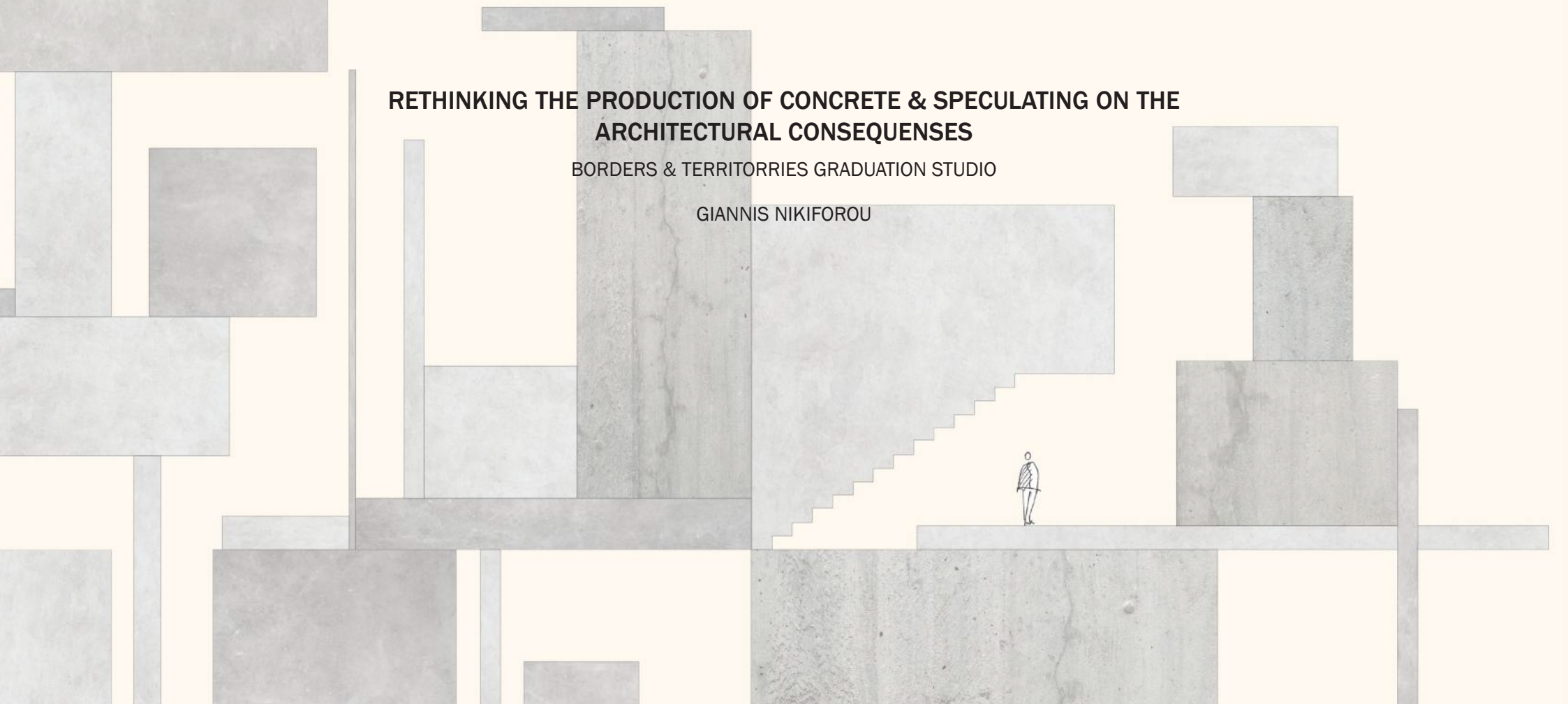
RETHINKING THE PRODUCTION OF CONCRETE & SPECULATING ON THE ARCHITECTURAL CONSEQUENSES

BORDERS & TERRITORRIES GRADUATION STUDIO

GIANNIS NIKIFOROU

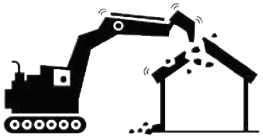


Process - orientated project

Notion of Re-use

City of Almaty

City as an Urban Mining



Concrete

Steel

Crushing Concrete with Smartcrusher

+

Re-use: Production of new precast concrete elements

Recycling at existing-Kazzferrostaal steel factory

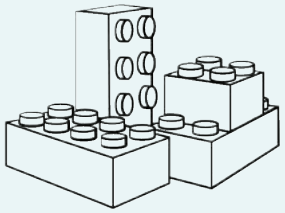
Theory: 'The Plastic Number' - Van der Laan

Robotic Fabrication / Customisation

Revisiting Existing Projects

Part 1: Research

Part 2: Design



Development of concrete elements.

Logic and Understanding:

- Structural Performance
- Assemblage method
- Form
- Materiality
- Climate performance

Part 3a: Architectural Potential / Value
What Spaces can we make out of these elements?

Part 3b: Applying the logic of building with elements in a house design in Almaty

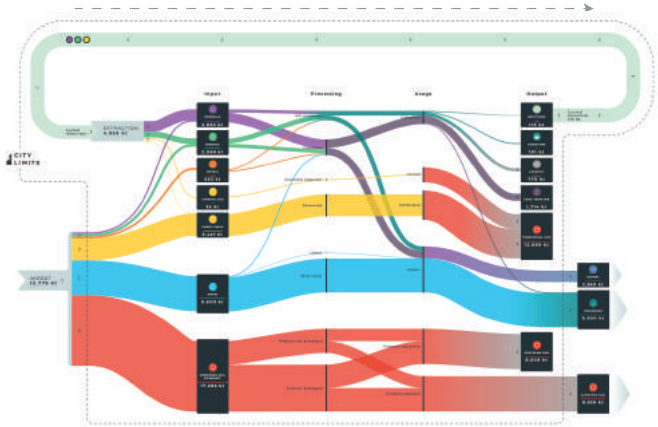
Introduction Scheme

Part 1: Research

Location: Almaty, Kazakhstan

Starting Point:
Source: Circular Economy Opportunities in Almaty, May 2019,
which onvolves different stakeholders and the Mayor of Almaty

