

Wind Driven Design

A starting point towards a wind-oriented design approach

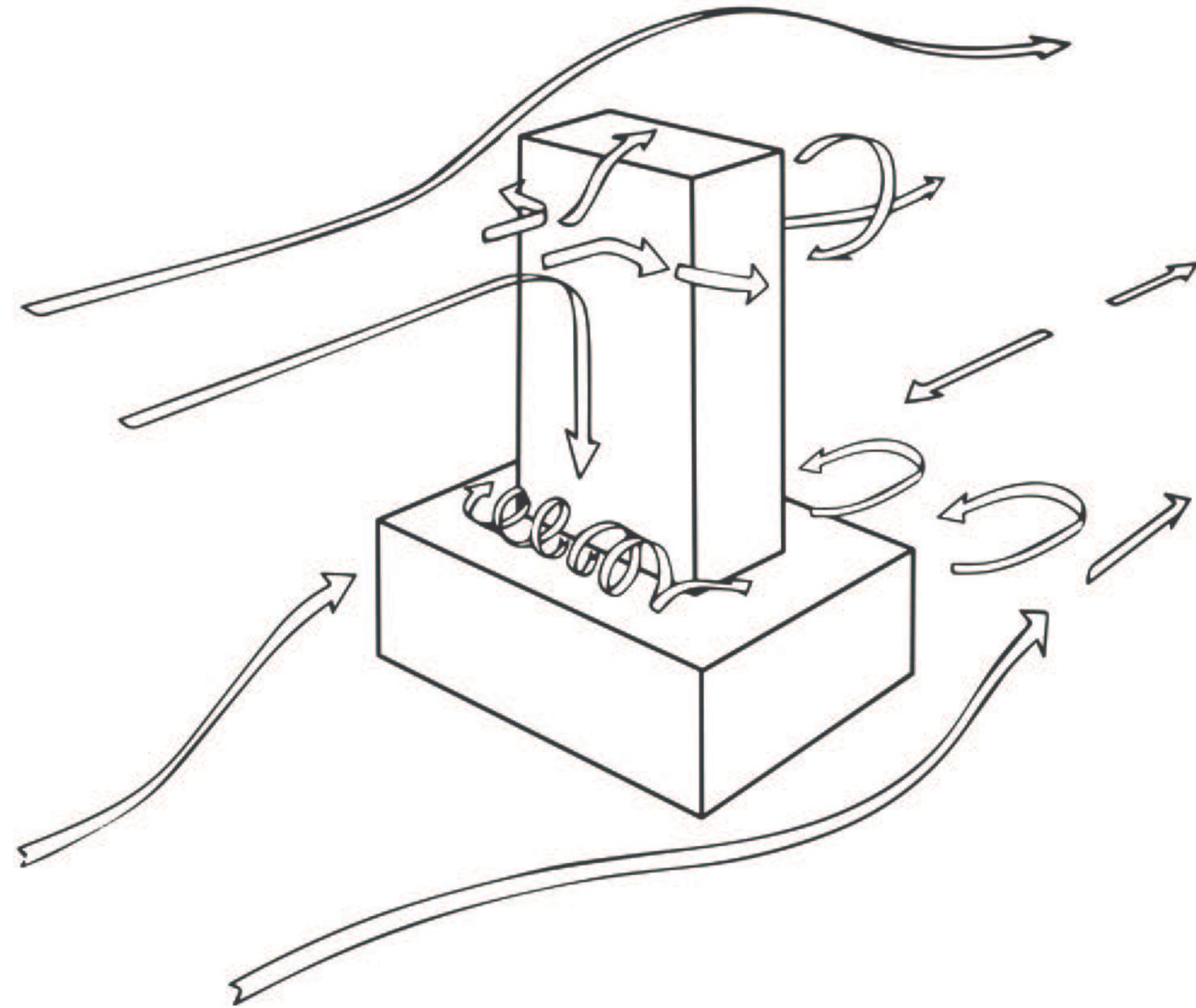


Faculty of Architecture and the built environment
Track: Architecture
Studio: Architectural Engineering,
Flow

Candidate
Thijs Kroft
(5078644)

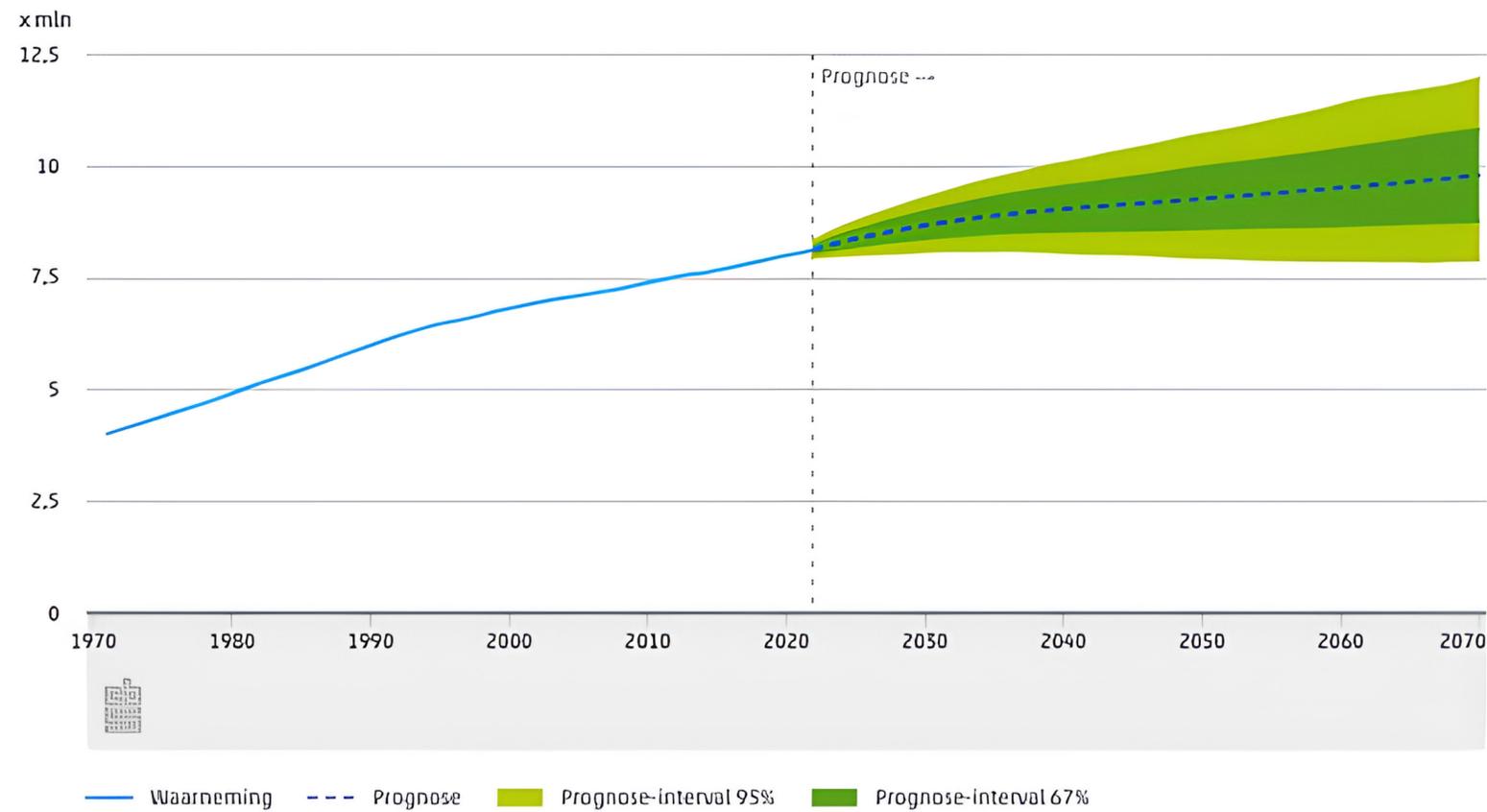
Tutors
Research Tutor: Clara Garcia-Sanchez
Design Tutor: Mauro Parravicini
Building Technology Tutor: Lex Van Deudekom



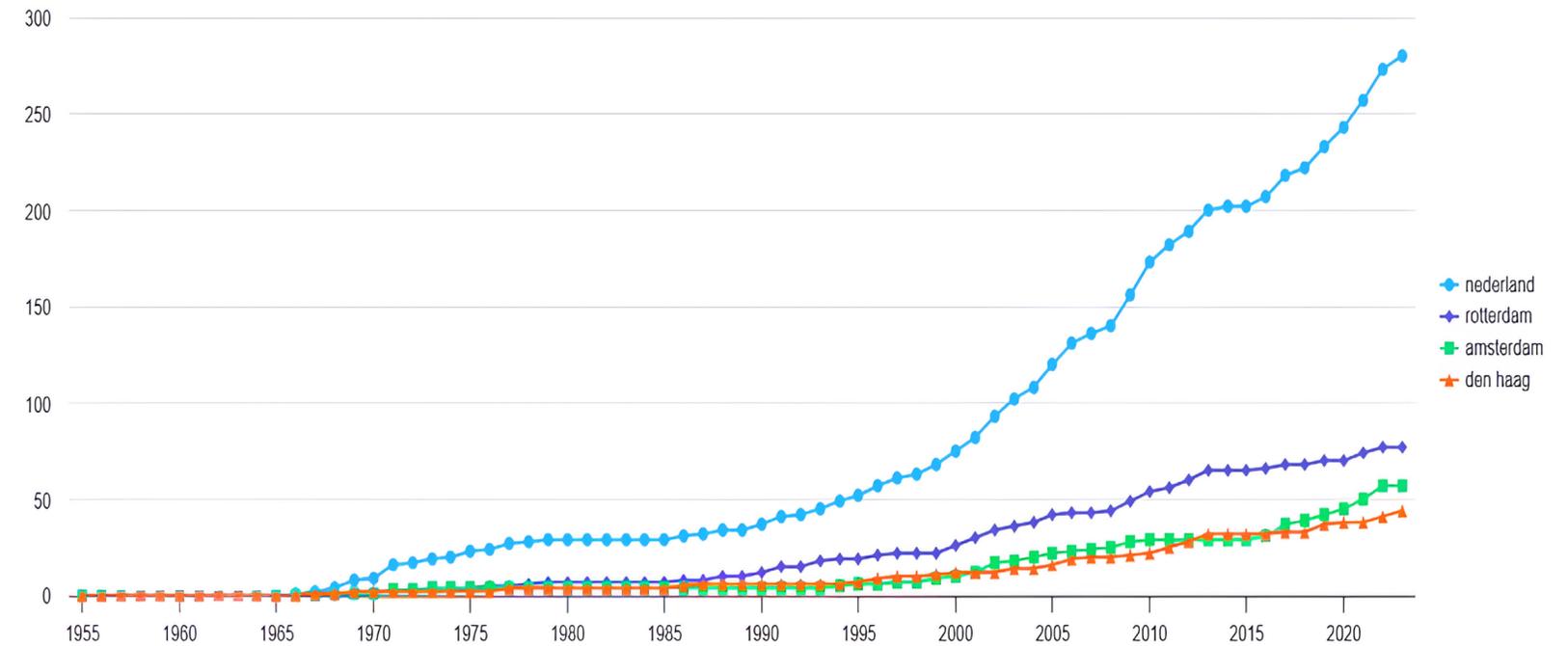


INTRODUCTION

PROBLEM STATEMENT



Household growth in the Netherlands, CBS



Increasing construction of buildings above 70 meters, hoog500.nl

INTRODUCTION

PROBLEM STATEMENT

Focus

- *Urban comfort*
- *Design freedom*
- *High-Rise*

SITE

OLD SITUATION



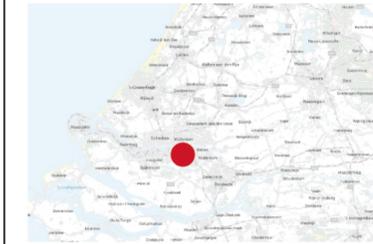
Wind Driven Design

Location: Rotterdam Rijnhaven

Date: 2024-10-24

Author: Thijs Kroft

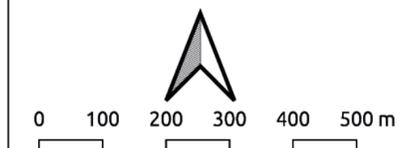
Student number: 5078644



Local Buildings

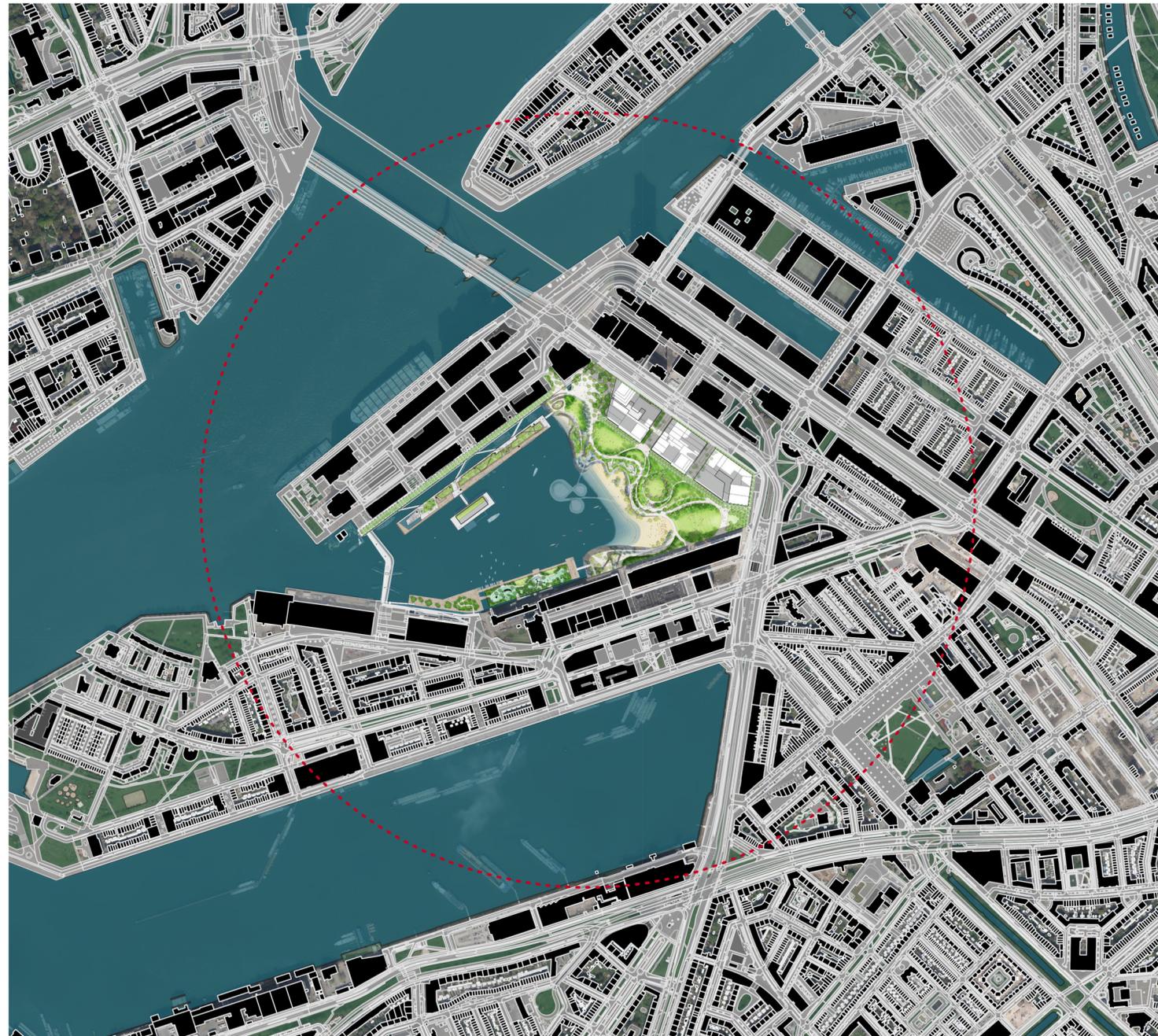
Legend

- road
 - Buildings
 - waterlots
 - Greenery
- Wind Domain
- domainBndBoundary



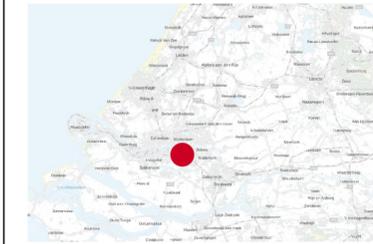
SITE

NEW SITUATION



Wind Driven Design

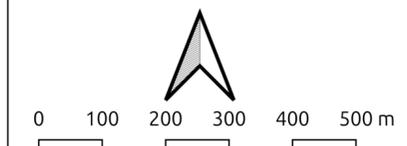
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Local Buildings

Legend

- road
 - Buildings
 - waterlots
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INTRODUCTION

OBJECTIVE

Research

How can an improved understanding of wind behaviour be integrated into high-rise design strategies to enhance pedestrian comfort and safety in Rijnhaven, Rotterdam?

Design

How does the incorporation of a wind-based design workflow impact the design process of a multifunctional highrise building in the the urban context of Rijnhaven, Rotterdam?

THEORETICAL BACKGROUND

WIND COMFORT

Exceedance Probability	Quality requirements	Activities		
<i>Exceedance of 5 m/s as a percentage of hours per year</i>	class	I. Walking	II. Strolling	III. Sitting for extended periods
≤ 2.5%	A	Good	Good	Good
2.5 – 5%	B	Good	Good	Moderate
5 – 10%	C	Good	Moderate	Poor
10 – 20%	D	Moderate	Poor	Poor
≥ 20%	E	Poor	Poor	Poor

Table 1: Requirements for assessing the local wind climate for wind nuisance. Based on the NEN8100

Exceedance Probability	Qualification
<i>$p(v_{LOK} \dot{\text{e}} v_{DR,G})$ as a percentage of hours per year</i>	
$0.05 < p < 0.30$	Limited Risk
$p \geq 0.30$	Dangerous

Table 2: Requirements for assessing the local wind climate for wind danger. Based on the NEN8100

THEORETICAL BACKGROUND

GOVERNING EQUATIONS

Continuity Equation

$$\nabla \cdot \mathbf{u} = 0 \quad (1)$$

Where:

- ∇ : Nabla operator, representing the gradient vector field.
- \mathbf{u} : Flow velocity vector field.

