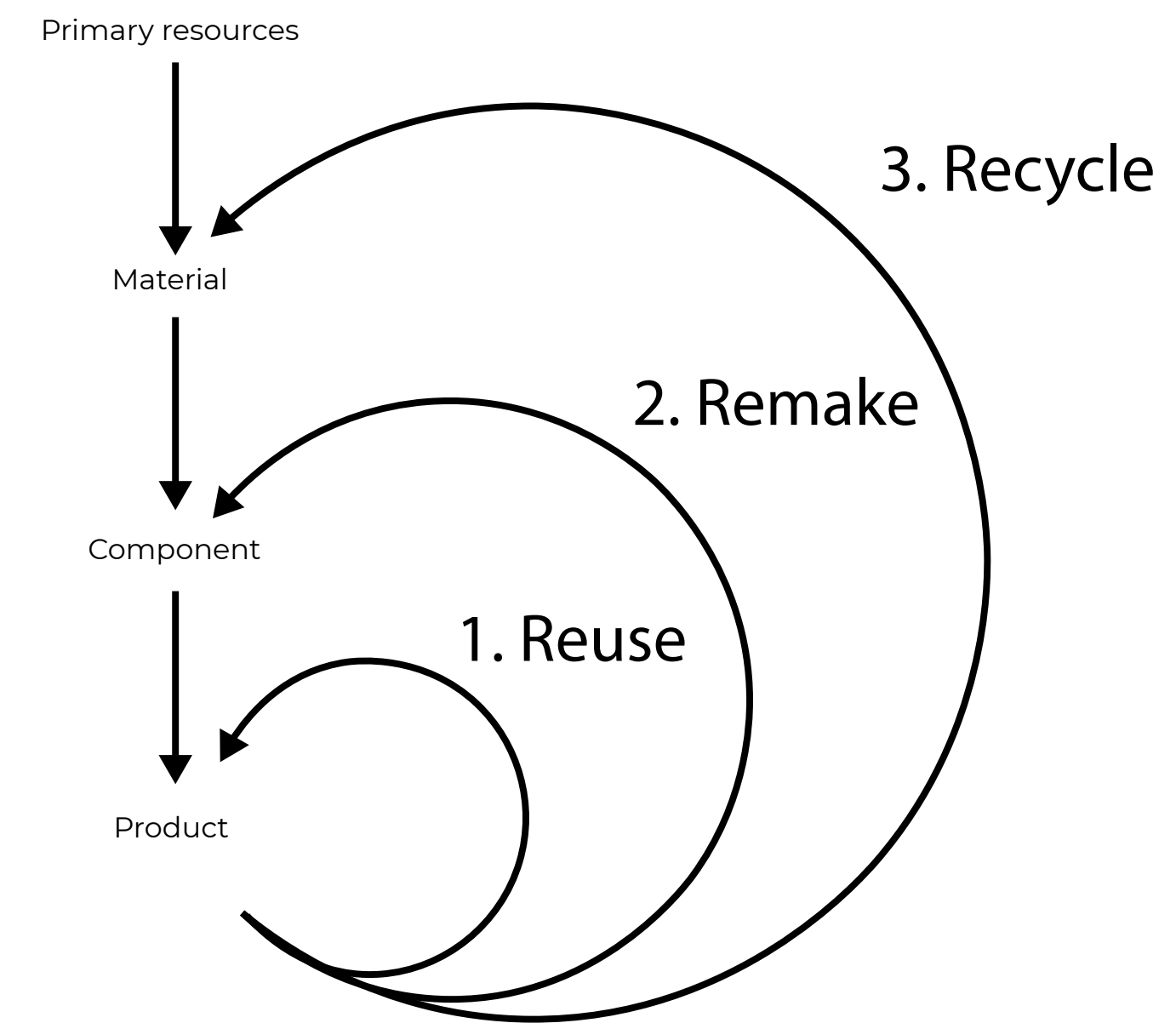


Circular material strategy

Principles



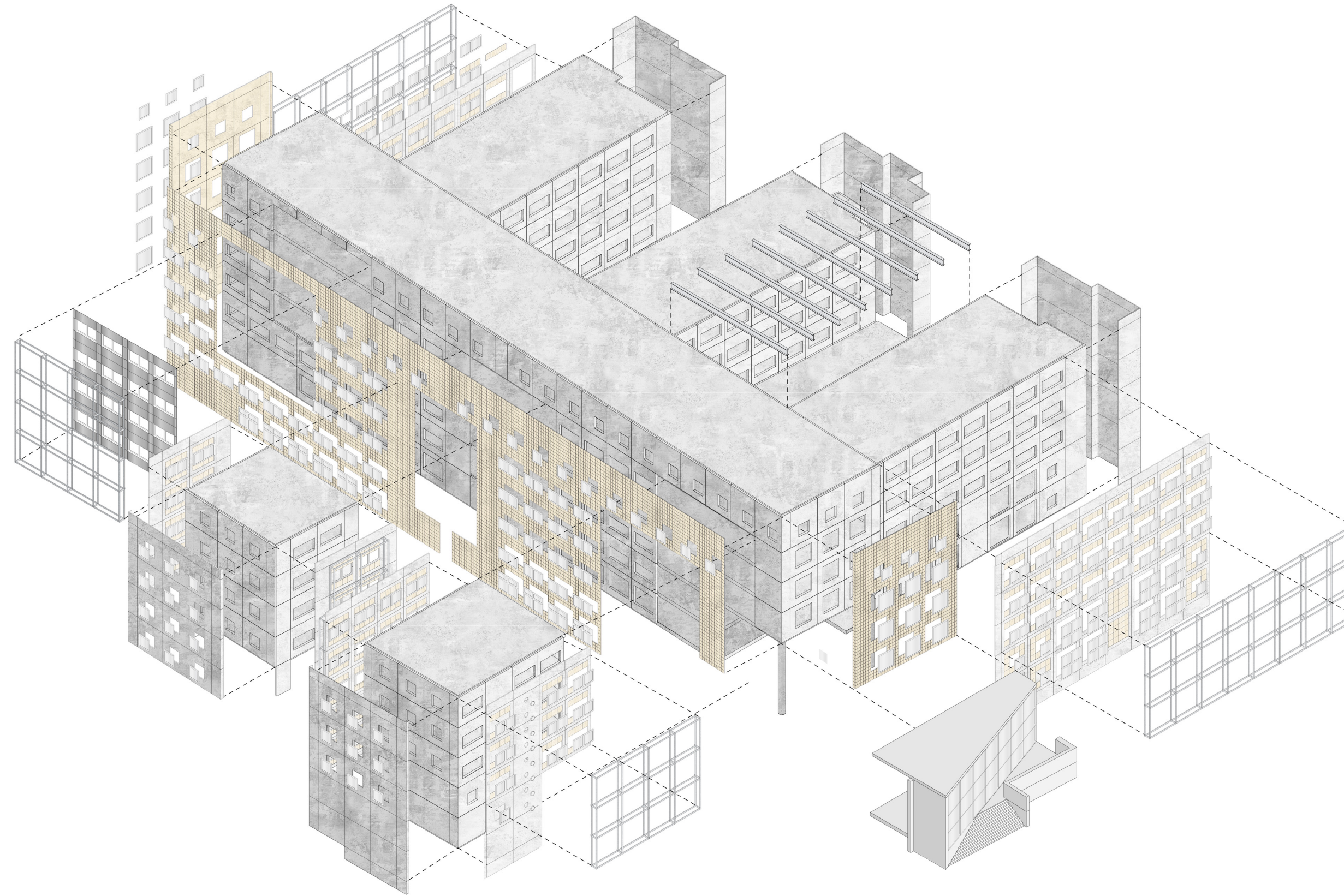
Materials out = materials in



Levels of reuse

Circular material strategy

Material inventory



Circular material strategy

Material inventory

Concrete

Amount
24.670 ton

Embodied carbon
2.556 ton CO₂

Steel

Amount
772 ton

Embodied carbon
1.550 ton CO₂

Aluminium

Amount
16 ton

Embodied carbon
105 ton CO₂

Glass

Amount
38 ton

Embodied carbon
62 ton CO₂

Limestone

Amount
62 ton

Embodied carbon
6 ton CO₂

Rockwool

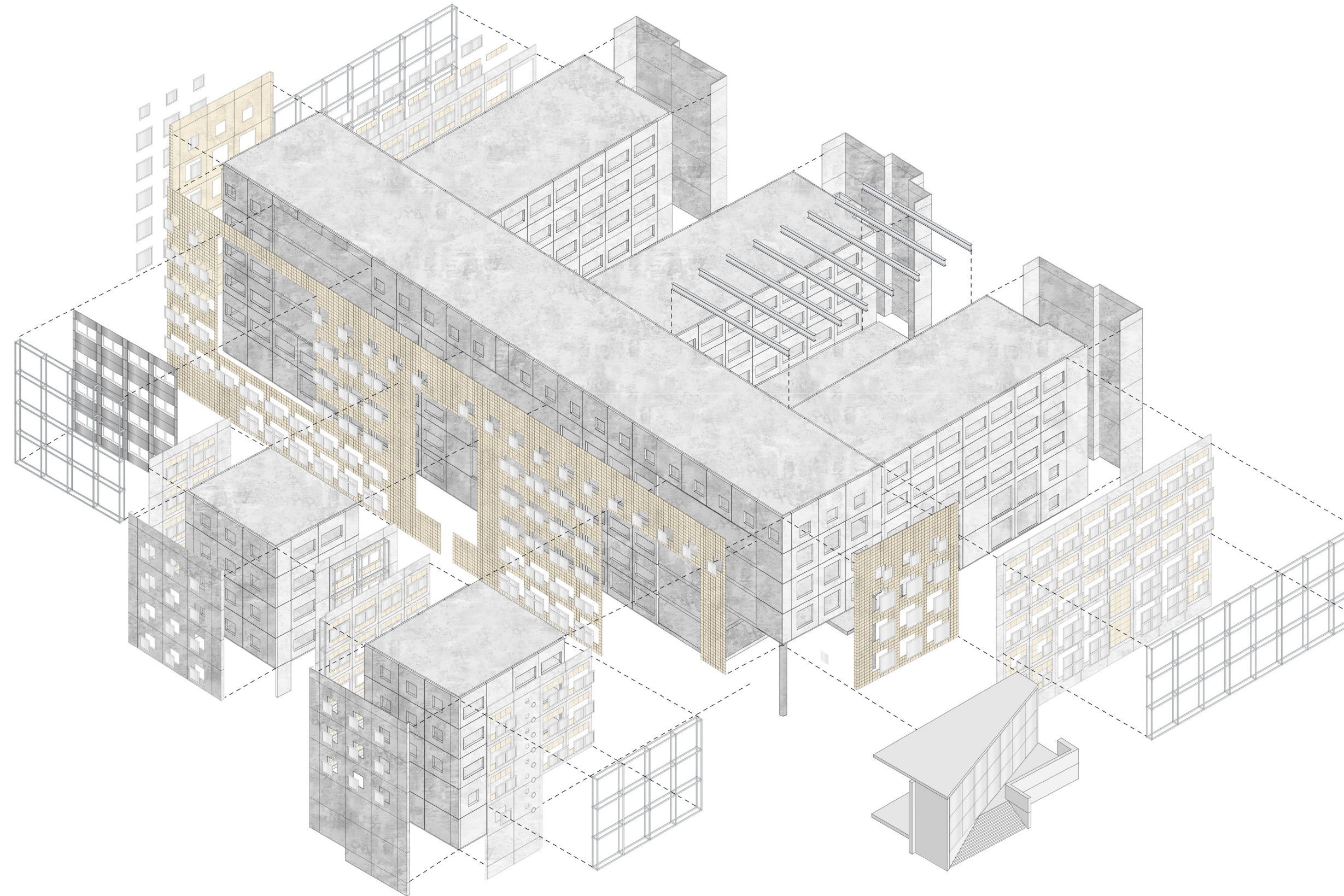
Amount
53 ton

Embodied carbon
70 ton CO₂

Gypsum

Amount
161 ton

Embodied carbon
317 ton CO₂



Circular material strategy

Embodied carbon

Concrete

Amount
24.670 ton

Embodied carbon
2.556 ton CO₂

Steel

Amount
772 ton

Embodied carbon
1.550 ton CO₂

Aluminium

Amount
16 ton

Embodied carbon
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Glass

Amount
38 ton

Embodied carbon
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Limestone

Amount
62 ton

Embodied carbon
6 ton CO₂

Rockwool

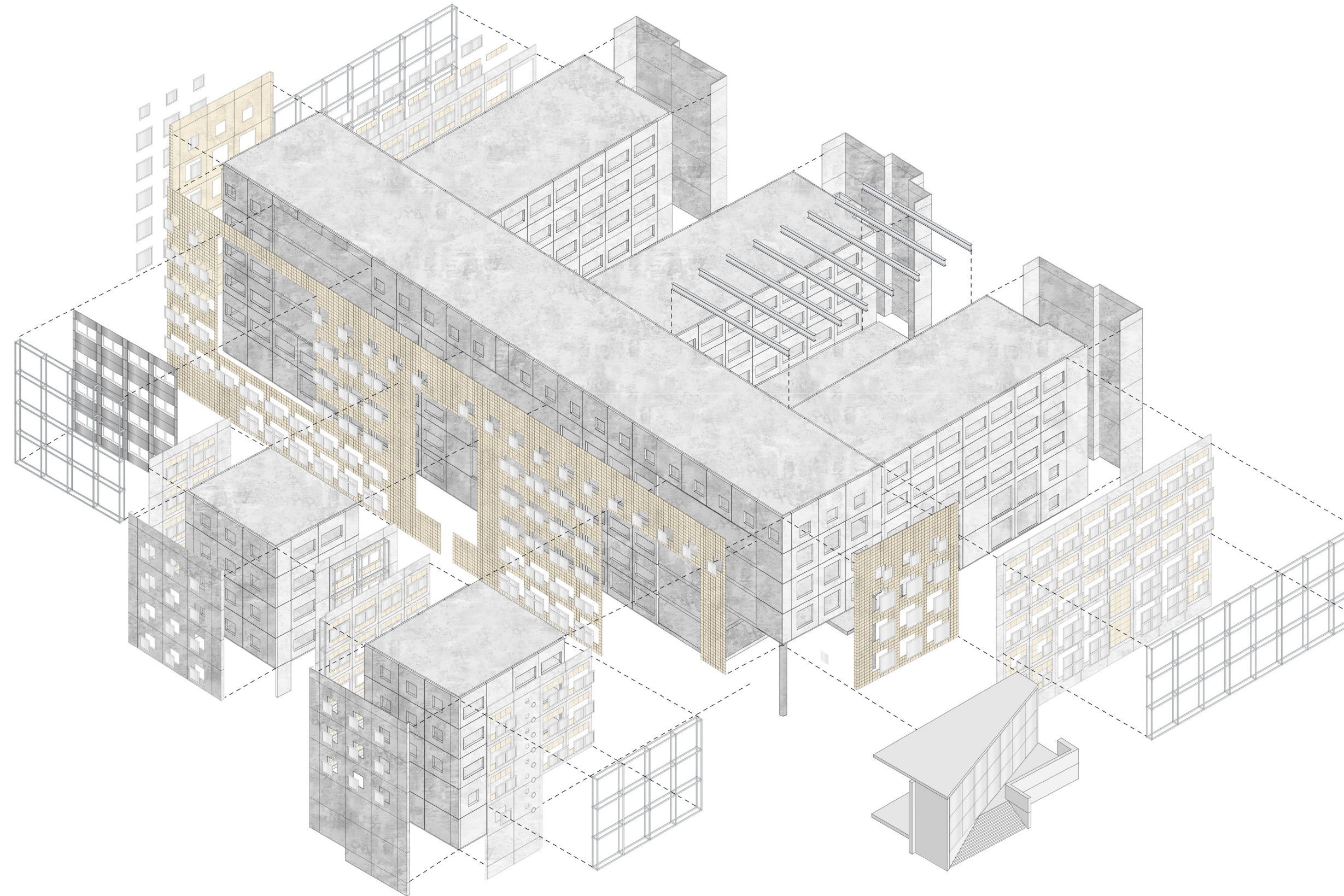
Amount
53 ton

Embodied carbon
70 ton CO₂

Gypsum

Amount
161 ton

Embodied carbon
317 ton CO₂



Total embodied carbon:

4666 ton CO₂ eq.

Circular material strategy

Current recycling rate

Concrete

Amount
24.670 ton

<3%

Embodied carbon
2.556 ton CO₂

Steel

Amount
772 ton

85%

Embodied carbon
1.550 ton CO₂

Aluminium

Amount
16 ton

95%

Embodied carbon
105 ton CO₂

Glass

Amount
38 ton

60%

Embodied carbon
62 ton CO₂

Limestone

Amount
62 ton

-

Embodied carbon
6 ton CO₂

Rockwool

Amount
53 ton

50%*

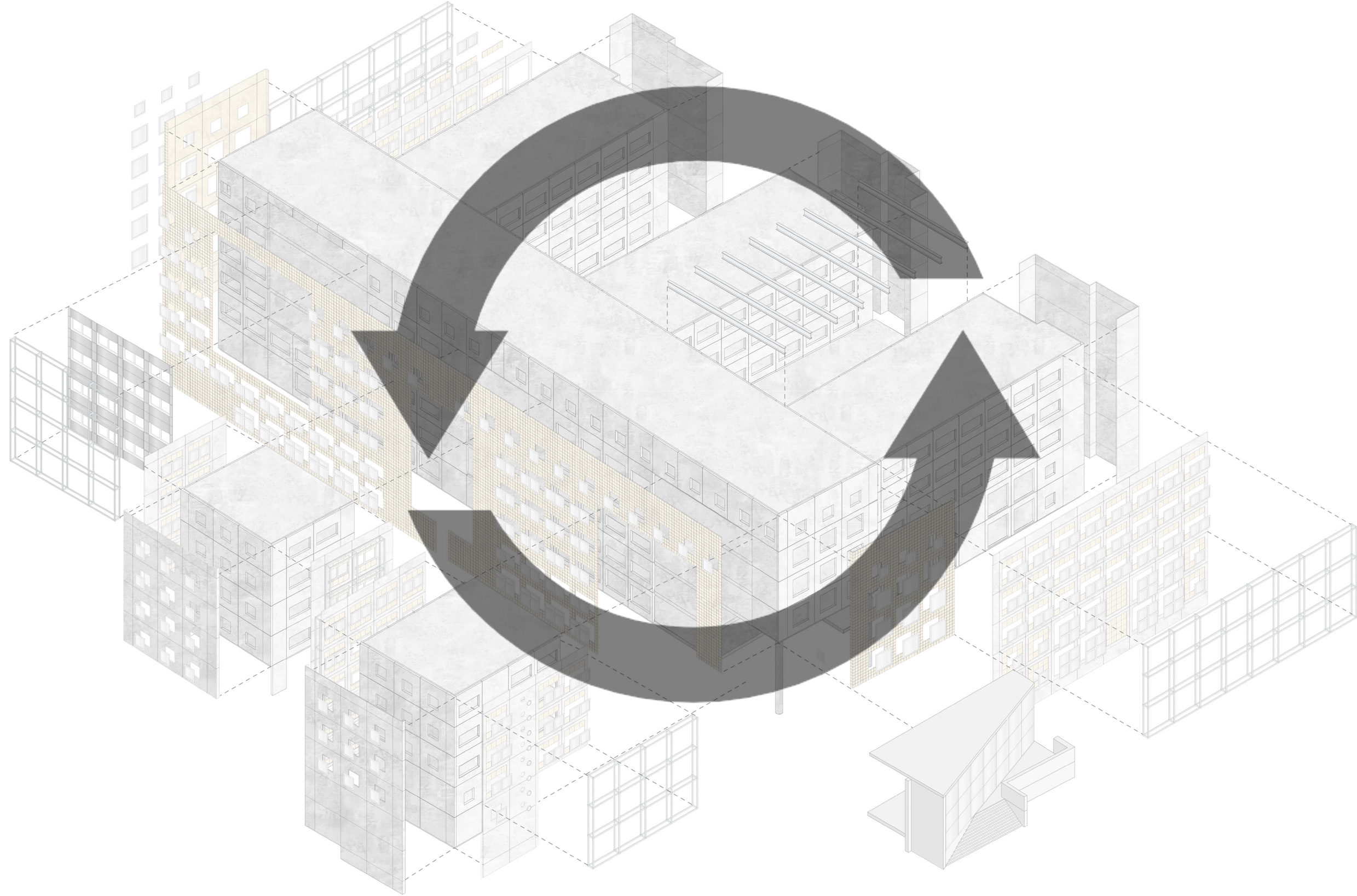
Embodied carbon
70 ton CO₂

Gypsum

Amount
161 ton

50%*

Embodied carbon
317 ton CO₂



* Recycled content in specific product types

Circular material strategy

Thematic research



Circular material strategy

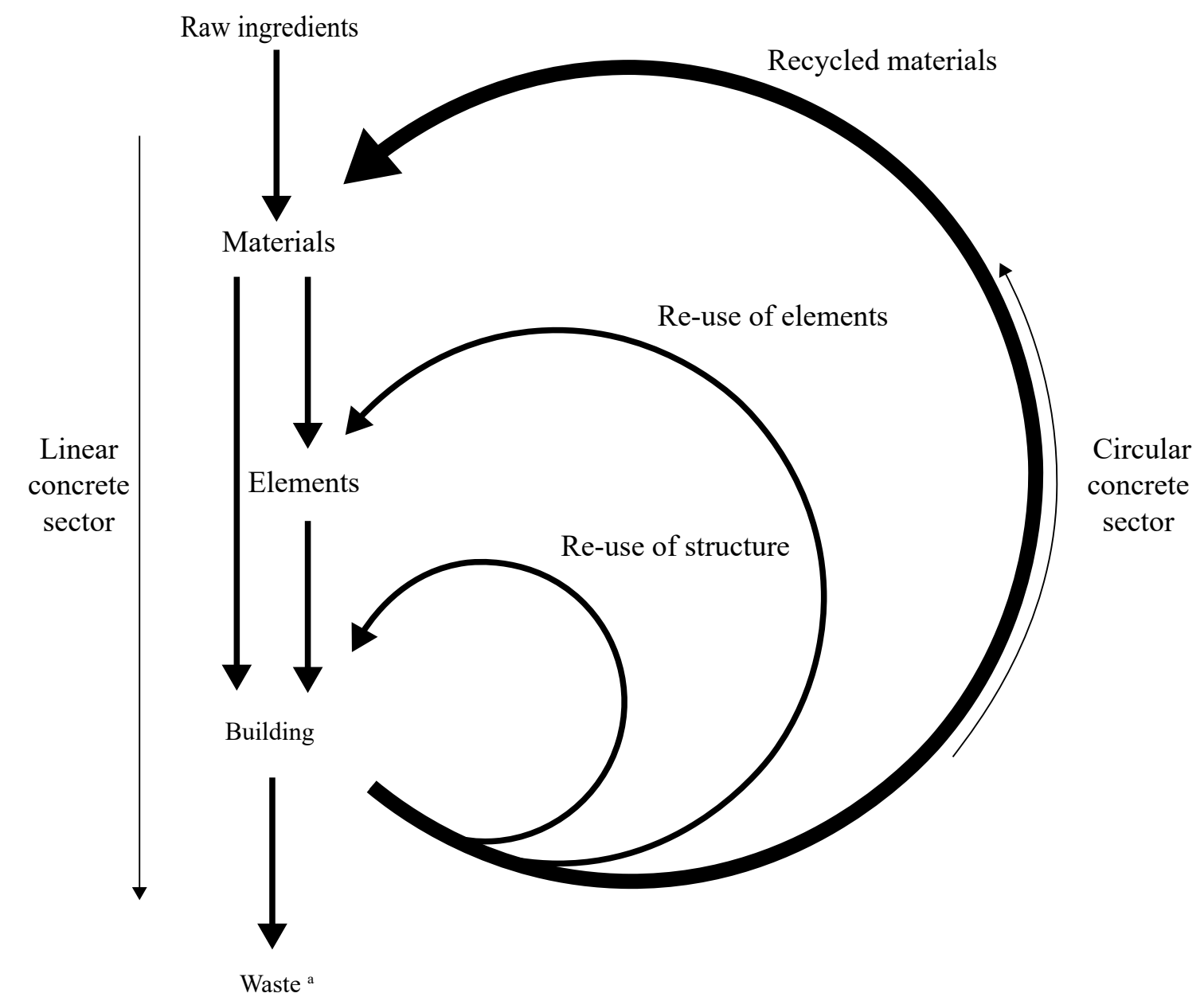
Thematic research



Circular material strategy

Thematic research

Towards a circular concrete sector



Circular material strategy

Thematic research

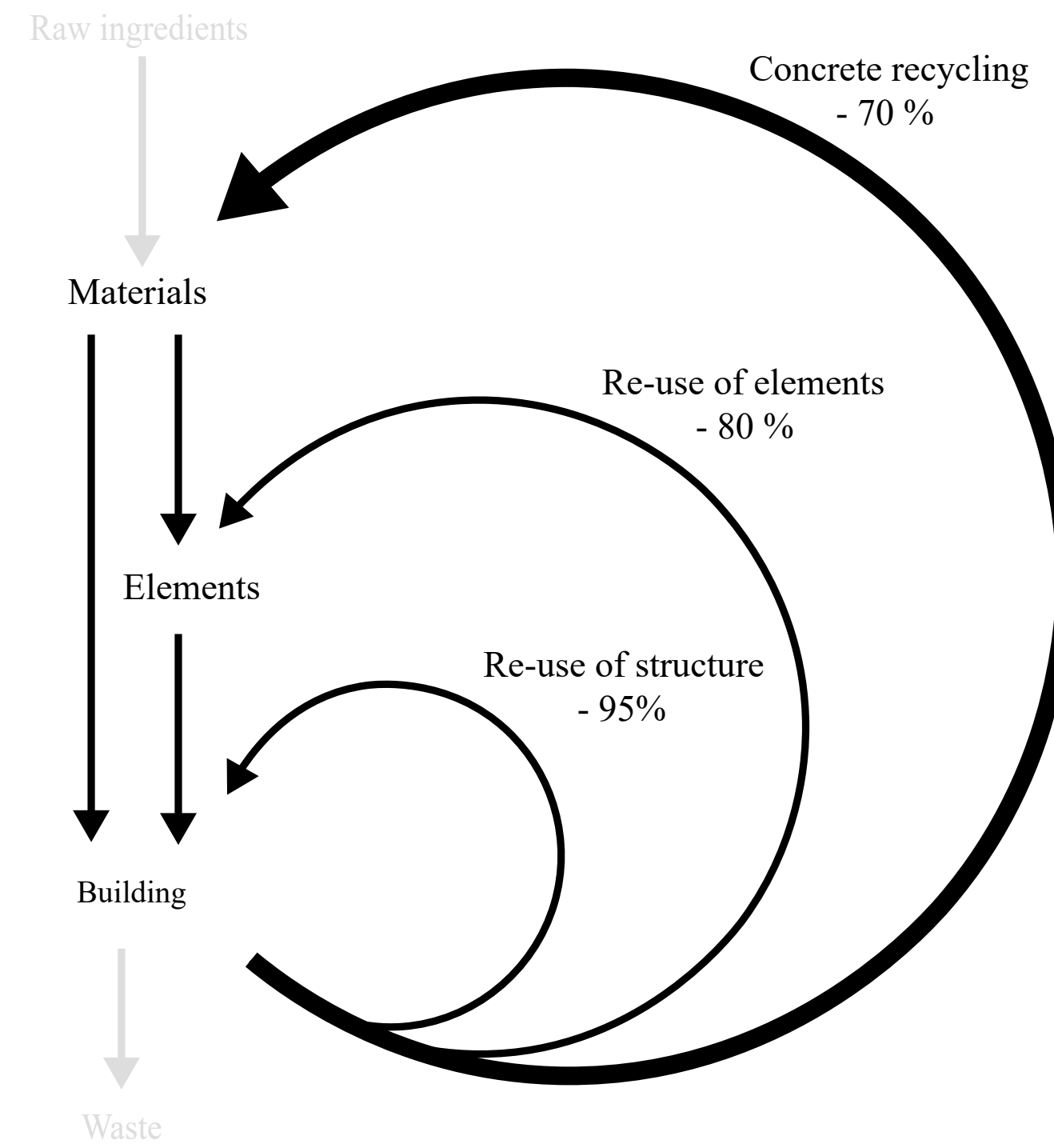
Concrete recycling



Smart crusher installation

Circular material strategy

Thematic research - conclusion



Circular material strategy

Conclusion

Research implementation:

'What are the environmental benefits of integrating reused and recycled materials into the design?'

3. Design

Extension building



Design

Objectives

Design objective:

'How to transform the extension building into a qualitative and flexible structure, with a uniform architectural expression, a clear organisation and a comfortable user environment to ensure a long lifespan?'

Research implementation:

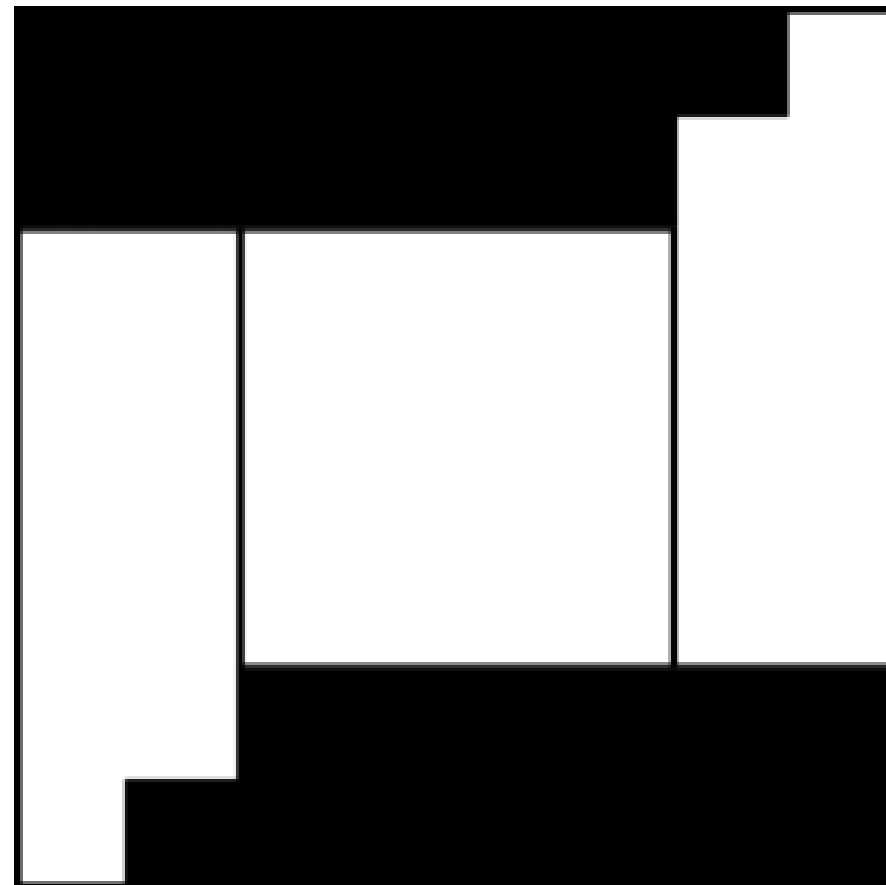
'What are the environmental benefits of integrating reused and recycled materials into the design?'