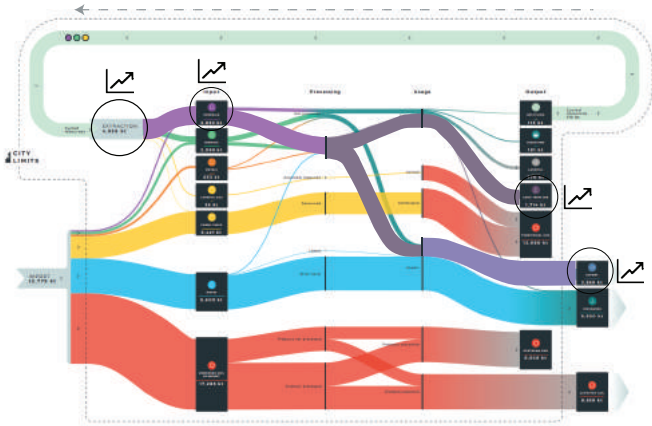
"The total extraction of sand, gravel and other rock materials in Almaty province is estimated at 37 million tonnes. The 1.5 million tonnes which is used to expand the actual city of Almaty is only a small part of this. The remainder is probably used for infrastructure in the province" and exports.



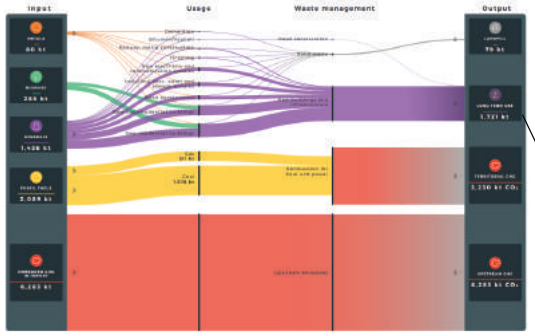
Existing Situation:
Circular Economy Opportunities in Almaty, May 2019

Strategic Place of Almaty along the New Economic Silk Road => Increased demand for exports

"Almaty is expanding. The overall floor surface is growing with 3% per year, or 2 million square metres. The growth is driven by migration from rural areas in Kazakhstan, migration from other countries and by a gradual growth of the average residential space. per person".

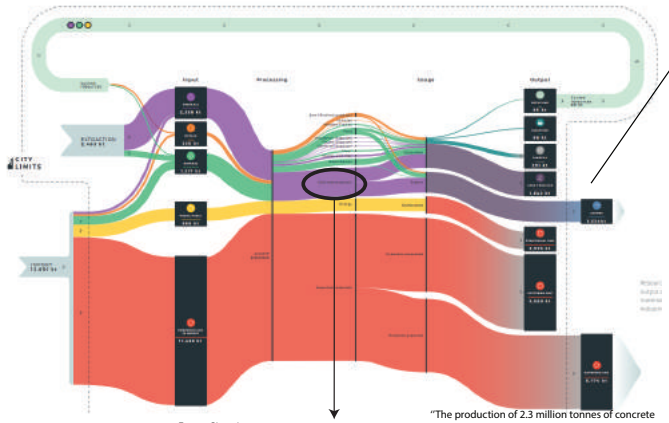


Future Situation:
Increased Extraction of Minerals and increased CO2 emmisions



Existing Situation:
Circular Economy Opportunities in Almaty, May 2019

"The material flows in the construction sector show that 33% of the stock addition is in the construction of residential buildings. 23% is non-residential buildings and the remaining 44% goes into new transport, communication and heat, water and sewage infrastructure."



Future Situation:
Need for More Concrete Products in the Future

"The production of 2.3 million tonnes of concrete construction materials far exceeds the volumes of biomass and metals processed".

"The most important material result of all construction activities in the city is expansion or 'long term use'.

Around 88% of the turnover is in the construction of new buildings, 6% in renovation, 6% in maintenance and less than 0.1% in demolition".

vs

"There are about a hundred abandoned sites in Almaty where construction has been frozen (…) According to the chairman of the board of the Kazakhstan Association of Appraisers, Alexander Kalinin, there are about a thousand hectares of such problem areas in Almaty".

"Almaty municipality plans to demolish around 500 houses in the 5 years after 2019. Most of these houses are two floor houses from the years between 1950 and 1960".

How can the Concrete Industry respond to the future needs and keep mineral extractions to a minimum?