Momentum Equation

$$\rho \frac{D\mathbf{u}}{Dt} = -\nabla p + \mu \nabla^2 \mathbf{u} + \sum \mathbf{F} \quad (2)$$

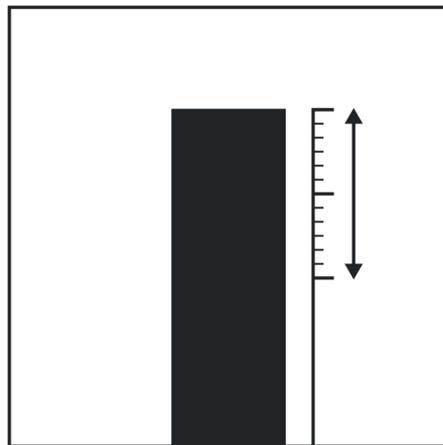
Where:

- ρ : Density of the fluid.
- $\frac{D}{Dt}$: Material derivative, accounting for both local and convective changes.
- p : Pressure within the fluid.
- μ : Dynamic viscosity of the fluid.
- ∇^2 : Laplacian operator, representing the diffusion of velocity.
- $\sum \mathbf{F}$: Sum of external forces acting on the fluid.

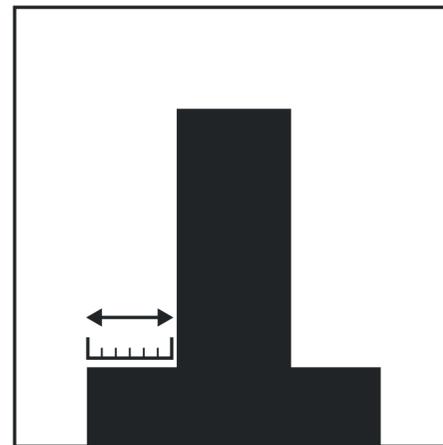
THEORETICAL BACKGROUND

DESIGN STRATEGIES

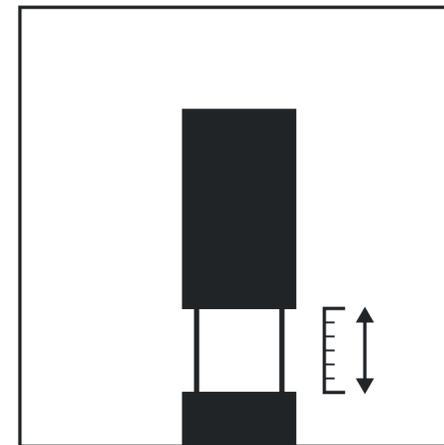
building height



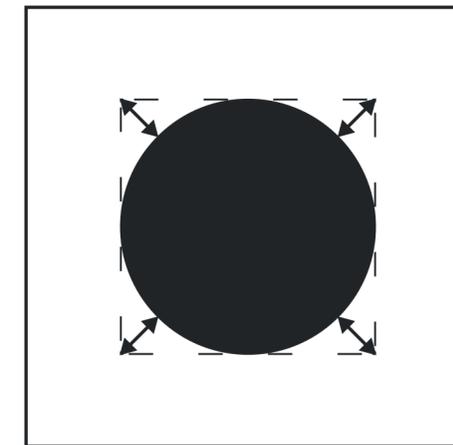
podium



open floor

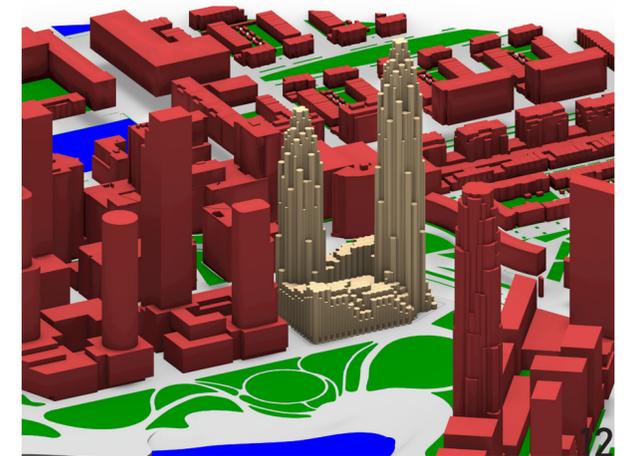
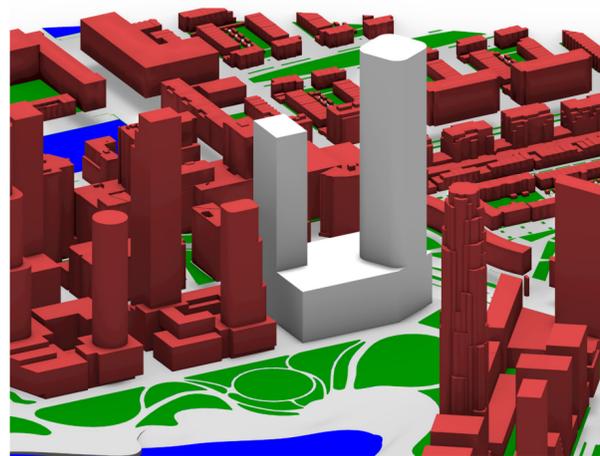
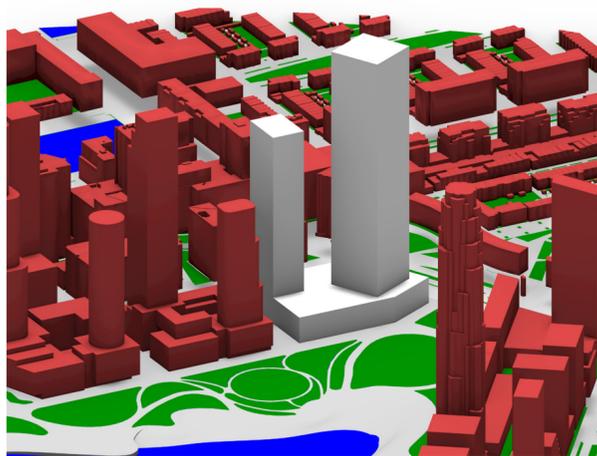
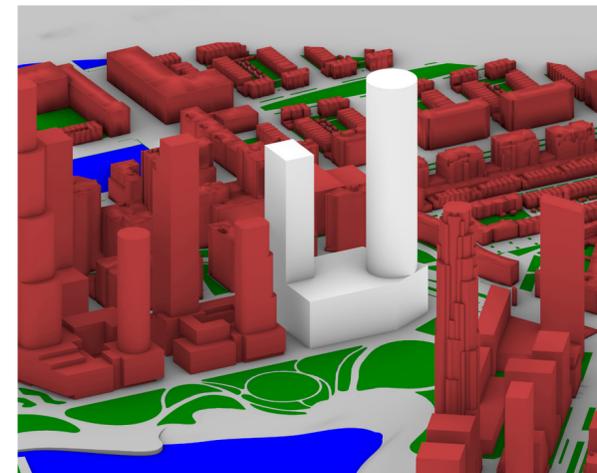
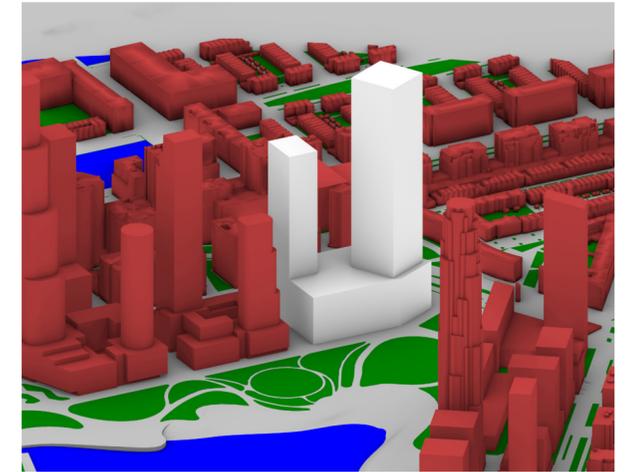
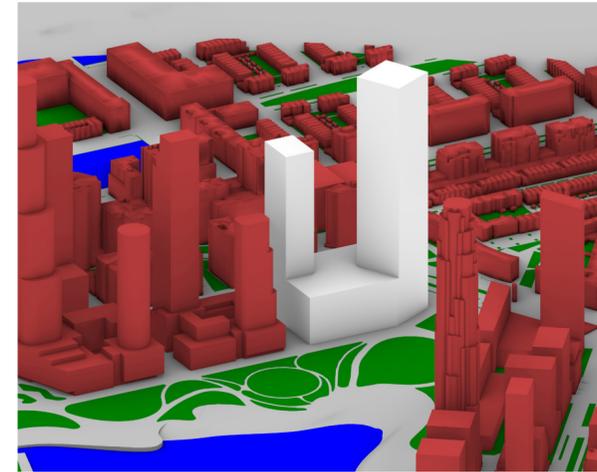
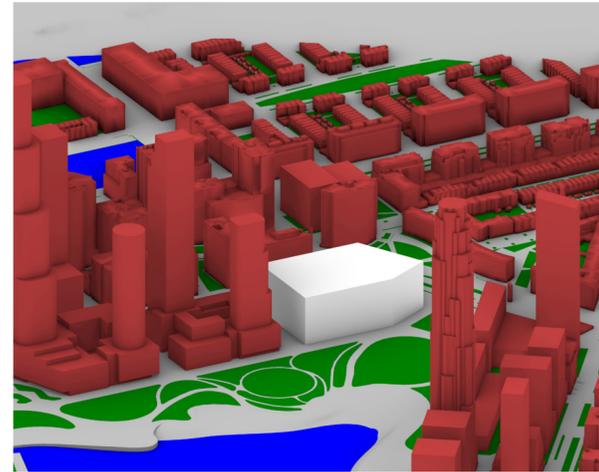
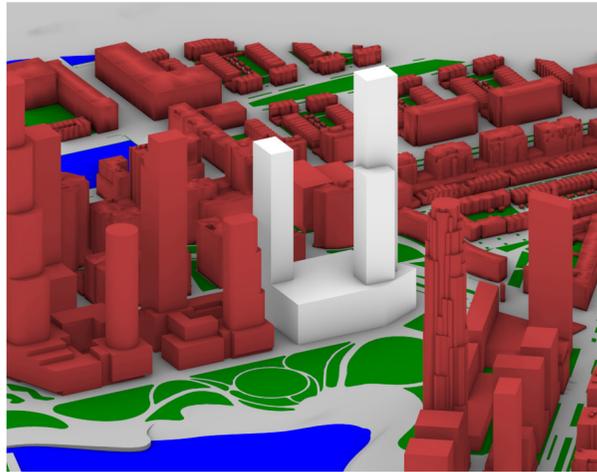