Design

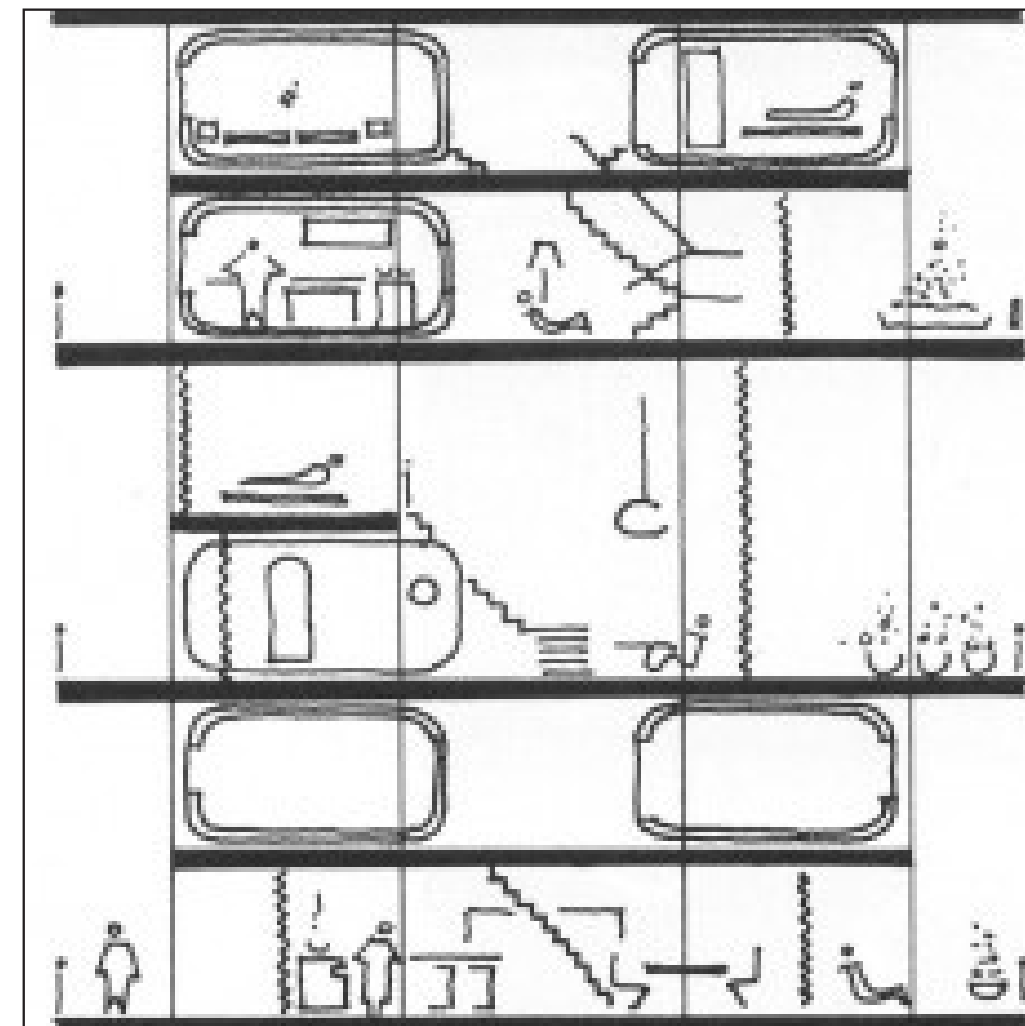
Principles

Design objective:

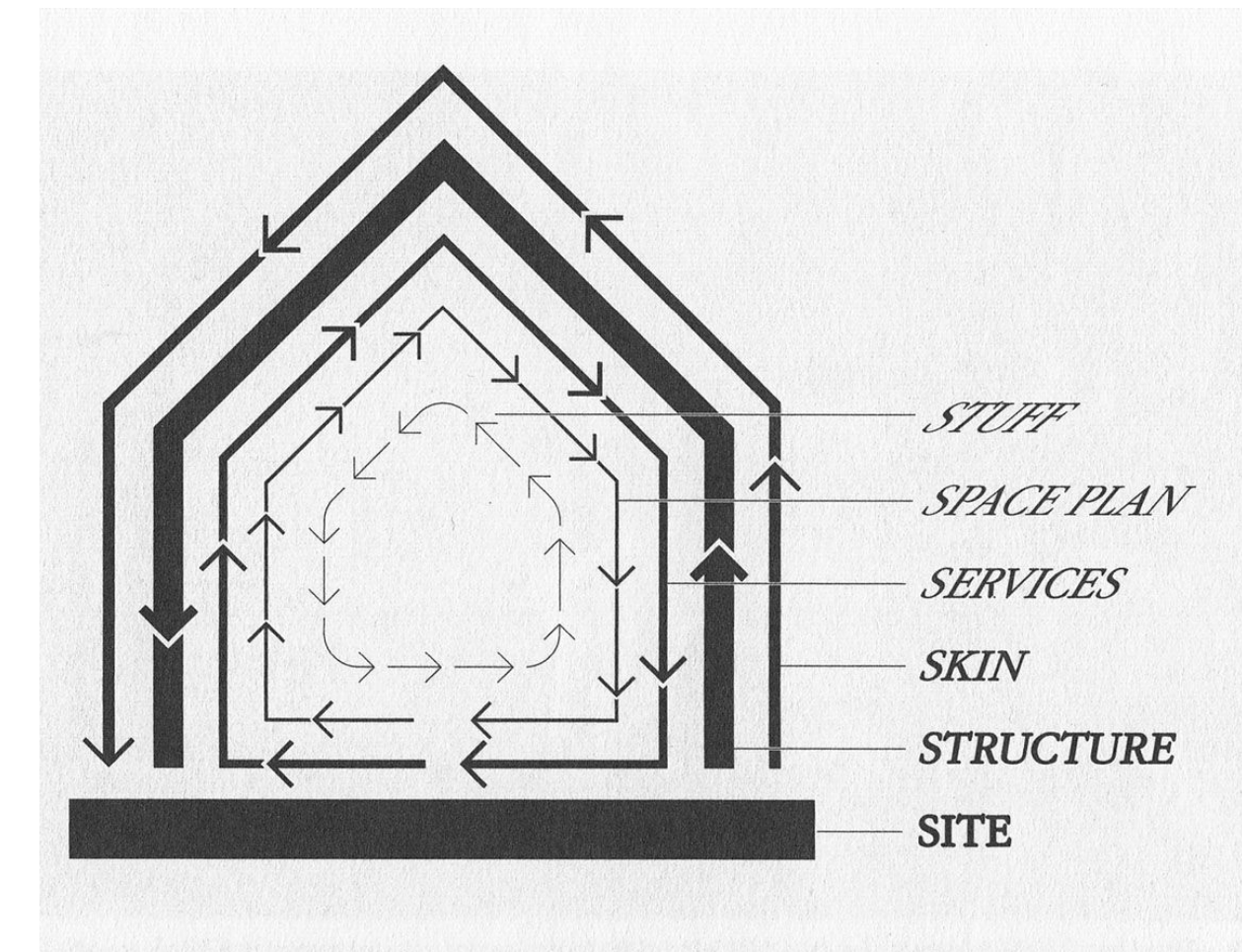
'How to transform the extension building into a qualitative and flexible structure, with a uniform architectural expression, a clear organisation and a comfortable user environment to ensure a long lifespan?'



Open building



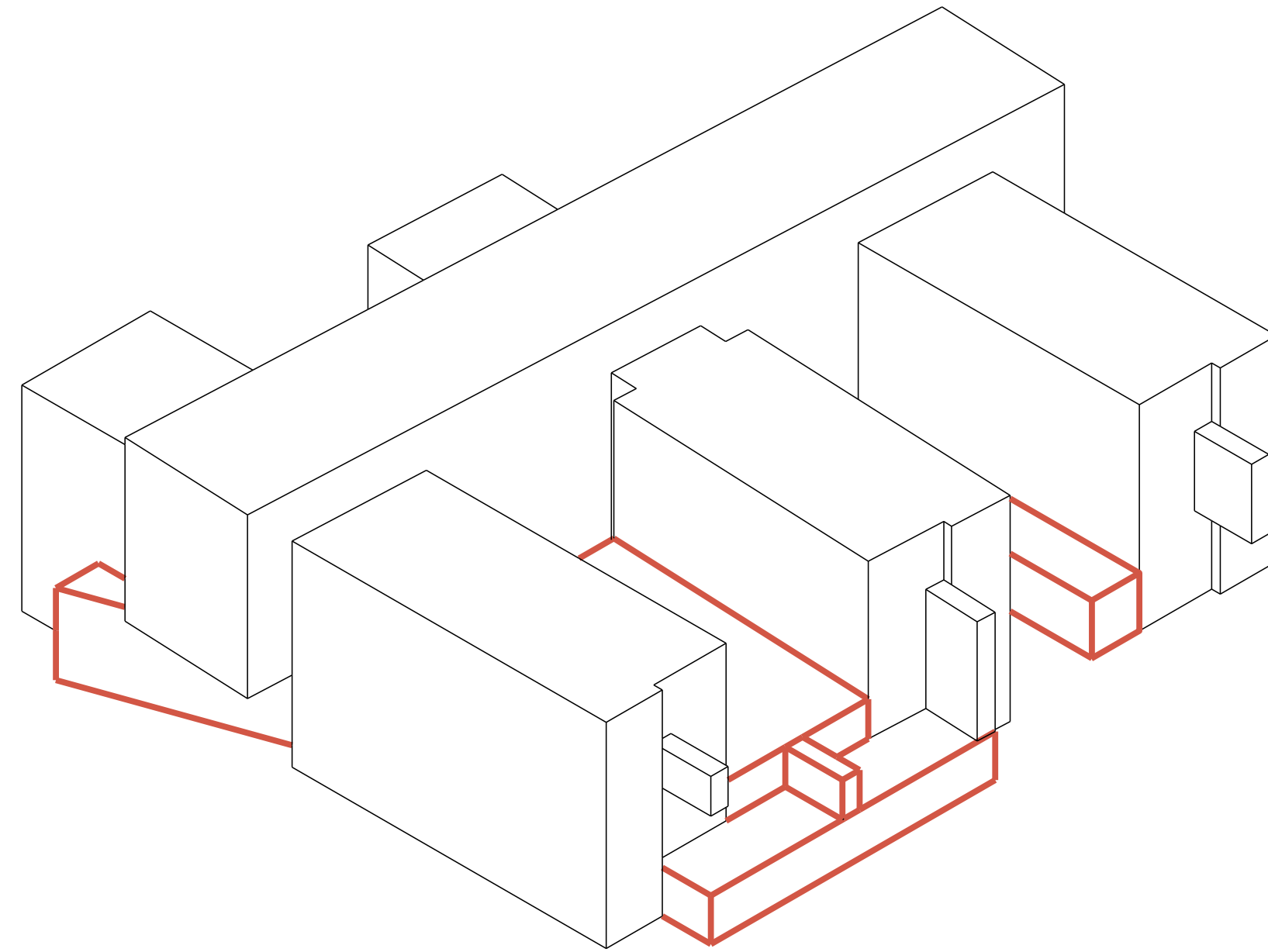
Support & infill



Shearing layers of change

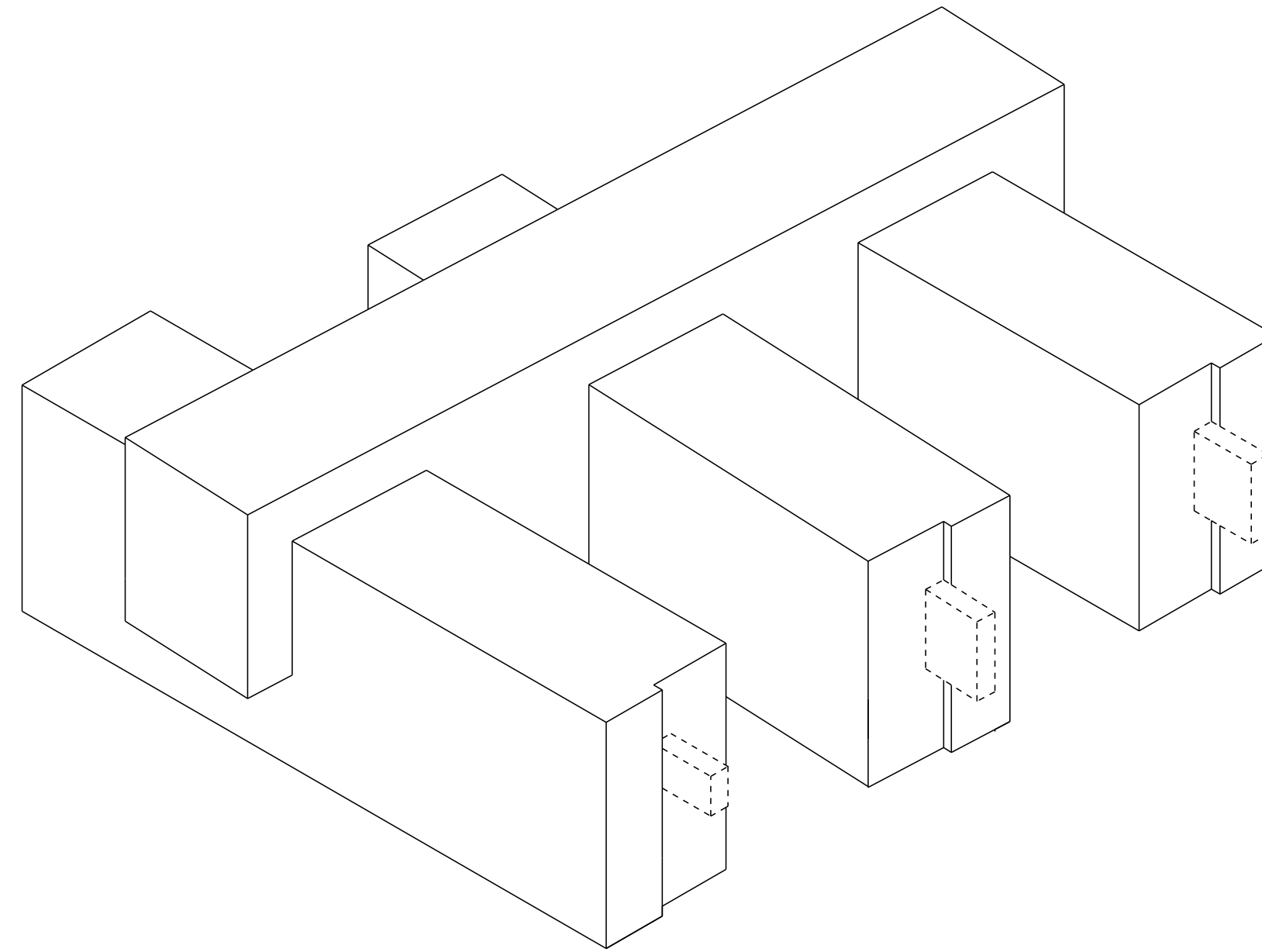
Design

Defining the basis - Volumetric arrangement



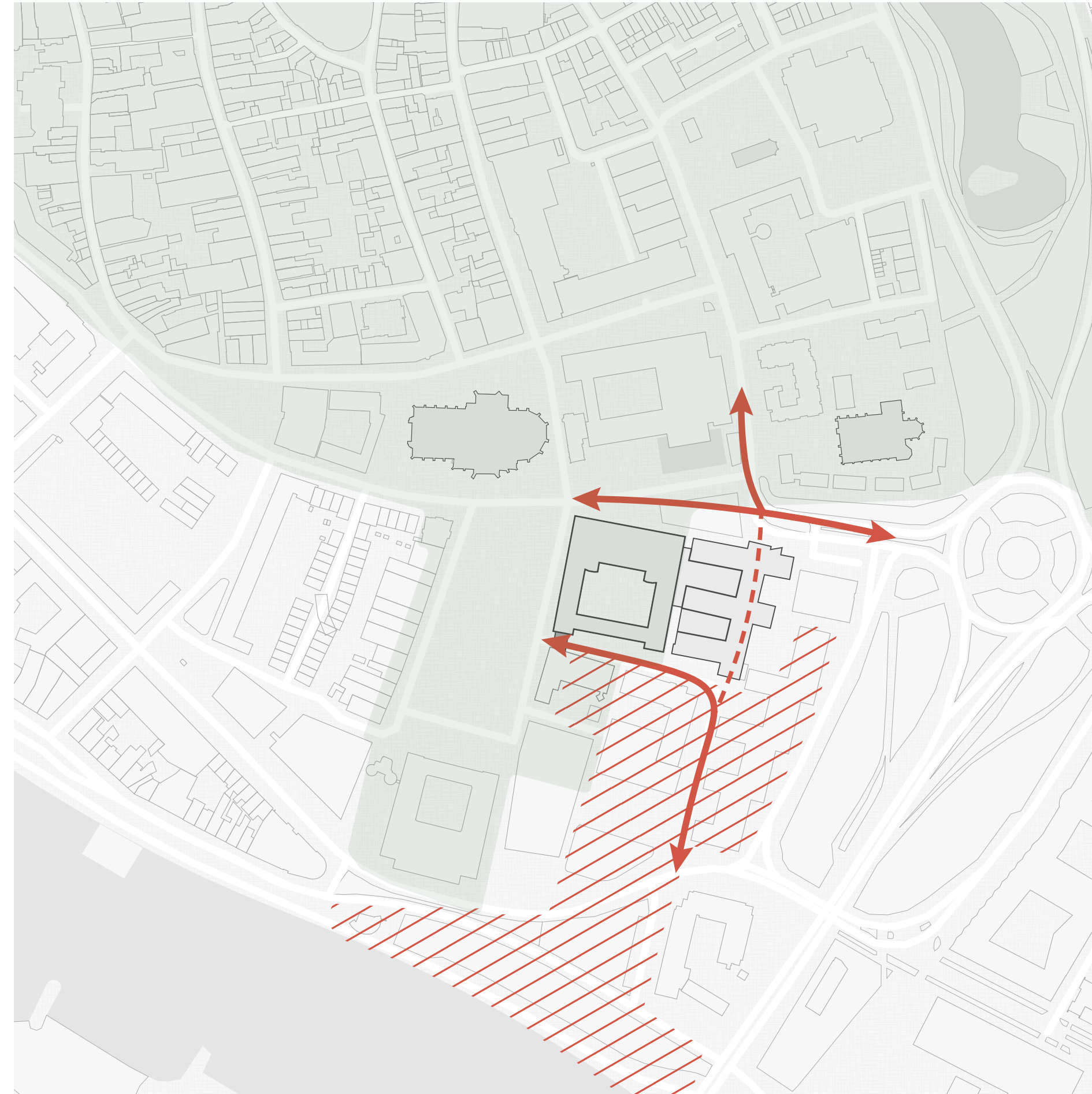
Design

Defining the basis - Volumetric arrangement



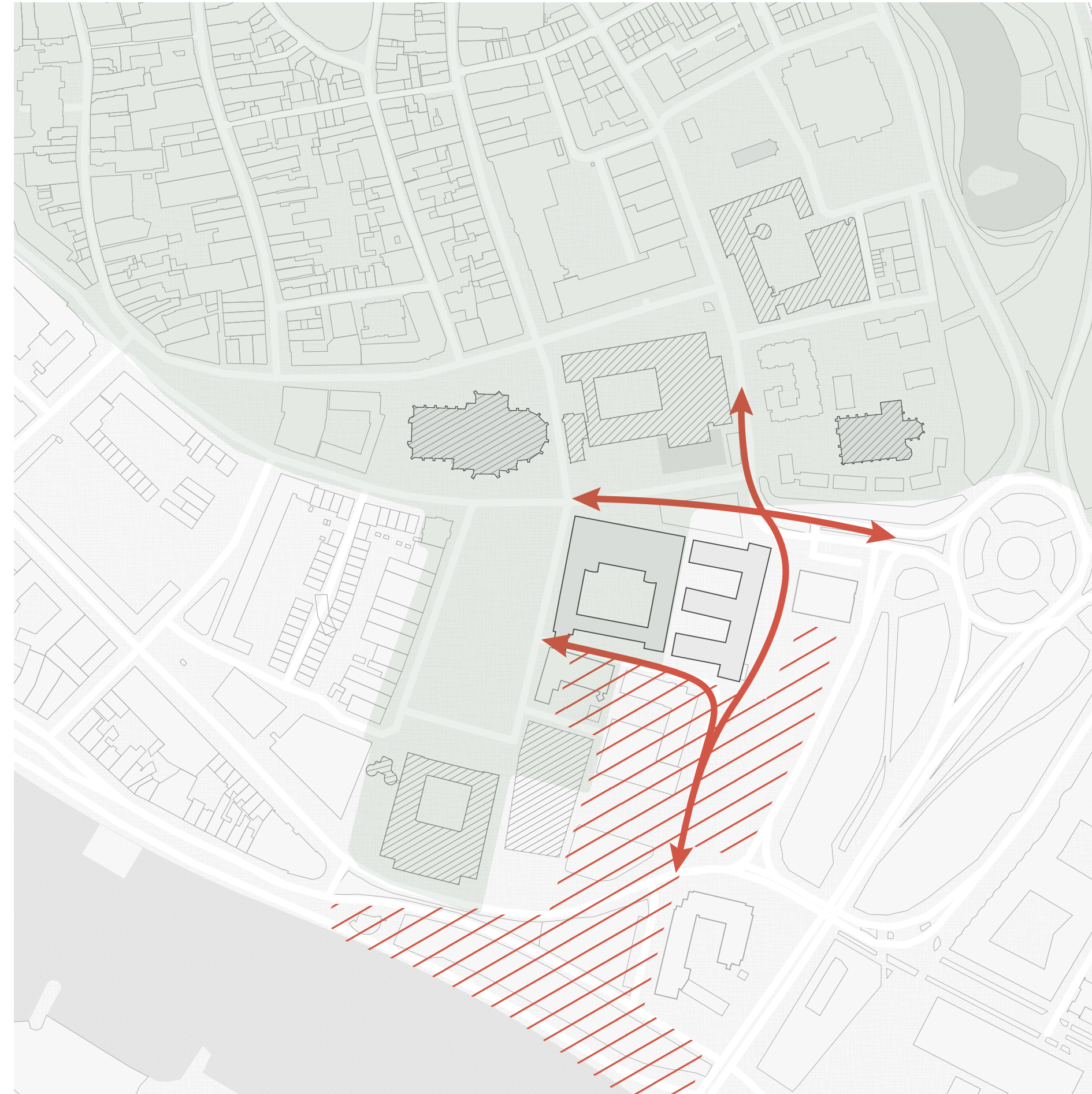
Design

Defining the basis - Urban scale



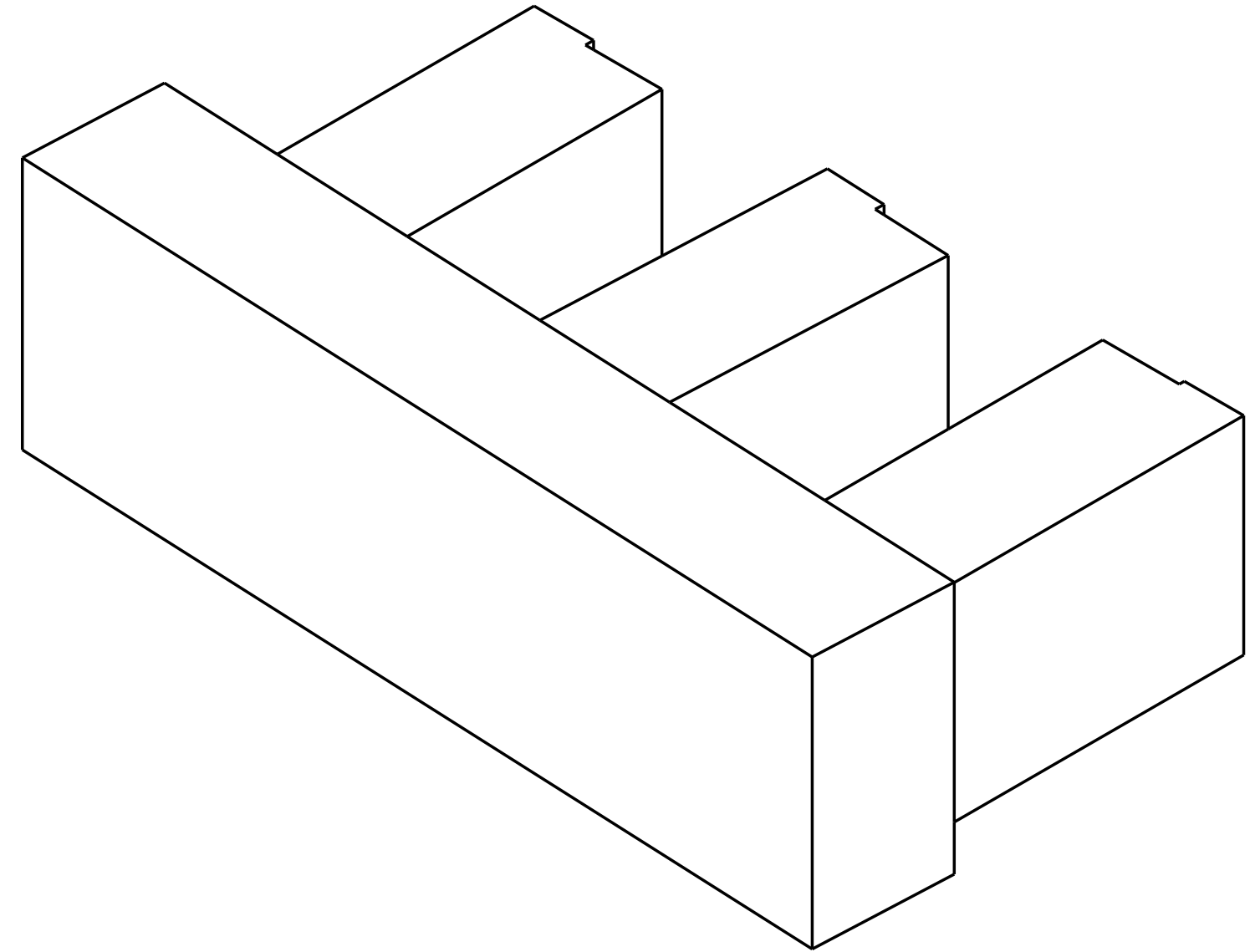
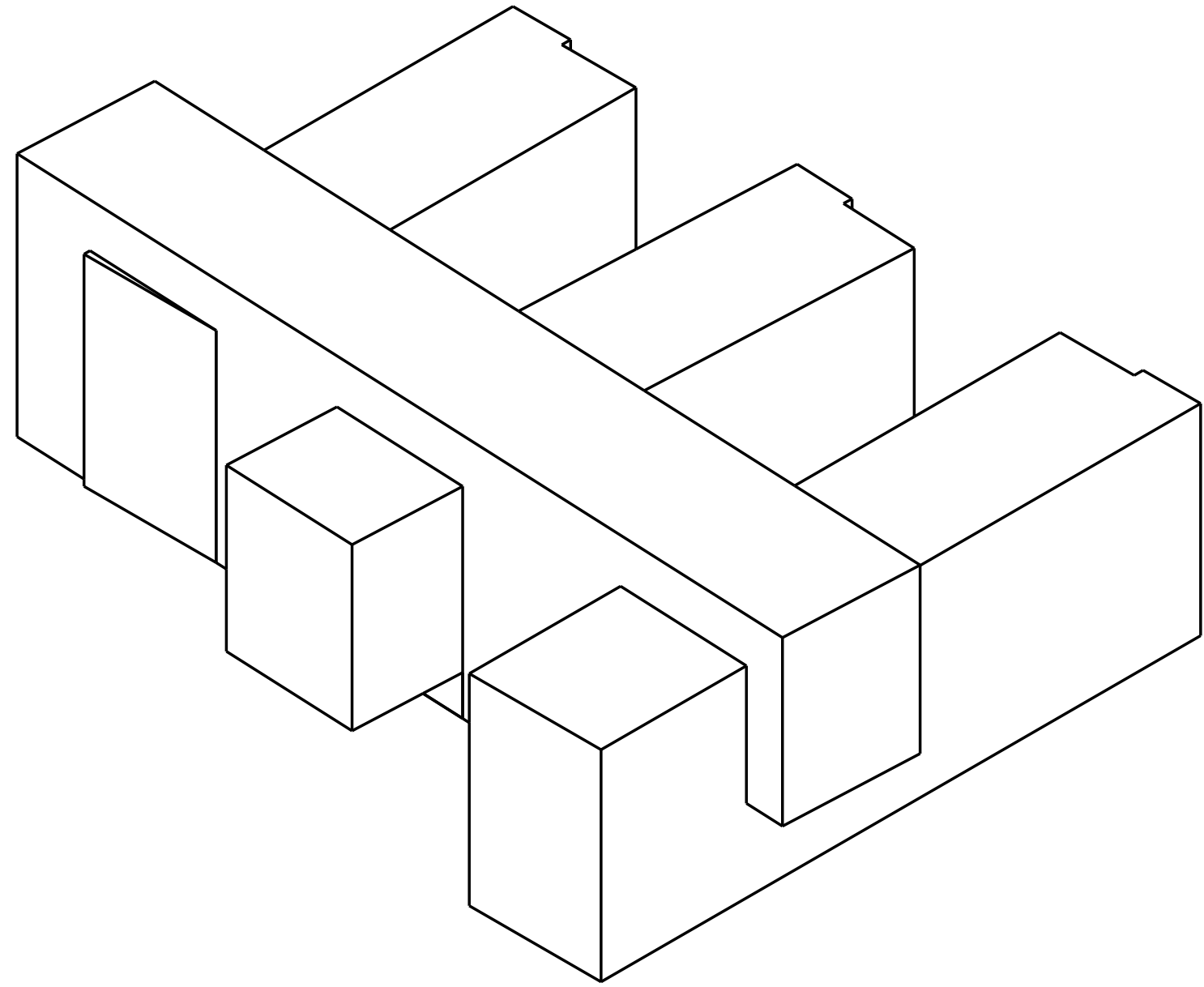
Design