Statistics about mineral mining in Almaty

Abandoned construction site

Almaty Technological College of Kazpotrebsoyuz

Abandoned construction site

Abandoned construction site

Former supermarket Alma

Hospital of the Ministry of Internal Affairs of the Kazakh SSR

Old workshops of the Almaty depot

Abandoned school college

Inventory of Abandoned buildings in Almaty

Inventory of different types of concrete in Almaty
Source: Walking Almaty.com

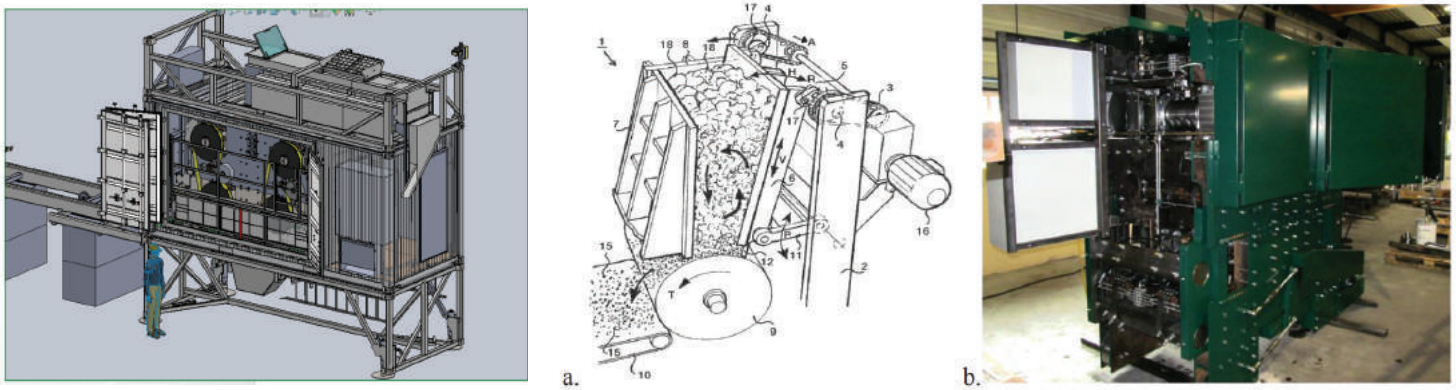
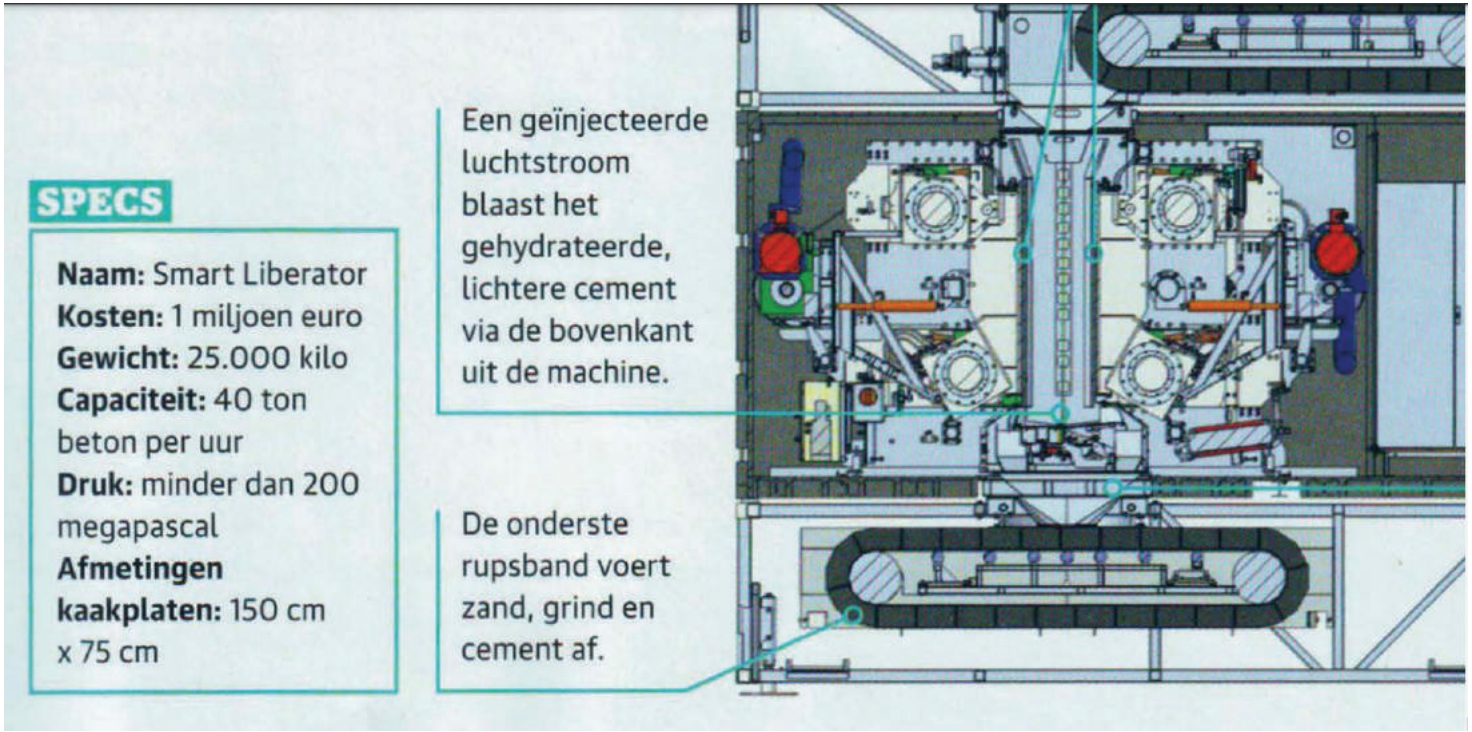
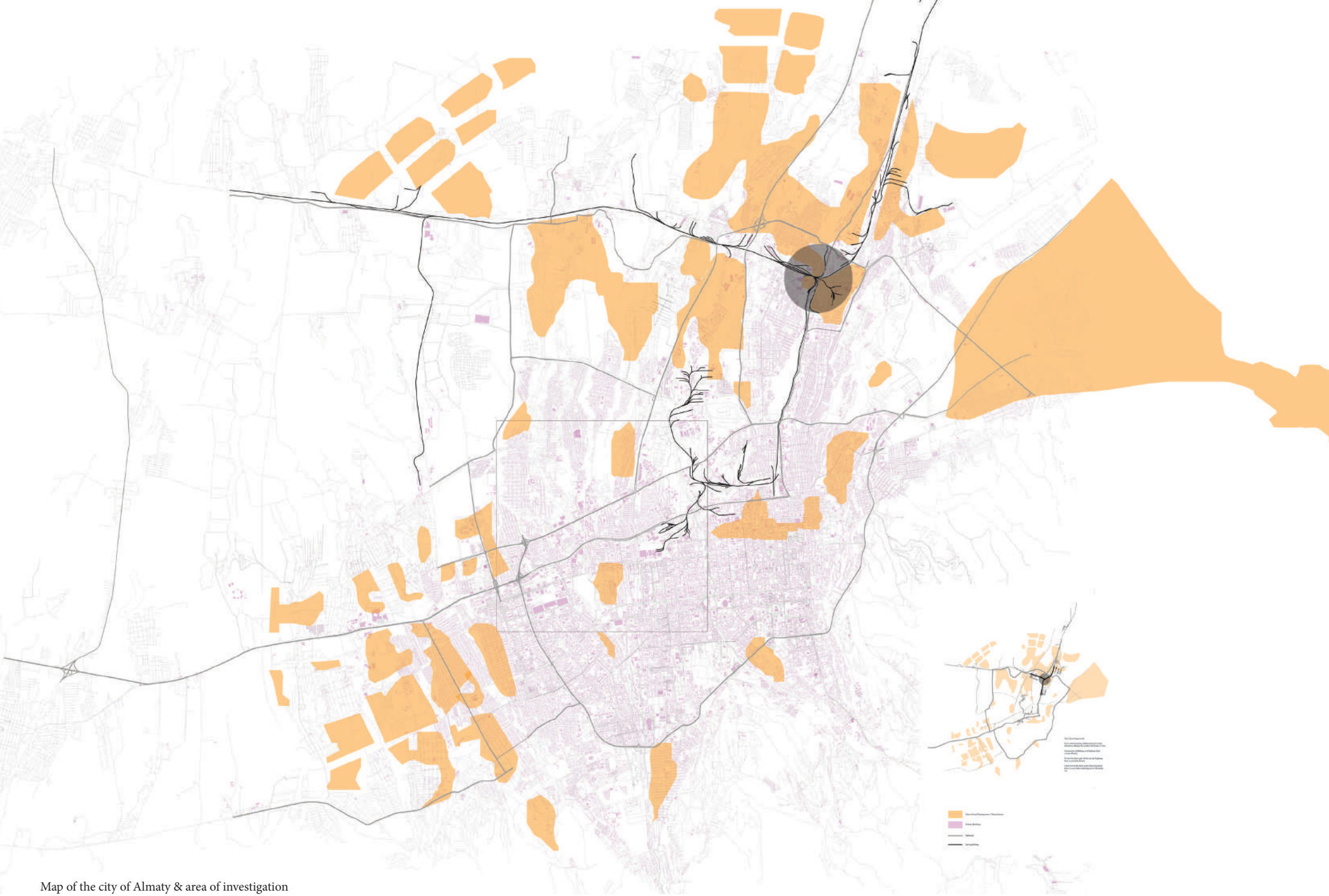