aerodynamic shape



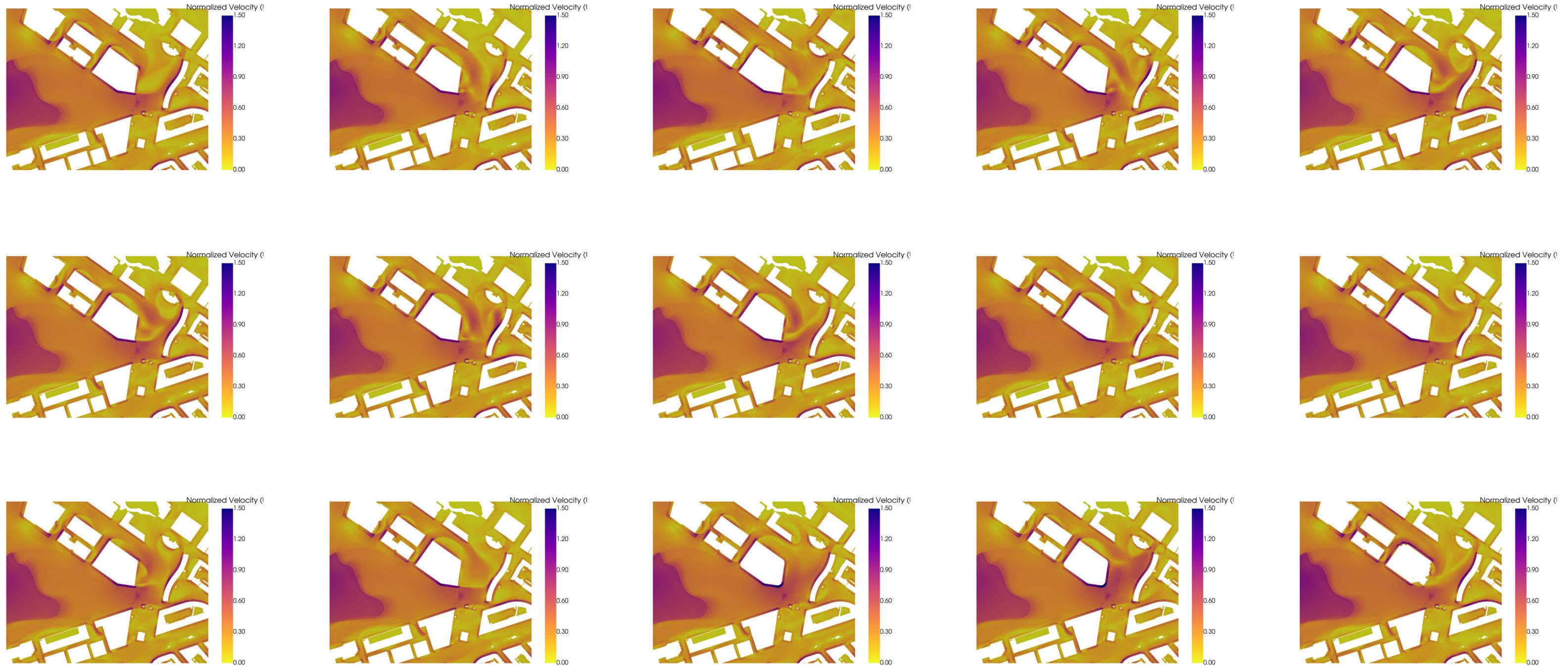
WORKFLOW DEVELOPMENT

MASSES



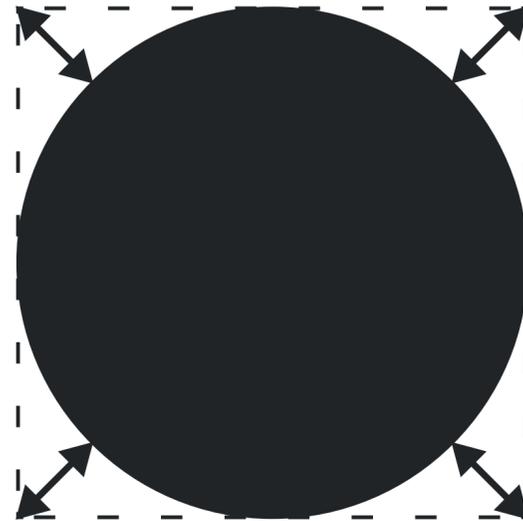
WORKFLOW DEVELOPMENT

RESULTS



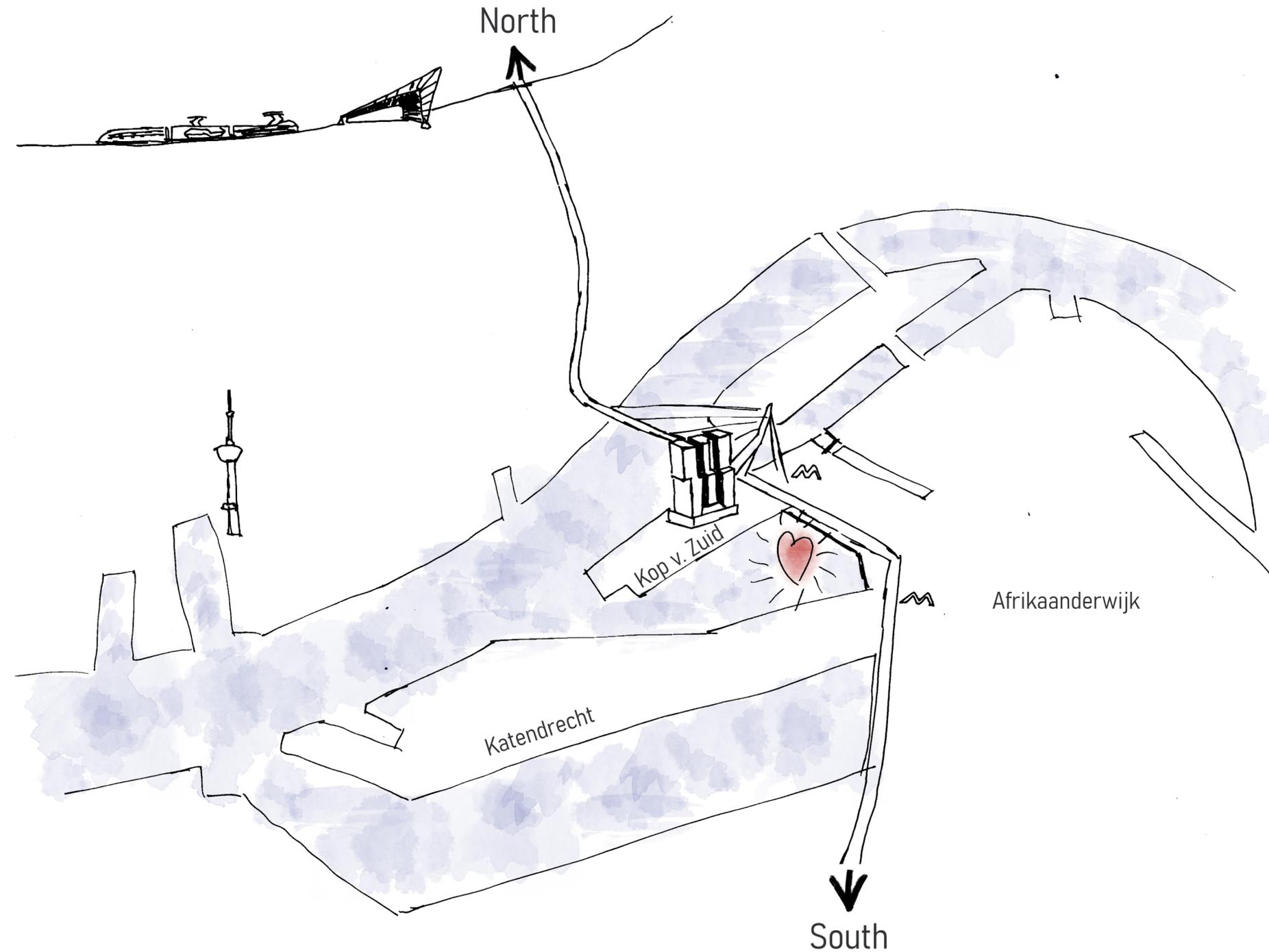
WORKFLOW DEVELOPMENT

CONCLUSIONS



SITE

PLACE IN THE CITY



SITE CHARACTERISTICS



SITE

NEW DEVELOPMENTS



SITE

NEW DEVELOPMENTS



SITE

NEW DEVELOPMENTS



SITE

NEW DEVELOPMENTS



SITE
SUMMARY

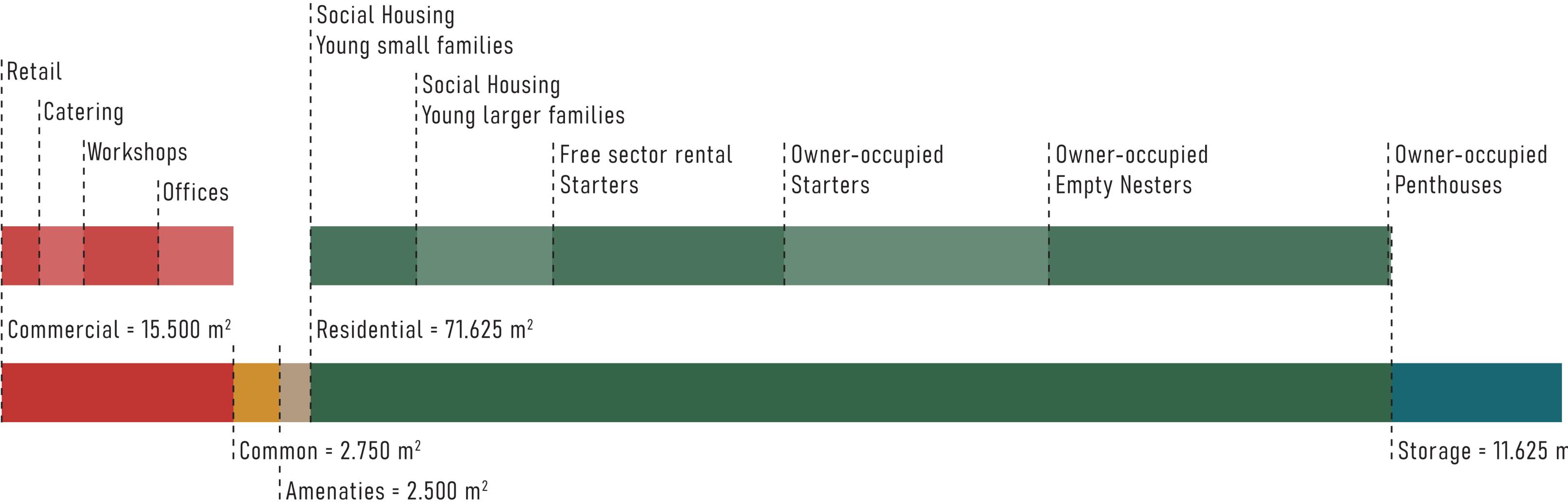
ROUGH, TOUGH, BOLD

SITE
SUMMARY

Kindness

MASTERPLAN

TOTAL = 101.501 m²



DESIGN GOALS

urban community



comfortable space

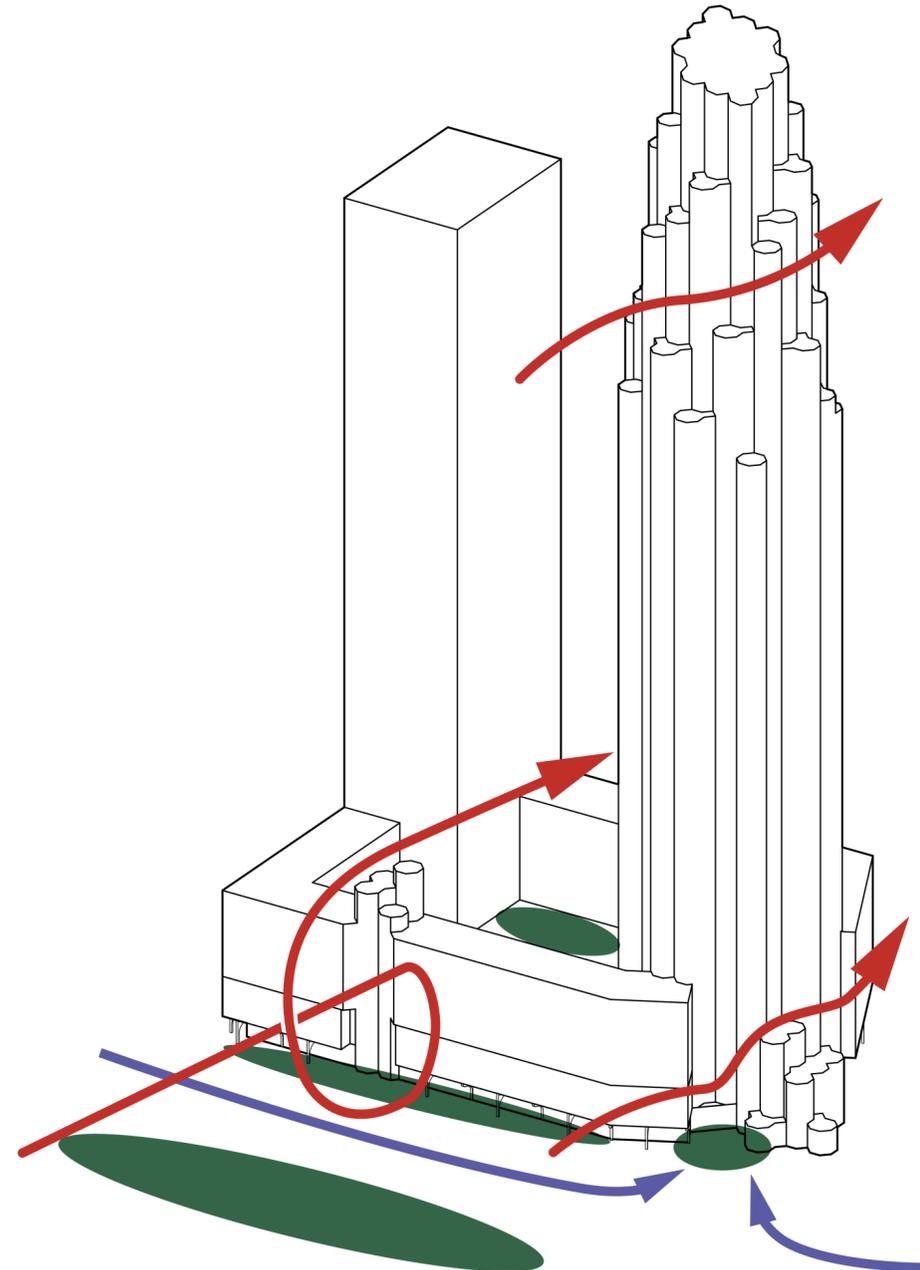


human scale



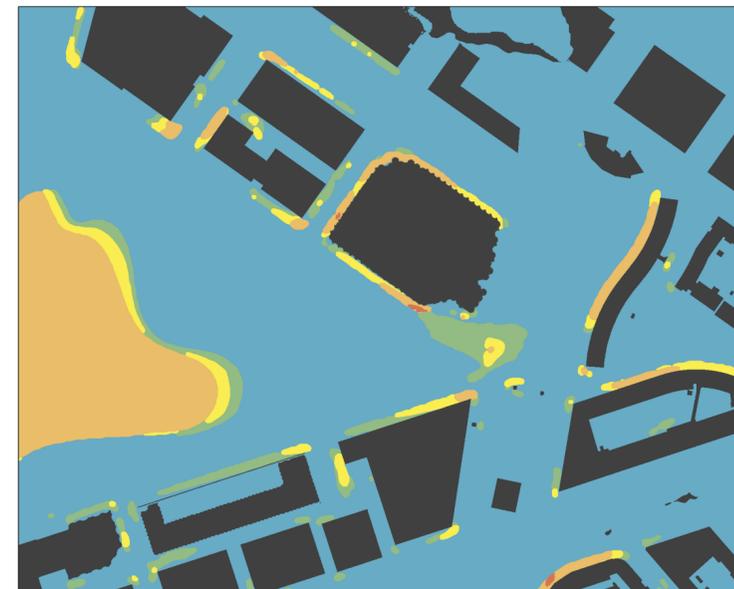
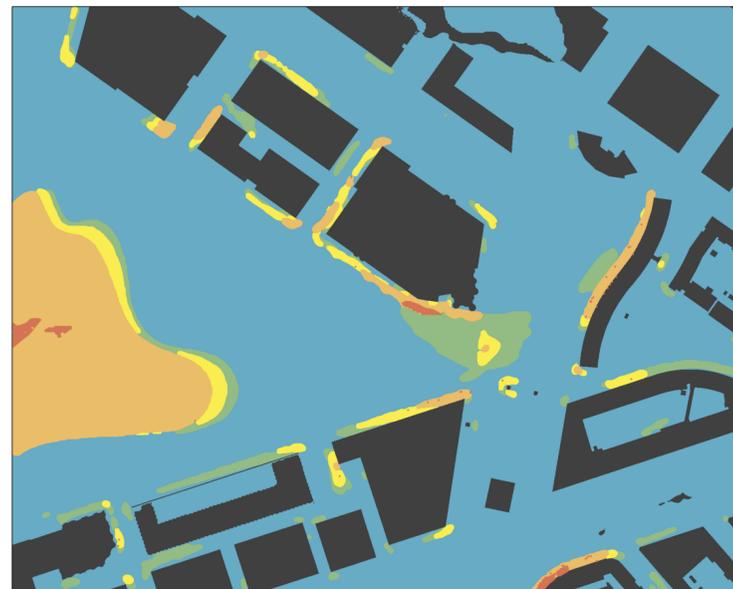
MASSING