Defining the basis - Urban scale



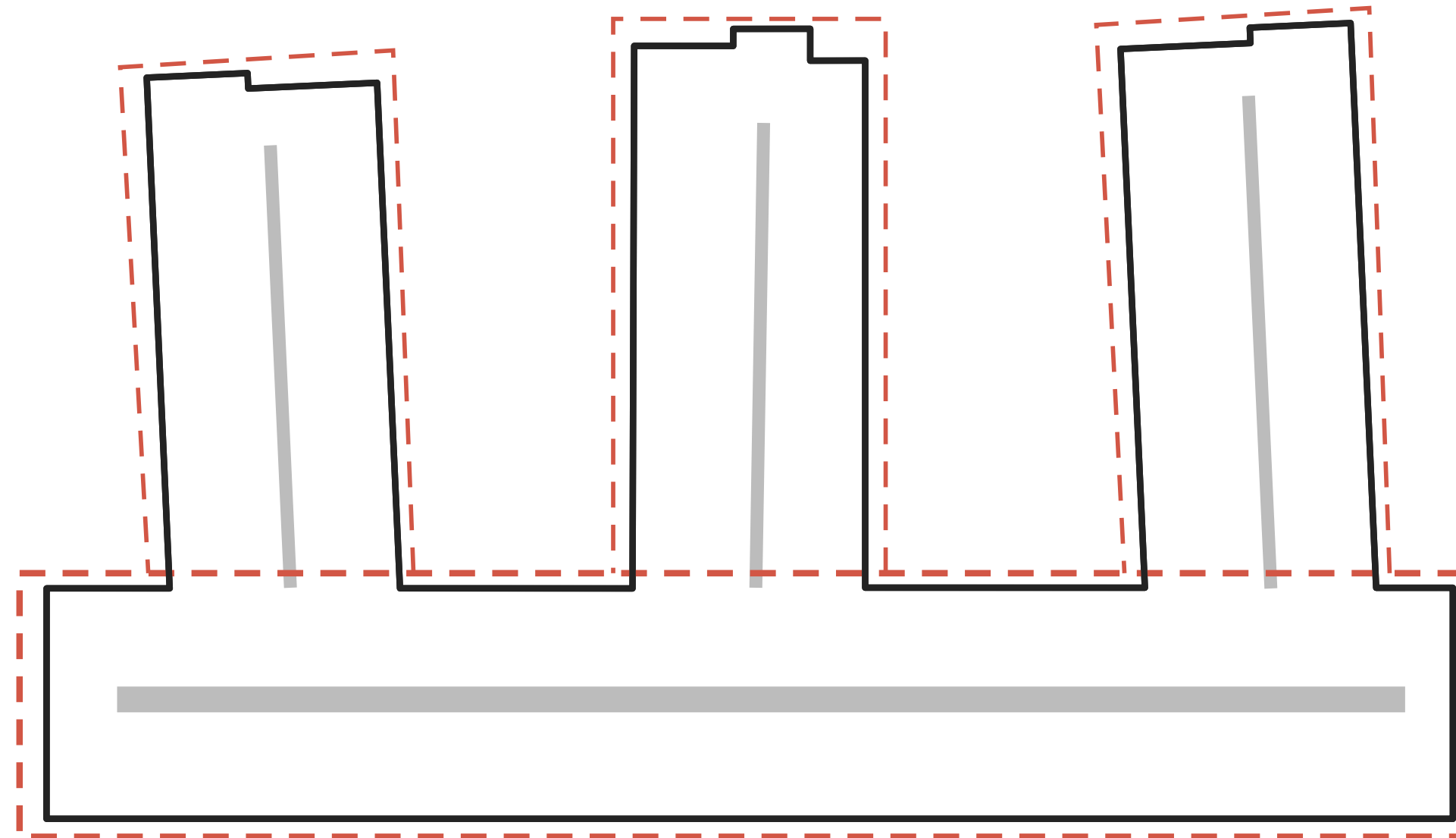
Design

Defining the basis - Internal hierarchy



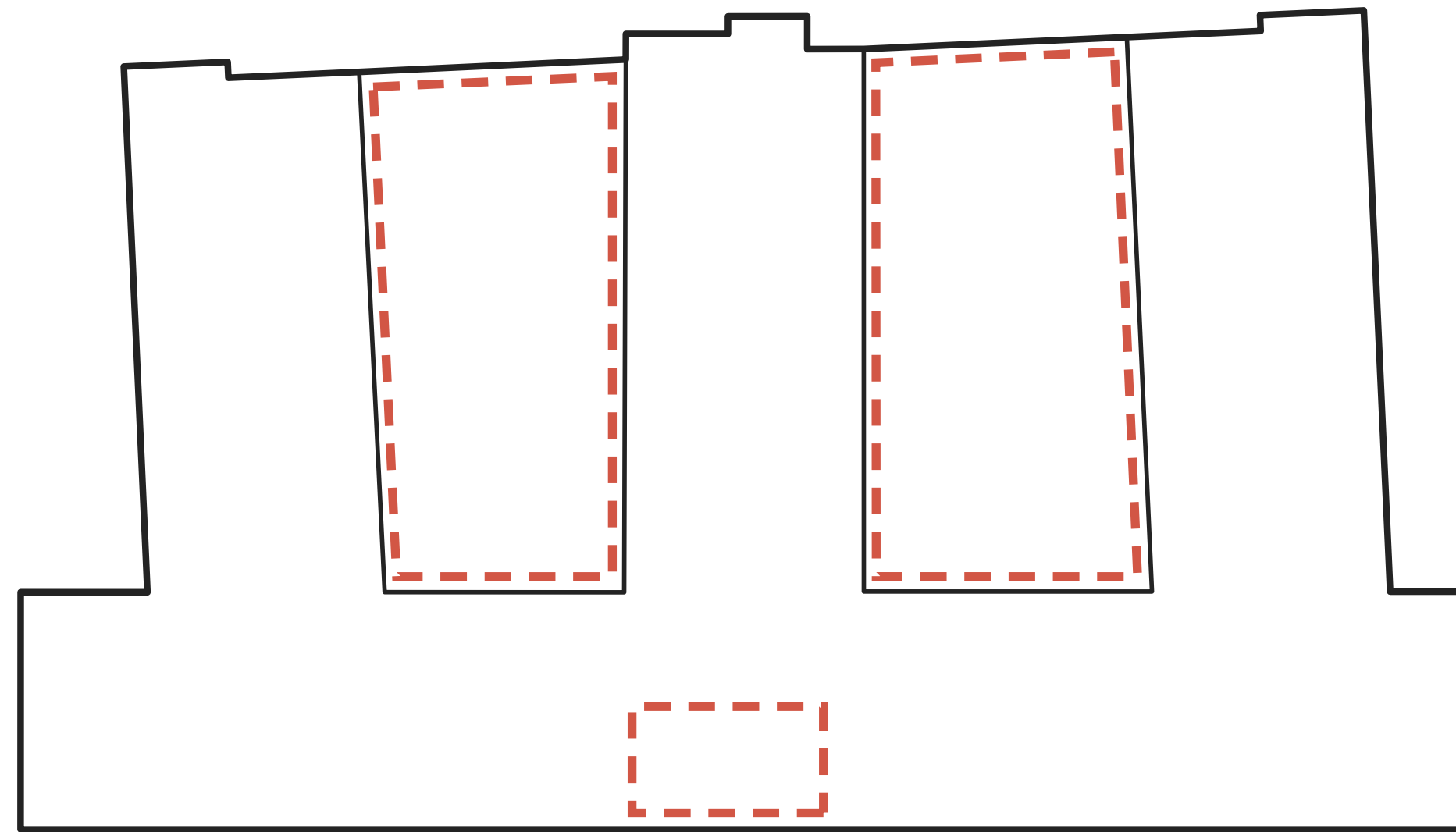
Design

Defining the basis - Internal hierarchy



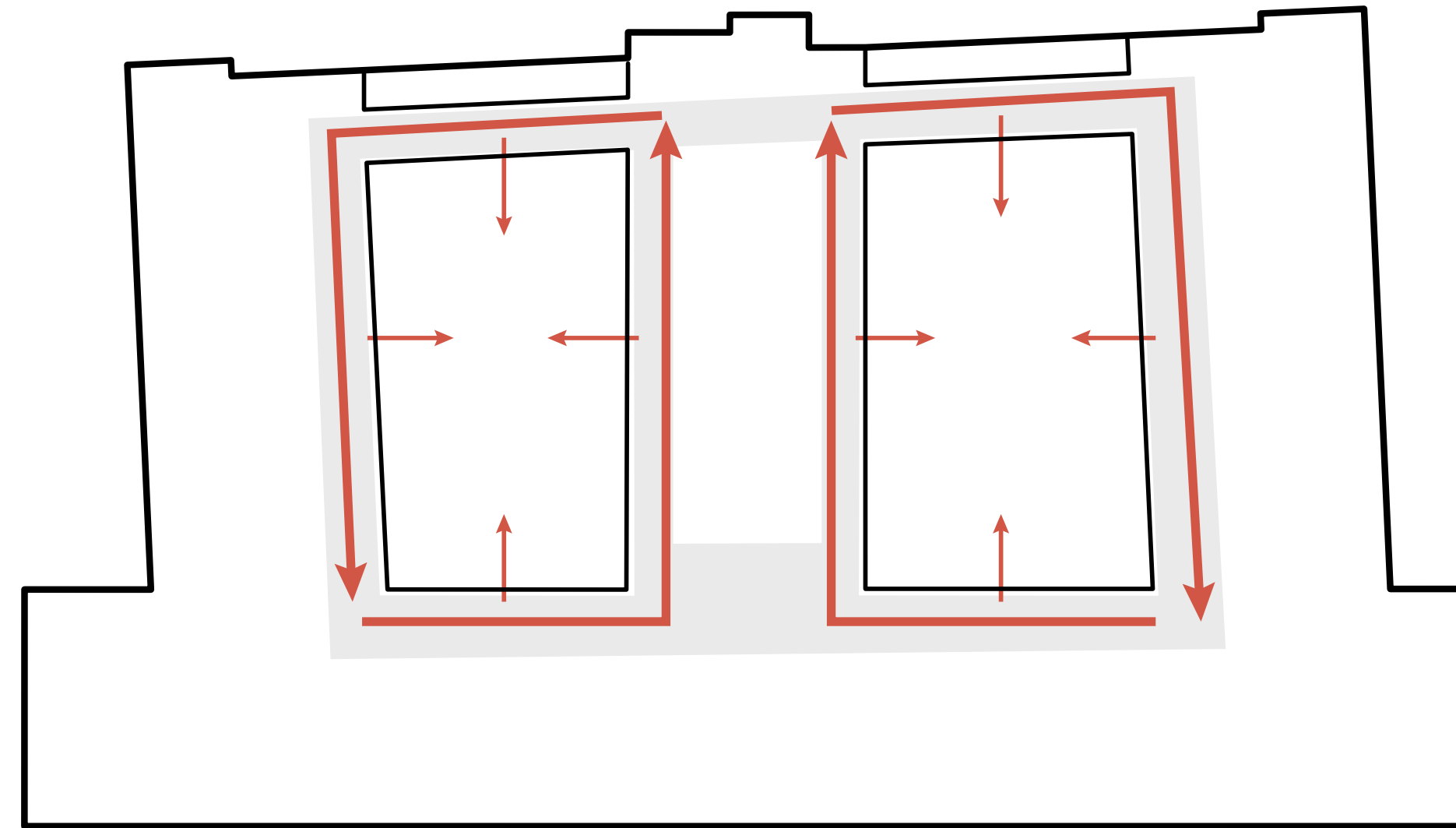
Design

Defining the basis - Adding quality



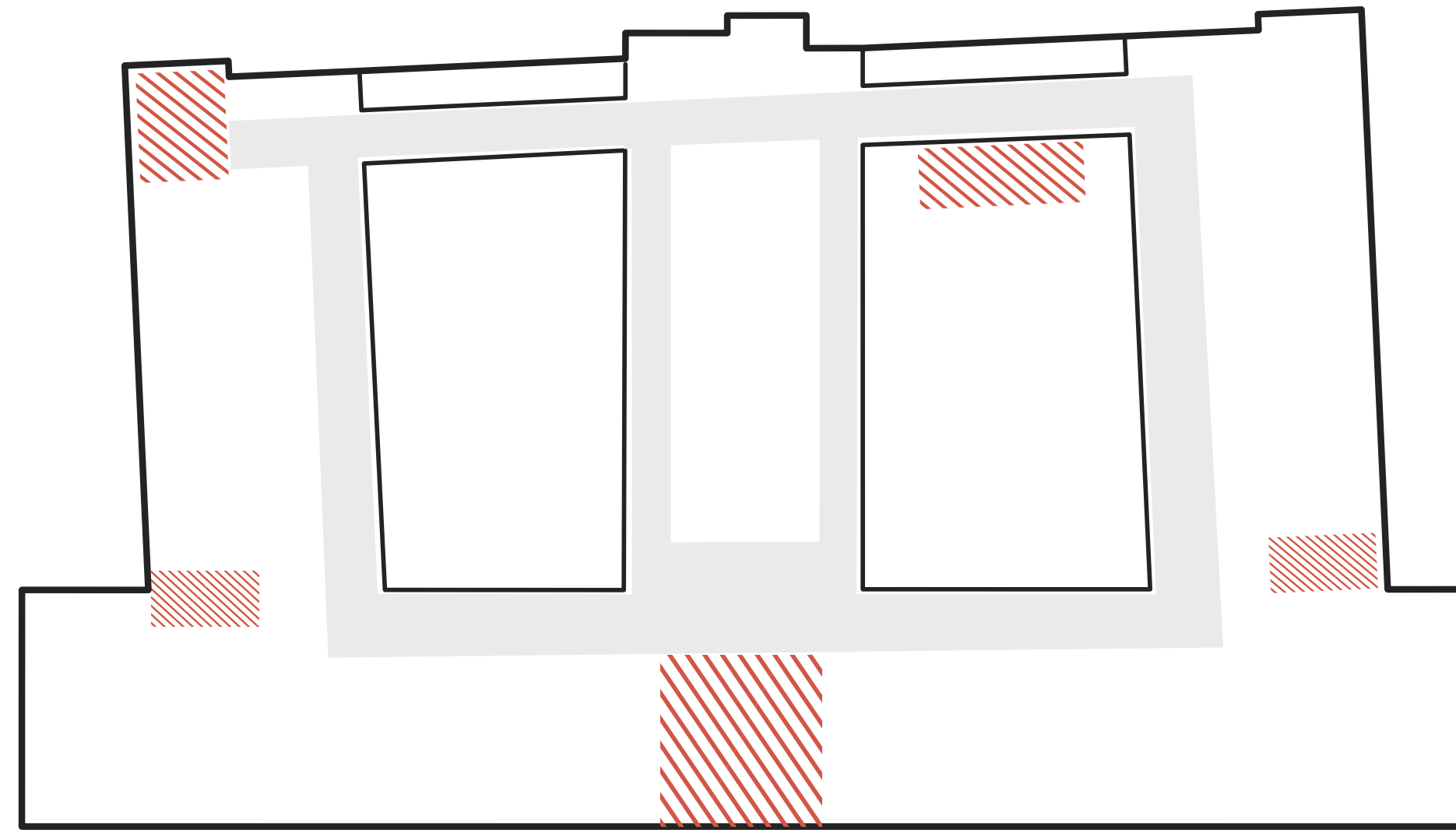
Design

Defining the basis - Routing



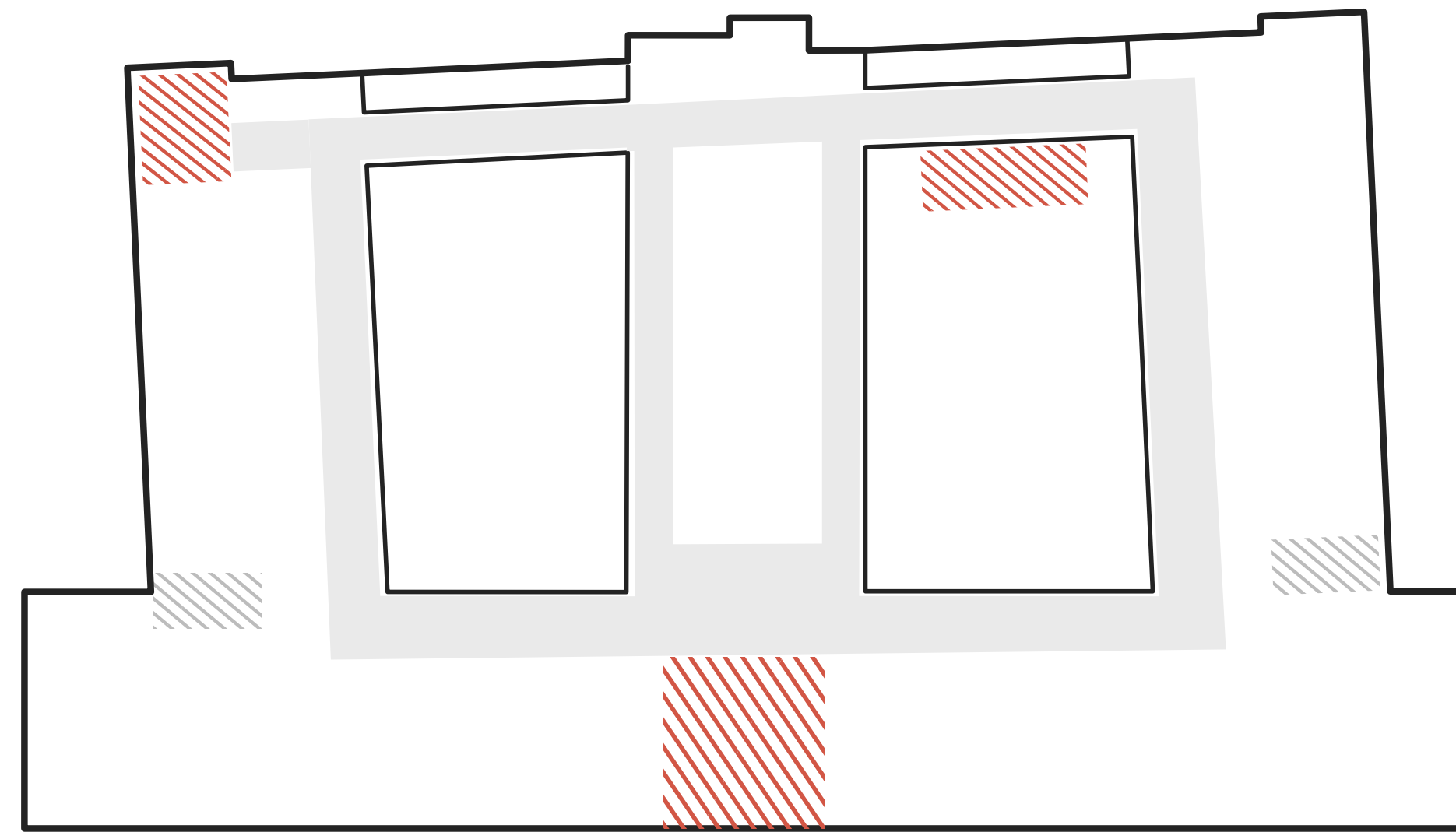
Design

Defining the basis - Circulation



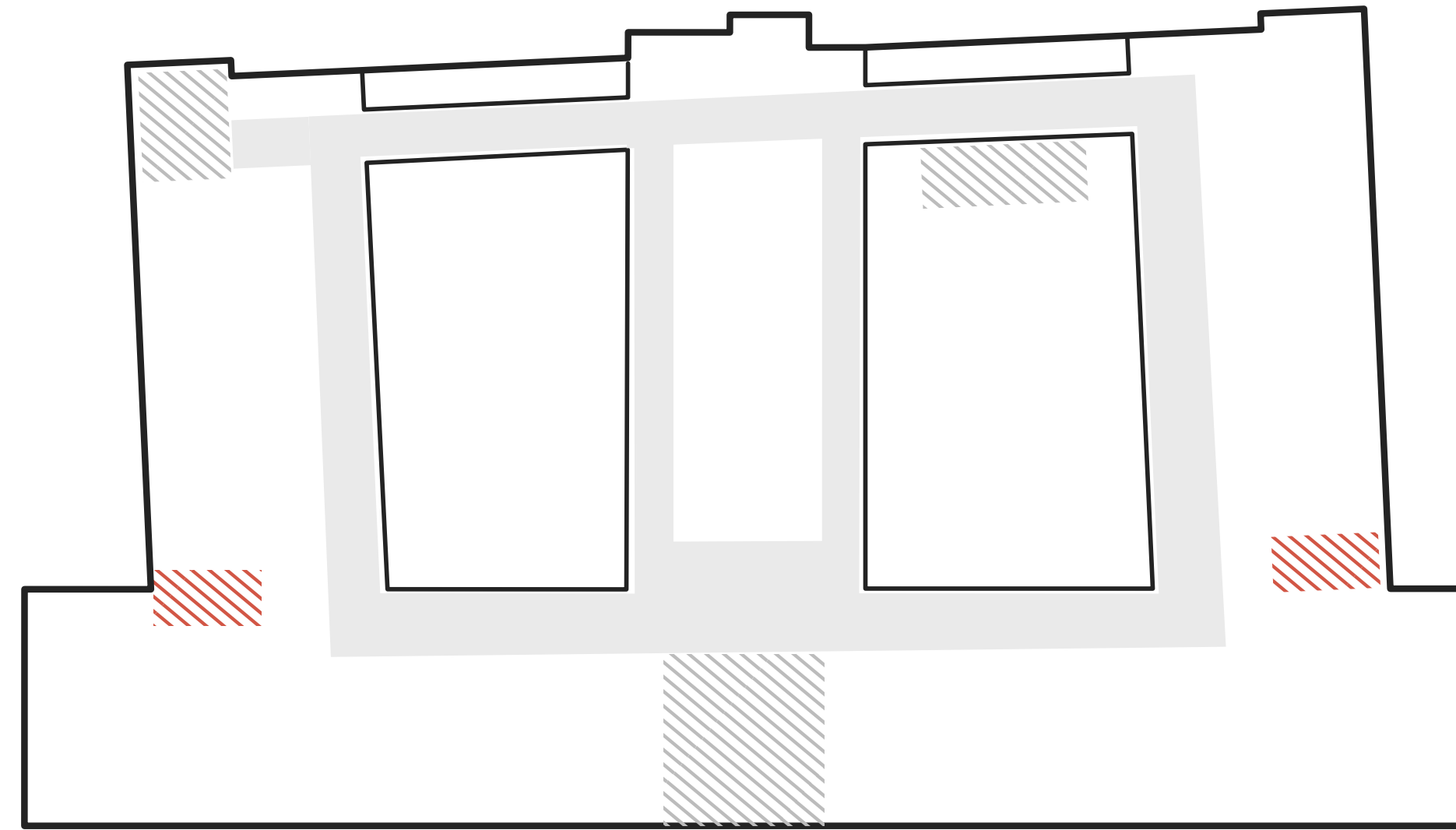
Design

Defining the basis - Circulation



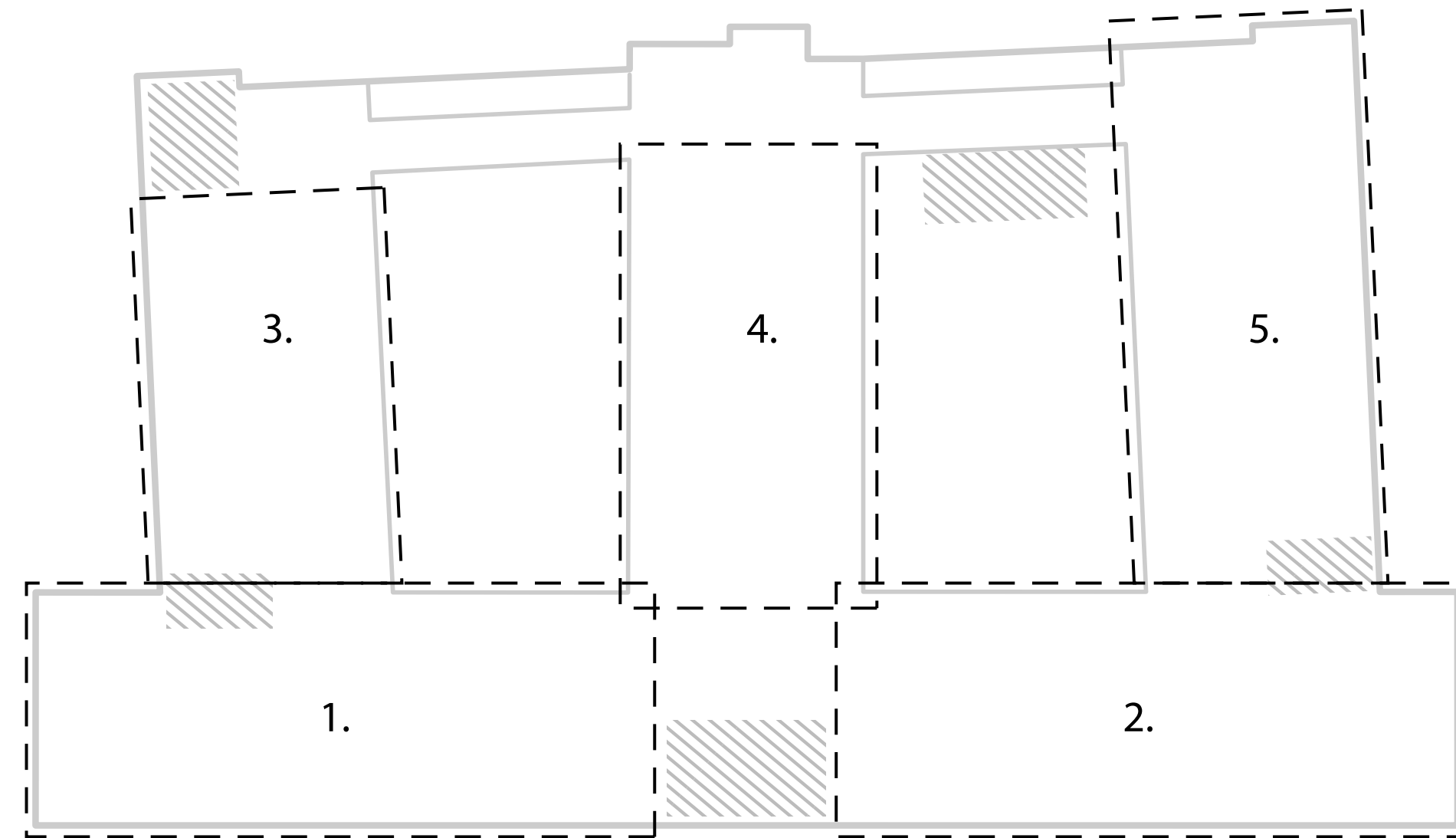
Design

Defining the basis - Circulation



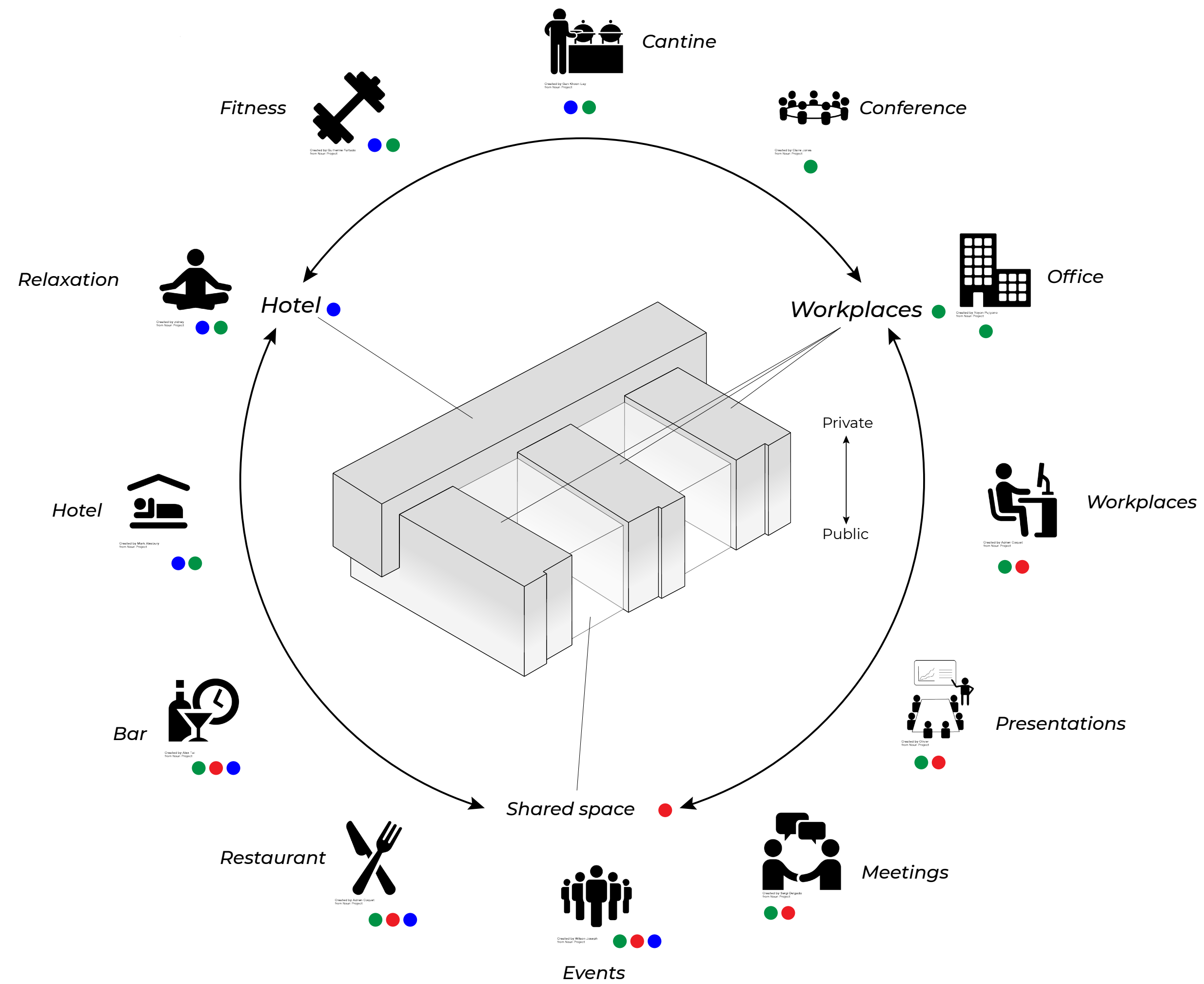
Design

Defining the basis - Functional flexibility



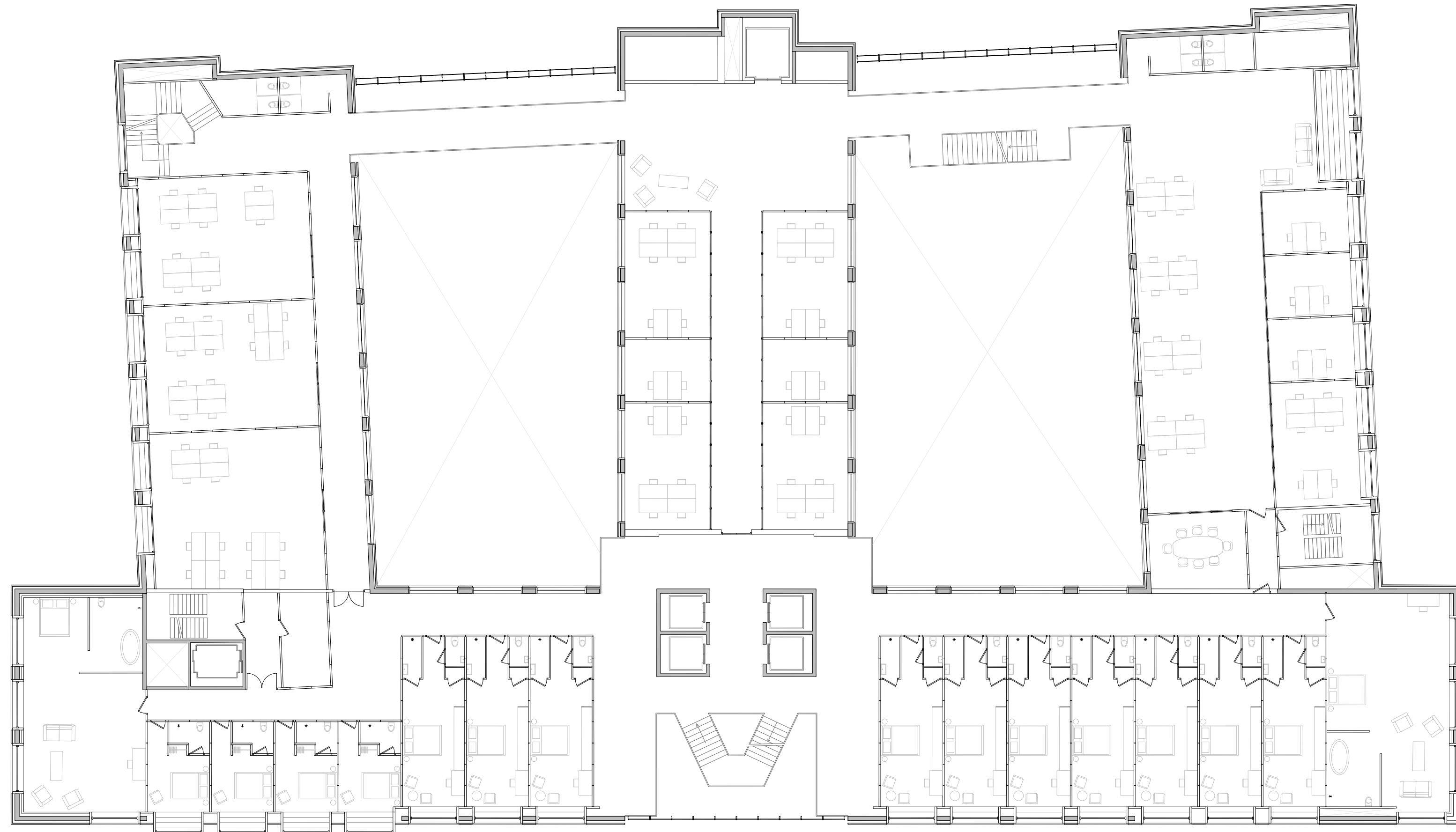
Design

Programmatic infill