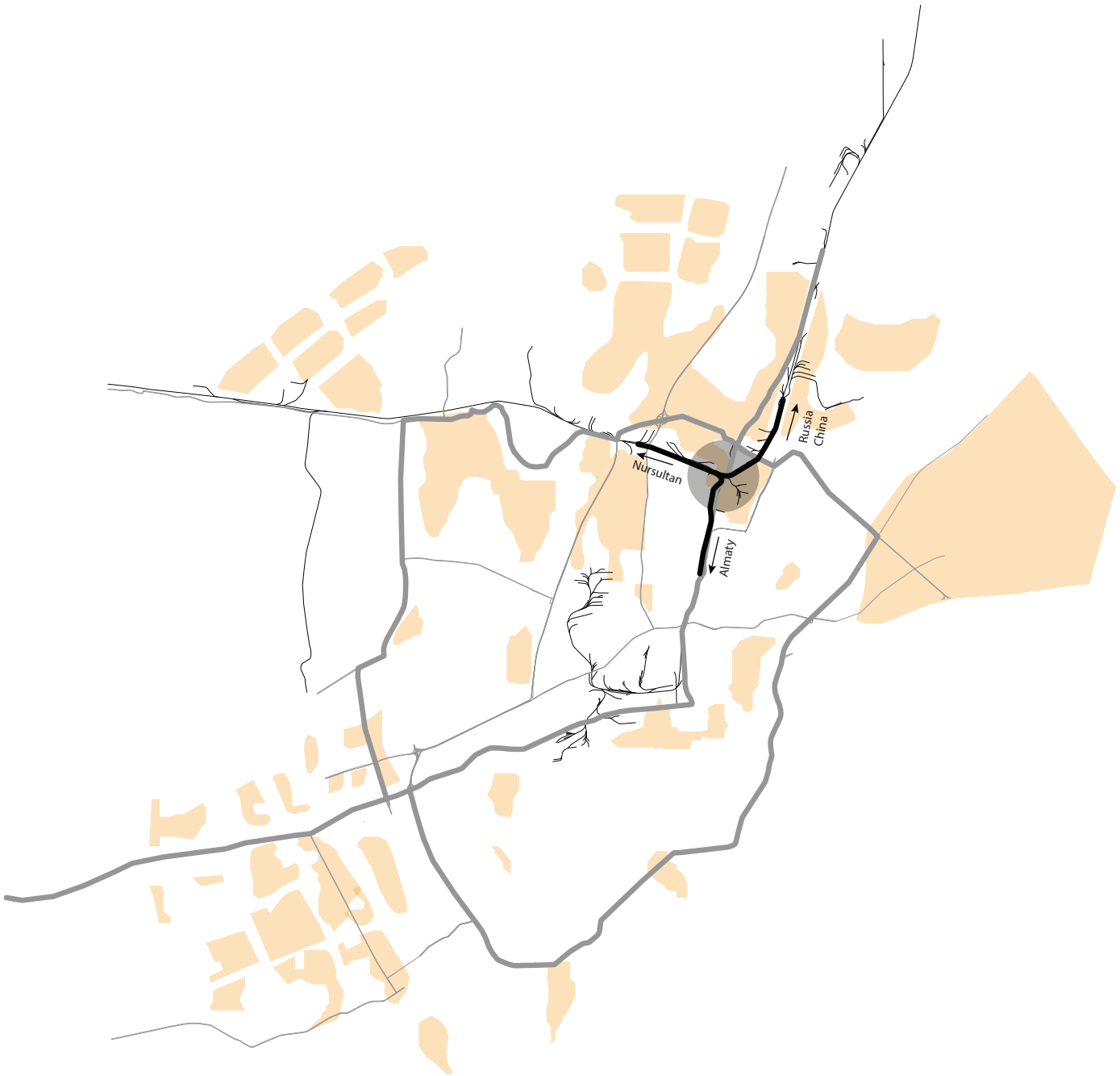
Figure 4.13. a. Sketch [124] and **b.** picture of the real scale Smart Crusher.