WIND BEHAVIOUR



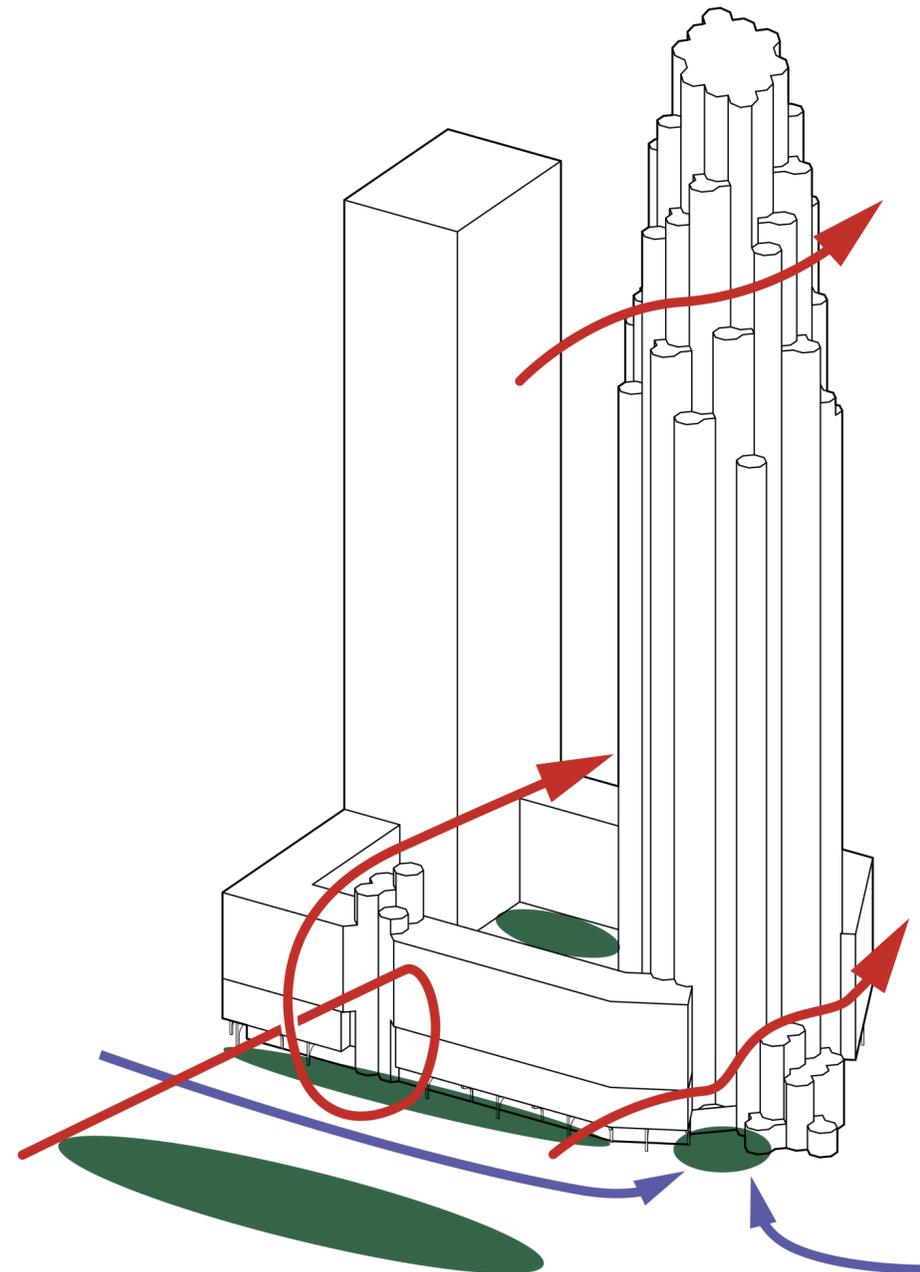
MASSING

RESULTS NEN Check



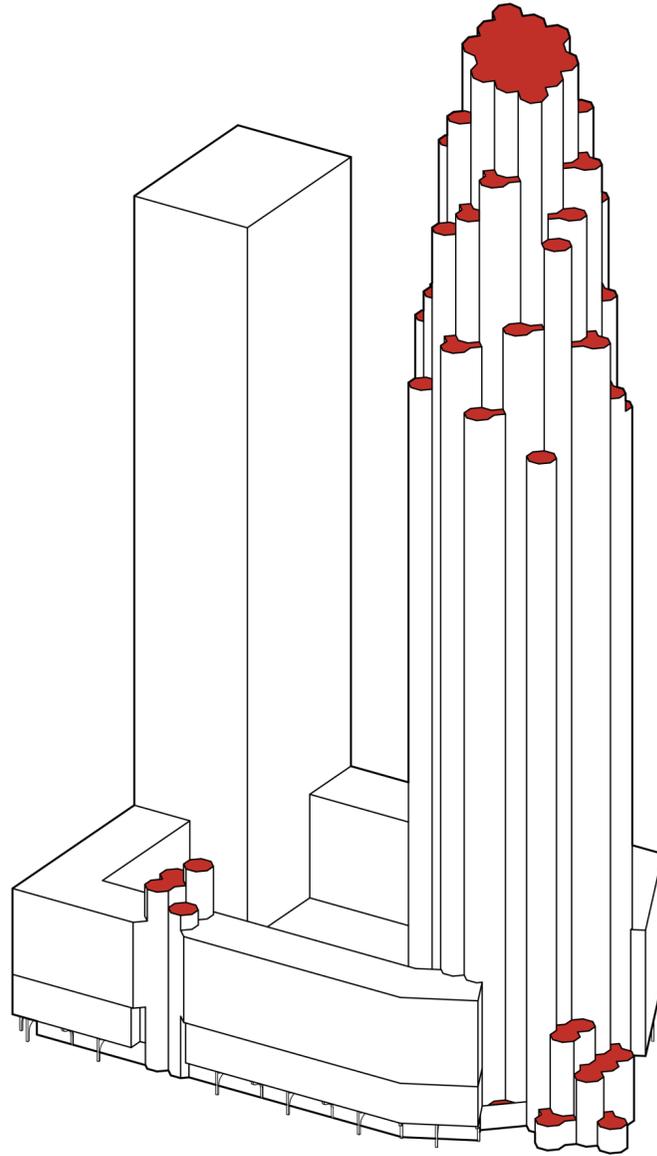
MASSING

WIND BEHAVIOUR



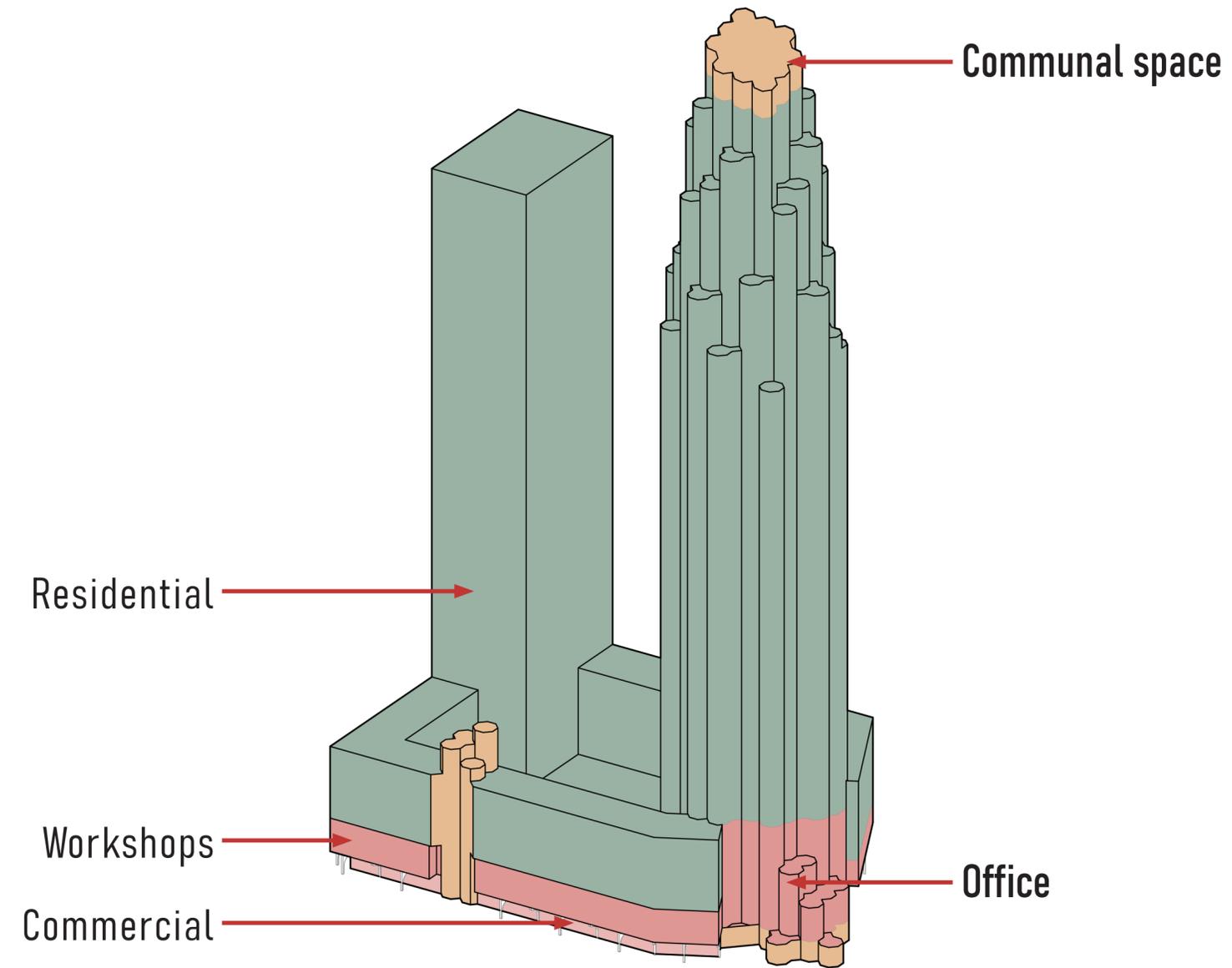
MASSING

SEGMENTATION



MASSING

PROGRAM DISTRIBUTION



ELEVATIONS

NORTHWEST

SOUTHEAST

NORTHEAST

SOUTHWEST



30m

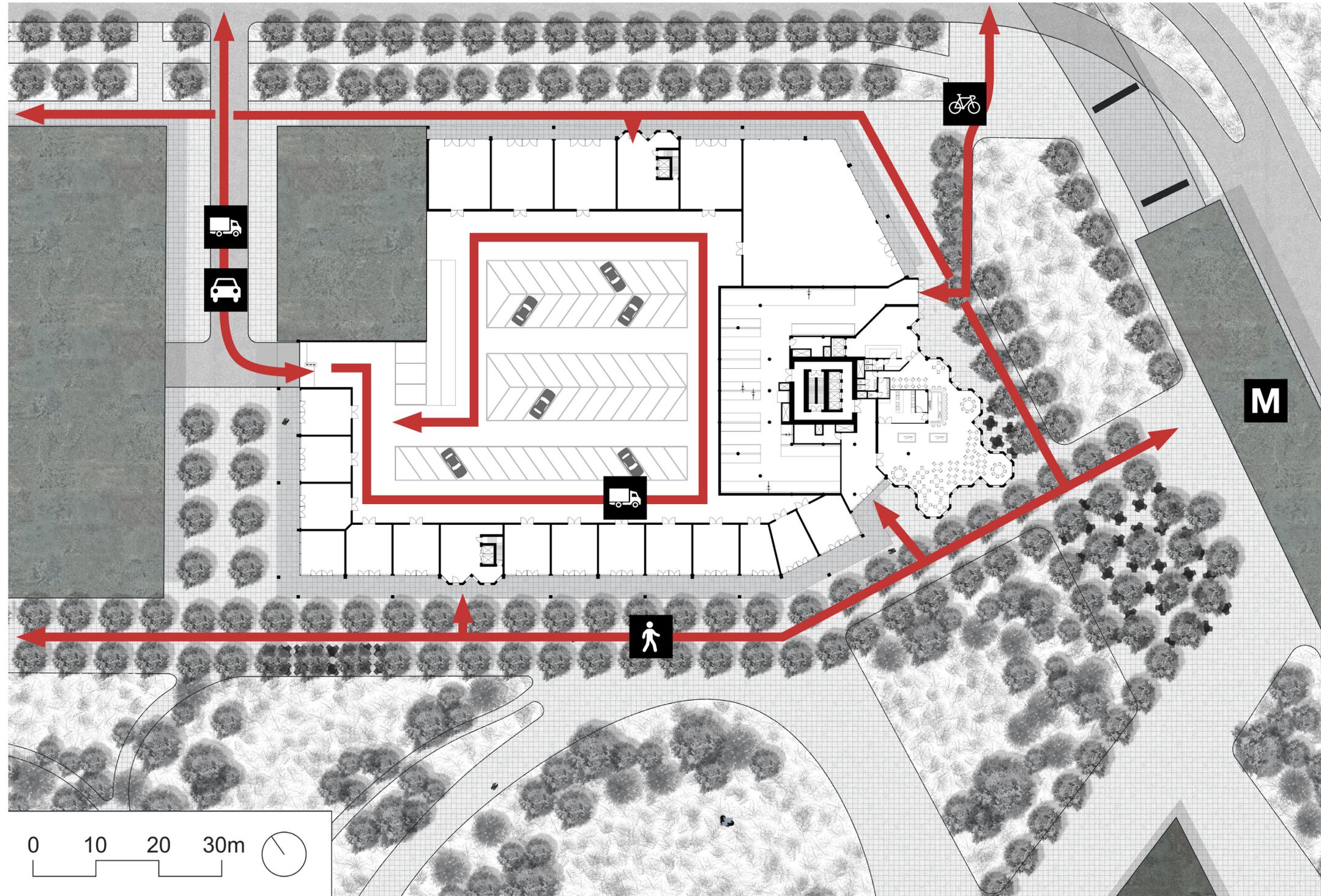


PLINTH

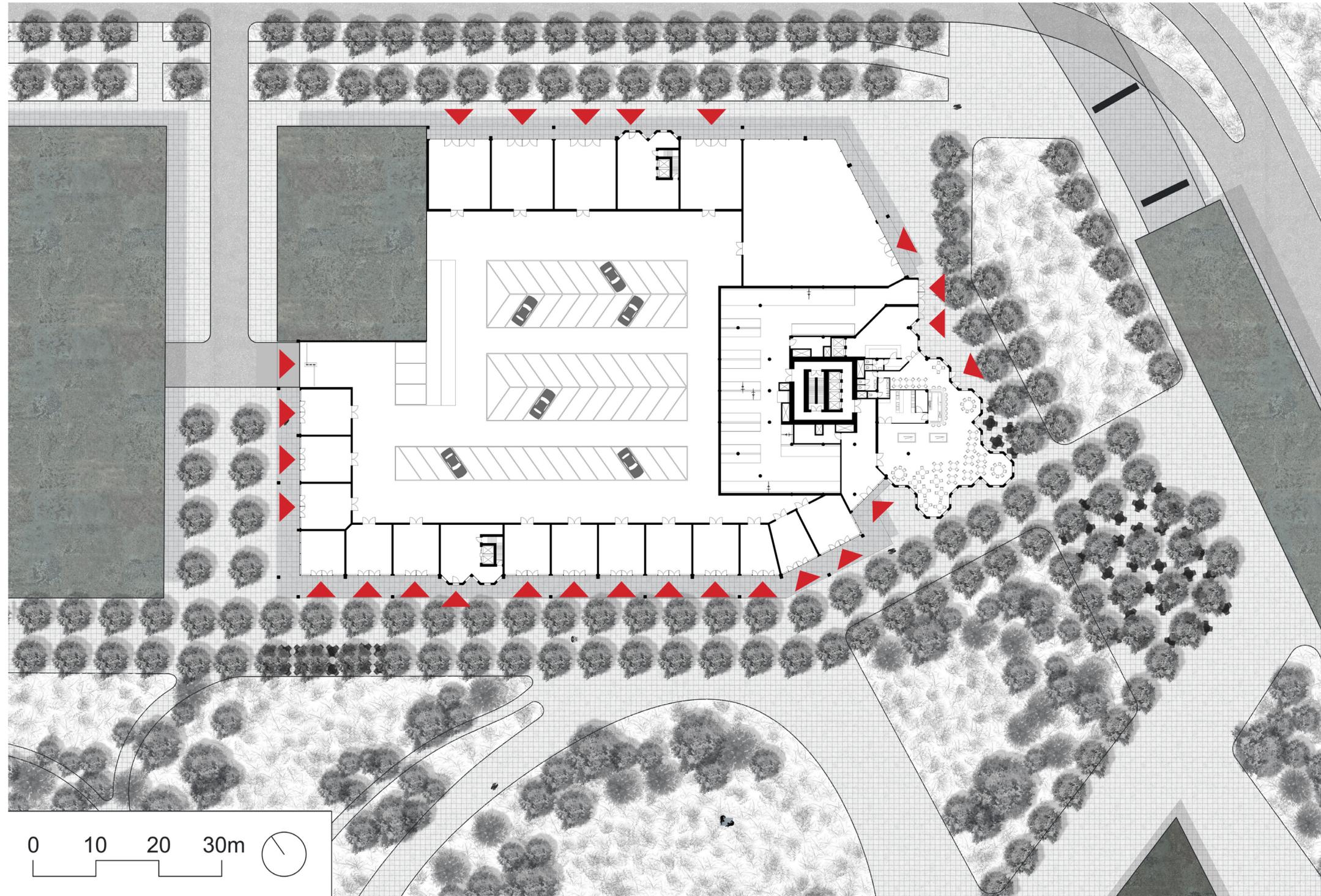
ACCESSIBILITY



PLINTH ACCESSIBILITY



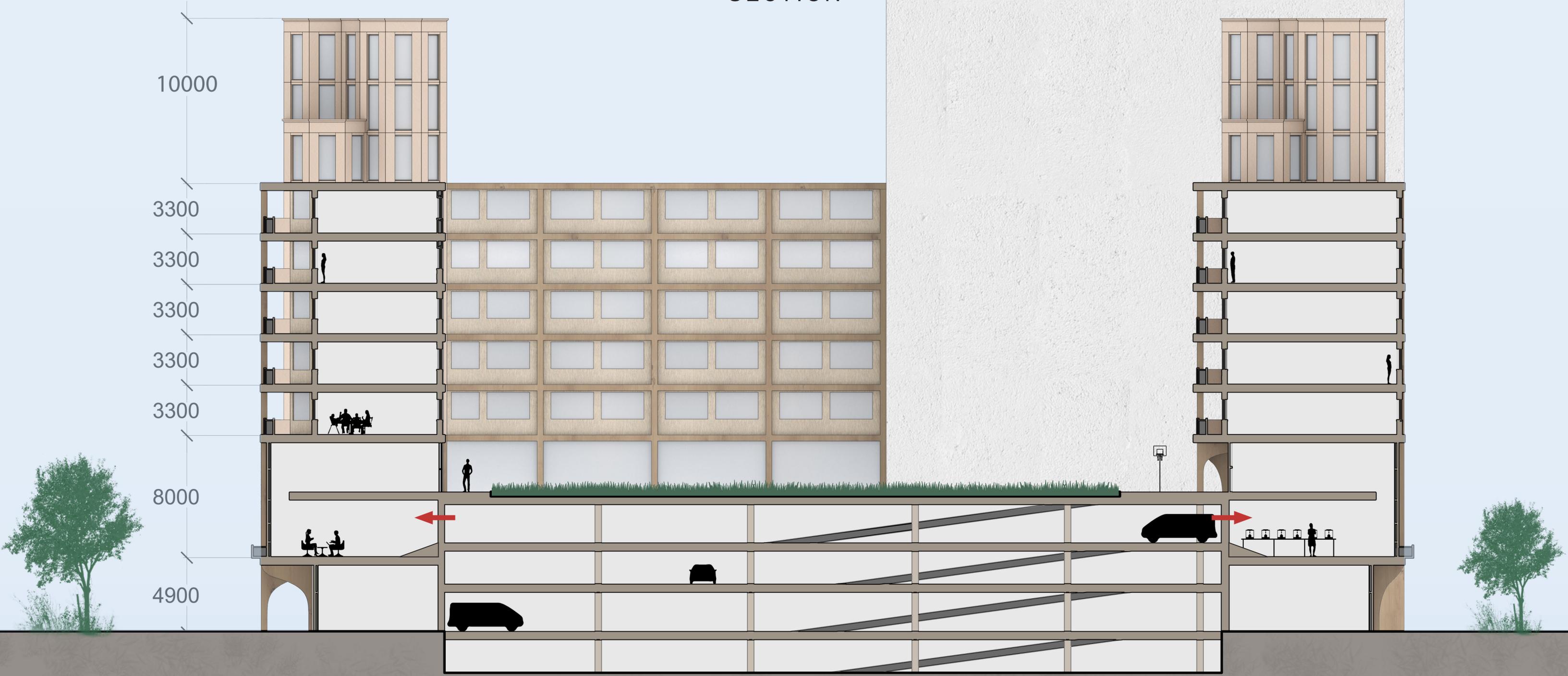
PLINTH ACCESSIBILITY





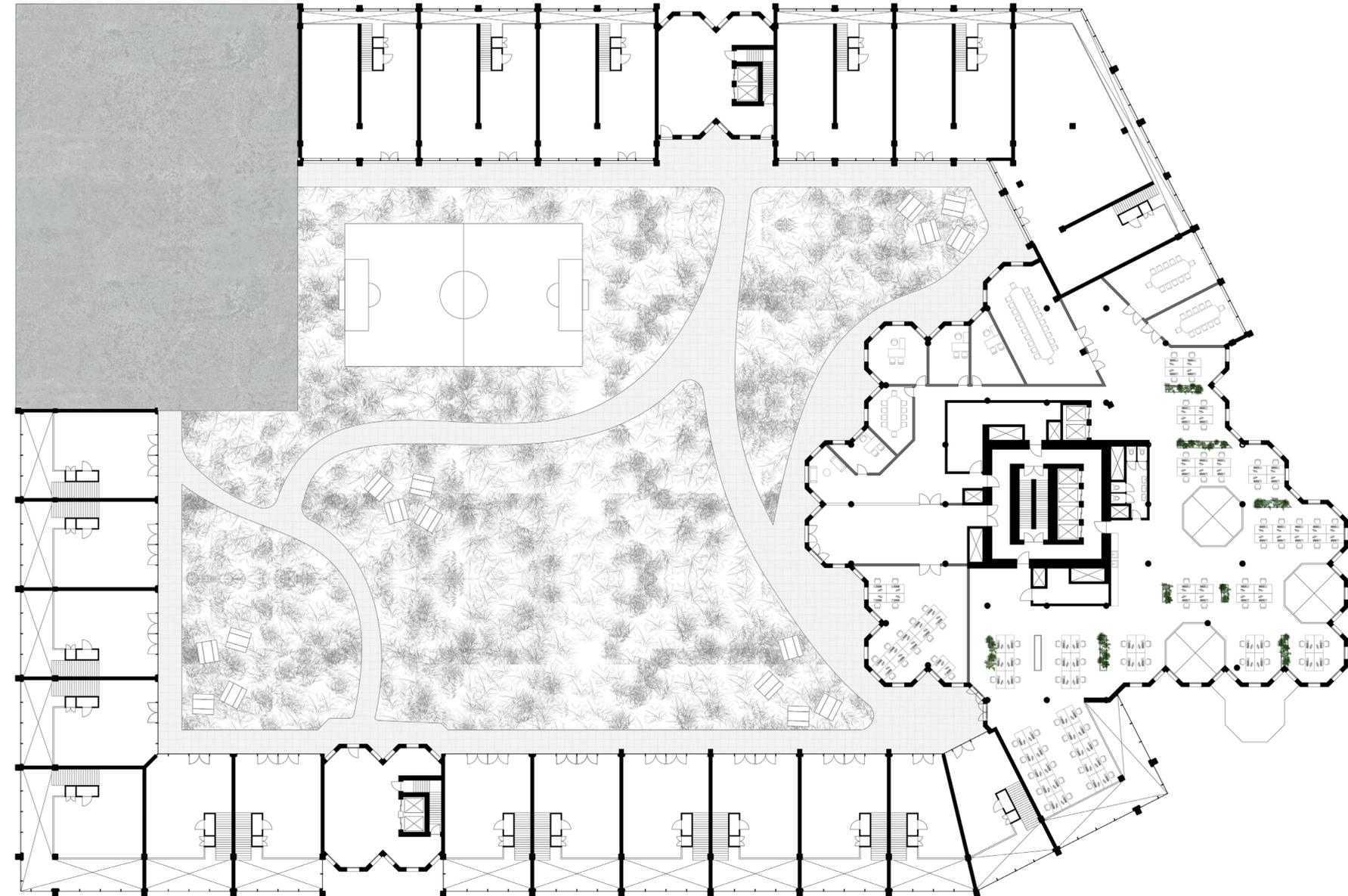
ROTTERDAMSE LAAG

SECTION



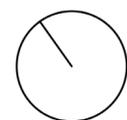
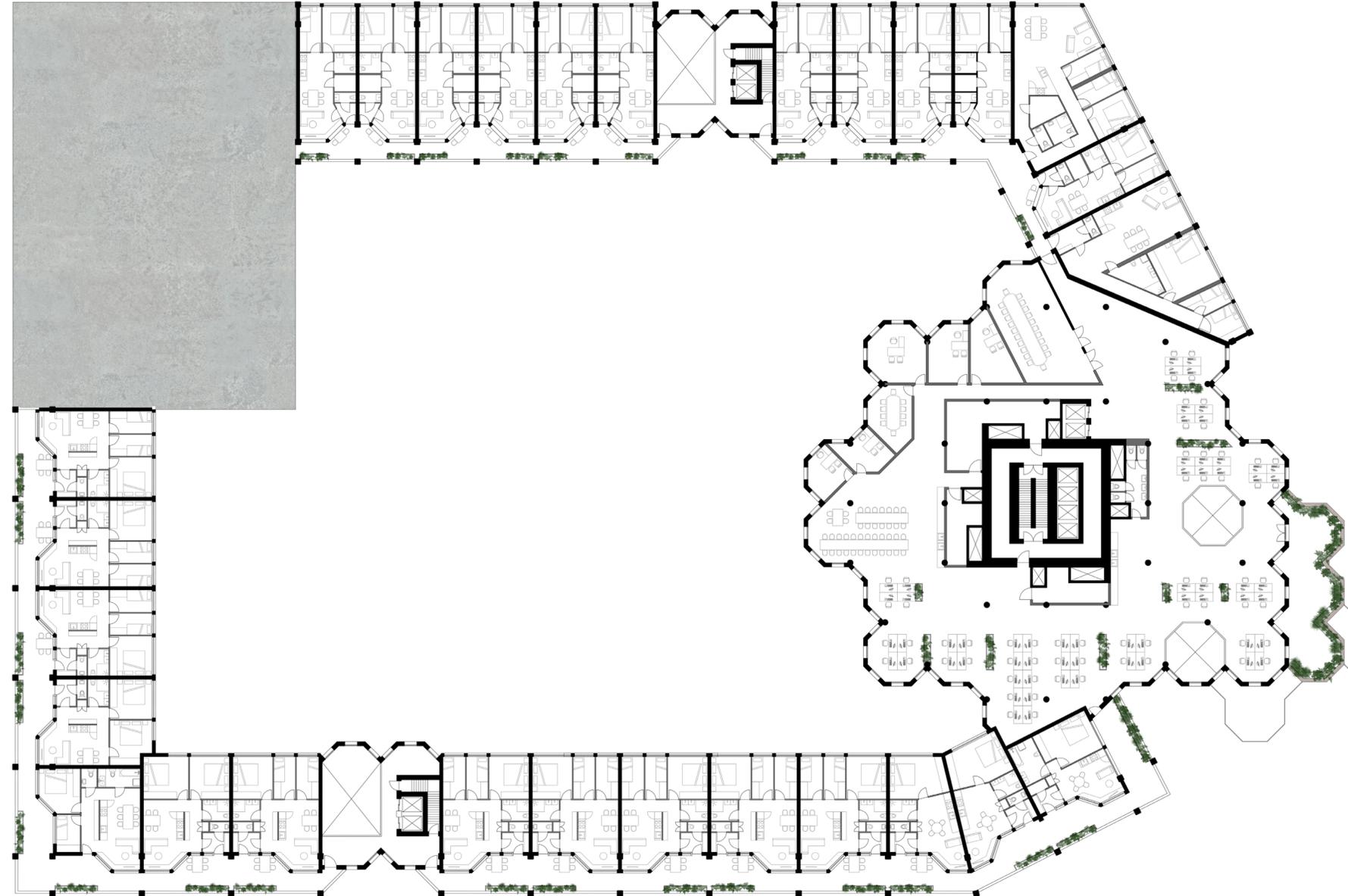
ROTTERDAMSE LAAG