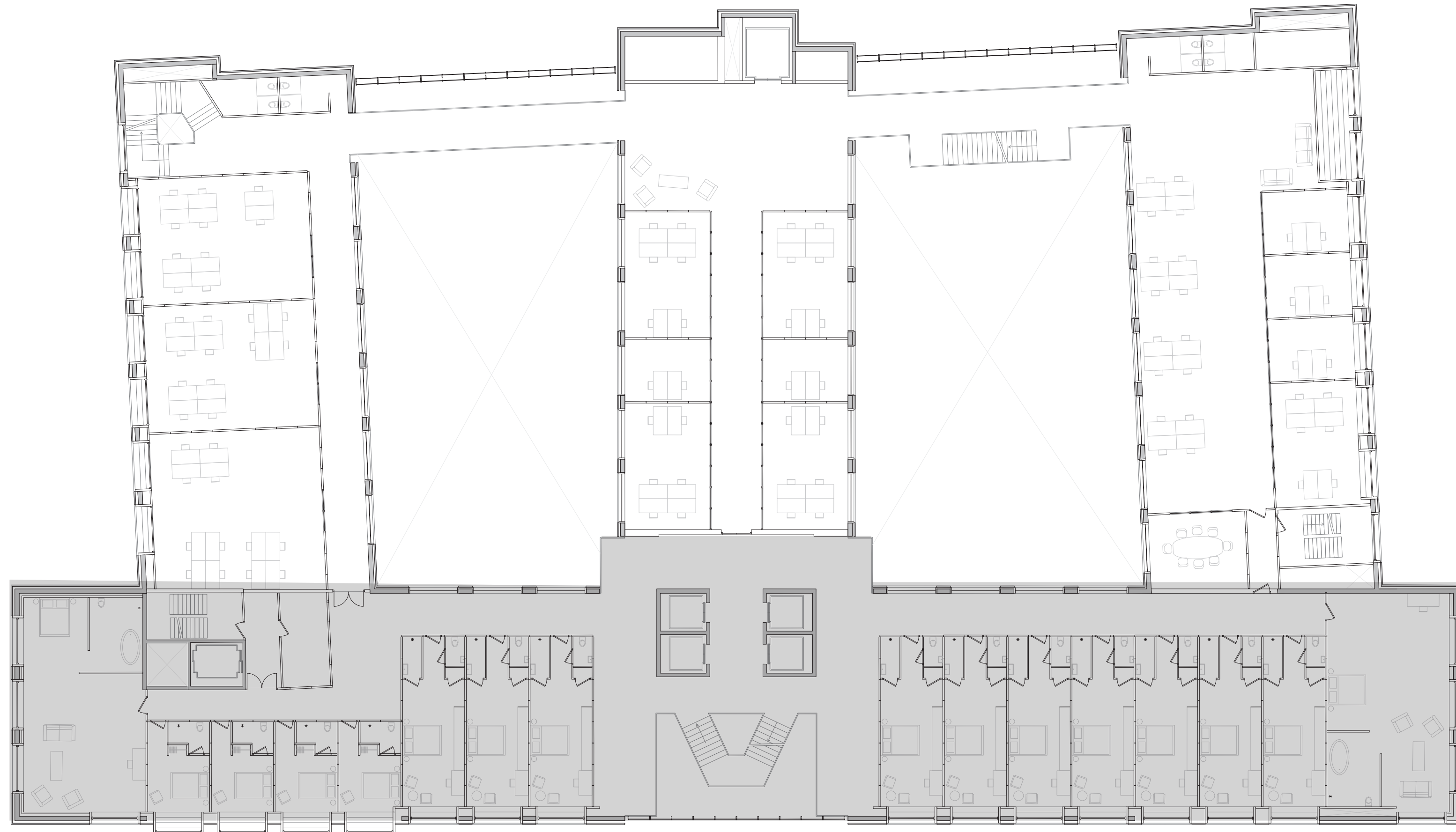
Design

Programm



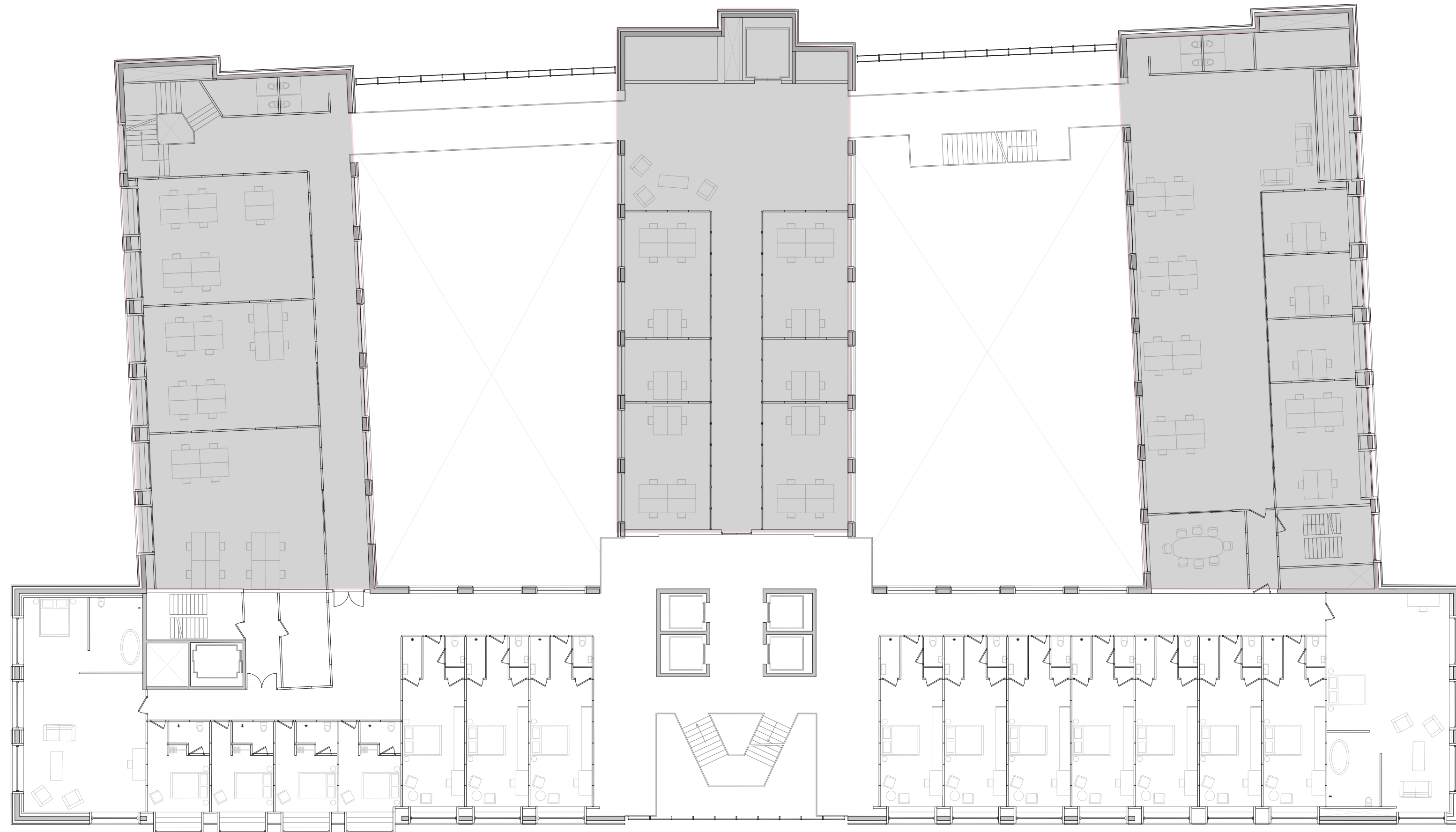
Design

Programm



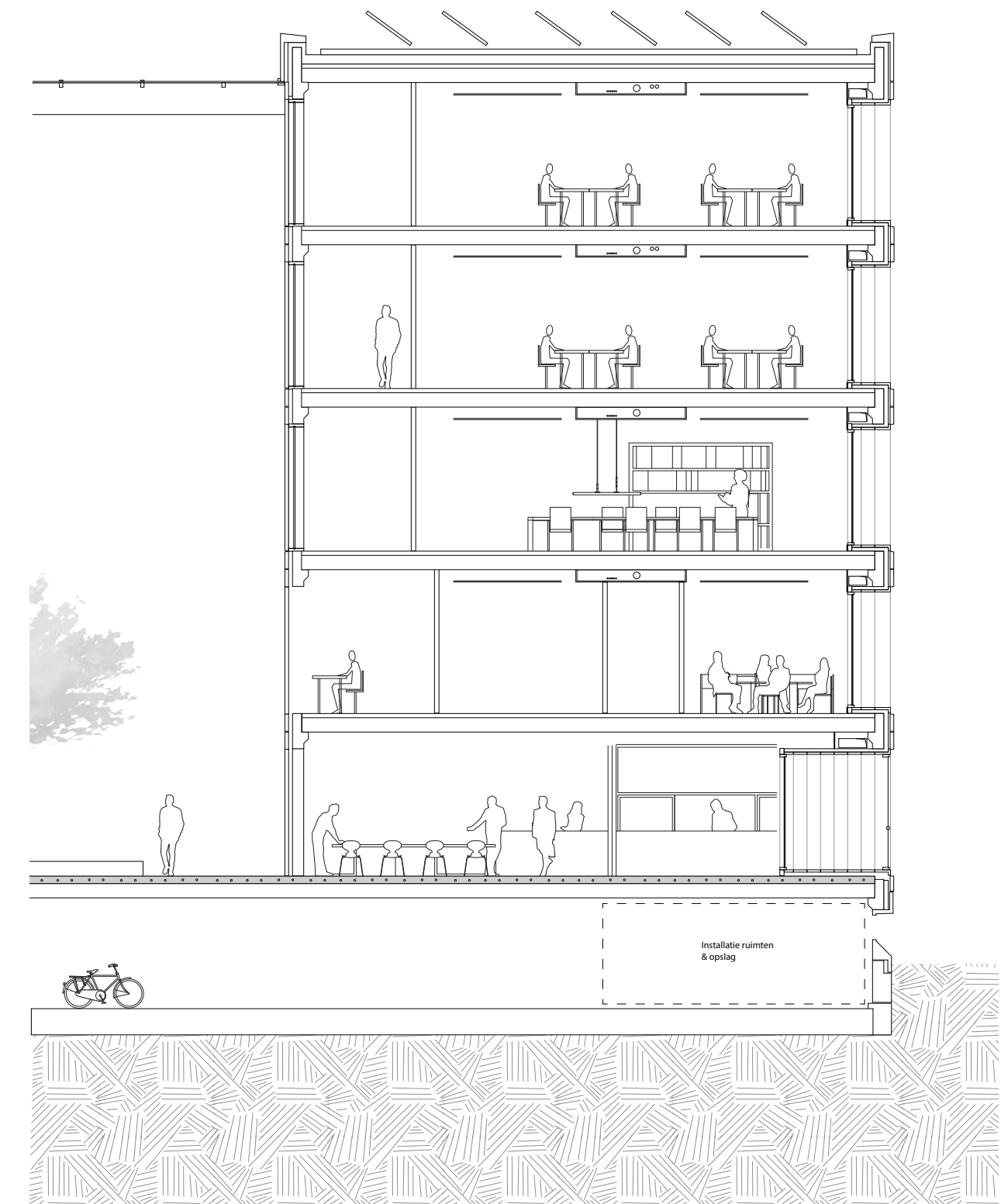
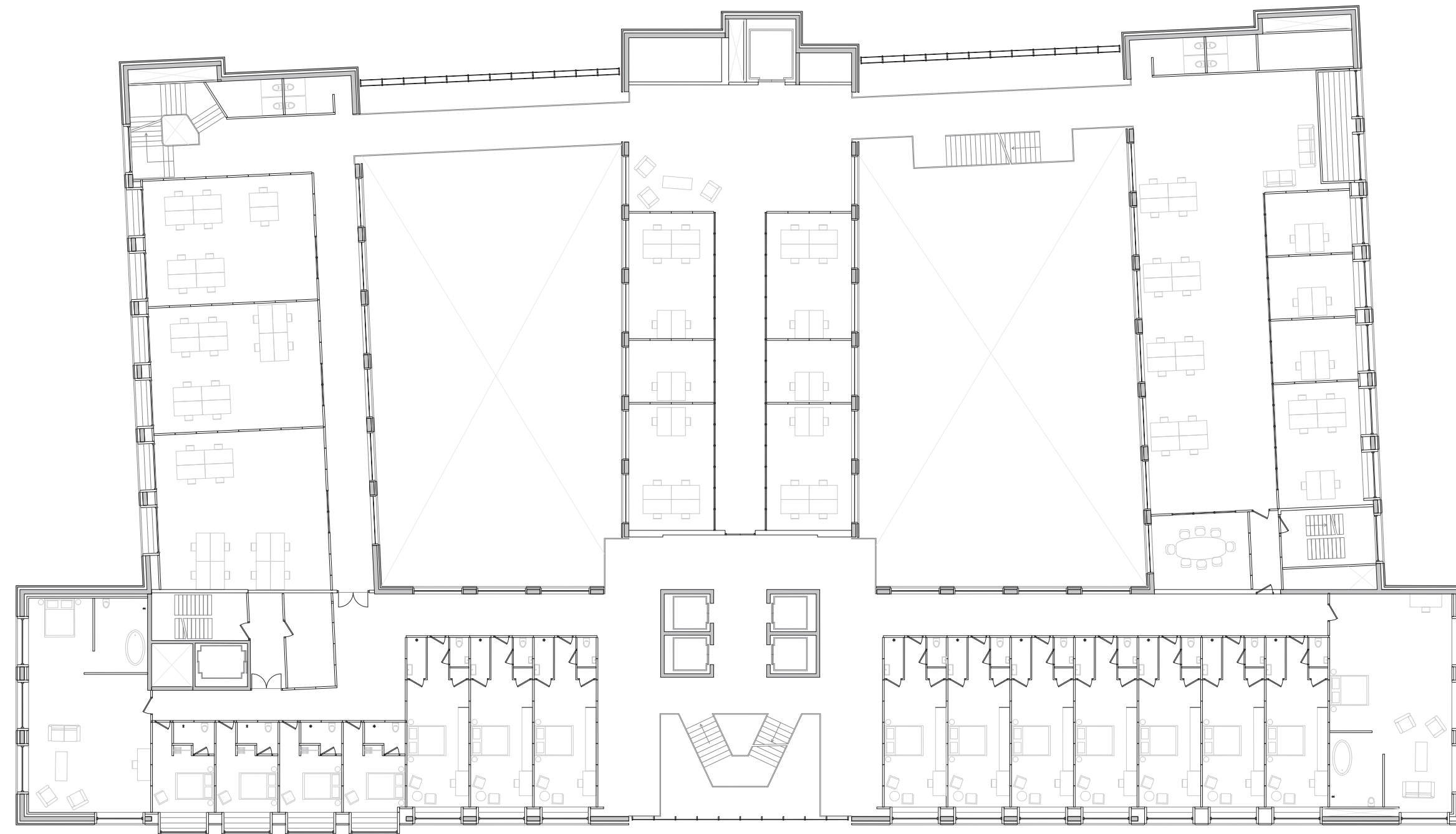
Design

Programm



Design

Programm



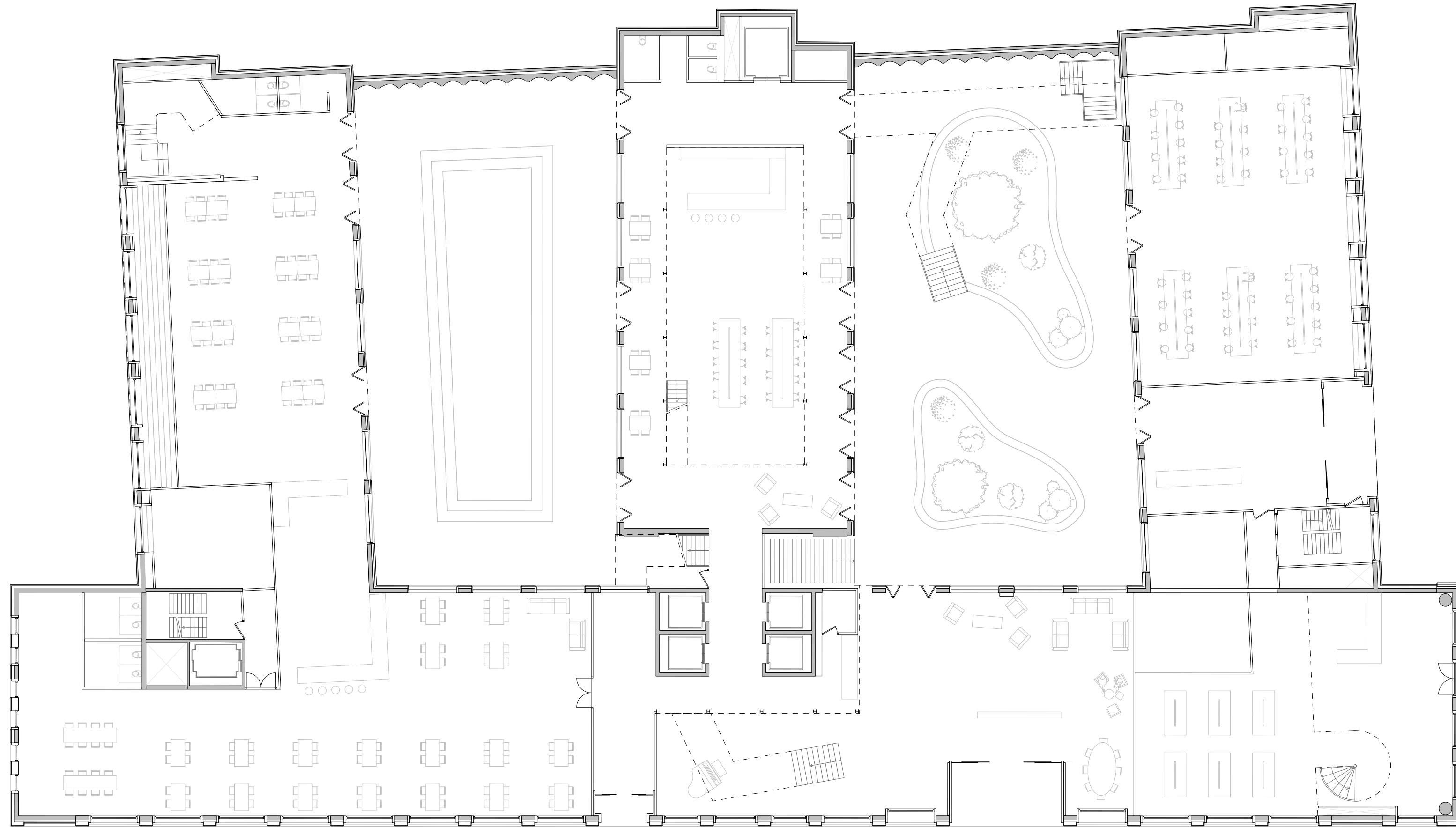
Design

Programm



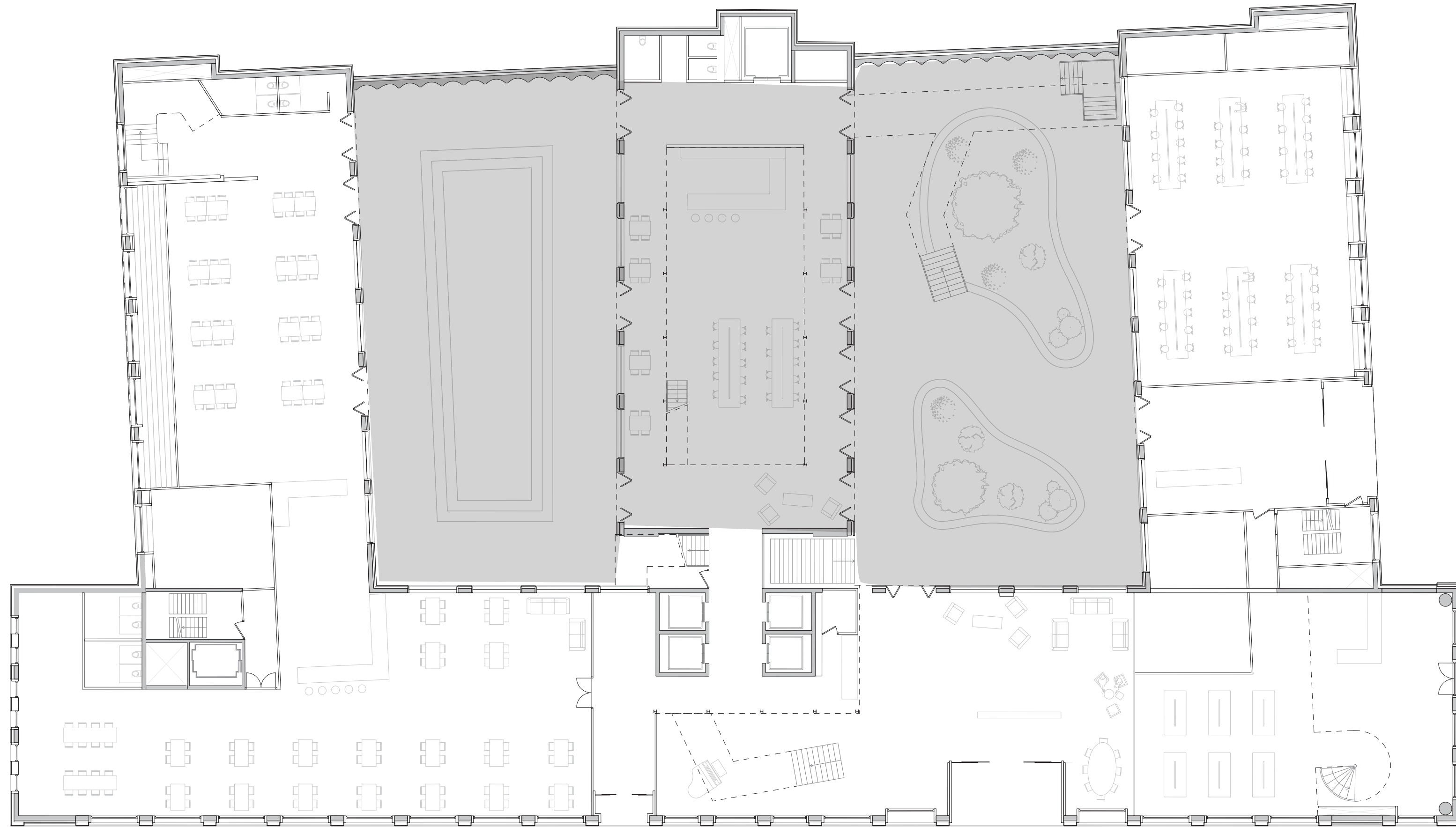
Design

Ground floor



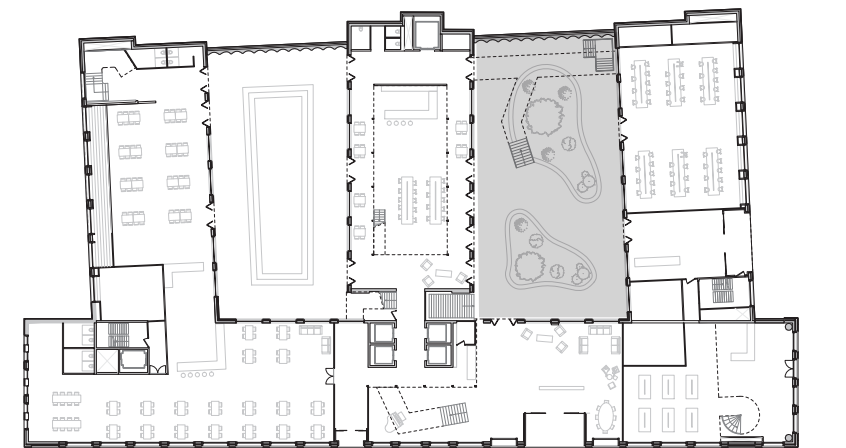
Design

Ground floor



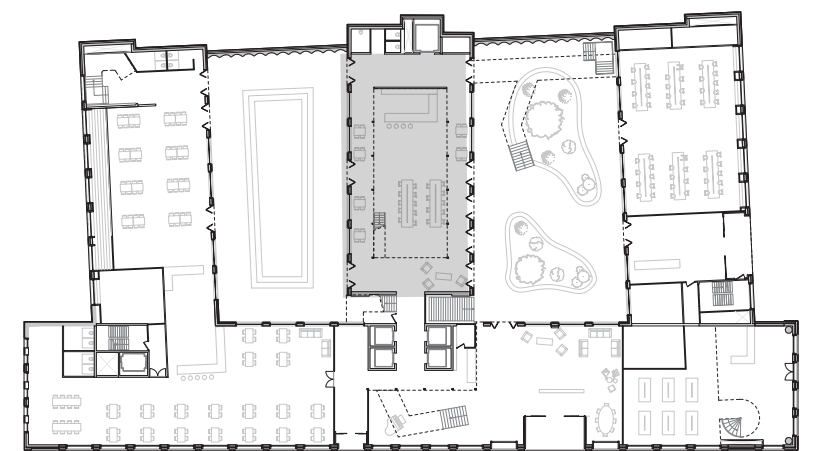
Design

Ground floor



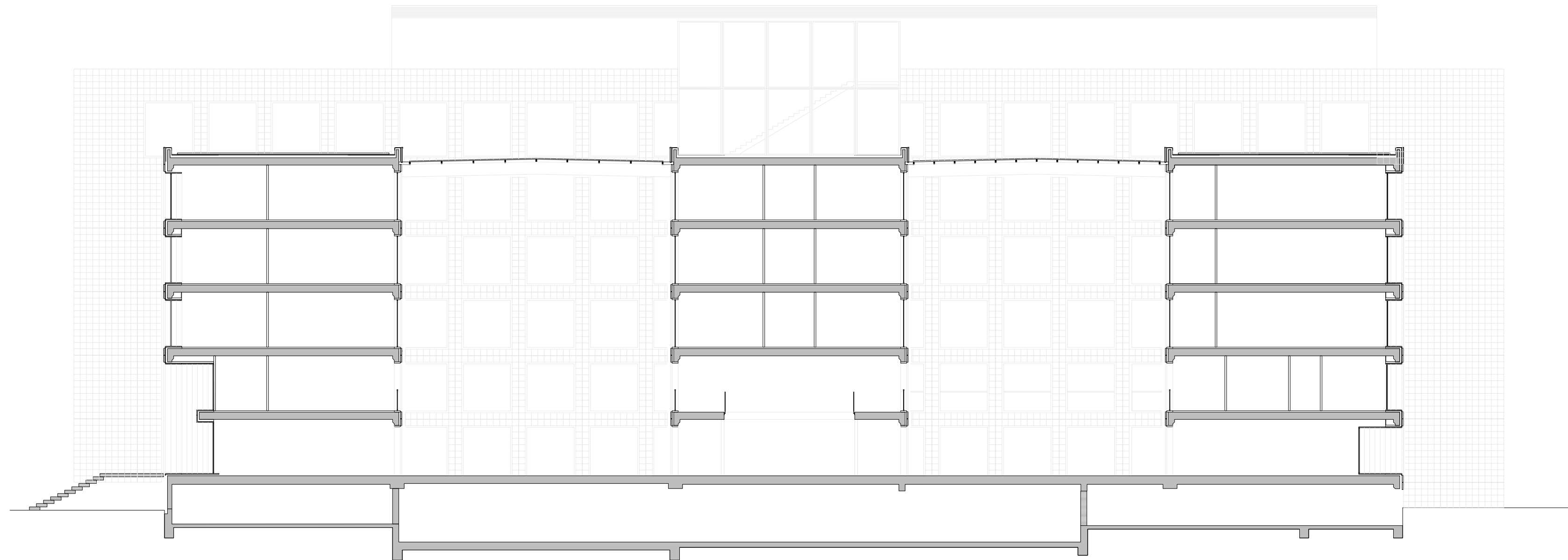
Design

Ground floor



Design

Ground floor

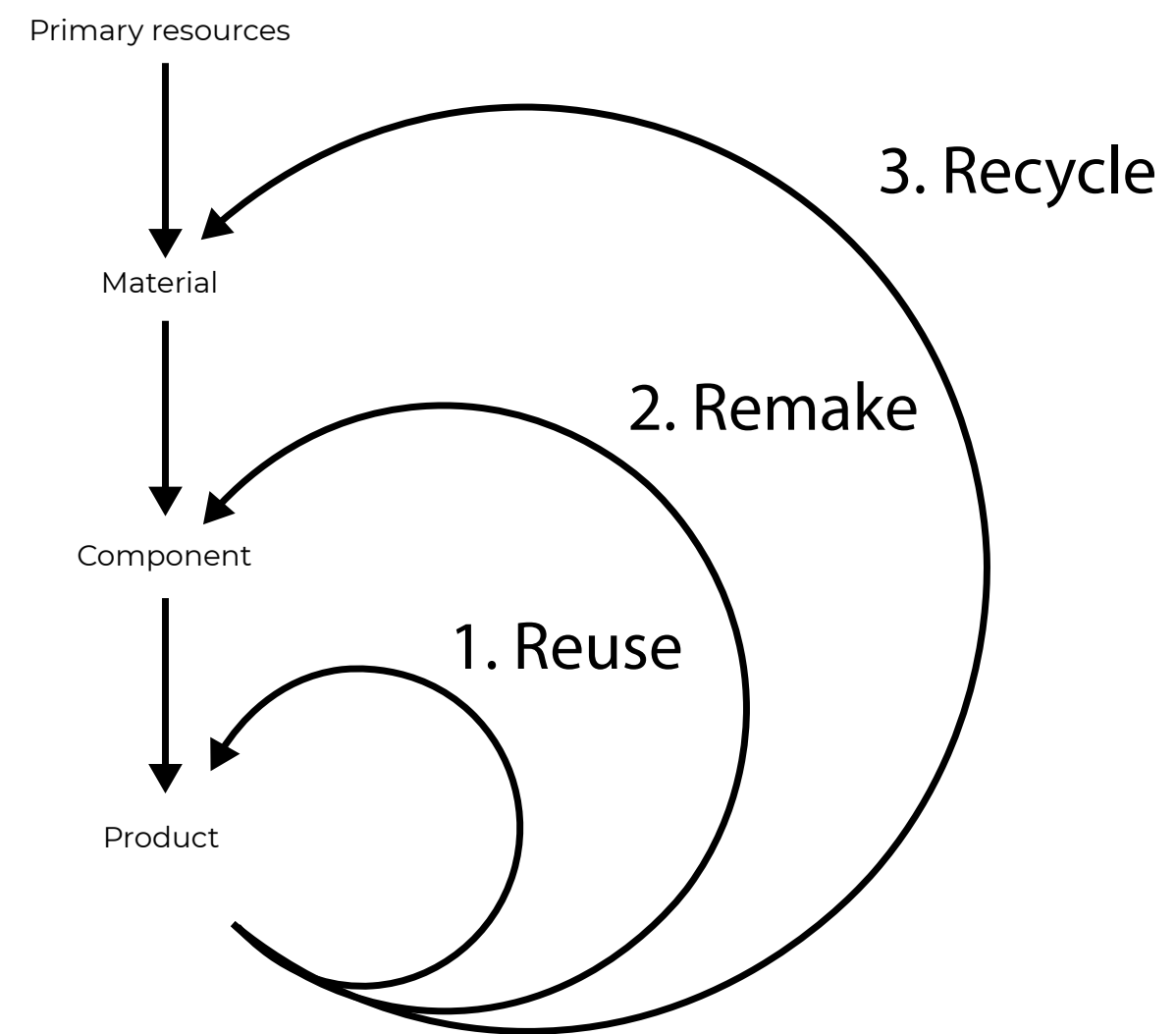


Design

Principles

Research objective:

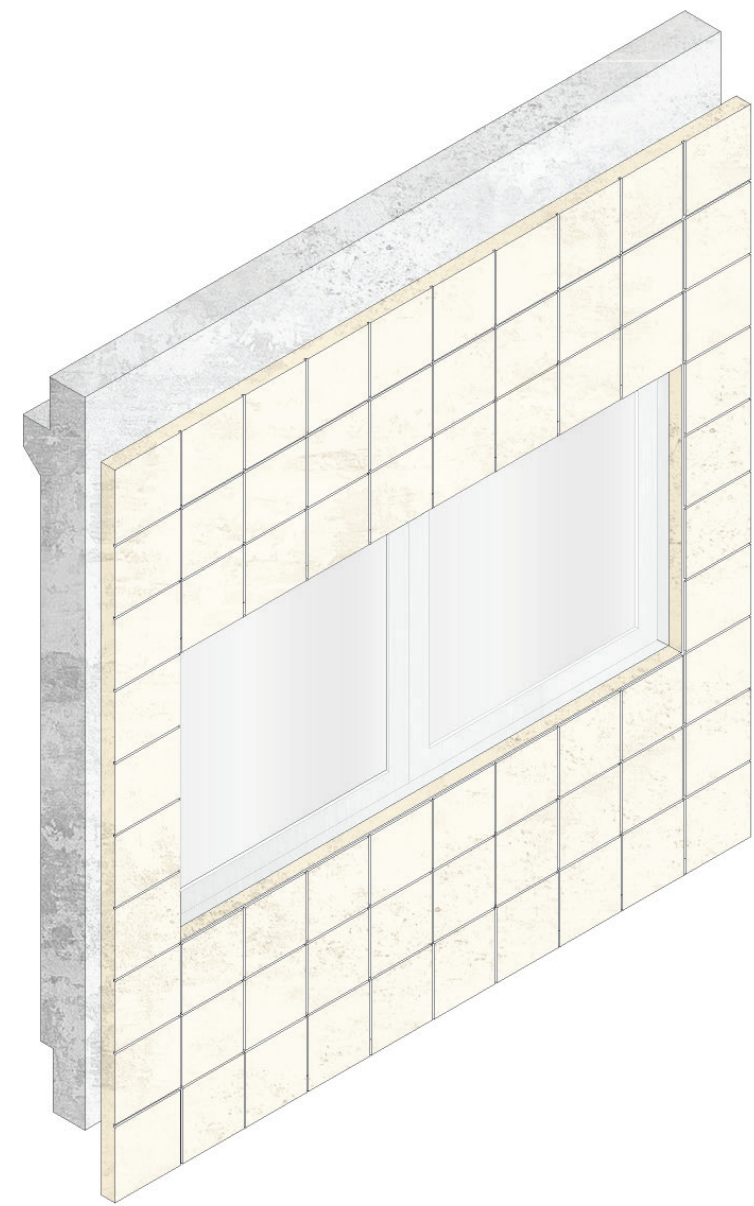
'What are the environmental benefits of integrating reused and recycled materials into the design?'