Smartcrusher
Source: Slimbreker.nl



Map of the city of Almaty & area of investigation

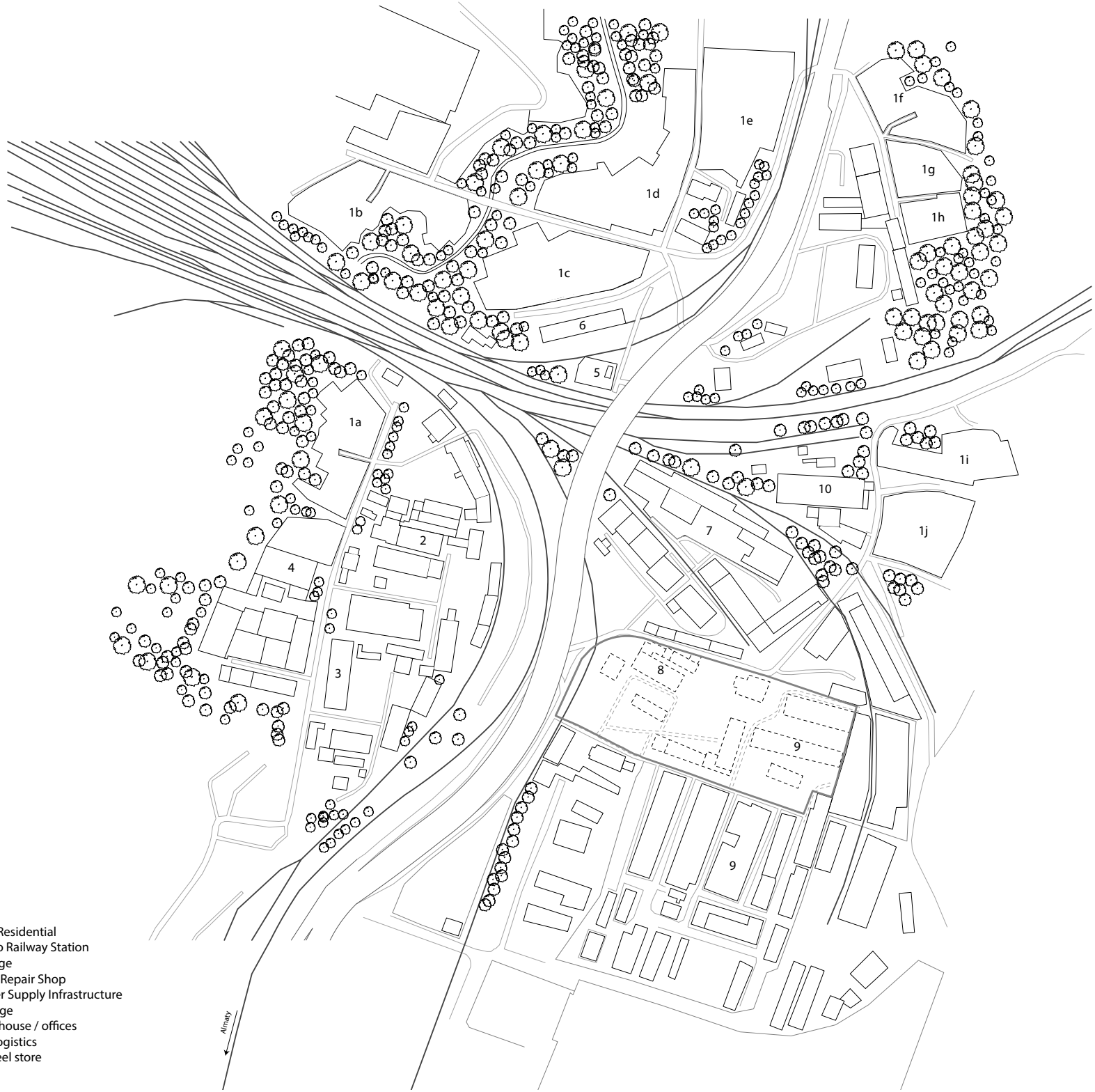


Future Urban Developments / Demolishions

Highways

Existing Railway

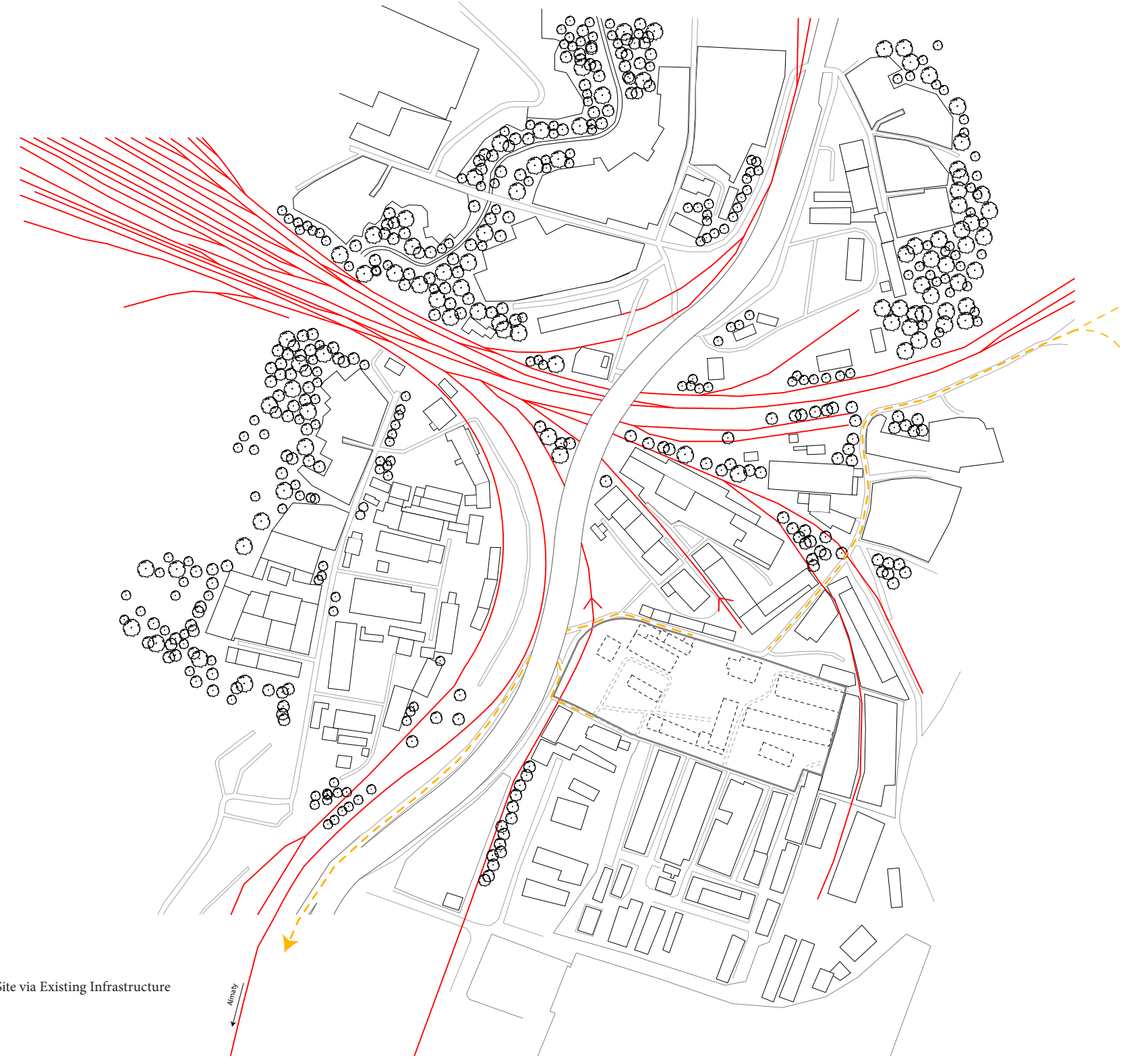
Area of Investigation for the recycling and re-making of new concrete



1a - 1j: Residential
2: Cargo Railway Station
3: College
4: Auto Repair Shop
5: Power Supply Infrastructure
6: Storage
7: Warehouse / offices
8 - 9 : Logistics