FLOORPLAN 2ND FLOOR



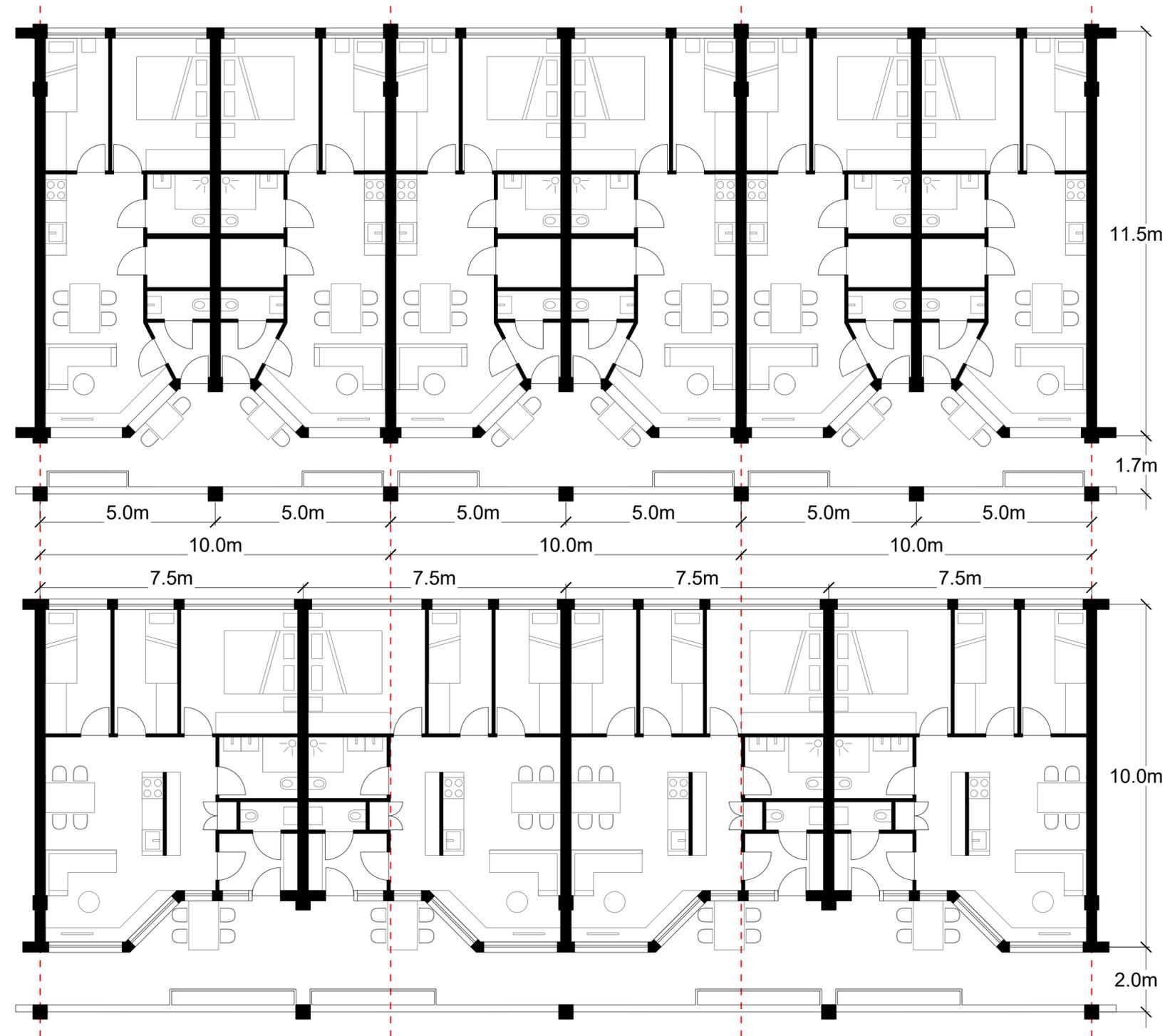
ROTTERDAMSE LAAG

FLOORPLAN 4th FLOOR



ROTTERDAMSE LAAG

RESIDENTIAL CONCEPT

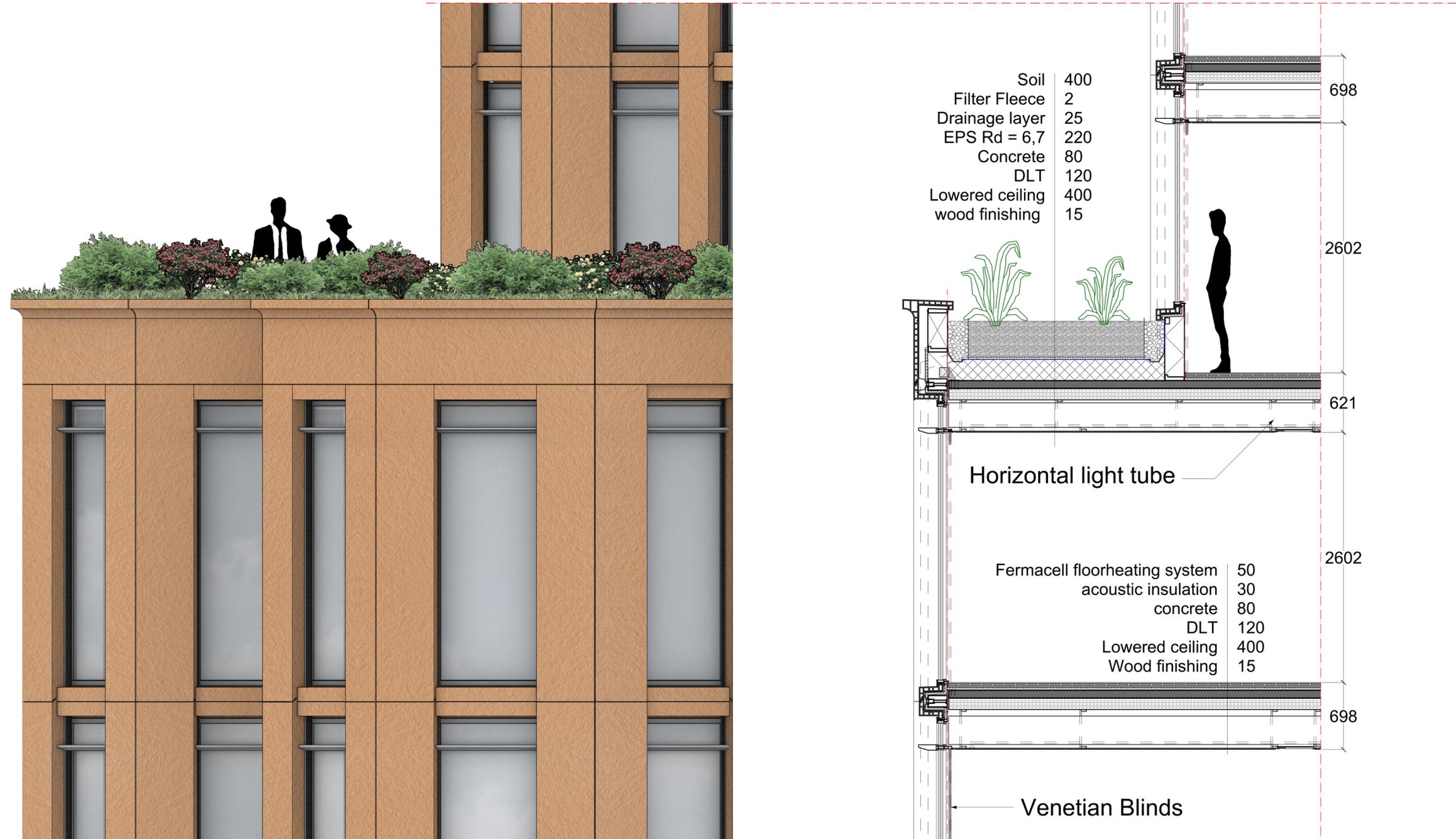


Type E
56m²
2x bedroom
Social housing
young families

Type F
69m²
3x bedroom
Social housing
families

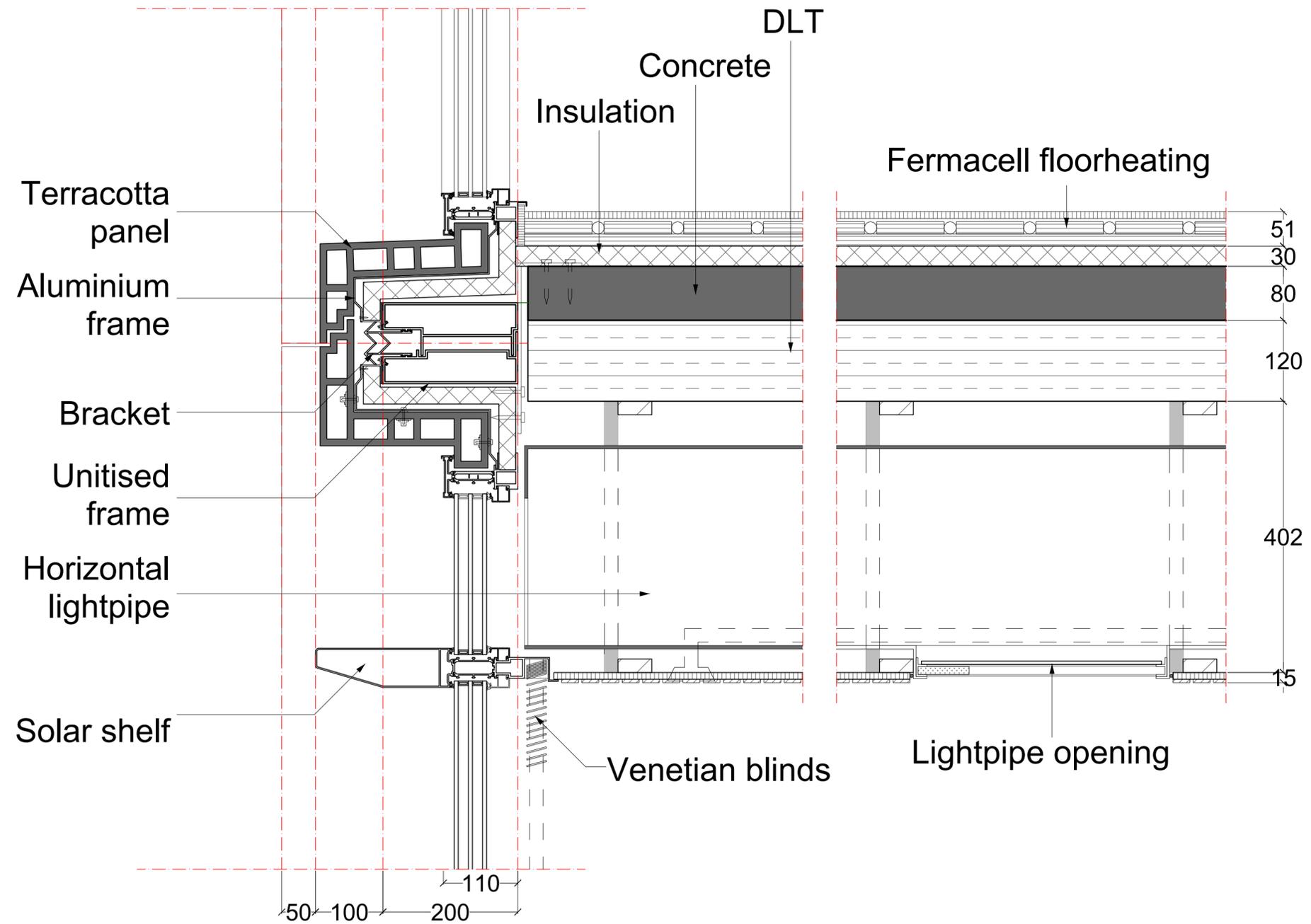
NAVIER

OFFICE FACADE



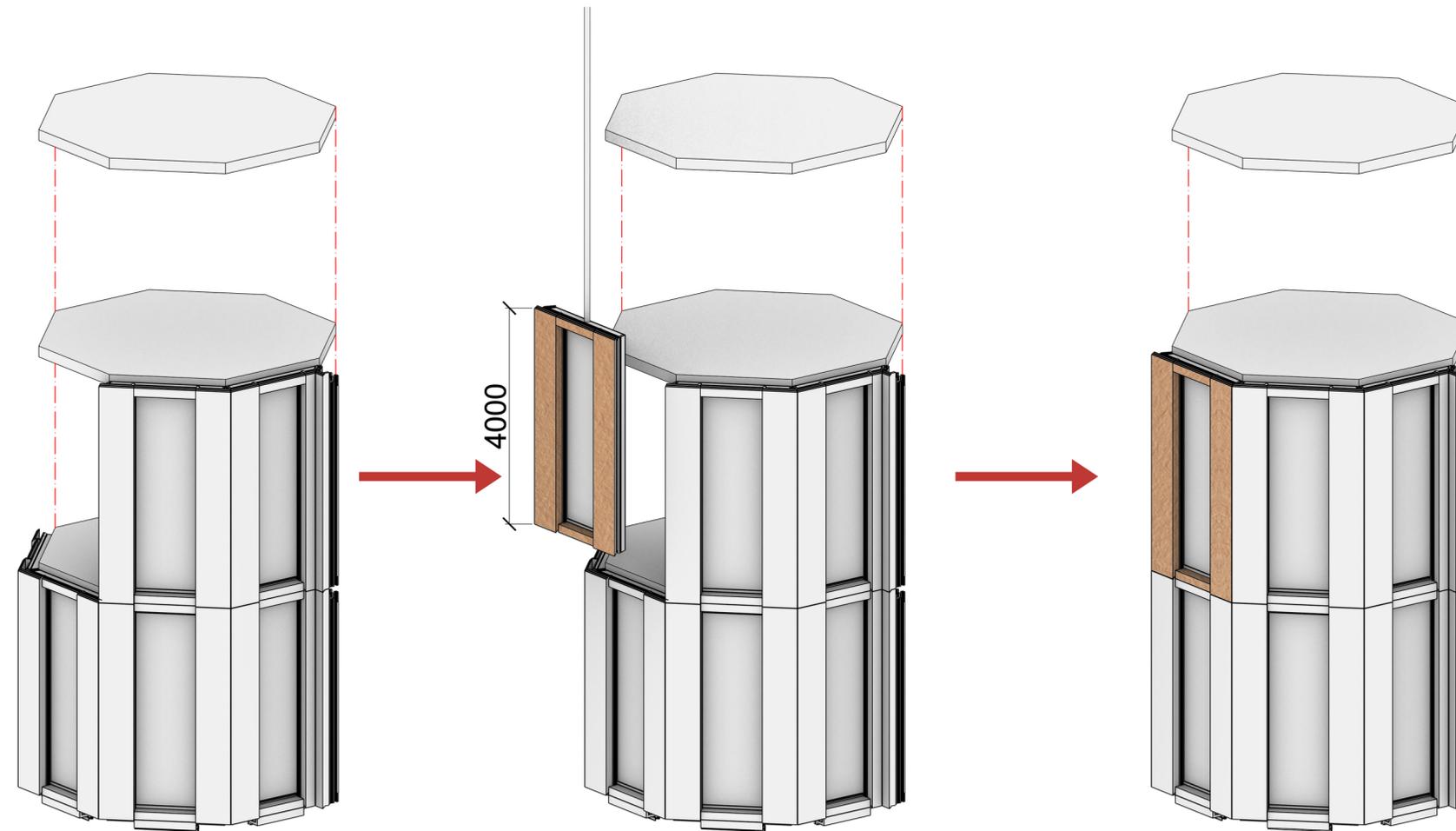
NAVIER

FLOOR DETAIL