Levels of reuse

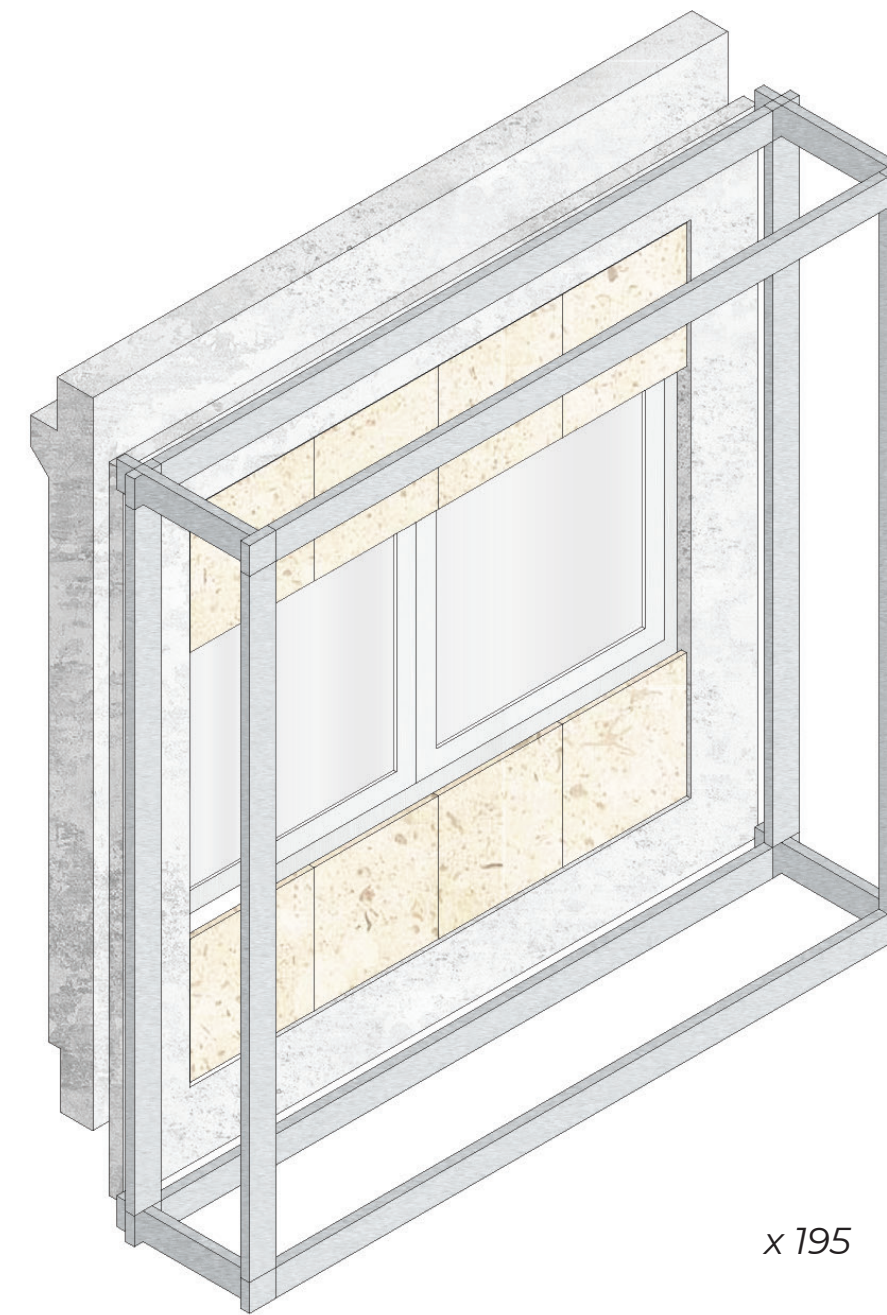
Design

Existing situation



x 80

Facade fragment main volume

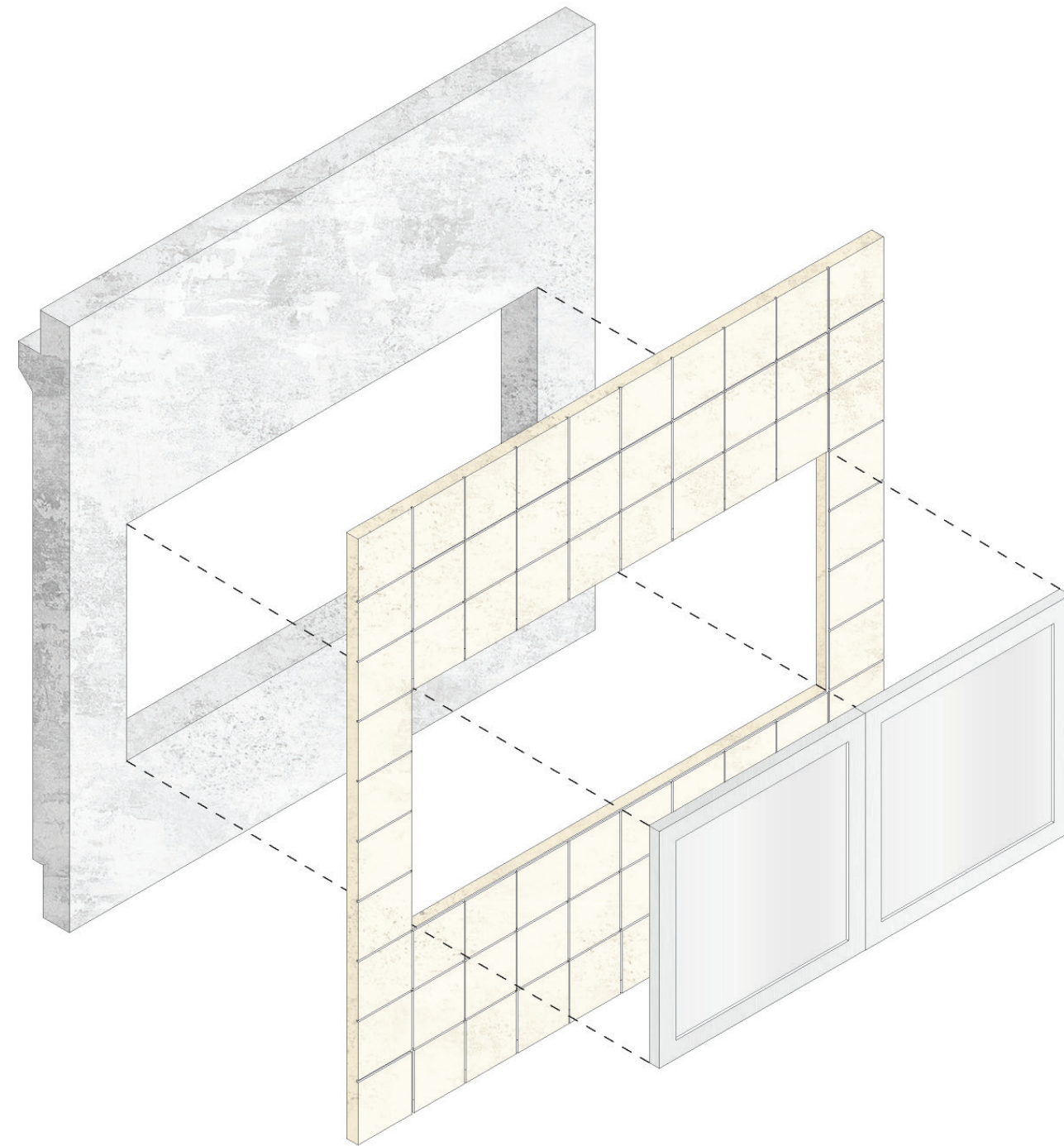


x 195

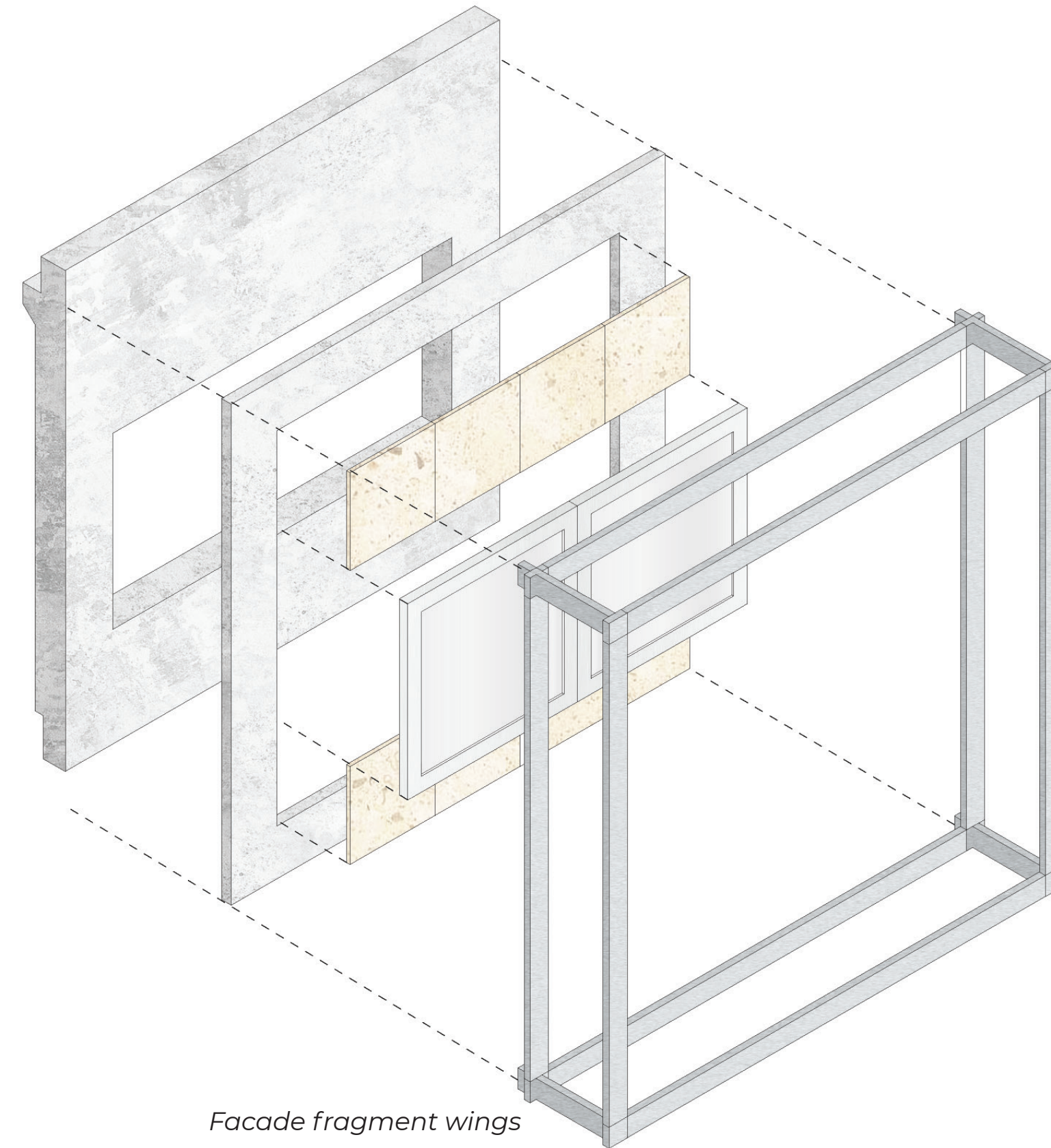
Facade fragment wings

Design

Existing situation



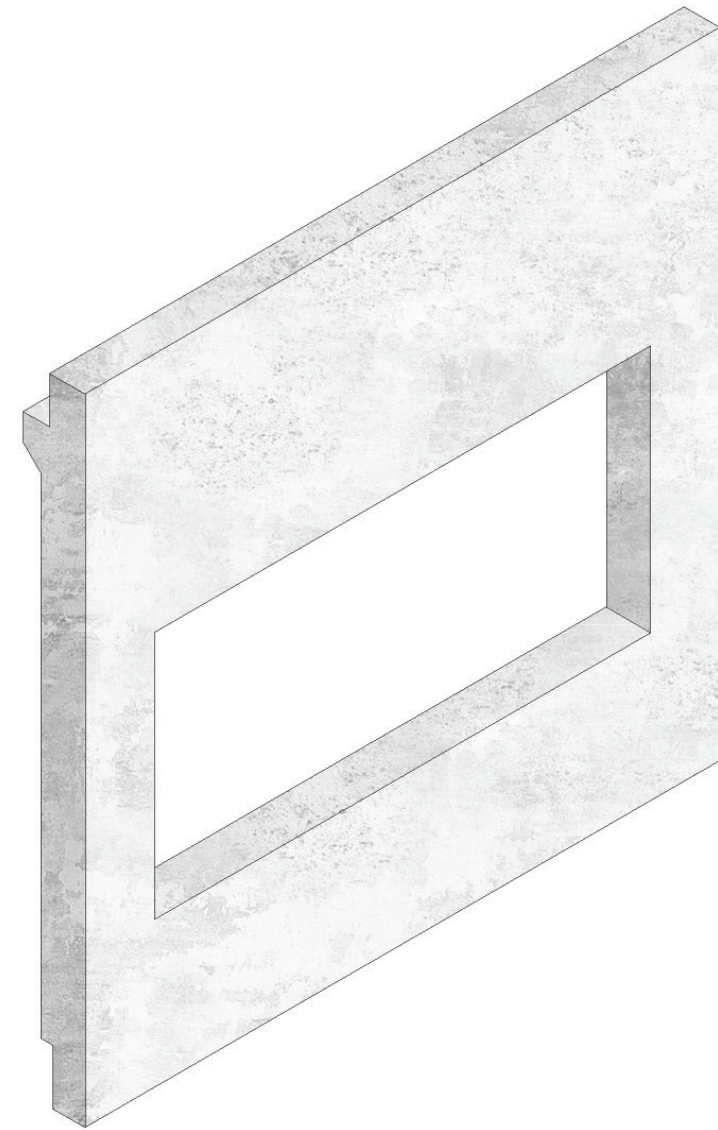
Facade fragment main volume



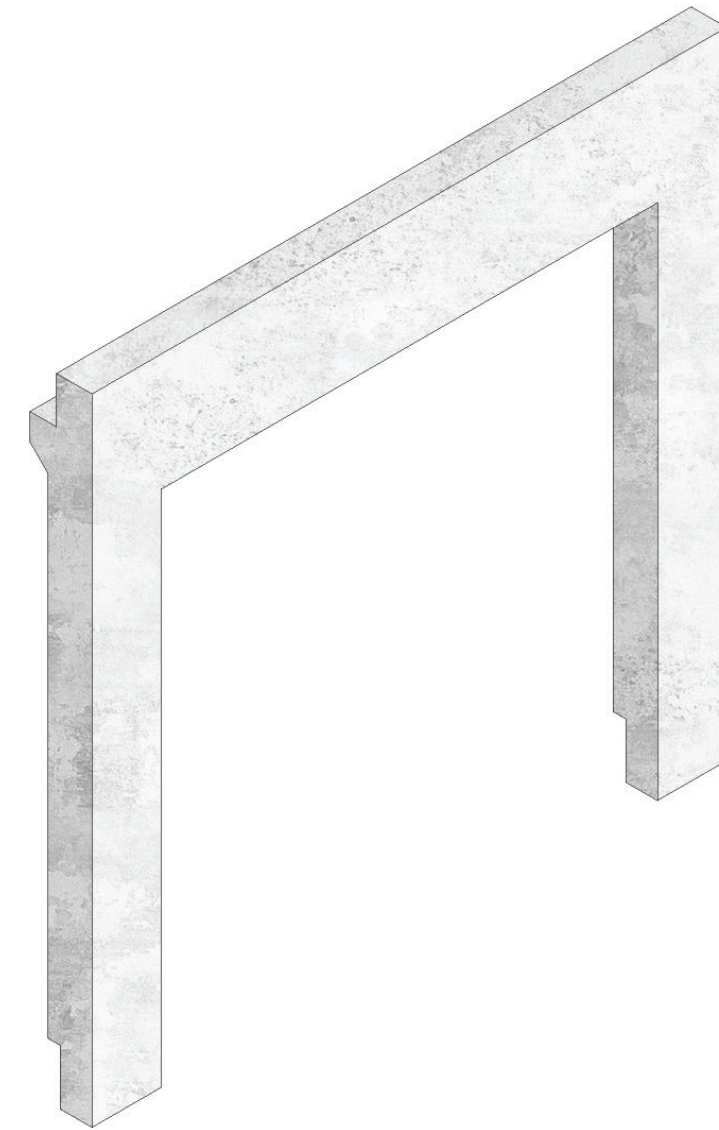
Facade fragment wings

Design

Existing situation



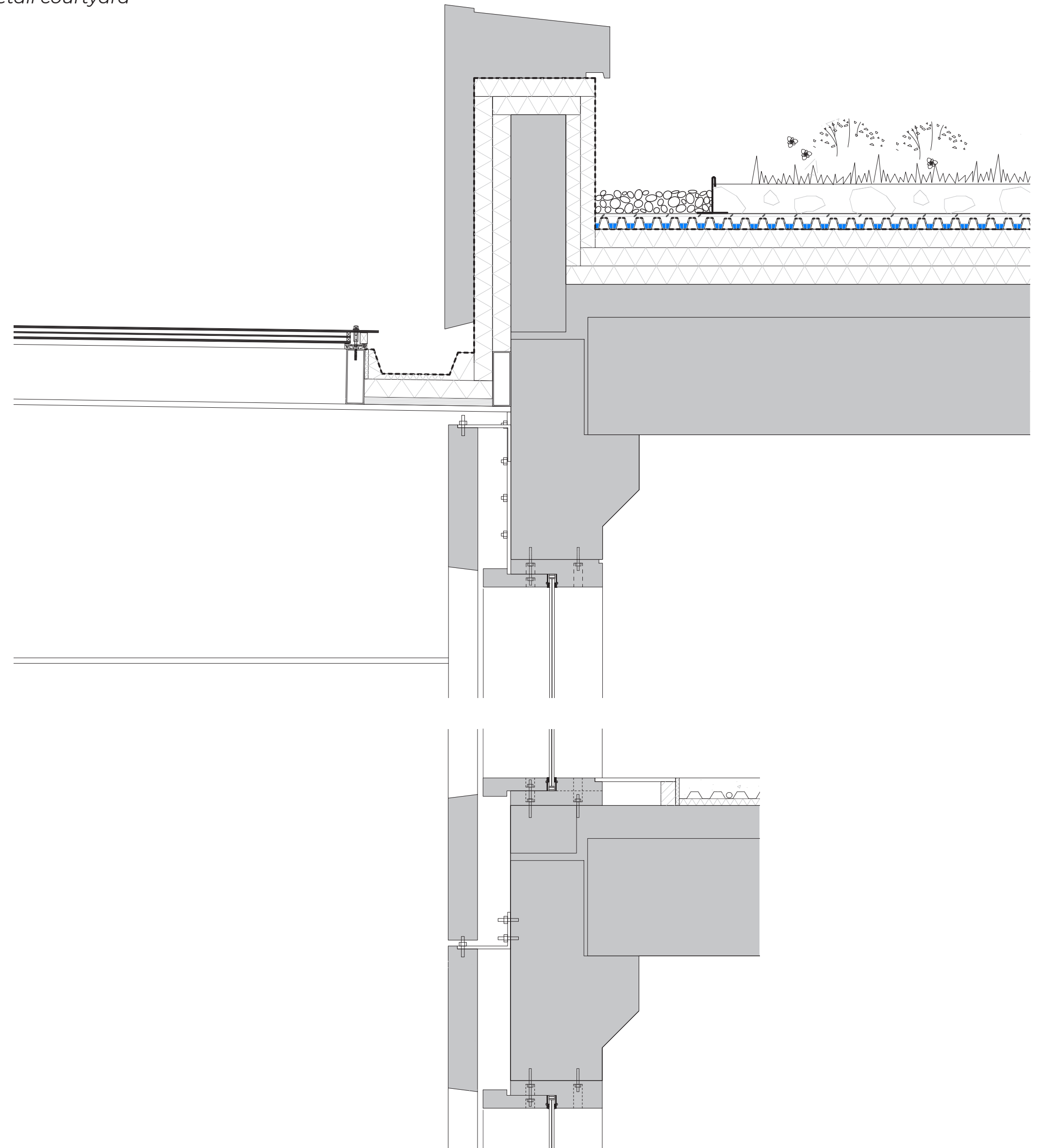
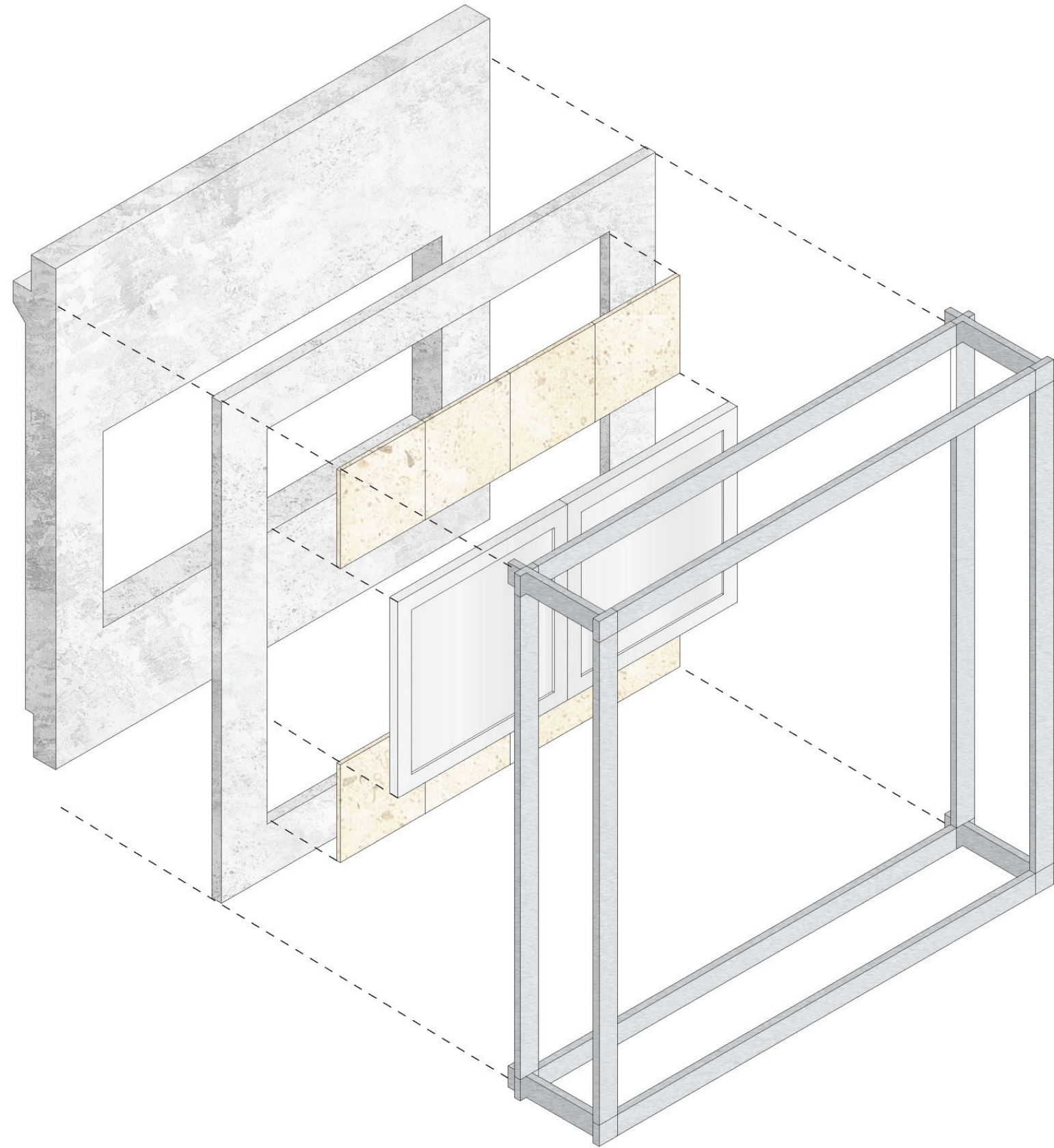
Current wall element



Facade fragment wings

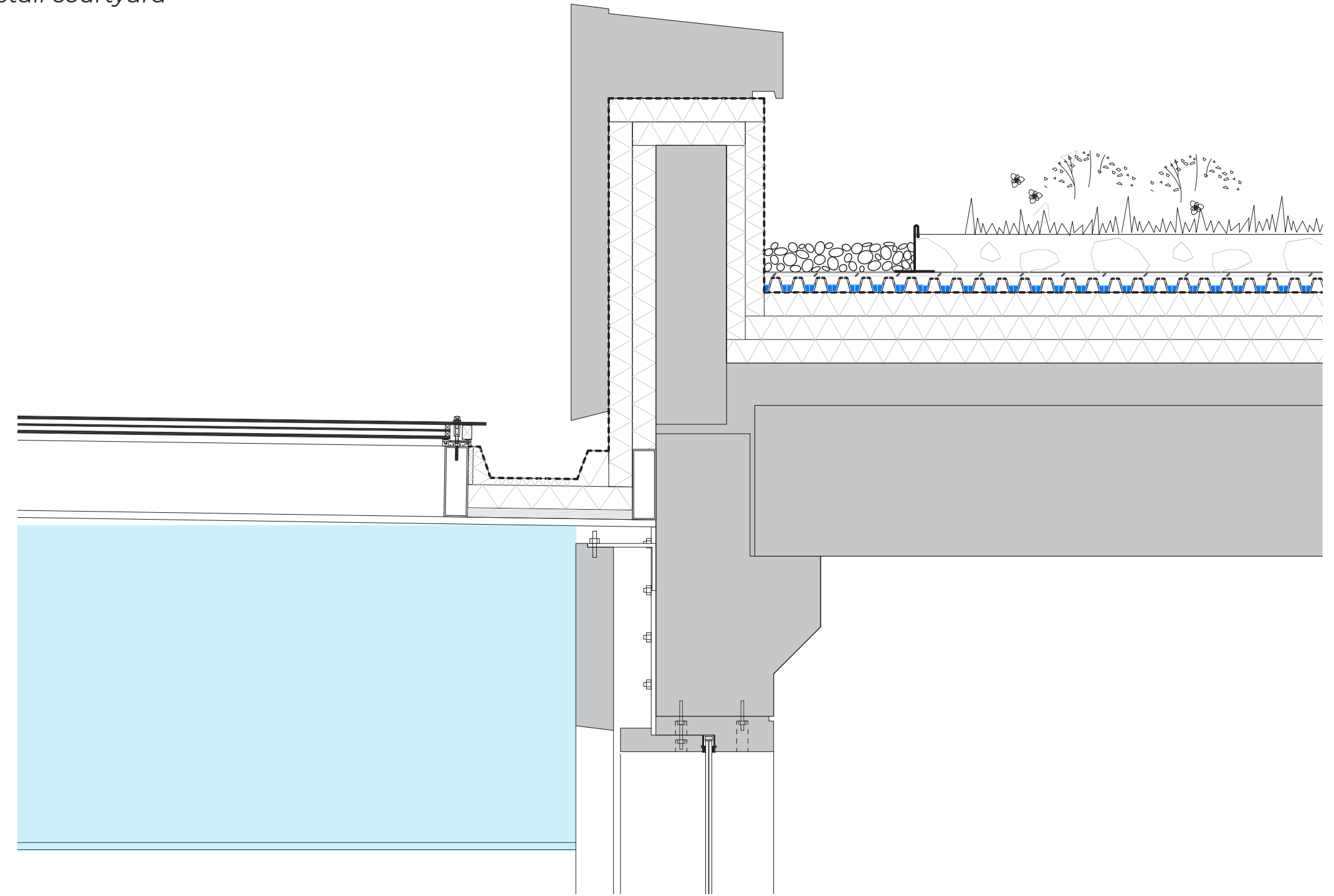
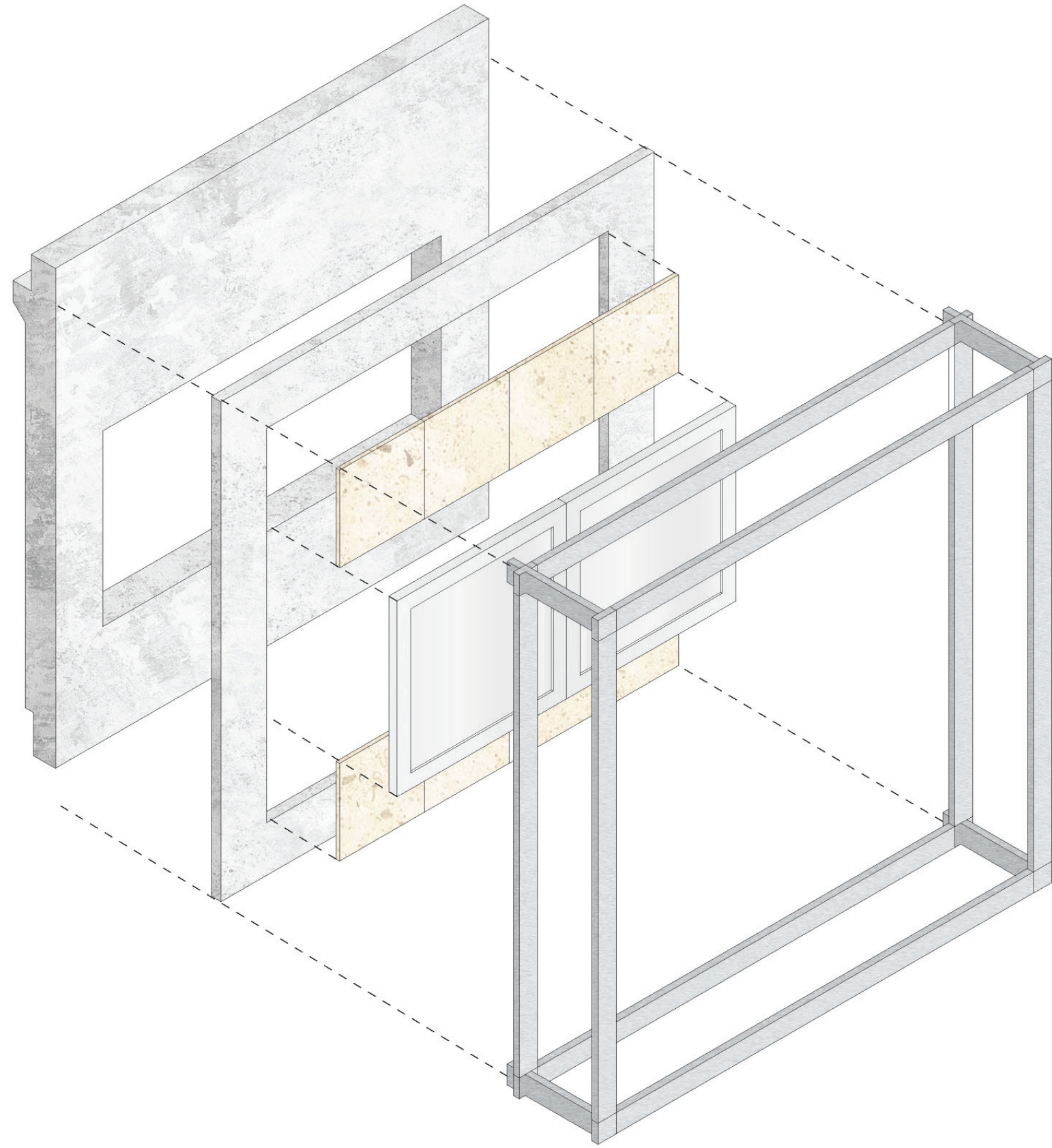
Design