10: Wheel store

Chosen Site and Demolishion

Material Entering the Site via Existing Infrastructure

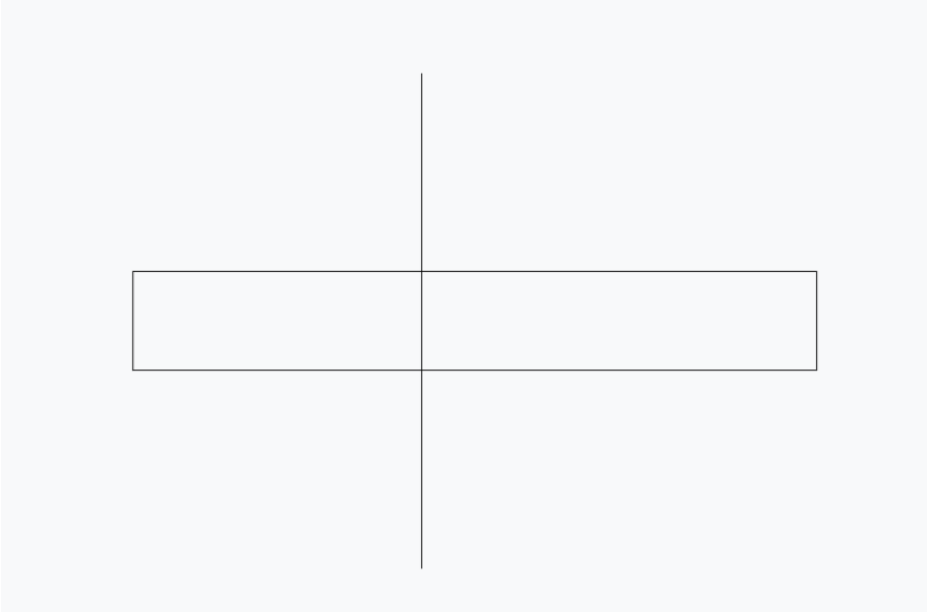


Material leaving the Site via Existing Infrastructure

Part 2: Design
Development of Concrete Elements - Logic and Understanding

Starting Point:
The Plastic Number, Dom Hans van der Laan

Van der Laan defines: 'to inhabit' as being able to enter into a relationship with a space, being able to measure that space.