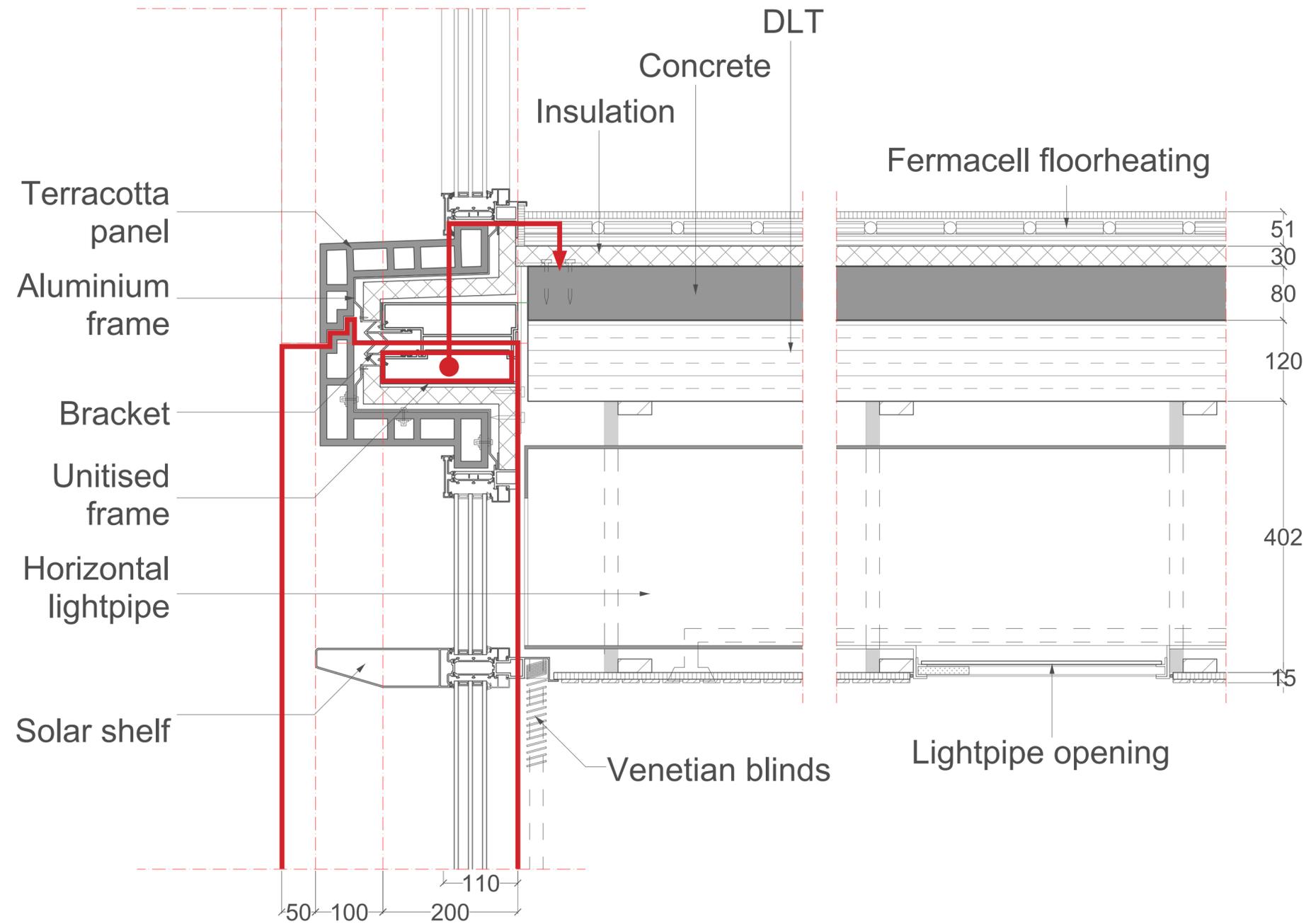
NAVIER

Facade assembly

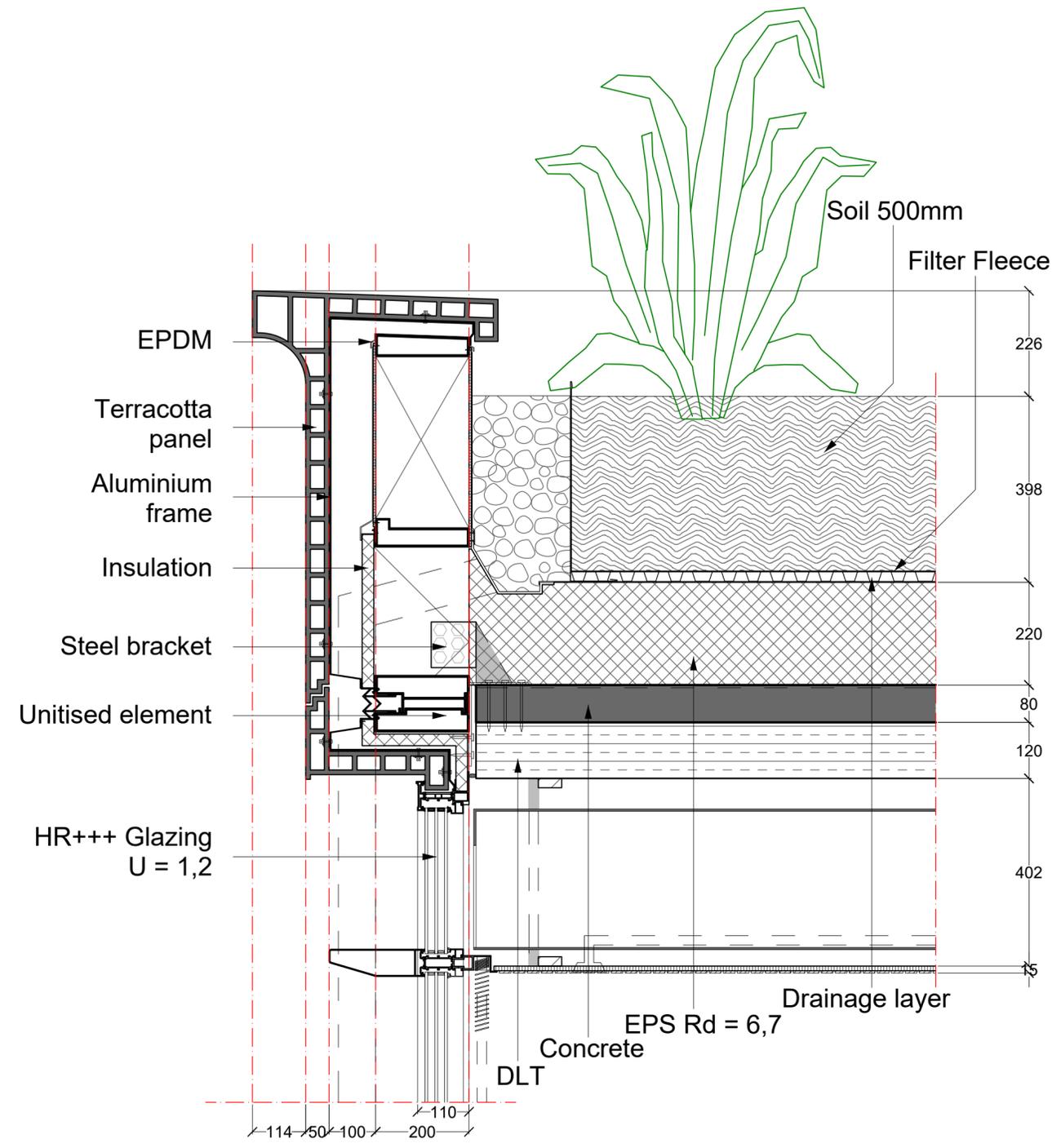


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FLOOR DETAIL

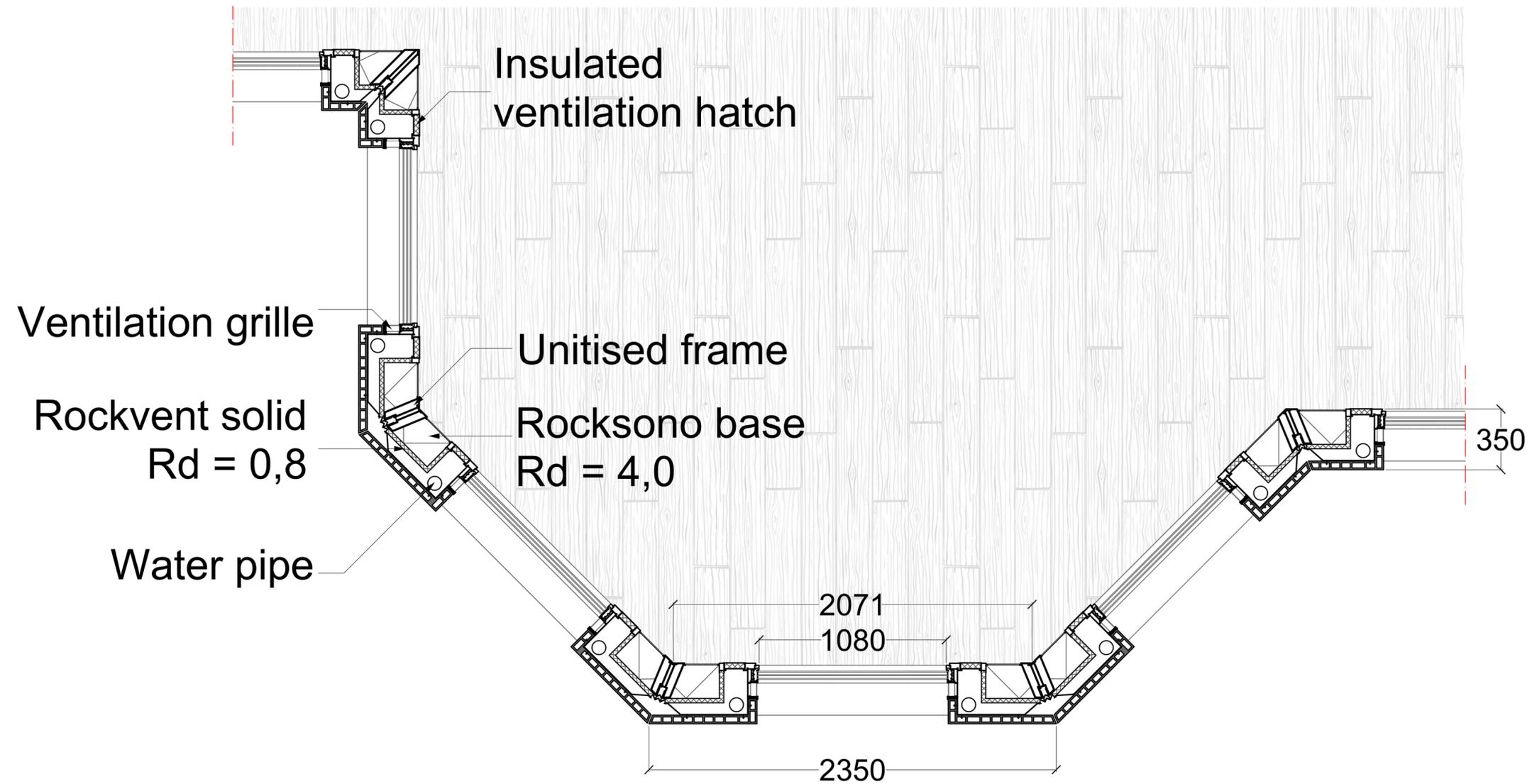


NAVIER ROOFEDGE



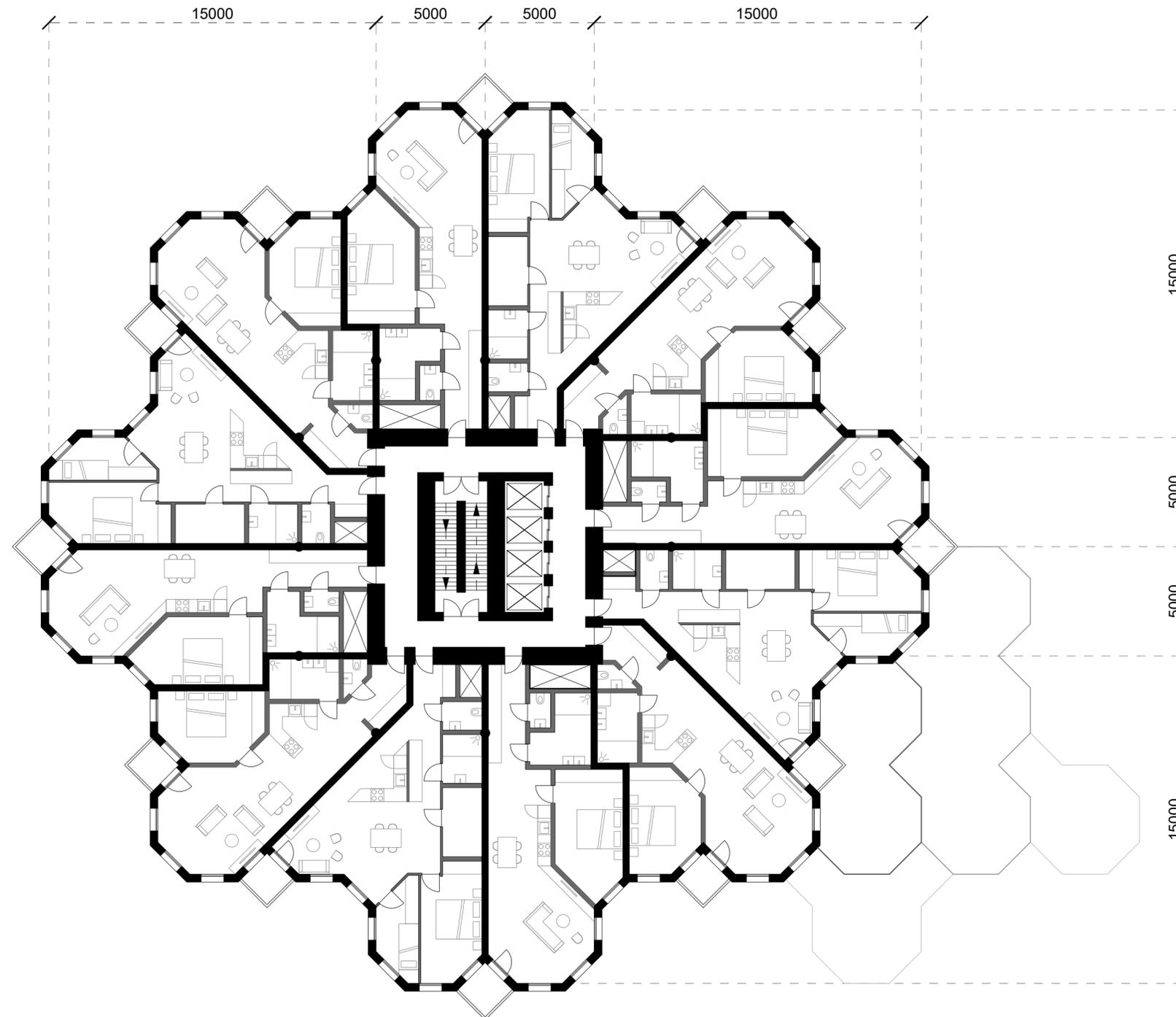
NAVIER

HORIZONTALDETAIL



NAVIER

TYICAL FLOORLAN





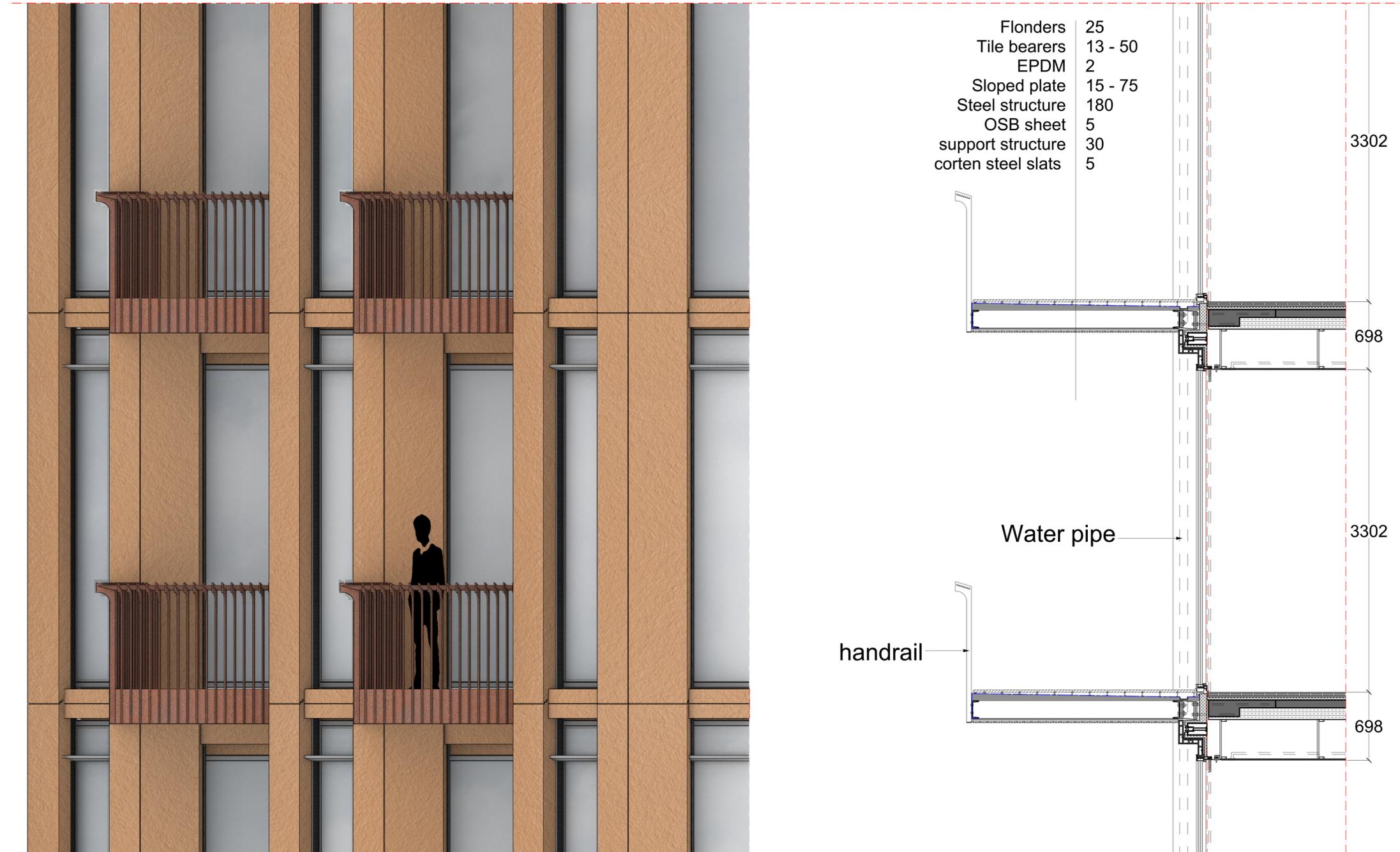
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Sunlight in apartments