Detail courtyard

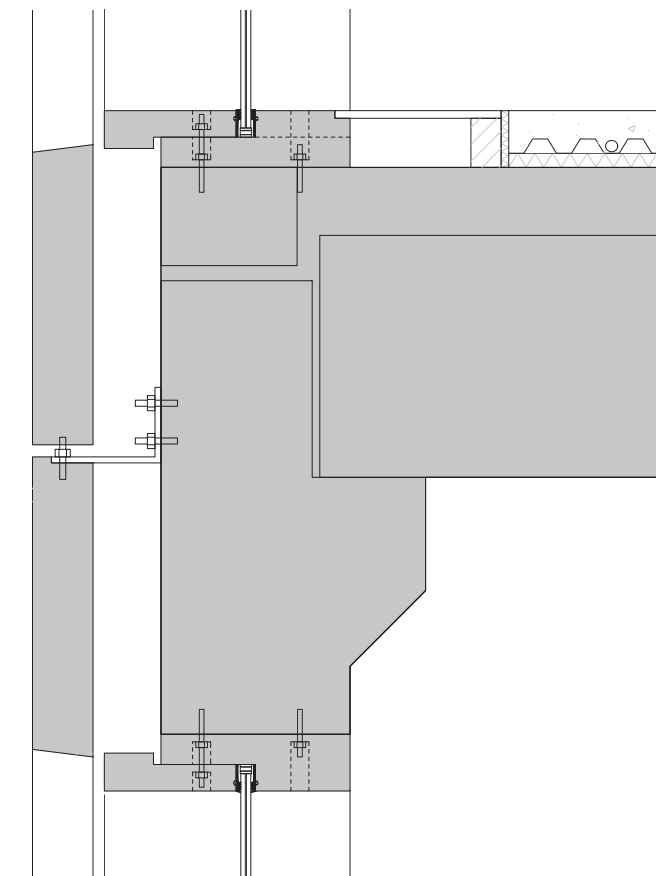


Design

Detail courtyard

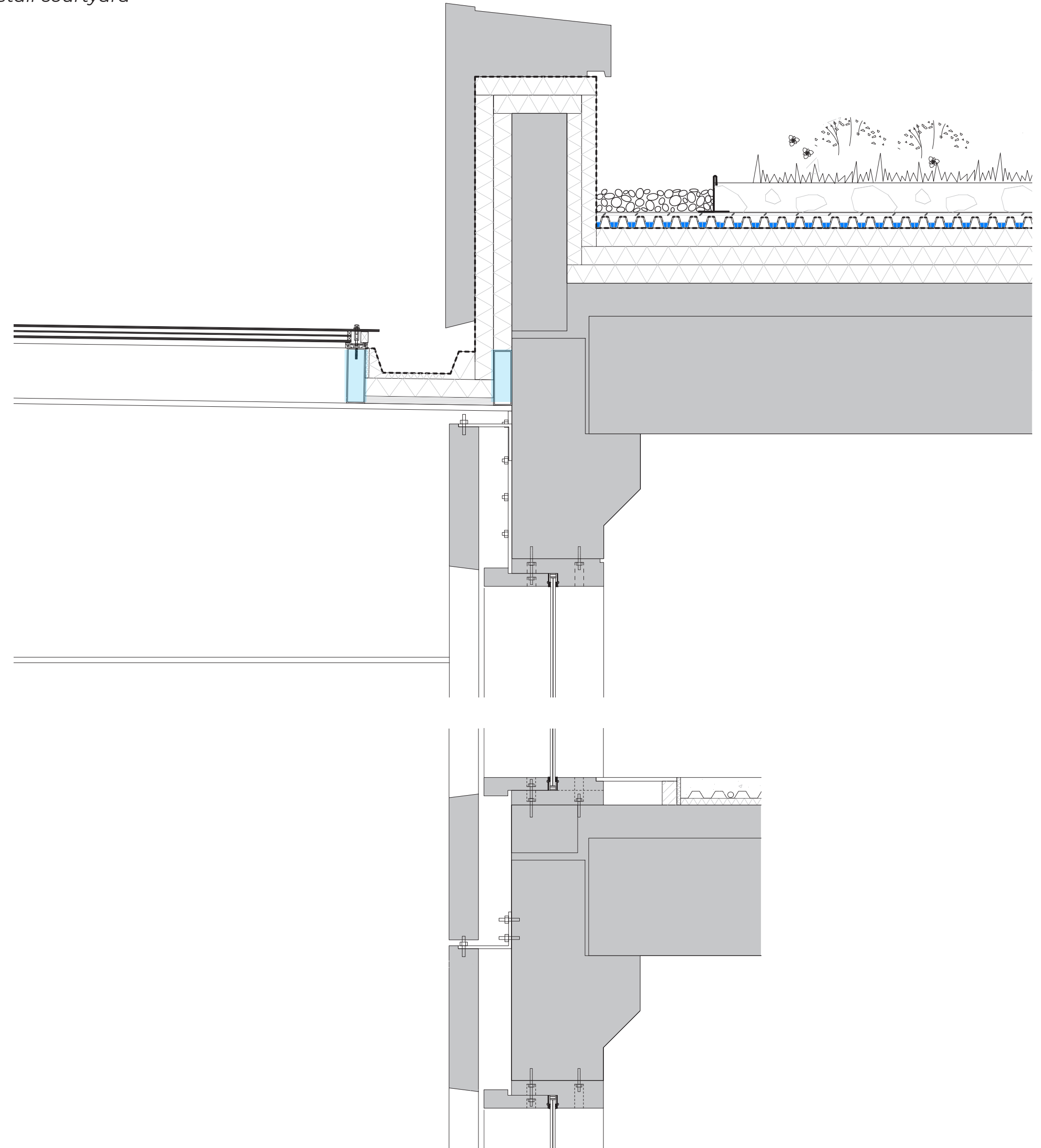
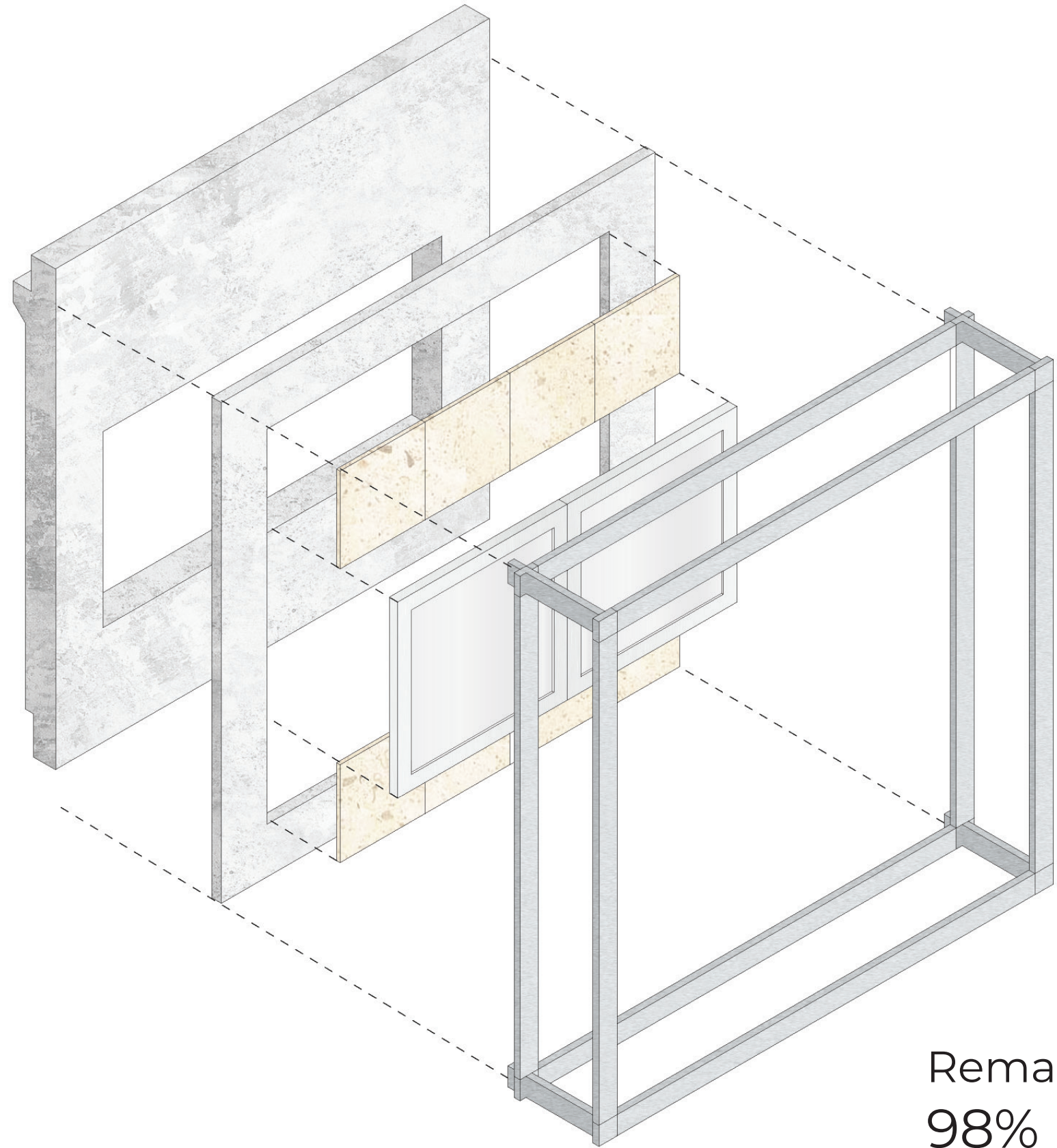


Reuse
100%
&
Recycle
24 ton



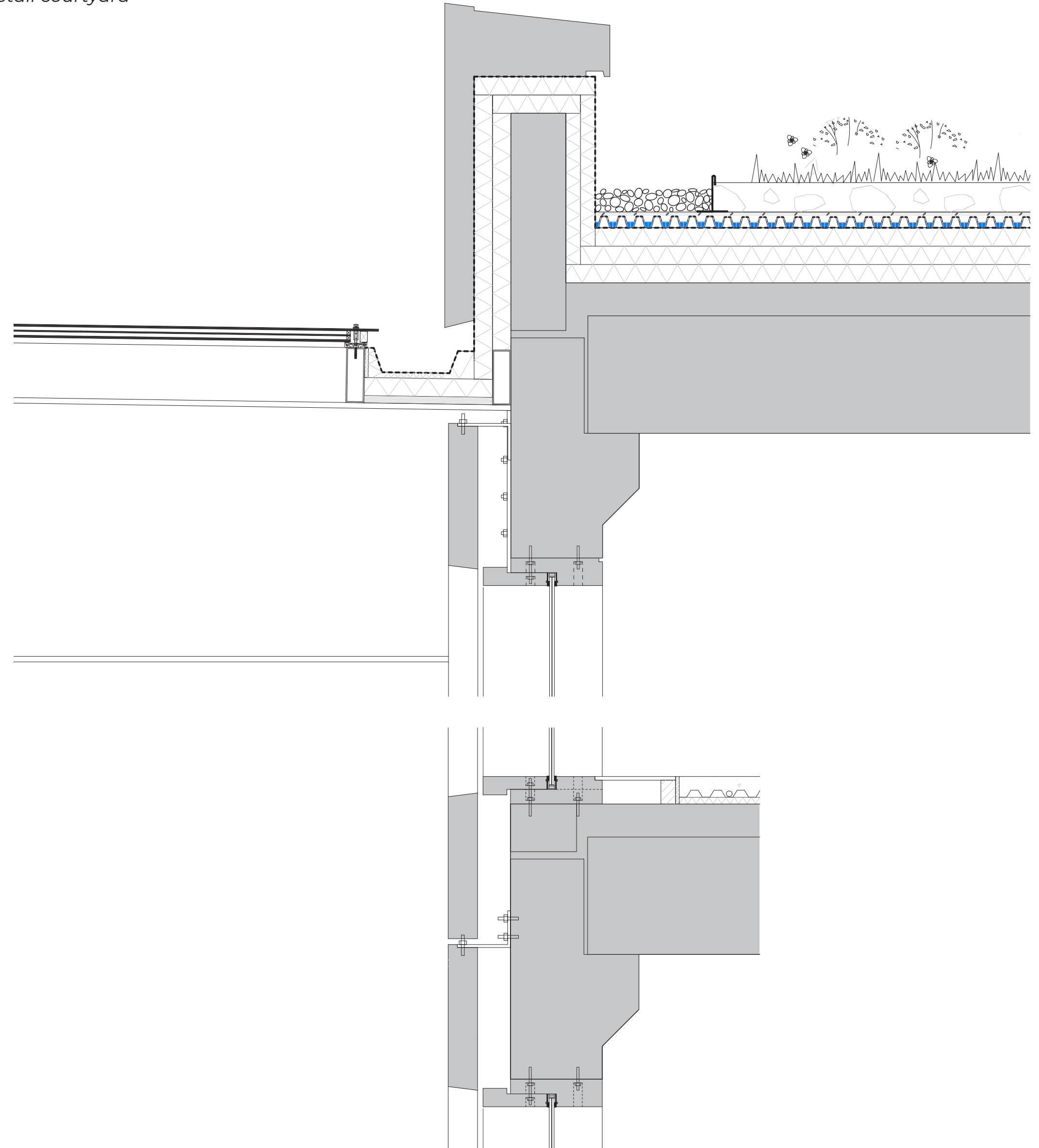
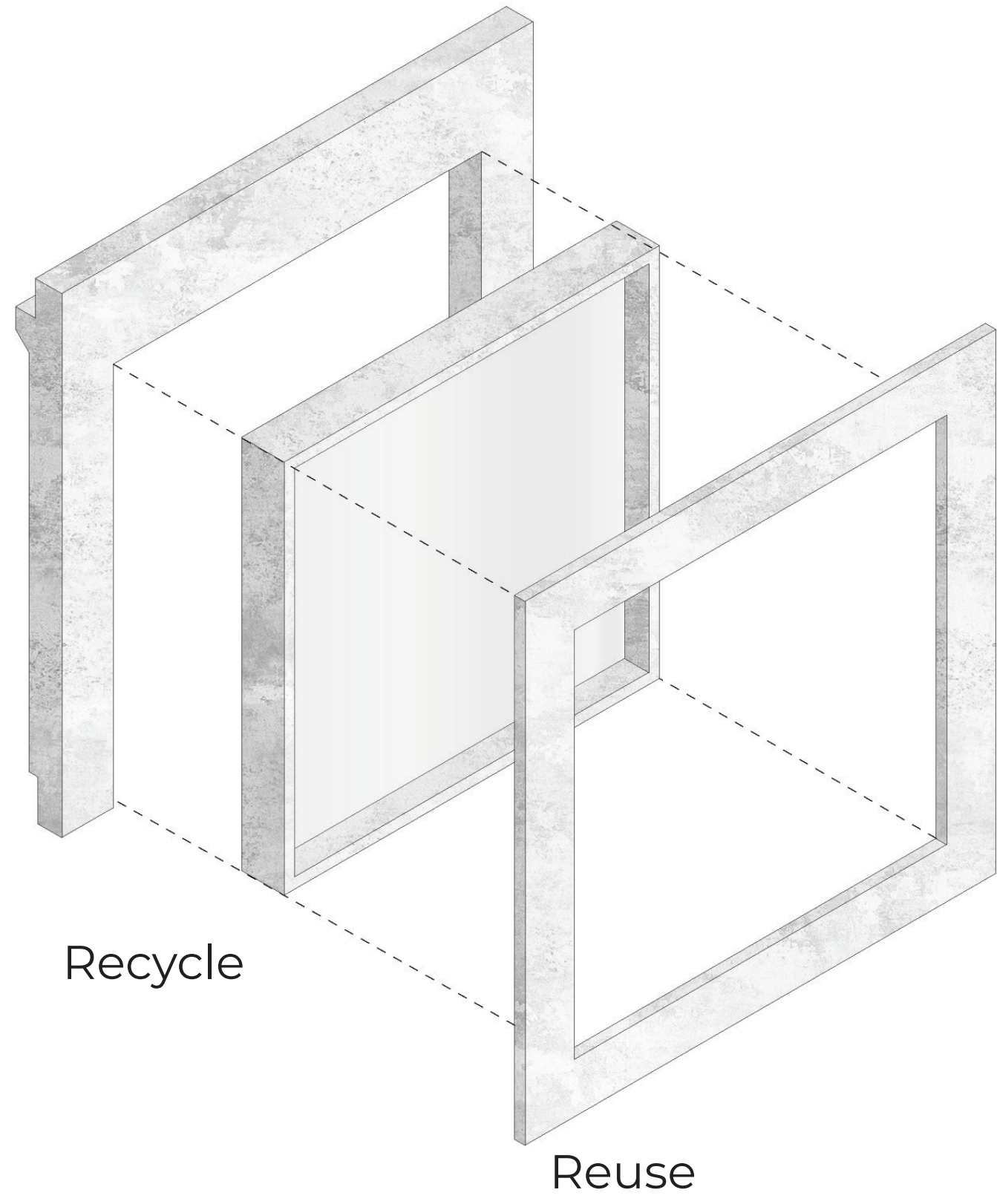
Design

Detail courtyard



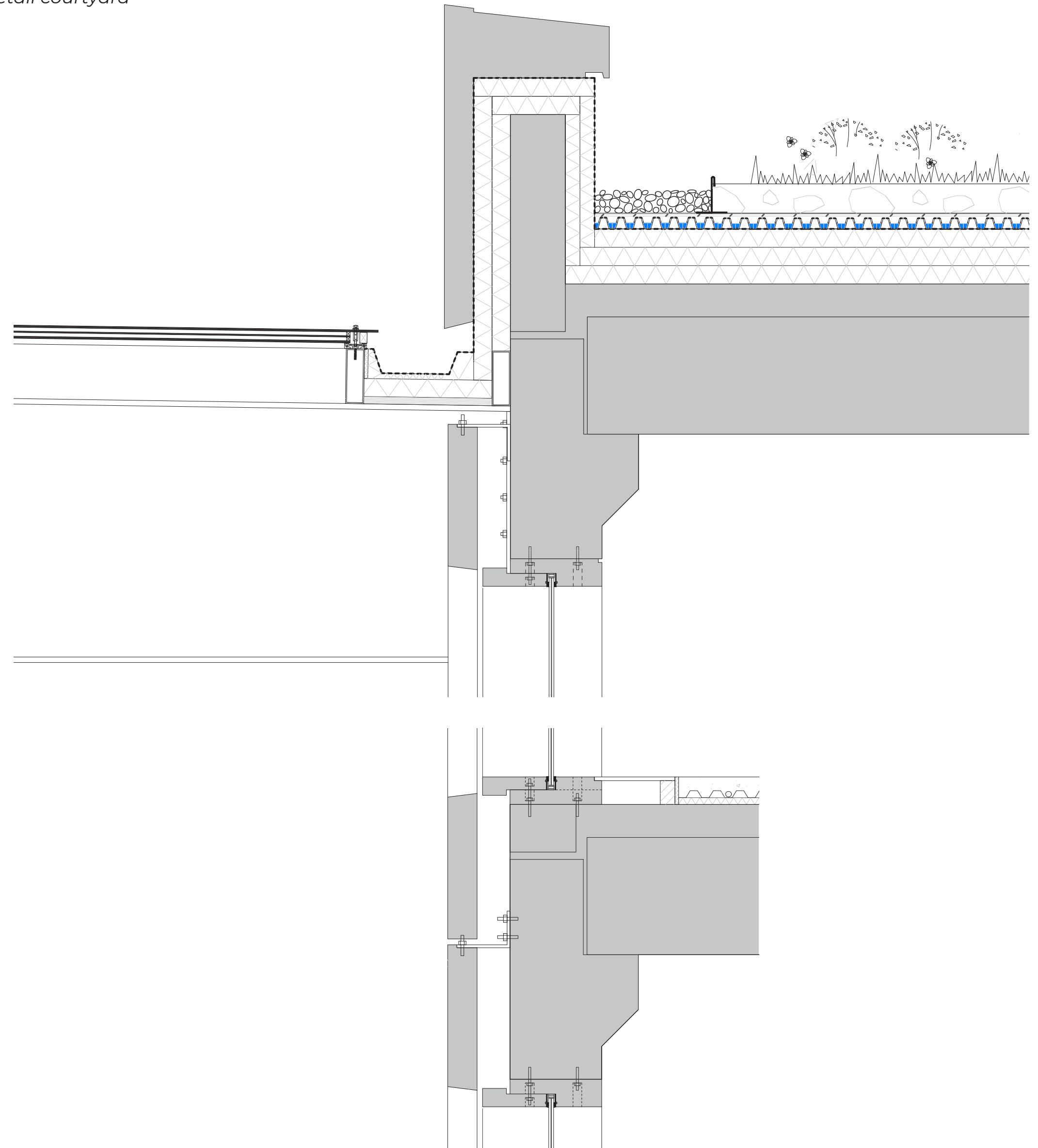
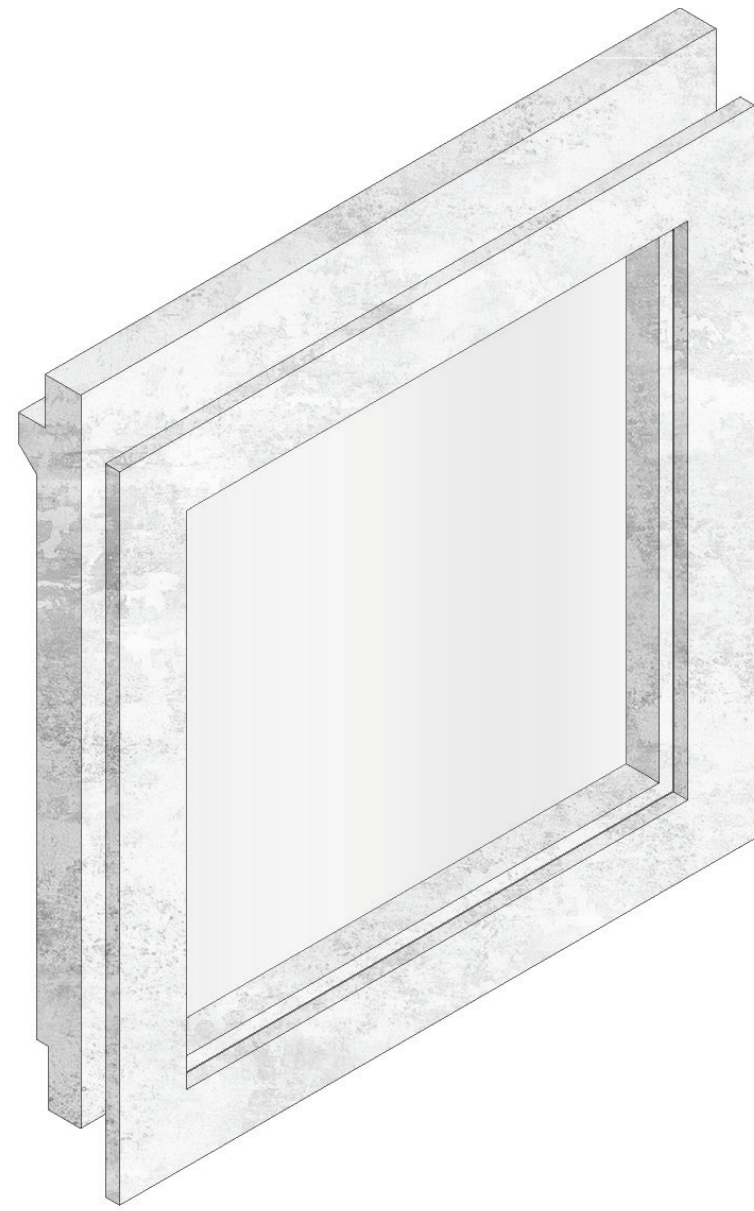
Design