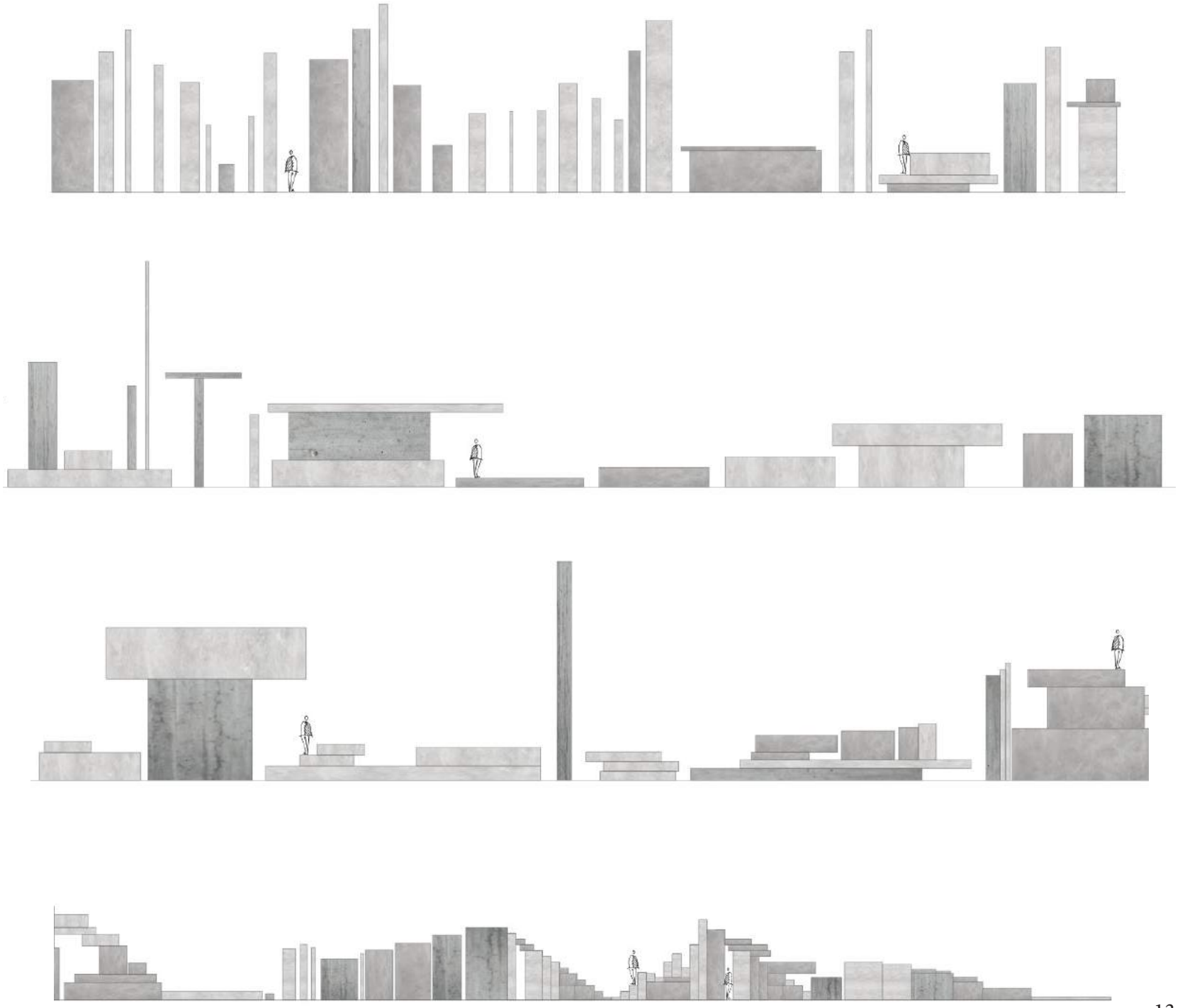


The Plastic Number:

'There are two ways of READING space: COUNTING and MEASURING. When confronted with two measures of the same size, one COUNTS. In the case of unequal parts, one MEASURES or compares. In order for space to be clearly readable, architecture makes measuring as straightforward as counting.'

'The difference between 3 and 4 is the minimum difference between two measures, so that one can compare them and name the difference clearly.' - Van Der Laan

Source: https://domhansvanderlaan.nl/theory-practice/theory/the-plastic-number-ratio/

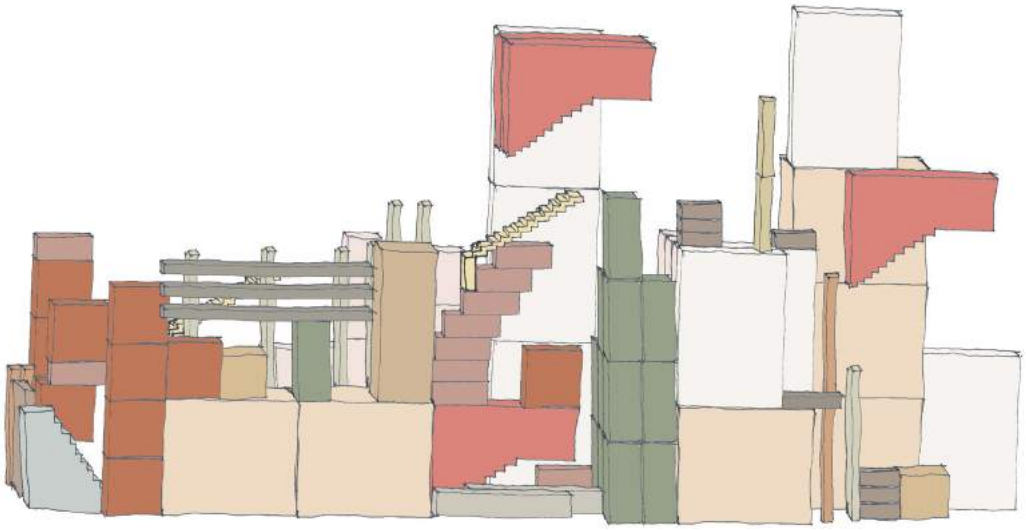


Exploring ways in which you can enter a relationship with a space. Can you read a space by counting and measuring at the same time?

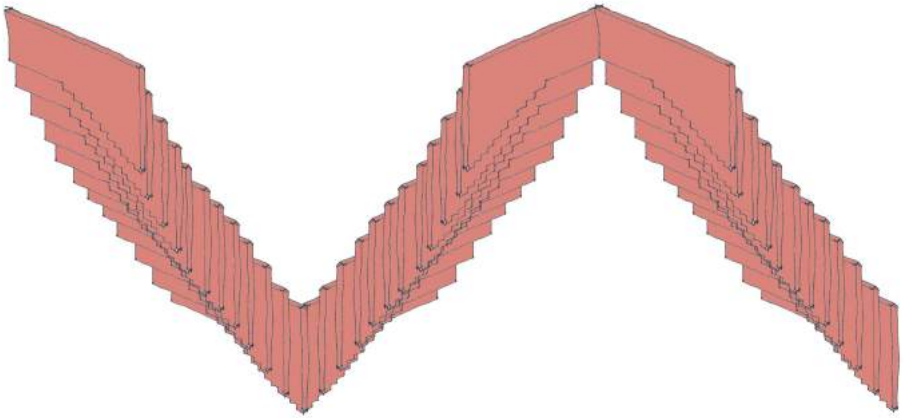
Challanging the proportions of basic building elements