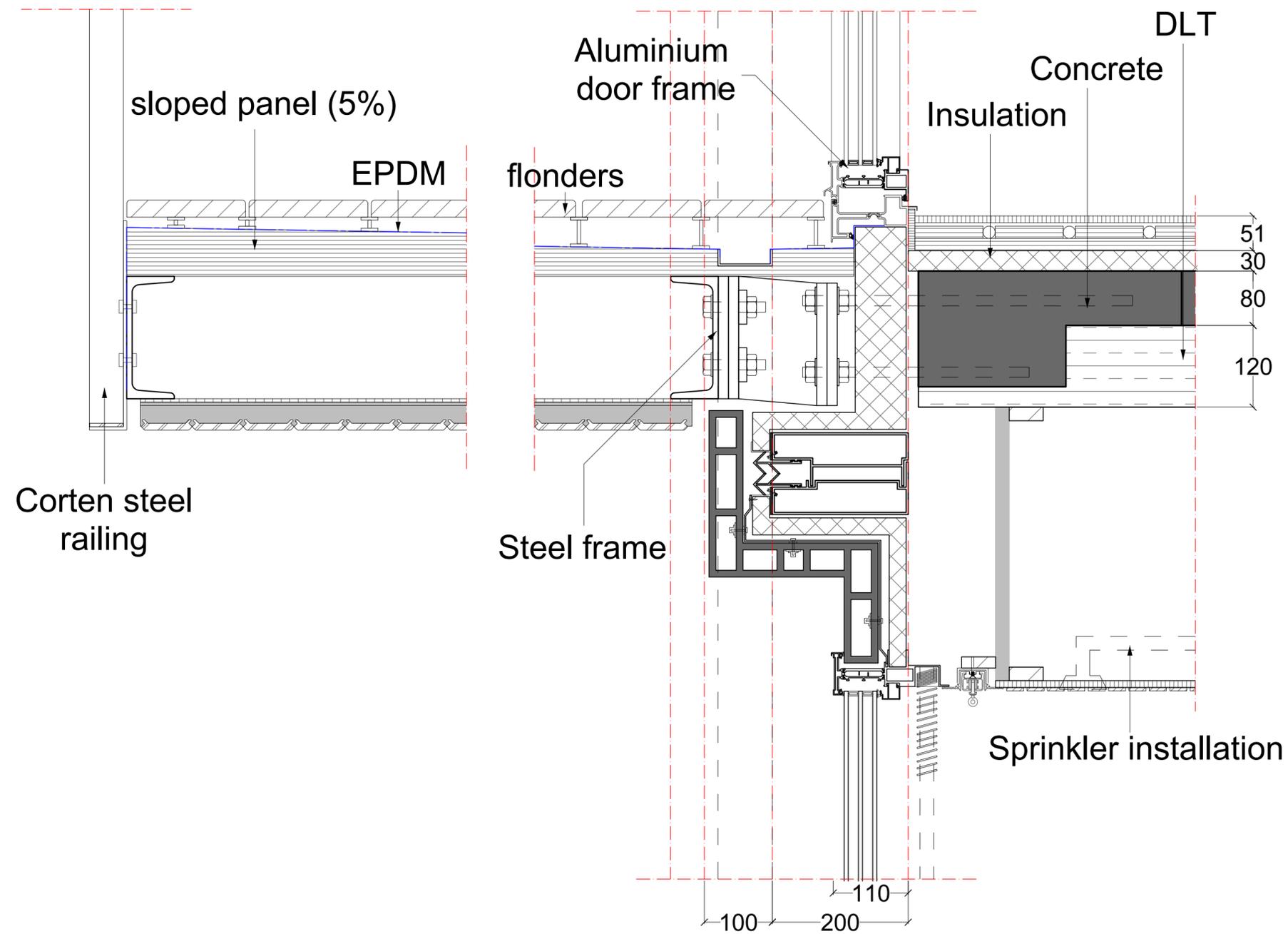


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RESIDENTIAL FACADE

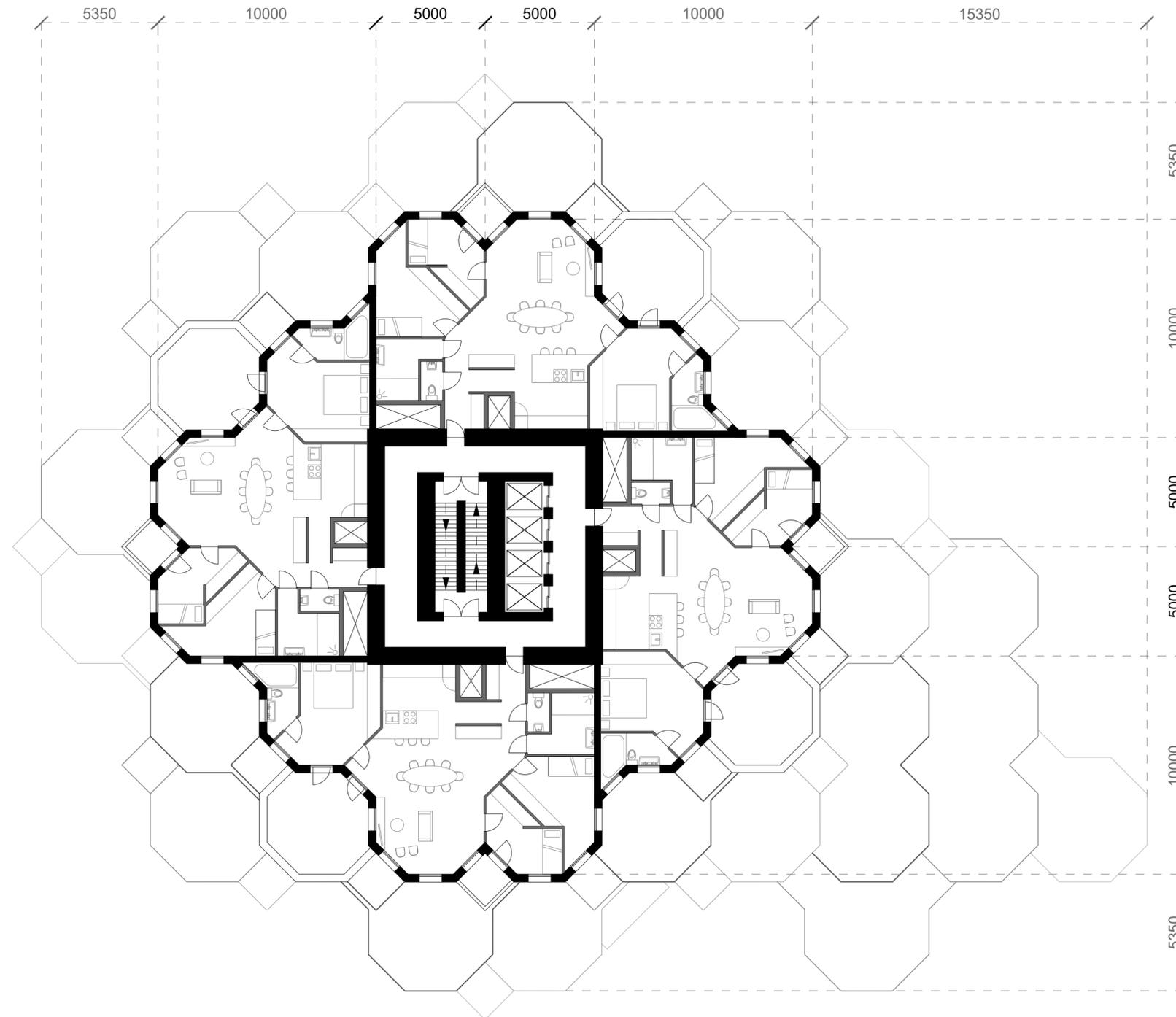


NAVIER BALCONY



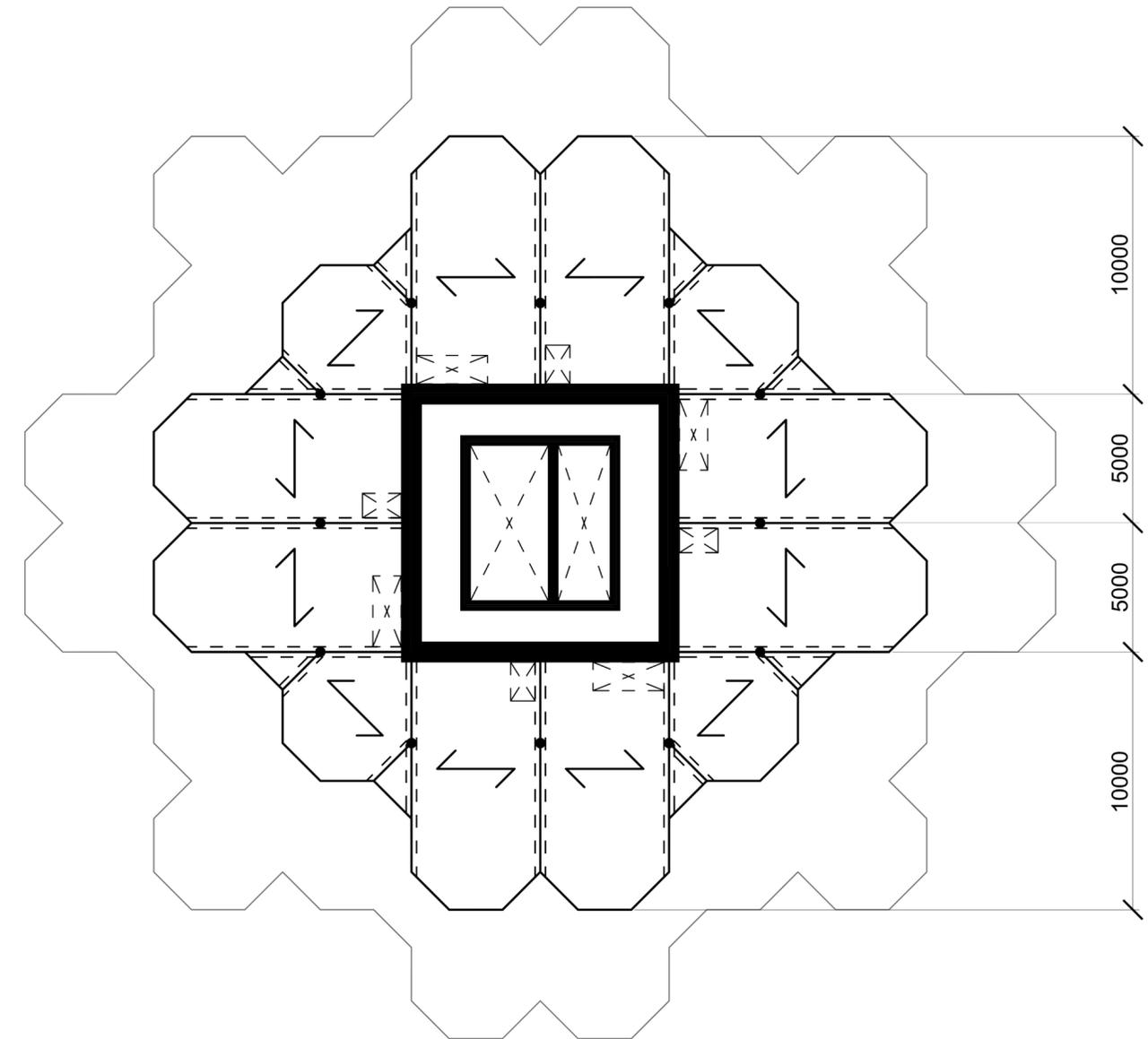
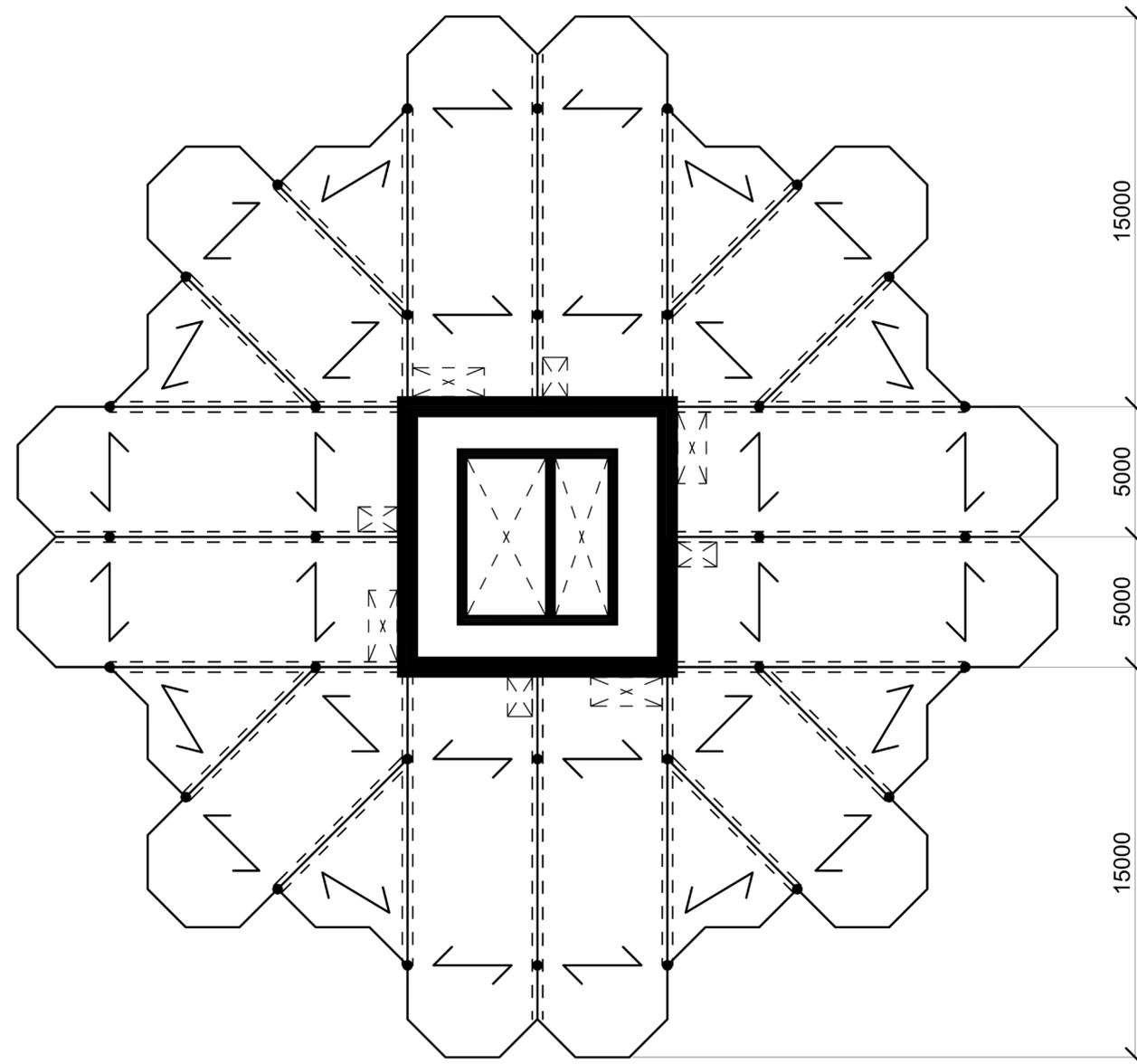
NAVIER