Detail courtyard



Design

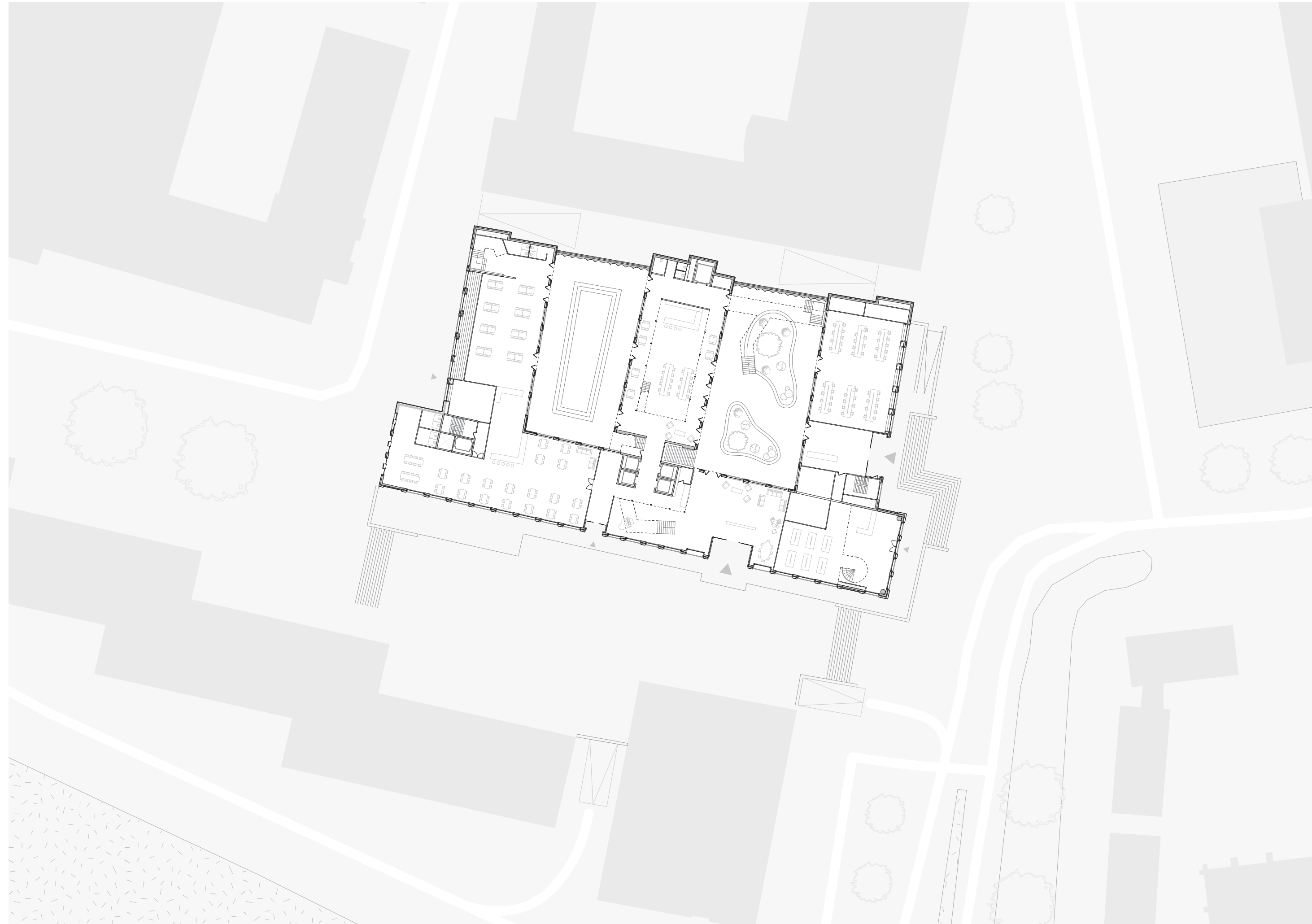
Detail courtyard





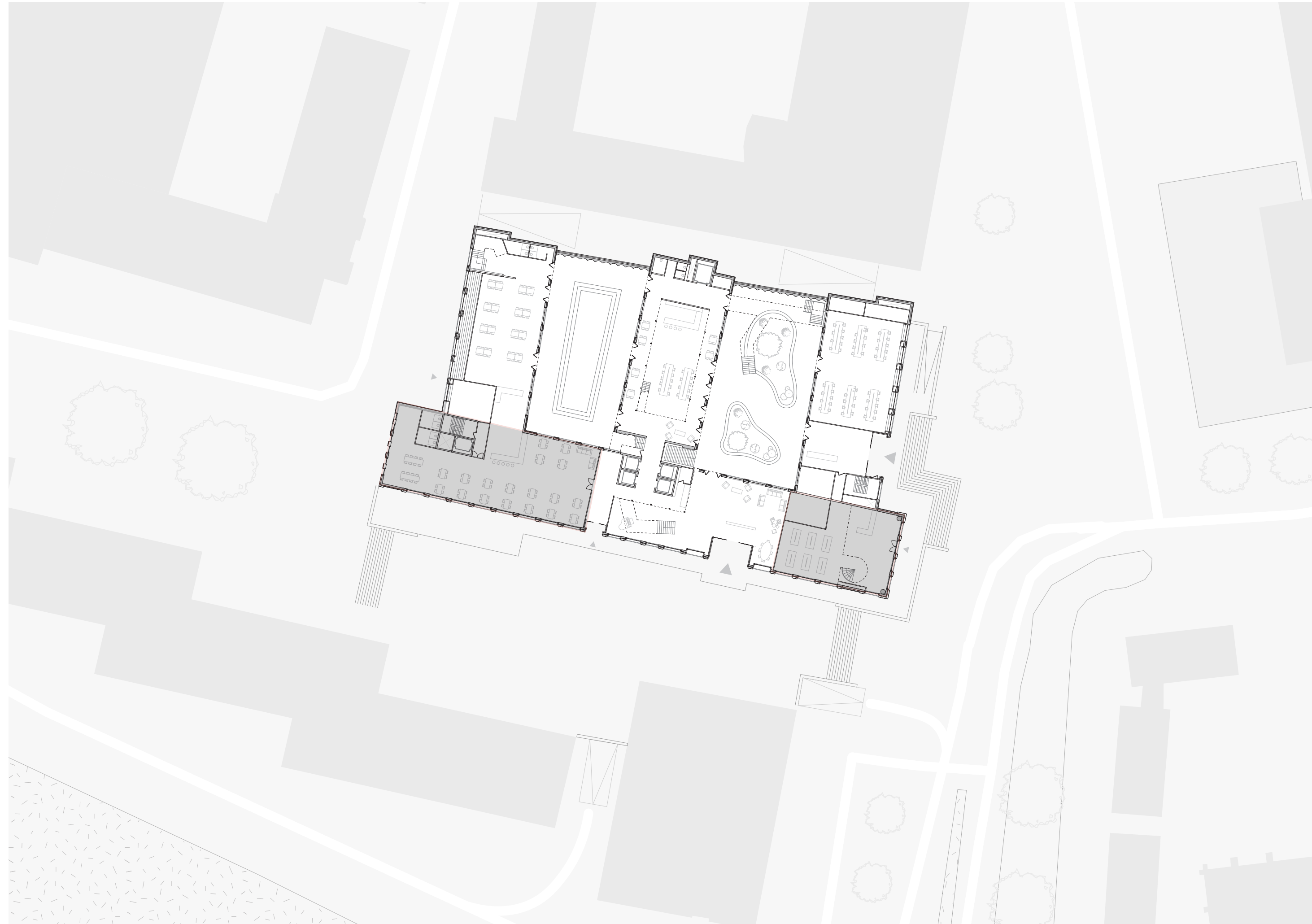
Design

Contextual relations



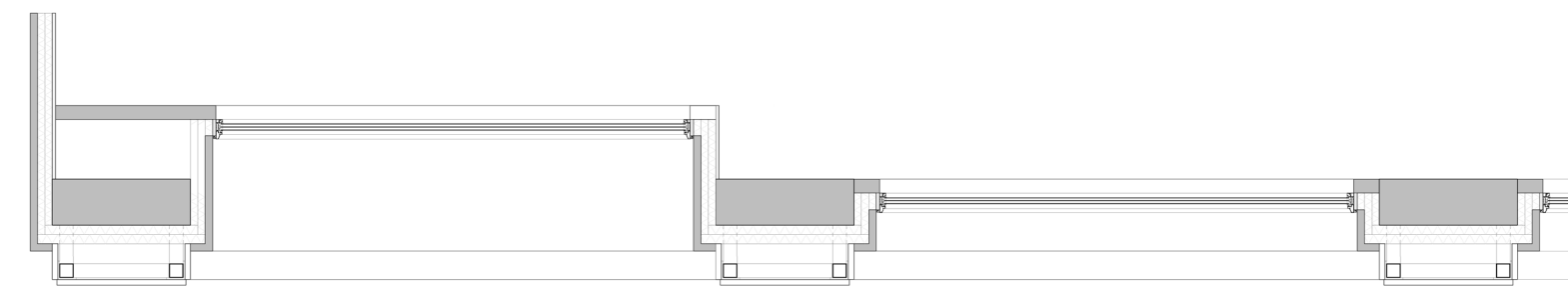
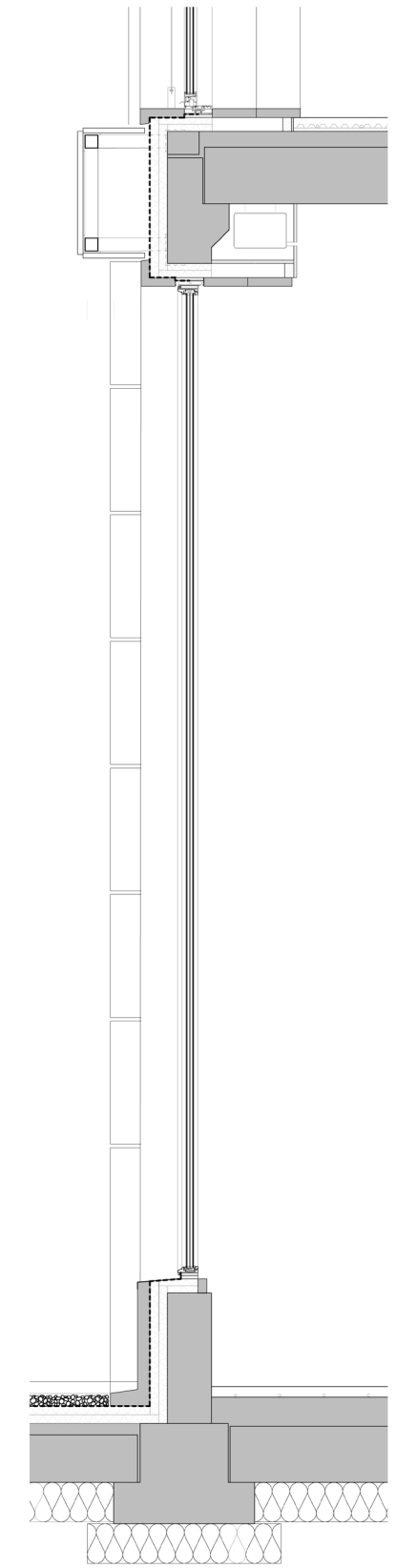
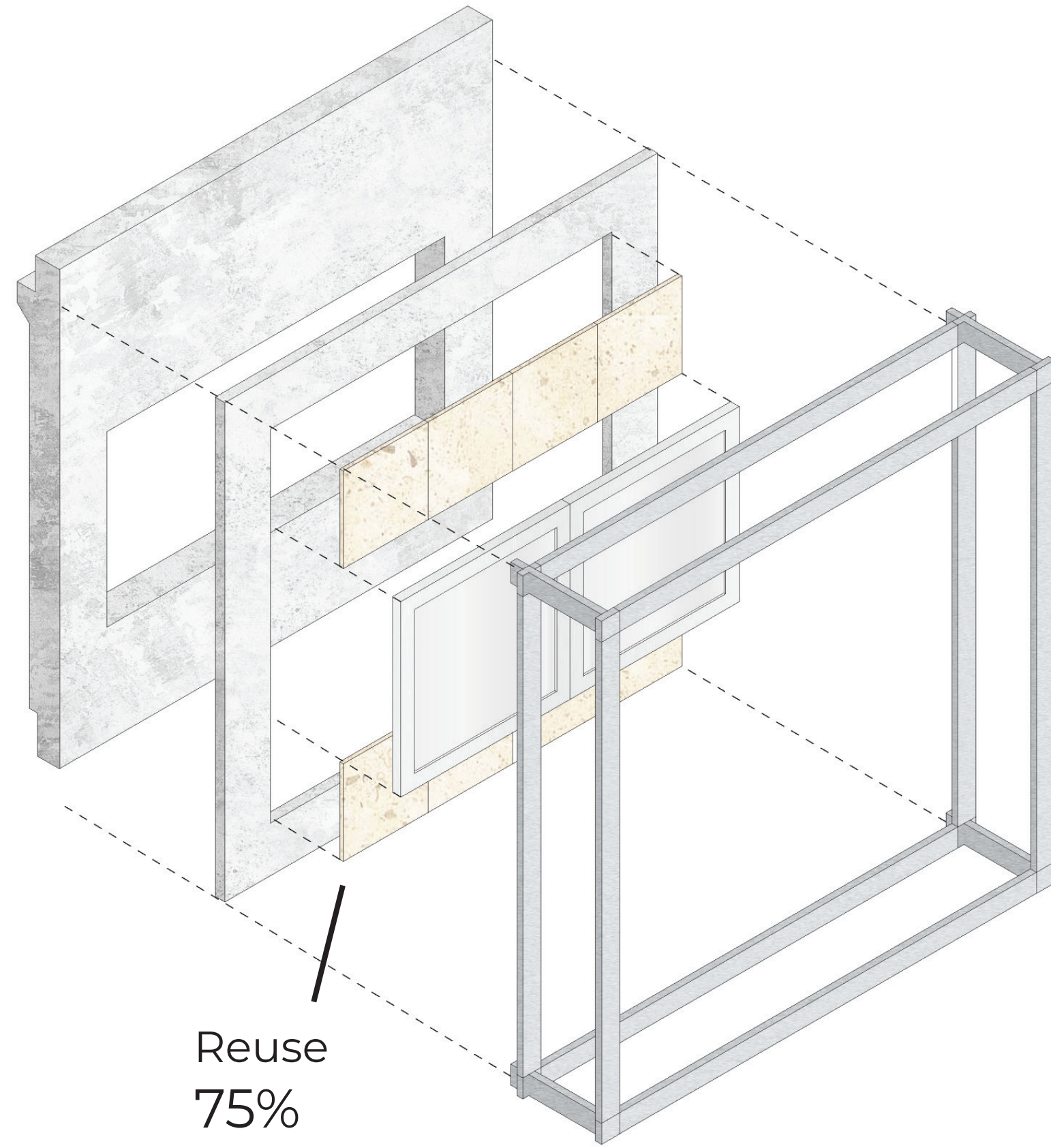
Design

Contextual relations



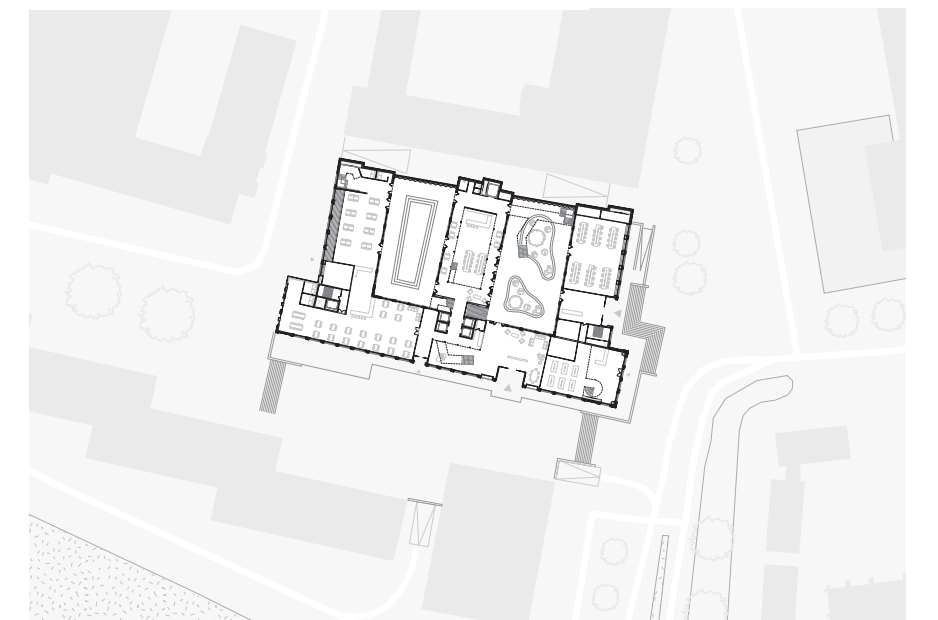
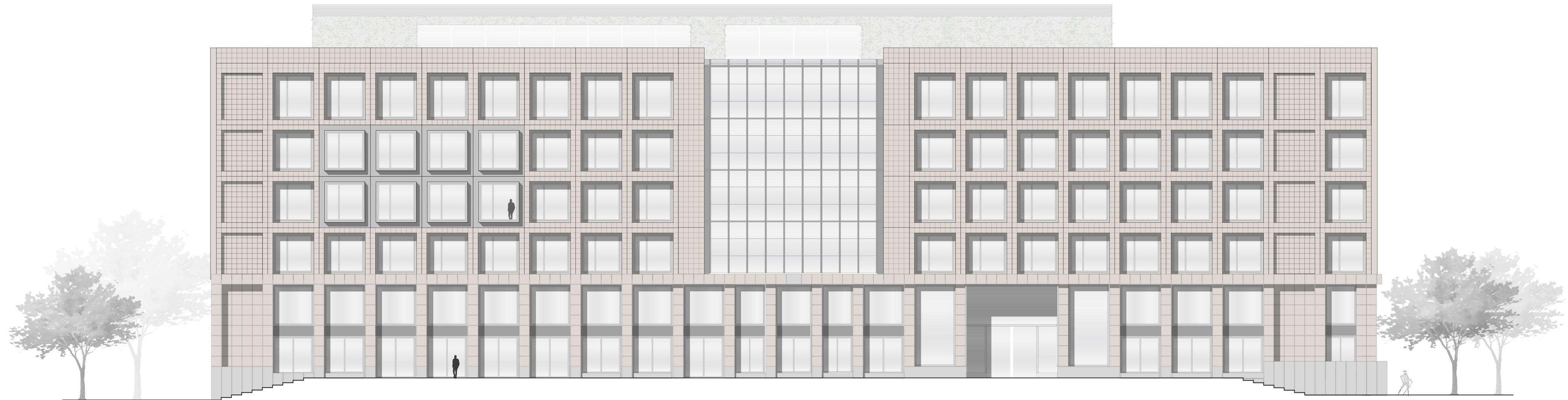
Design

Facades



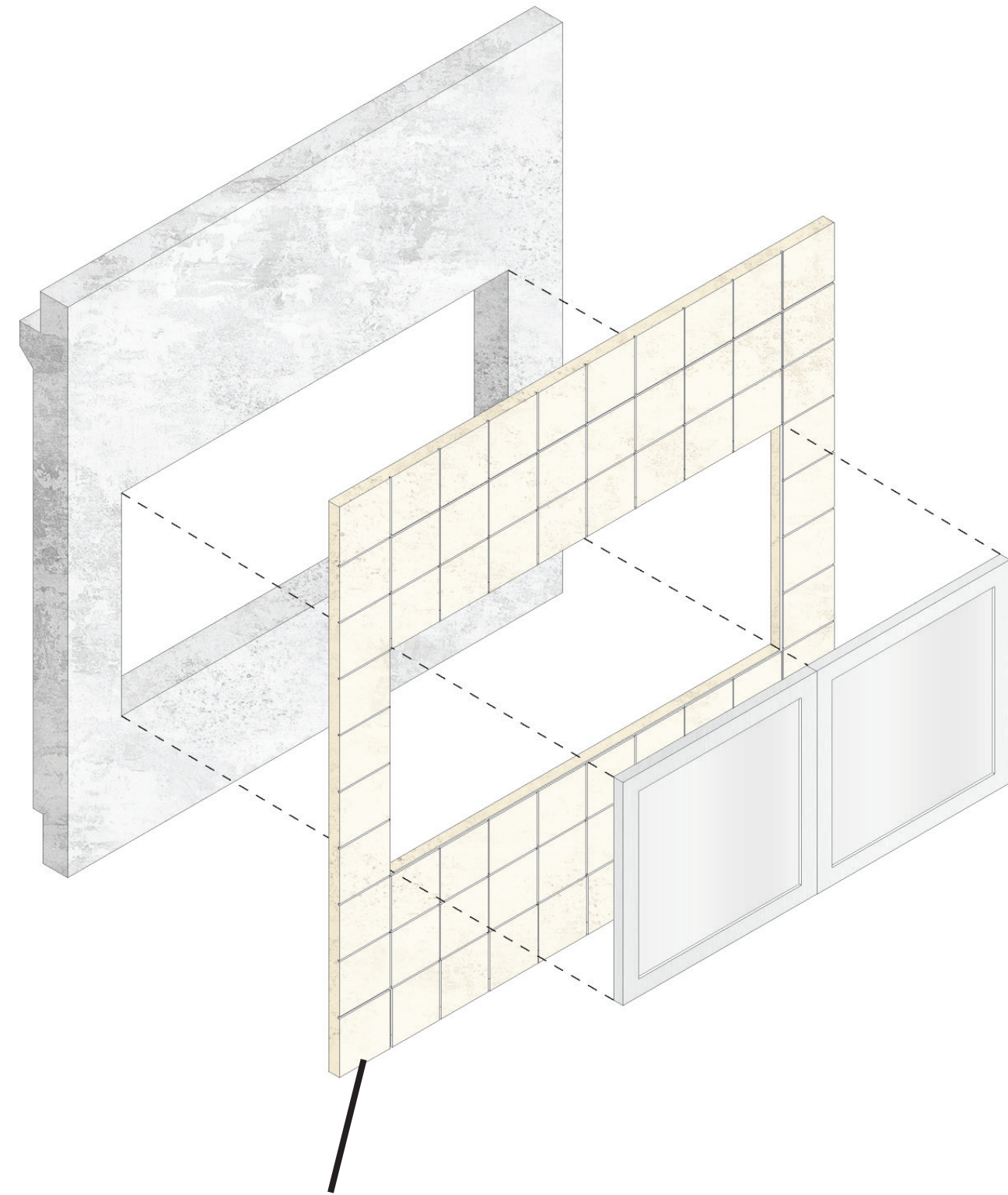
Design

Facades

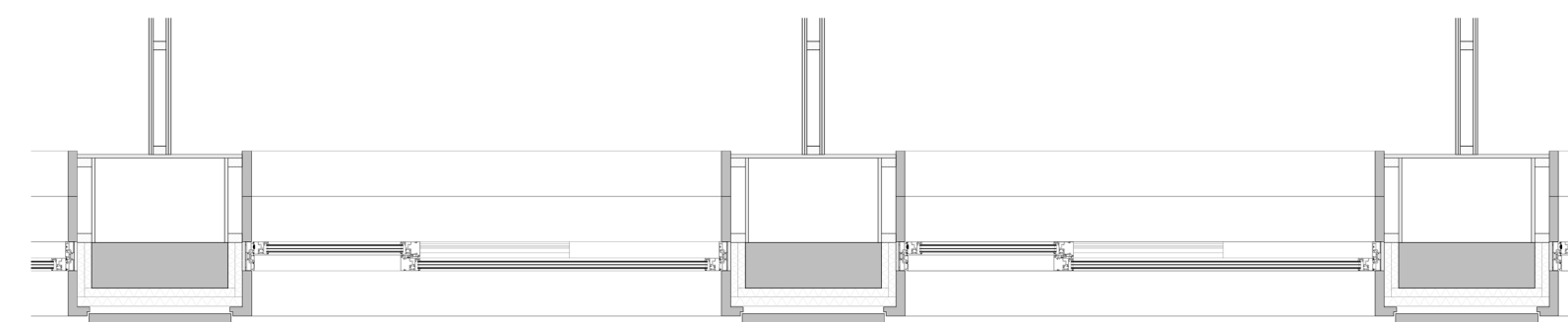
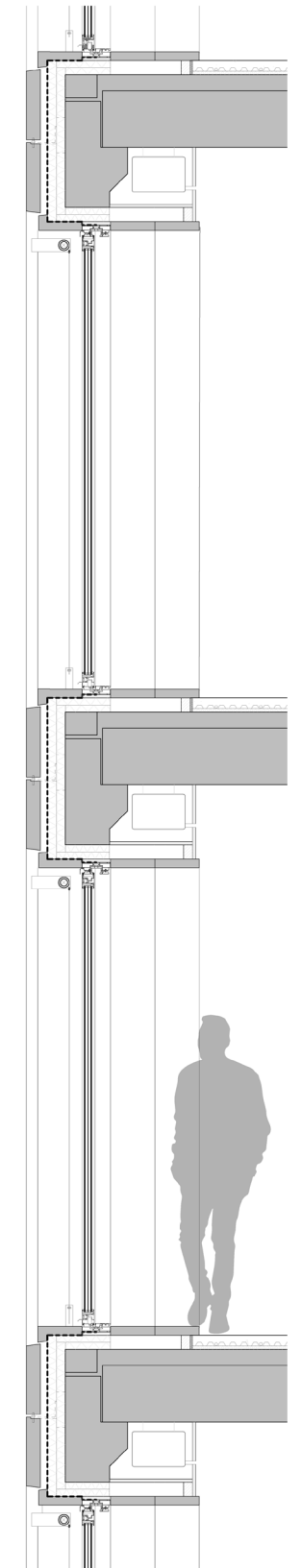
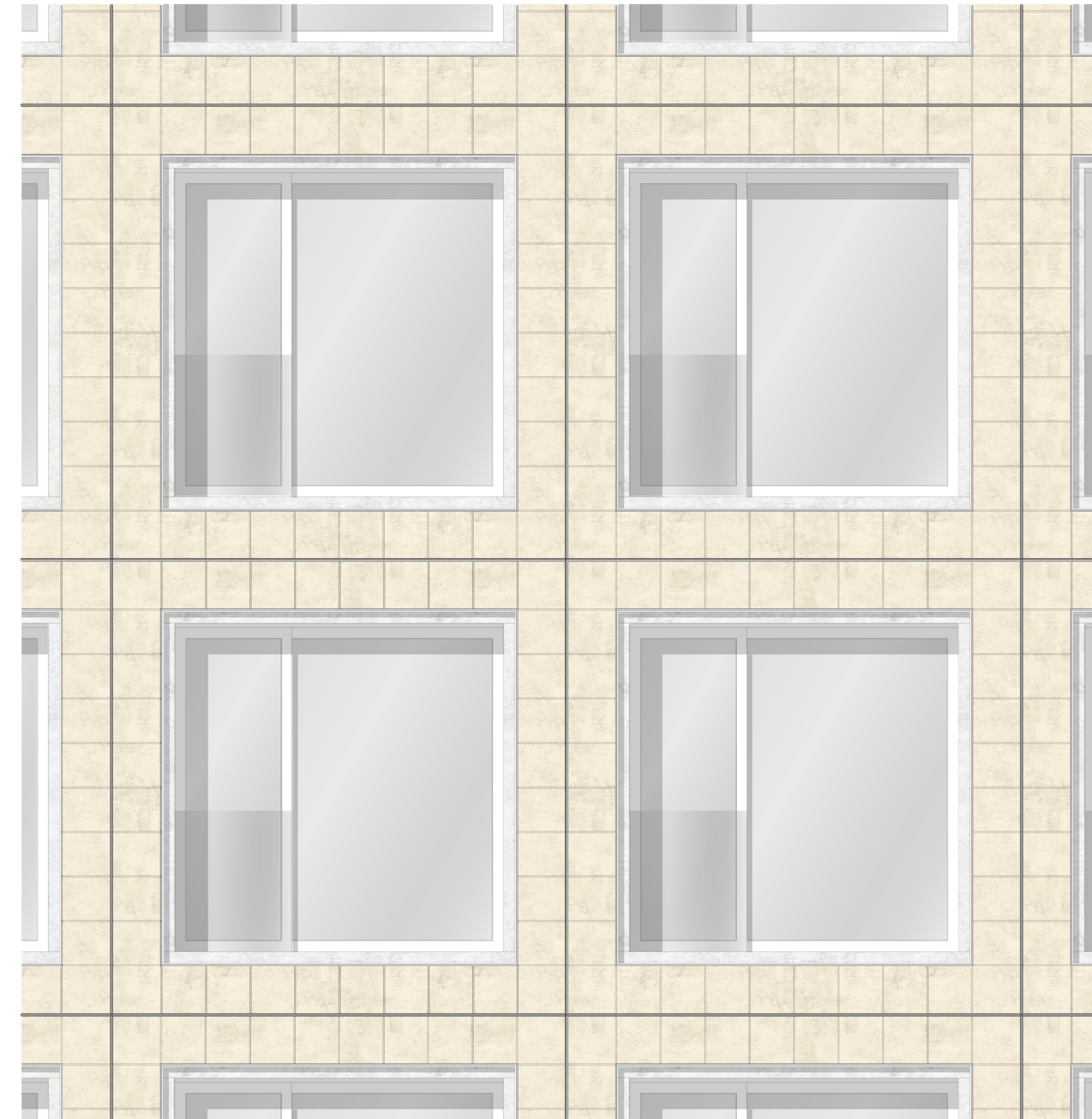


Design

Facades

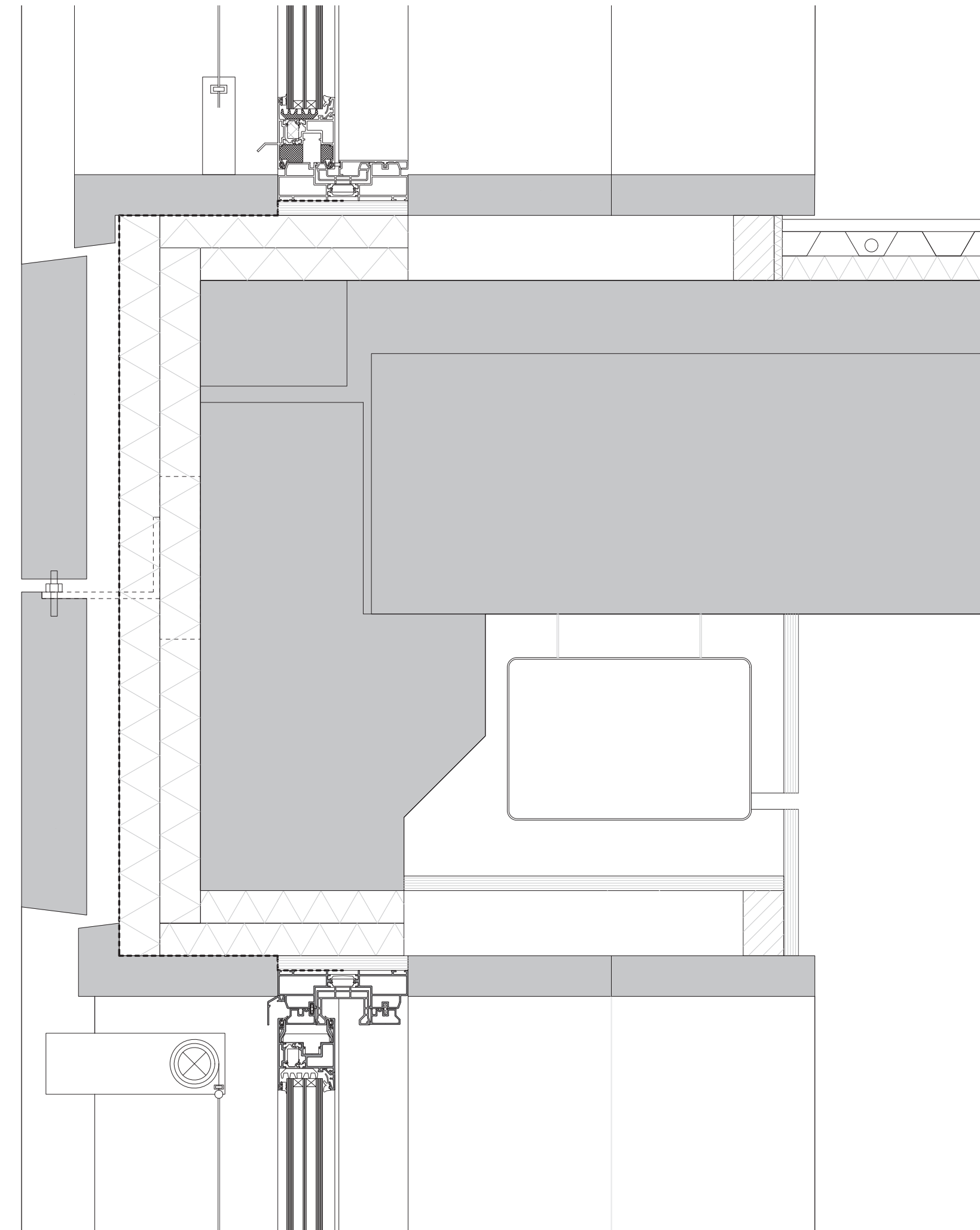
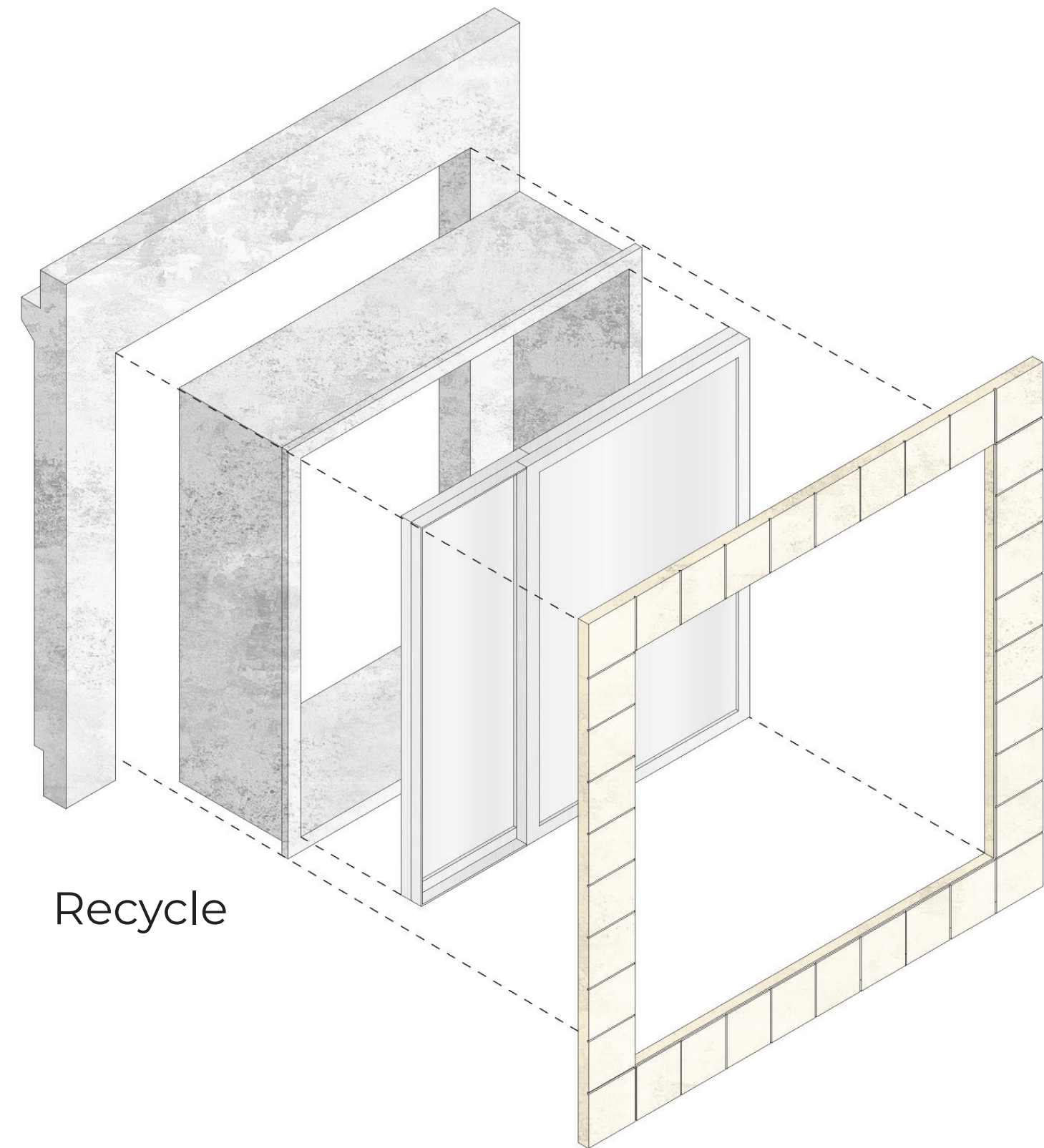