FLOORLAN 40th floor



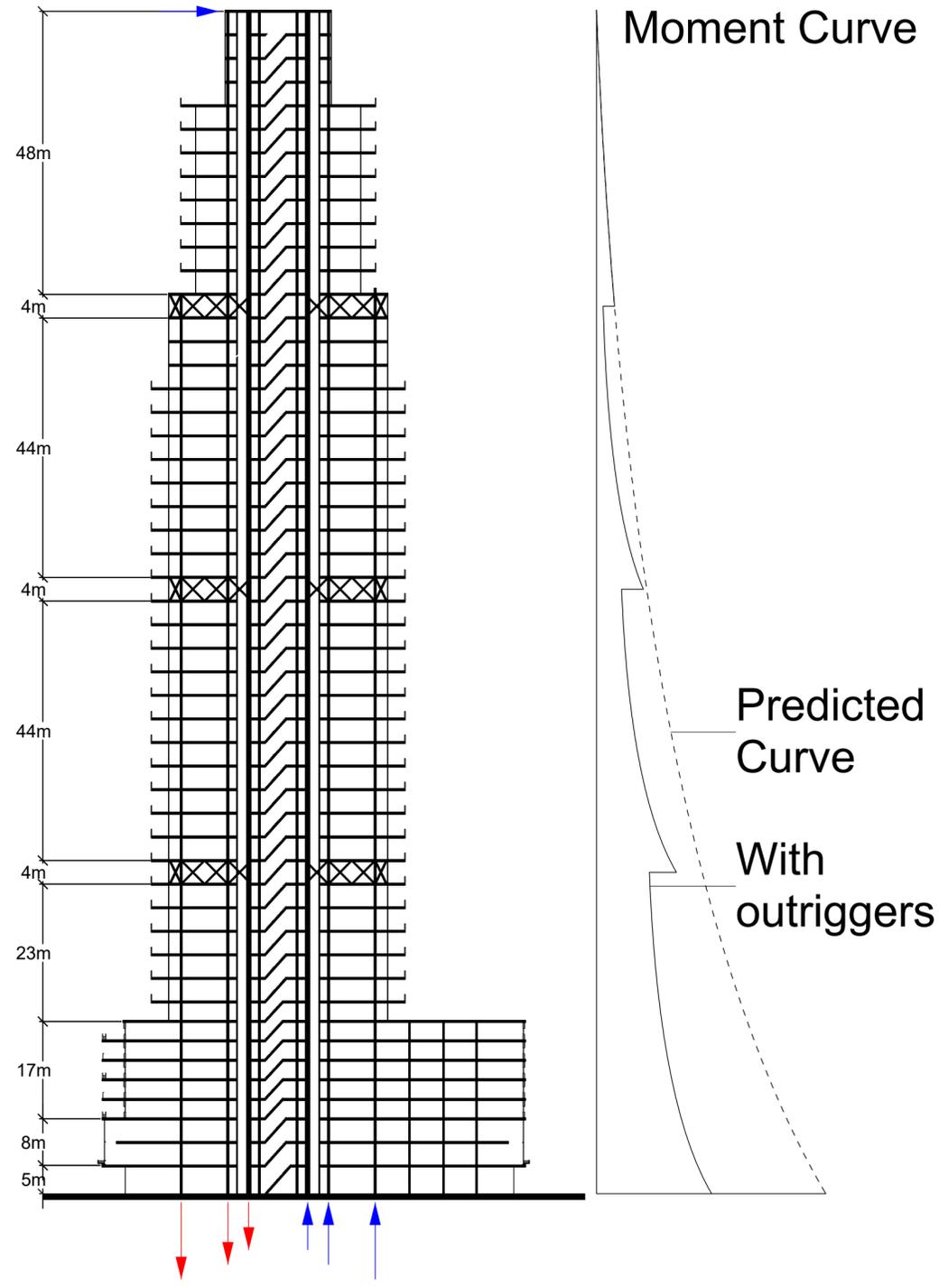
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STRUCTURAL FLOORPLANS



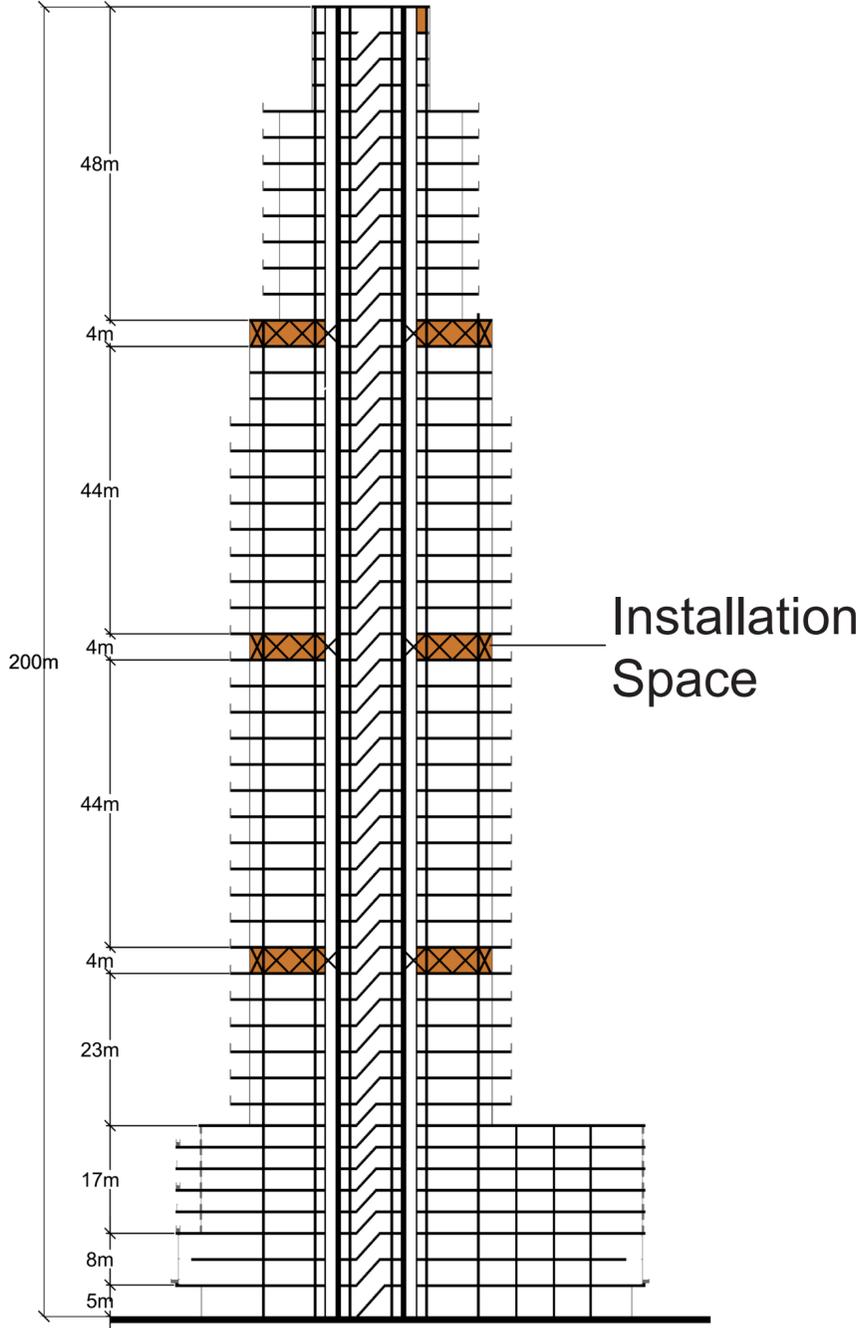
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STRUCTURAL CONCEPT



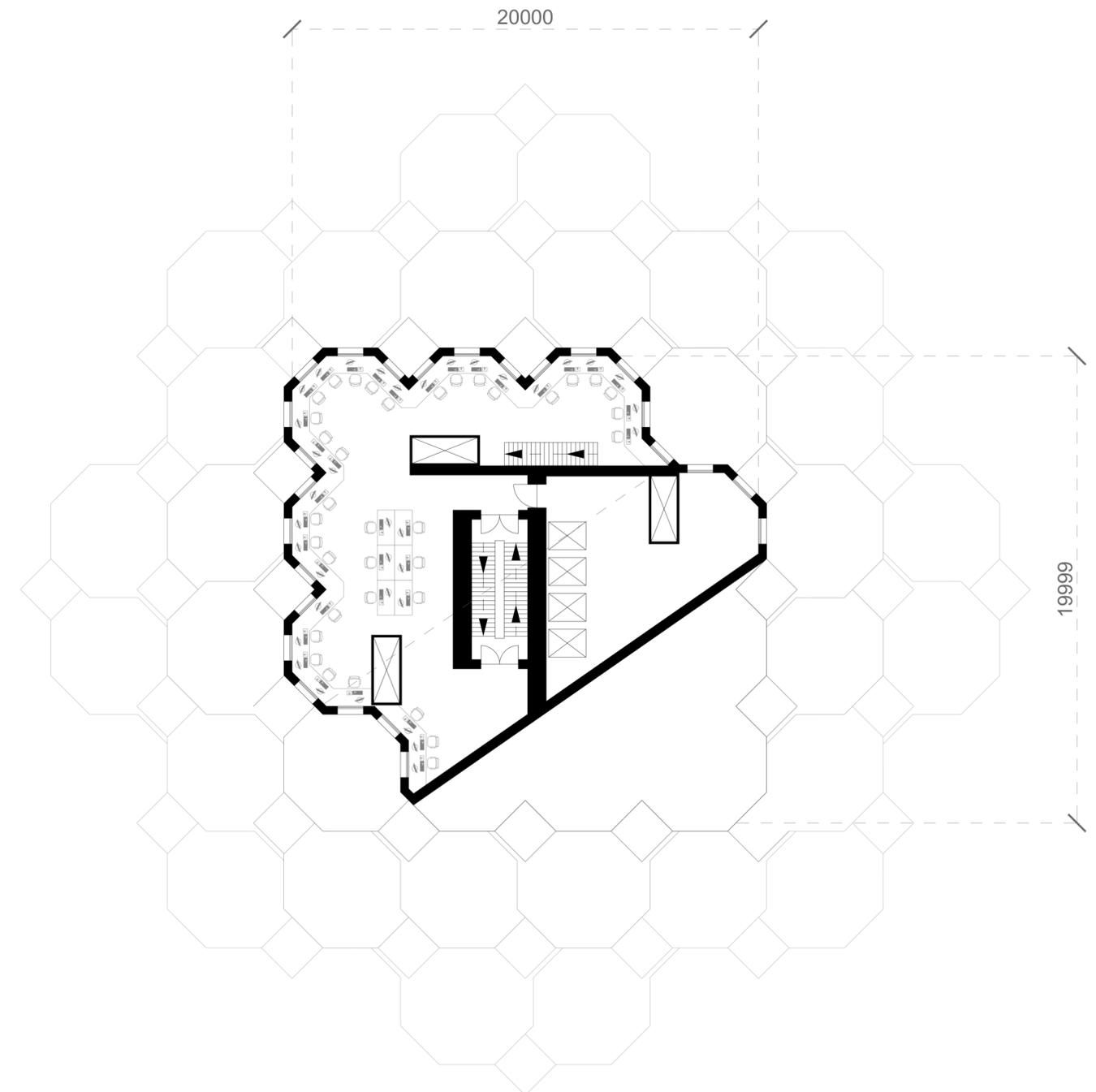
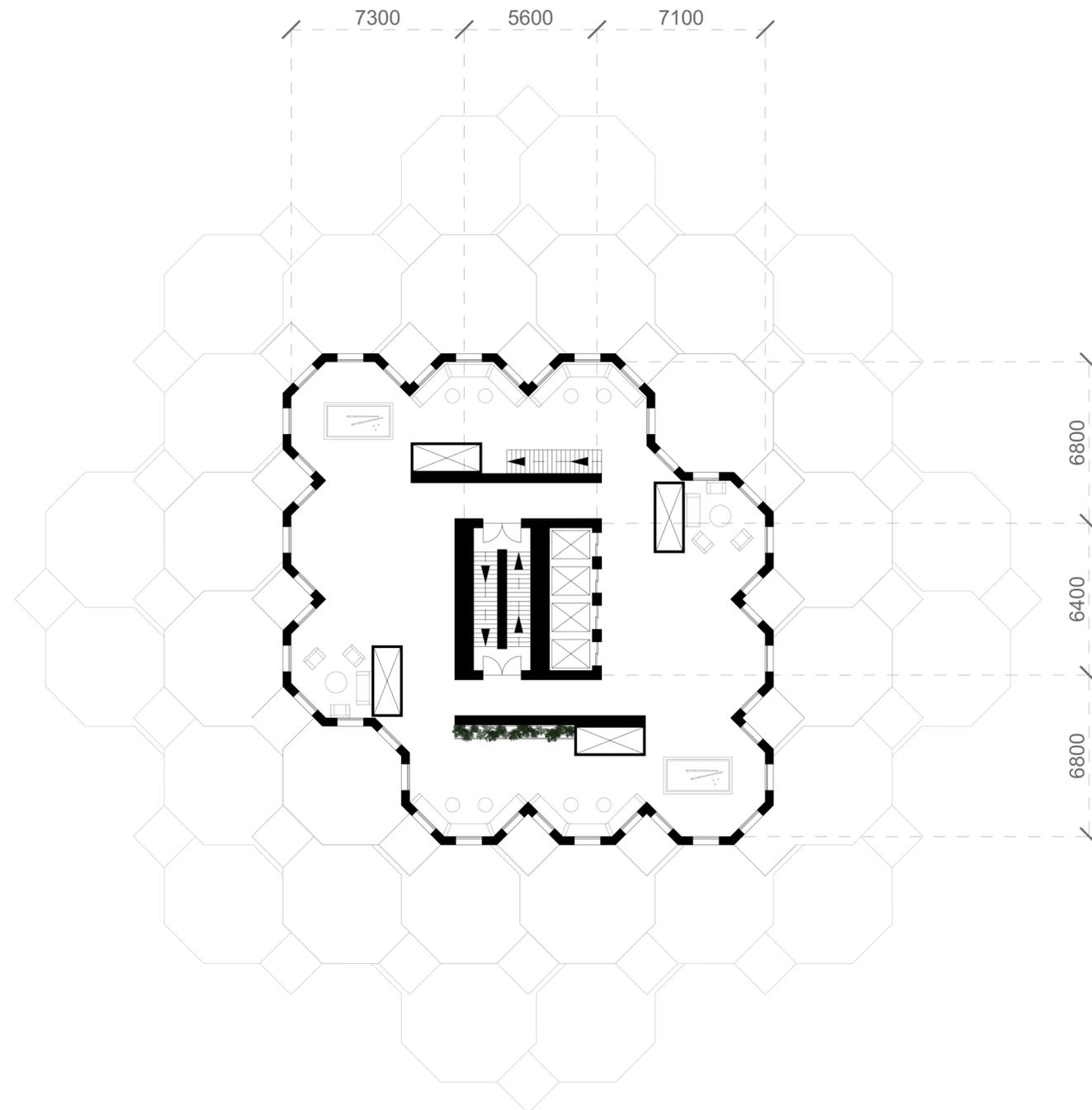
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INSTALLATION SPACES



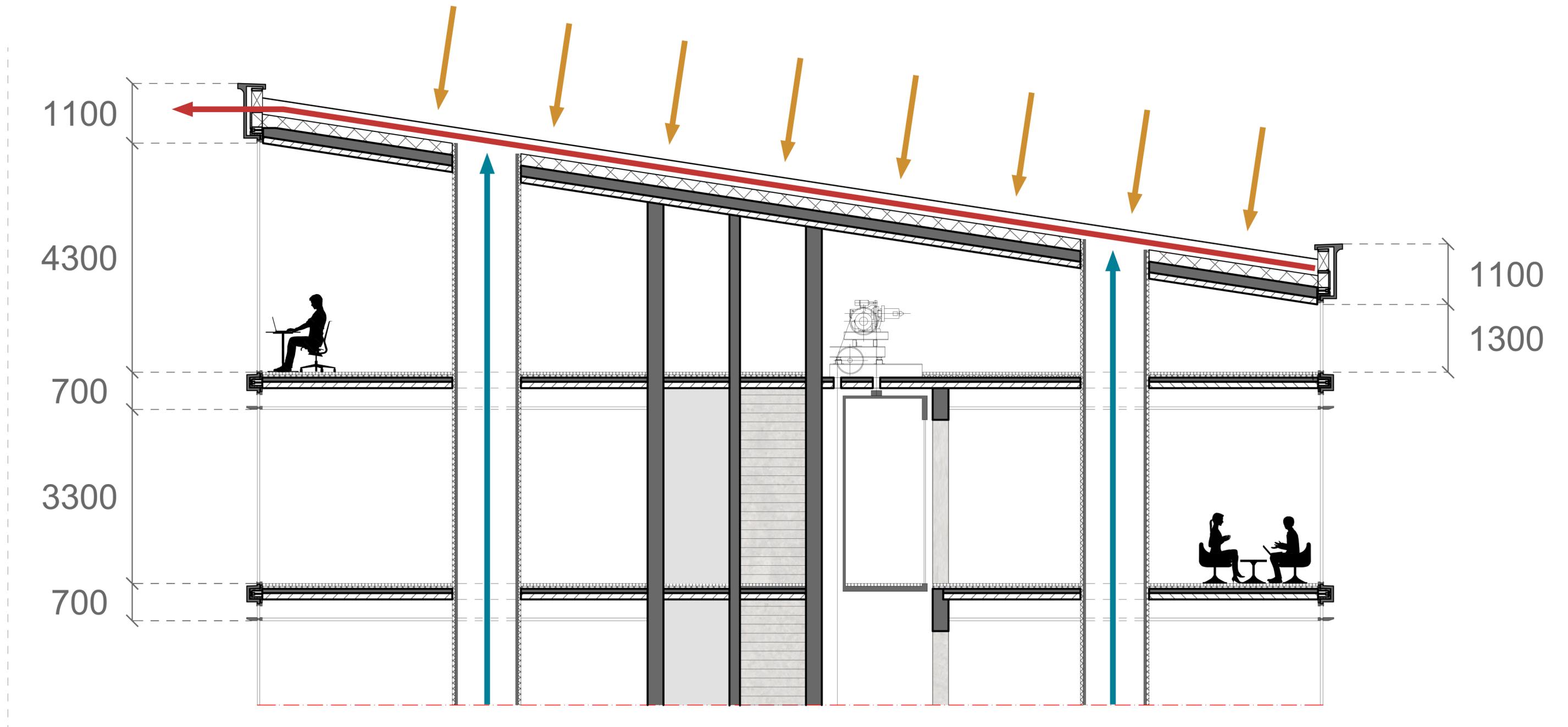
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FLOORPLAN TOP FLOOR



NAVIER

SECTION TOP FLOOR



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Faculty of Architecture and the built environment
Track: Architecture
Studio: Architectural Engineering,
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