Remake
100%



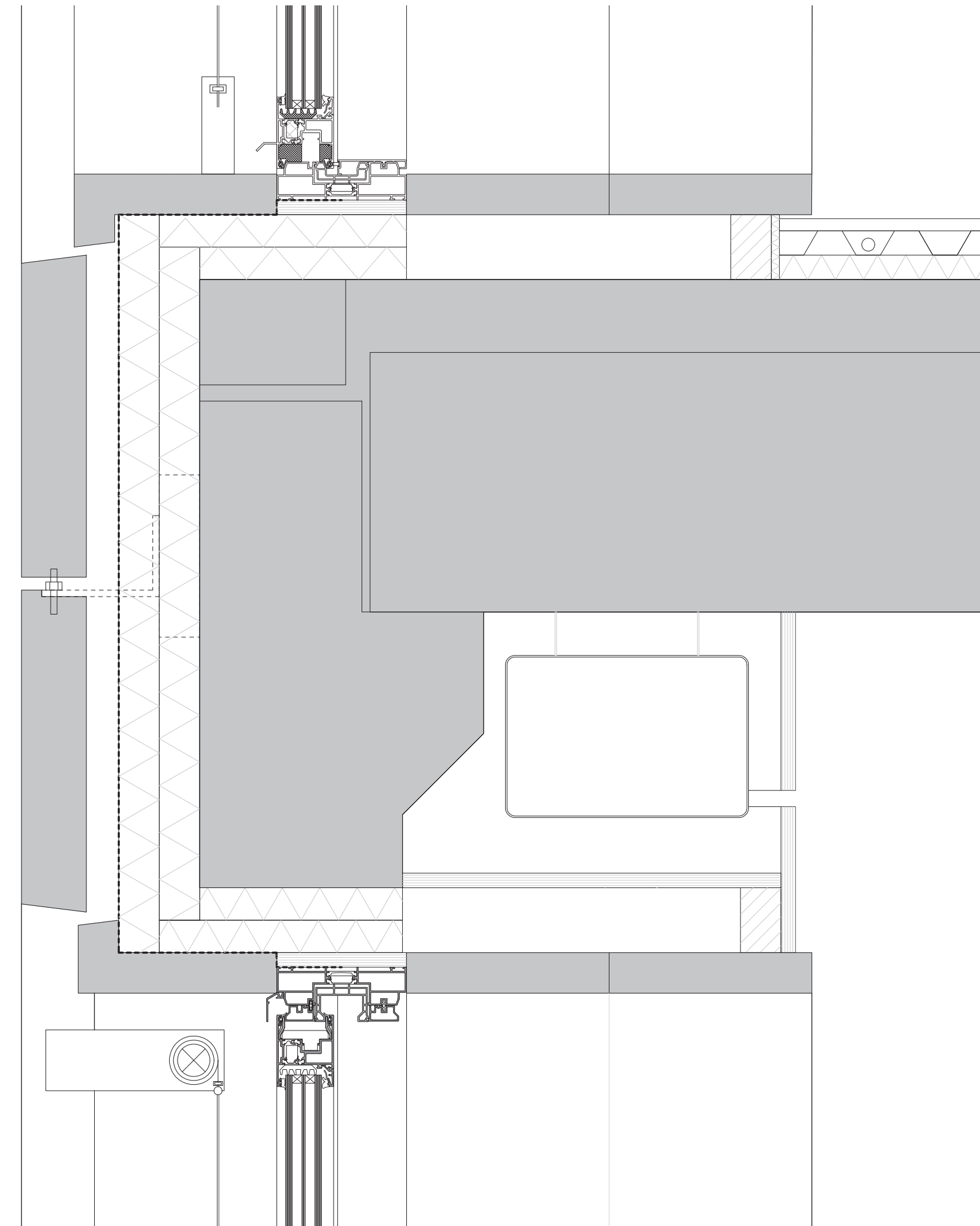
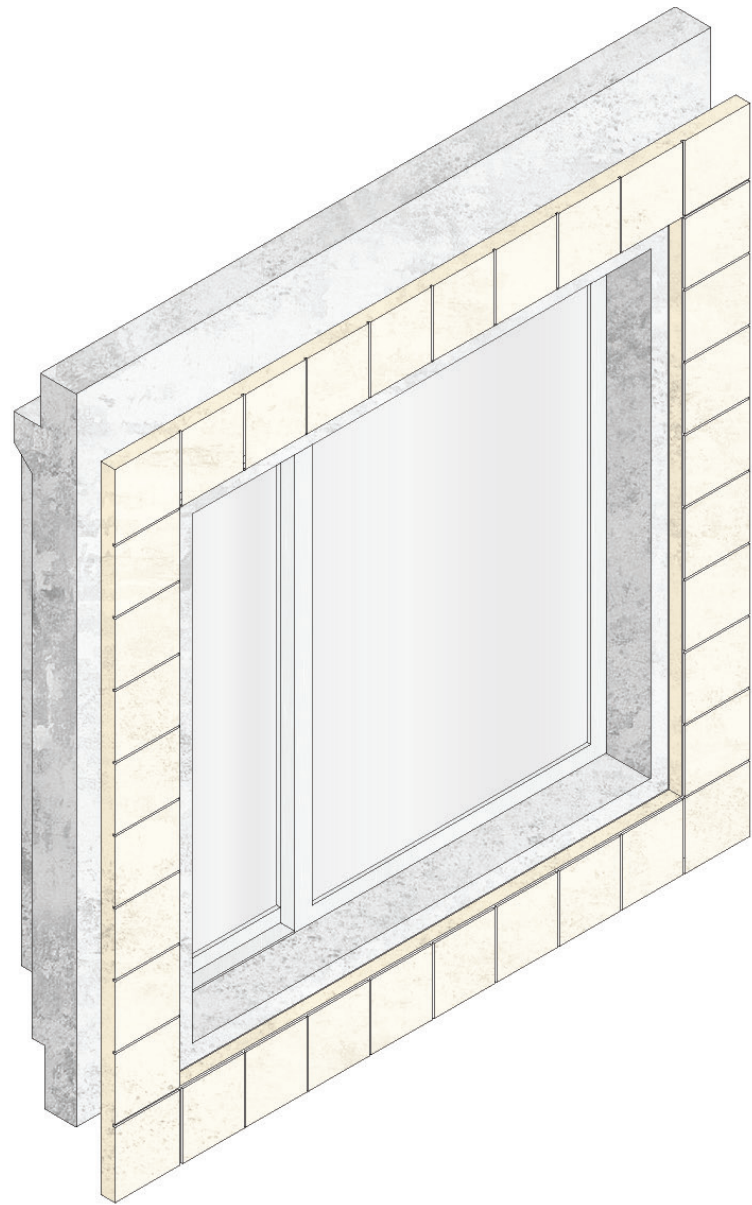
Design

Facades



Design

Facades



Design

Facades



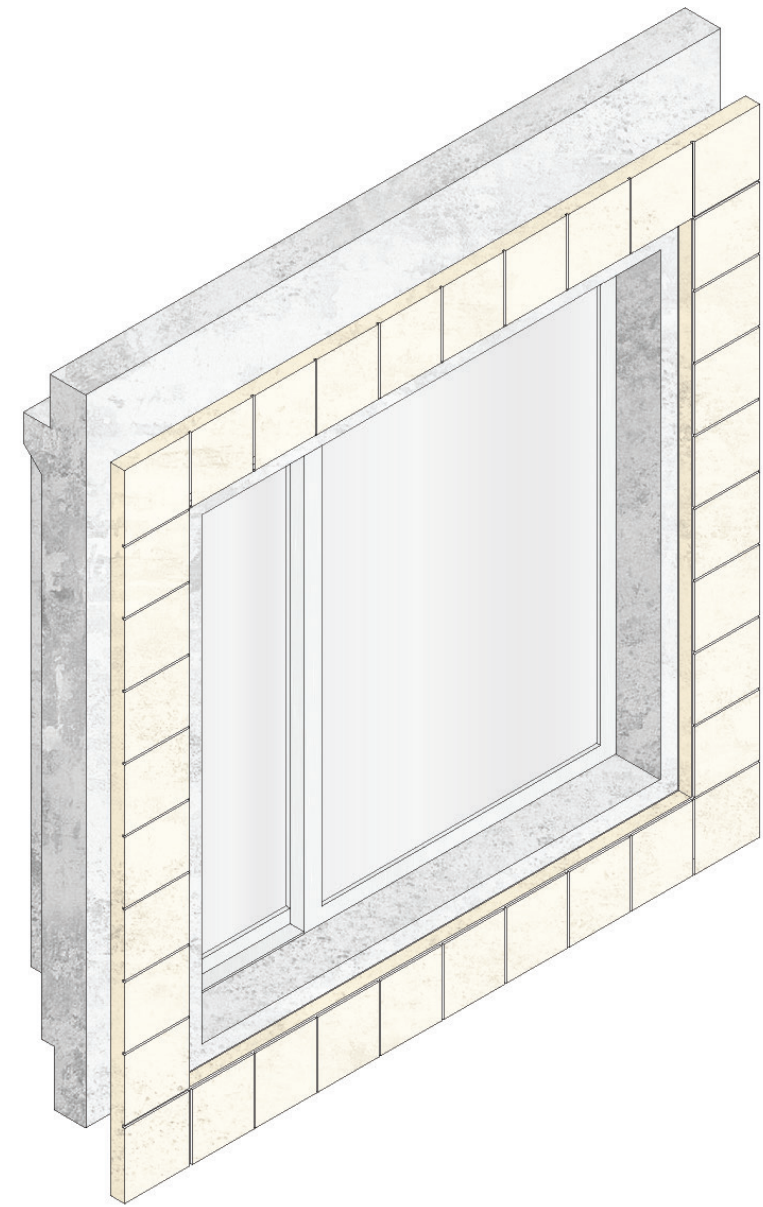
South facade



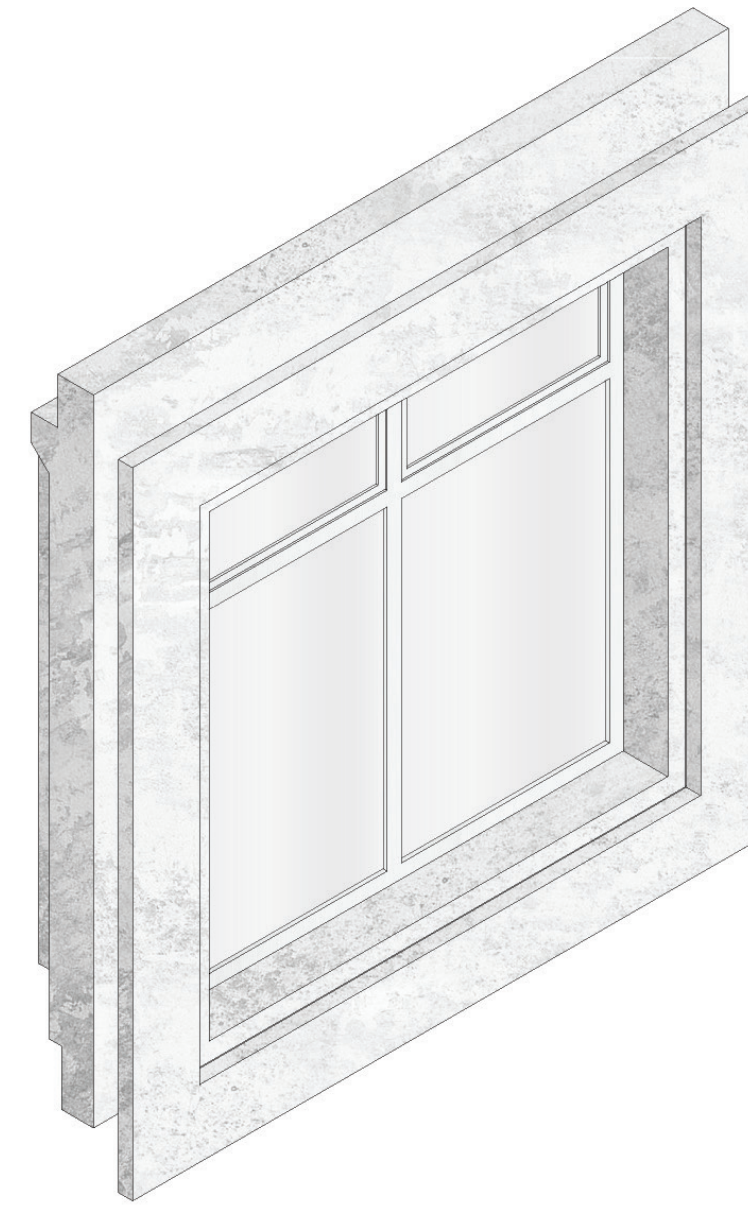
North facade

Design

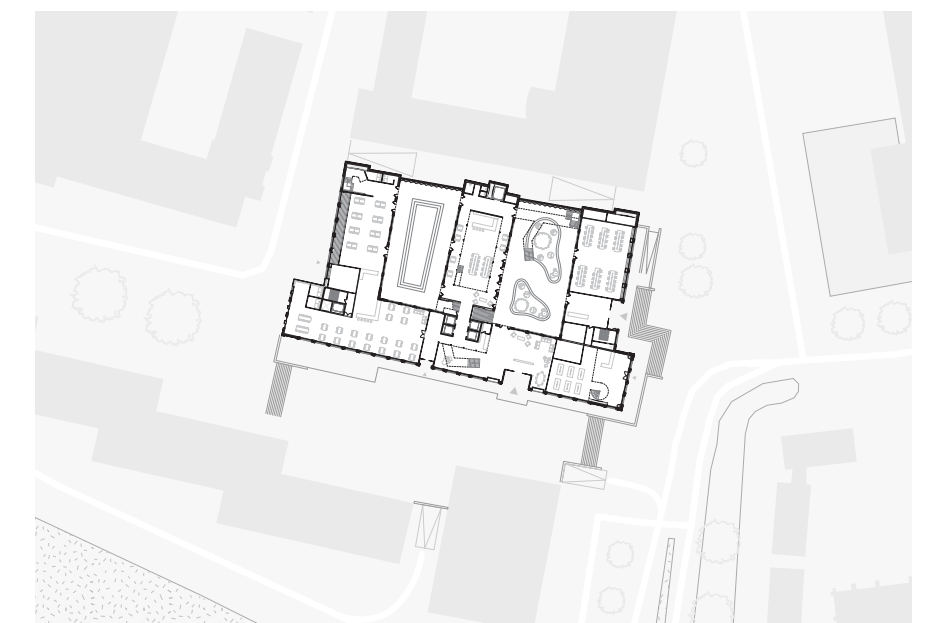
Facades



Facade fragment main building



Facade fragment wings

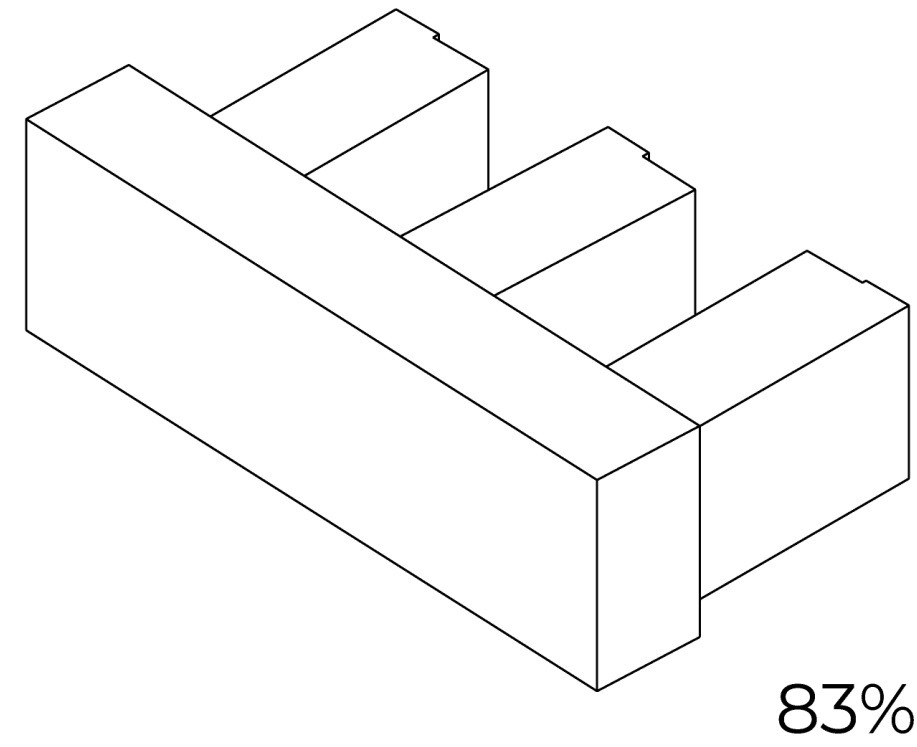


Conclusion

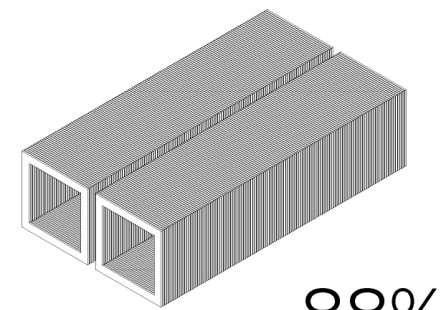


Conclusion

1. Reuse

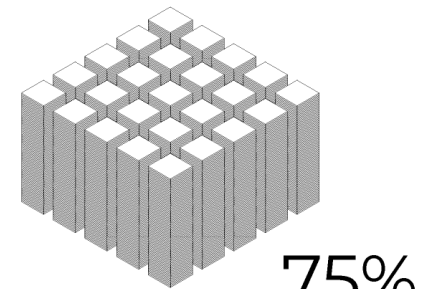


Concrete structure
Total: 23.800 ton
Reused: 19.833 ton



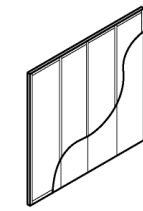
Concrete facade frame
Total: 242x
Reused: 214x

reused on same location



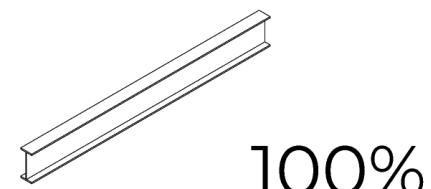
Limestone facade cladding
Total: 1772x
Reused: 1326x

reused as facade cladding in plinth



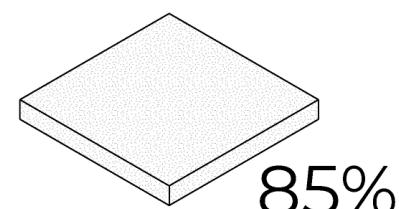
Gypsum
Total: 20700 m²
Reused: 8432 m²

reused as 1st layer in partition wall finish



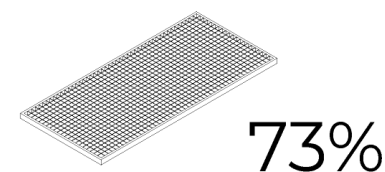
Steel HEB700 beam
Total: 7x
Reused: 7x (100%)

reused in courtyard roof structure



Rockwool insulation
Total: 30,5 ton
Reused: 25,8 ton (85%)

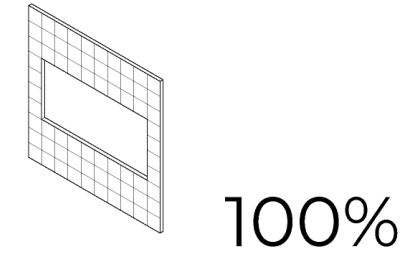
reused in basement insulation and inside partition walls



Steel floor panel
Total: 510 m²
Reused: 374 m²

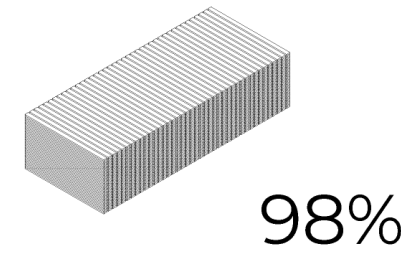
reused as facade covering of rooftop pavilion

2. Remake



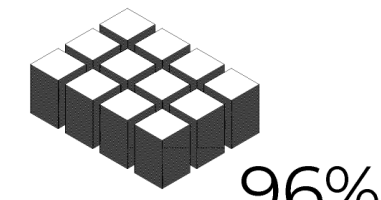
Concrete facade cladding
Total: 208x
Reused: 208x

adapted to be used on same location



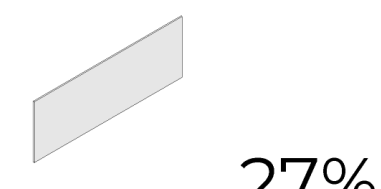
Steel tubes
Total: 510x
Reused: 500x

adapted to be used in courtyard and atrium sub-structure



Double glass panels
Total: 777x
Reused: 744x

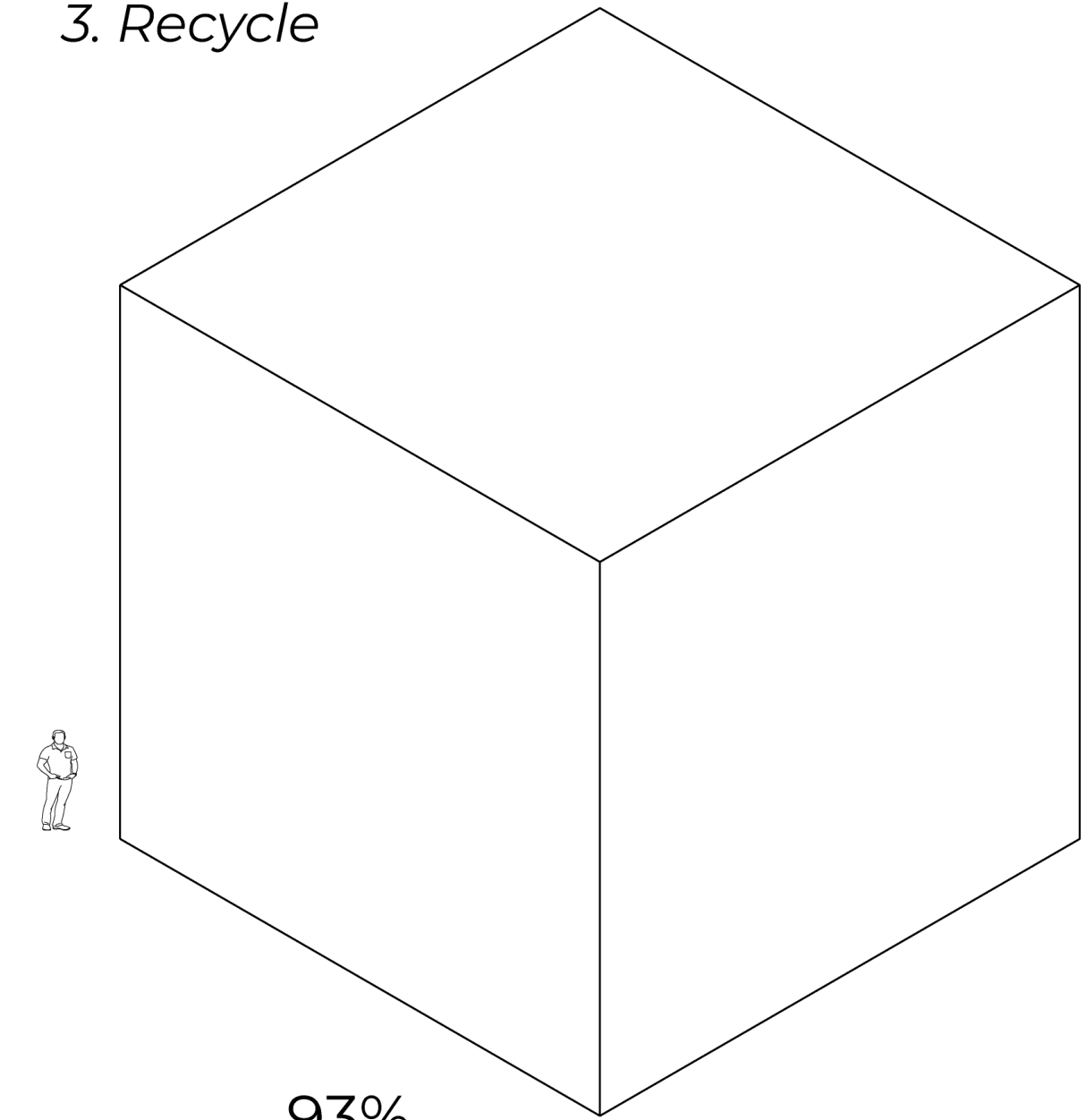
adapted to be used as double double glass in courtyard and atrium covering



Enamelled glazing
Total: 160 m²
Reused: 42 m²

reused as separating panel in plinth

3. Recycle



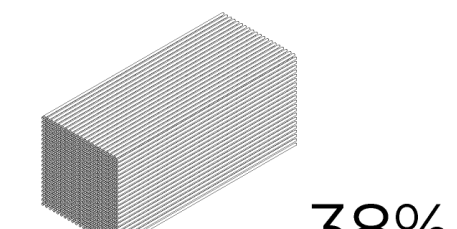
Concrete
Total: 3670
Recycled: 3432

recycled to be used in:
Facade infill 320 ton
external: 197,5 ton
internal: 122,5 ton
Floor finish 1940 ton
Stairs 110 ton
Walkways 228,5 ton
Courtyard wall 234 ton



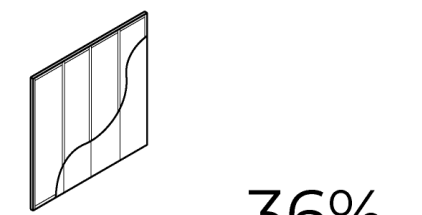
Aluminium window frames
Total: 16 ton
Reused: 16 ton

adapted to be used in courtyard and atrium sub-structure



Steel rebar
Total: 129 ton
Recycled: 48 ton

recycled to be used in courtyard roof structure and railings



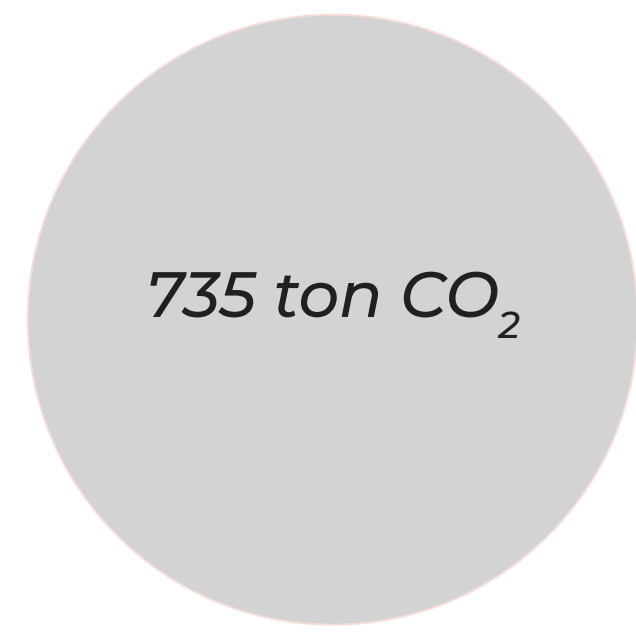
Gypsum
Total: 162 ton
Reused: 59 ton

reused as 2nd layer in partition wall finish

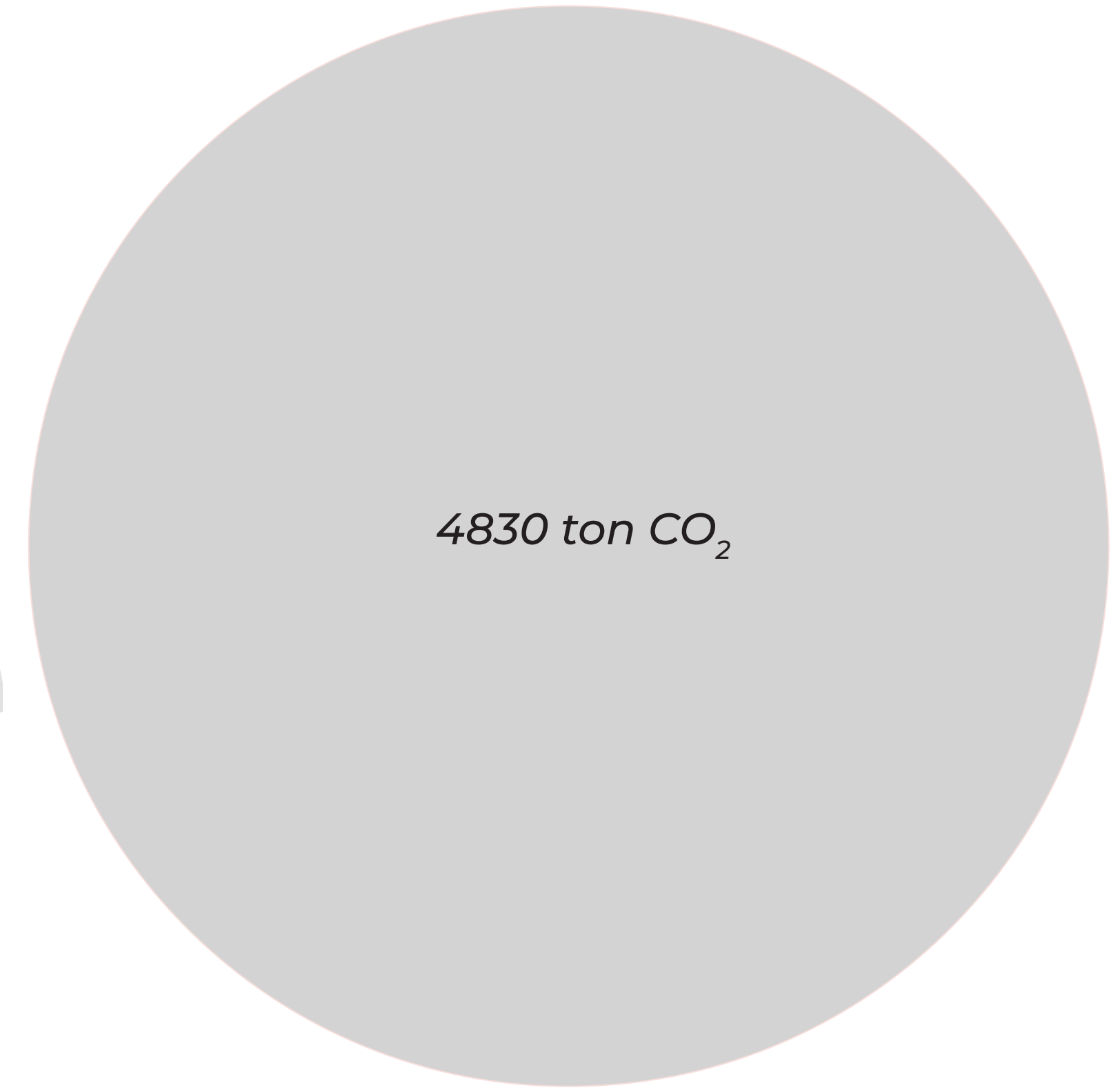
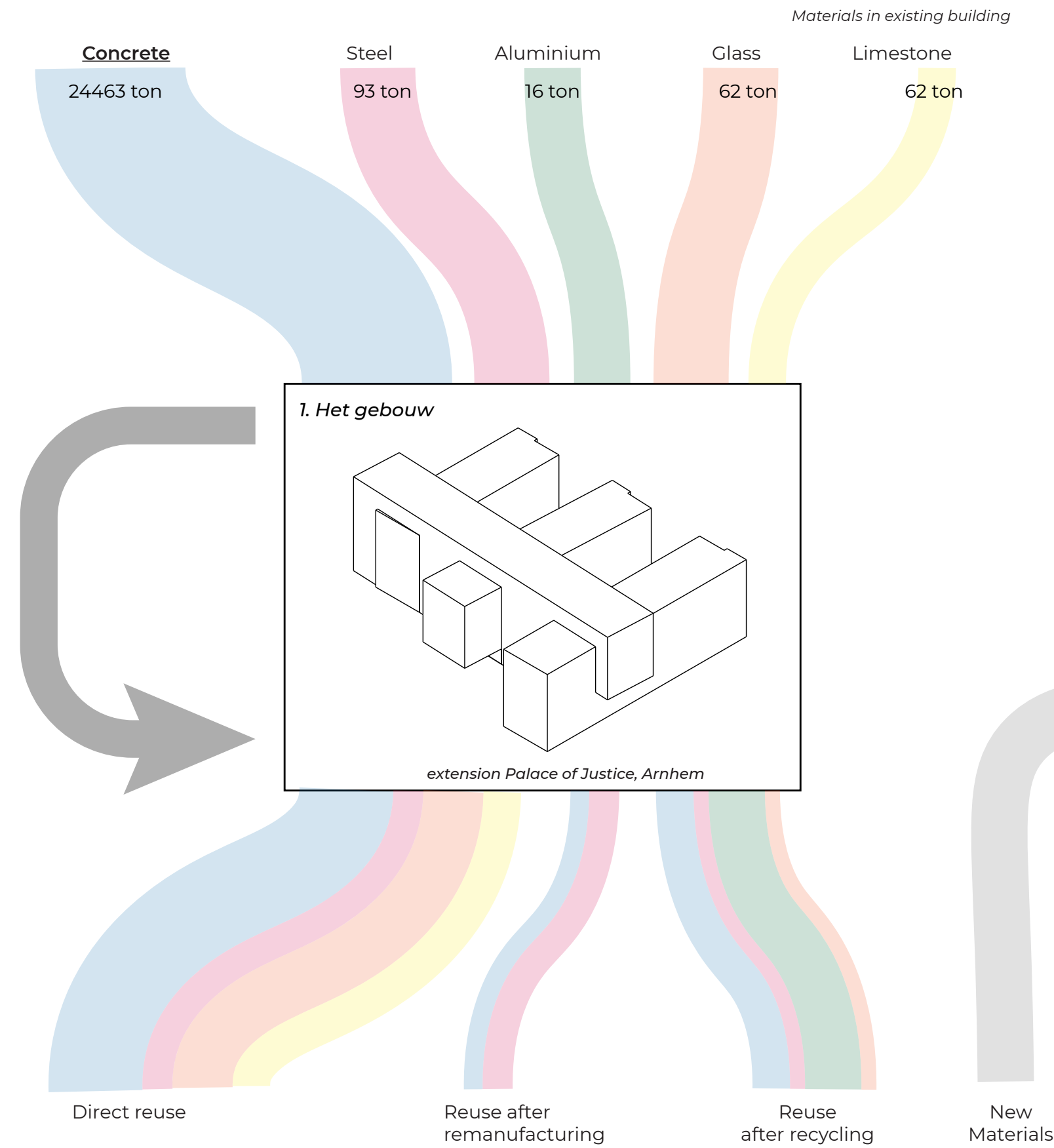
Conclusion

Circular transformation

New construction



85% reduction



Reflection



END

THANK YOU