Introduction of Stacking: Exploring the relationships between Mass & Void

Introduction of Stacking: Exploring the relationships between Mass & Void

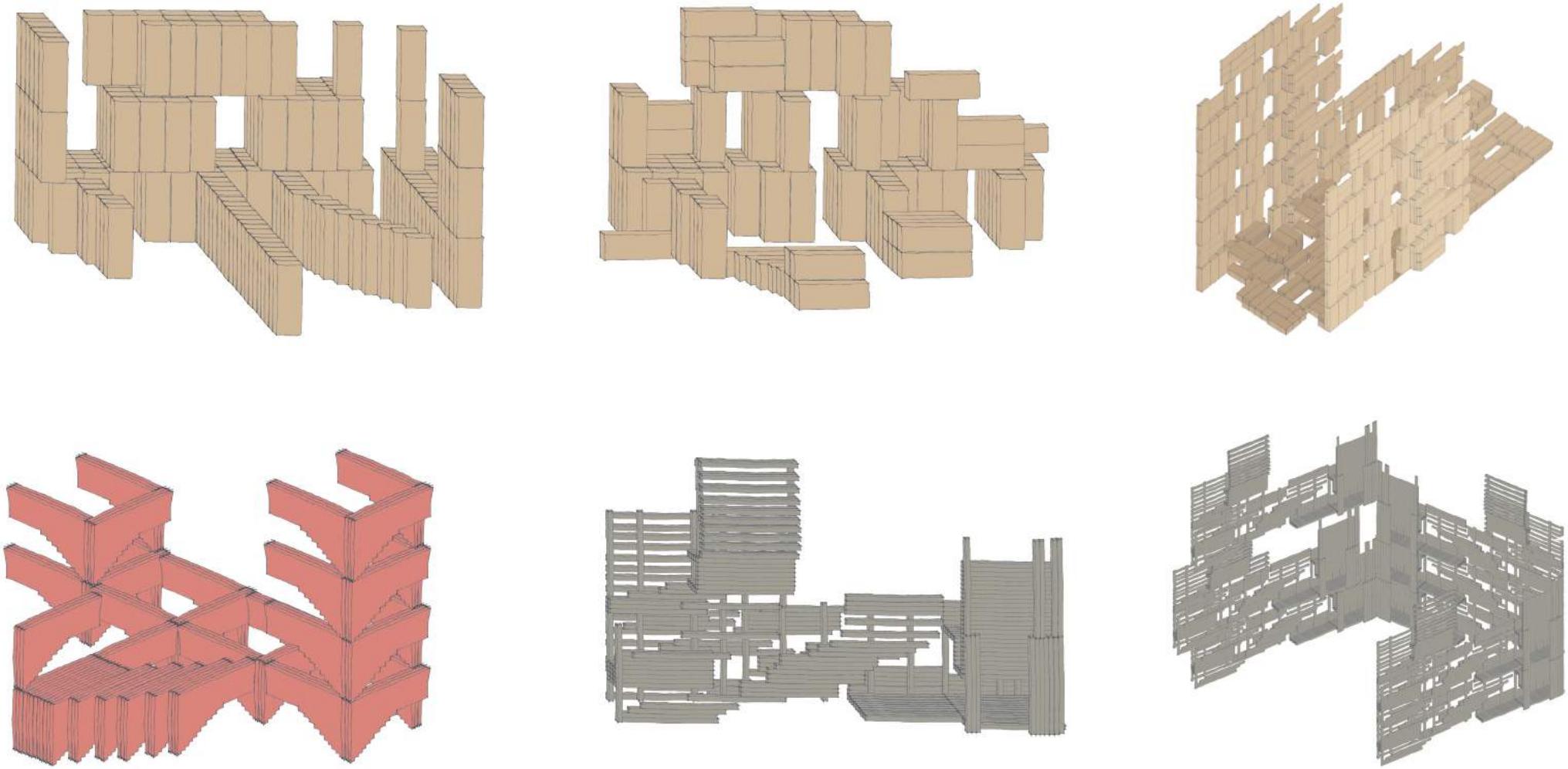


Strategy 1: Assamblage of all the concrete elements that explores the outcome spatial qualities

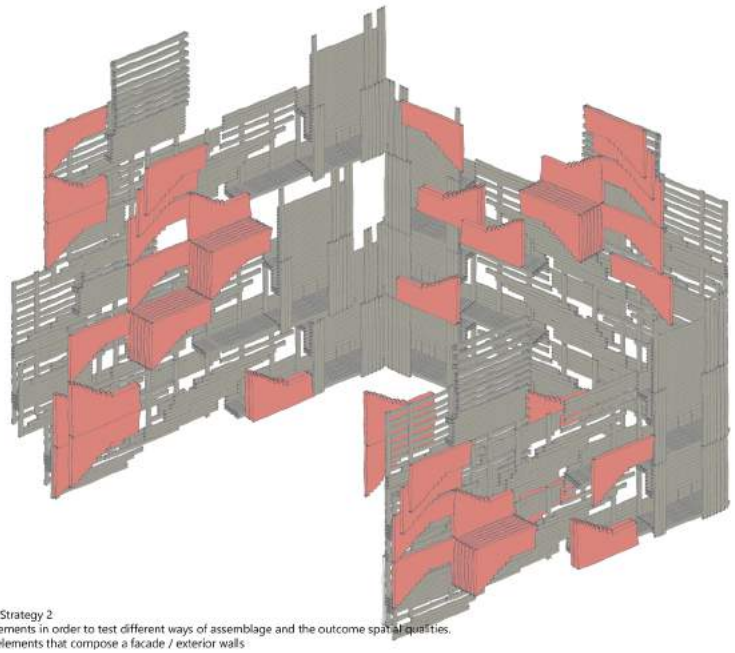


Strategy 2: Repetition of one element and different ways of assembling in order to reveal spatial qualities

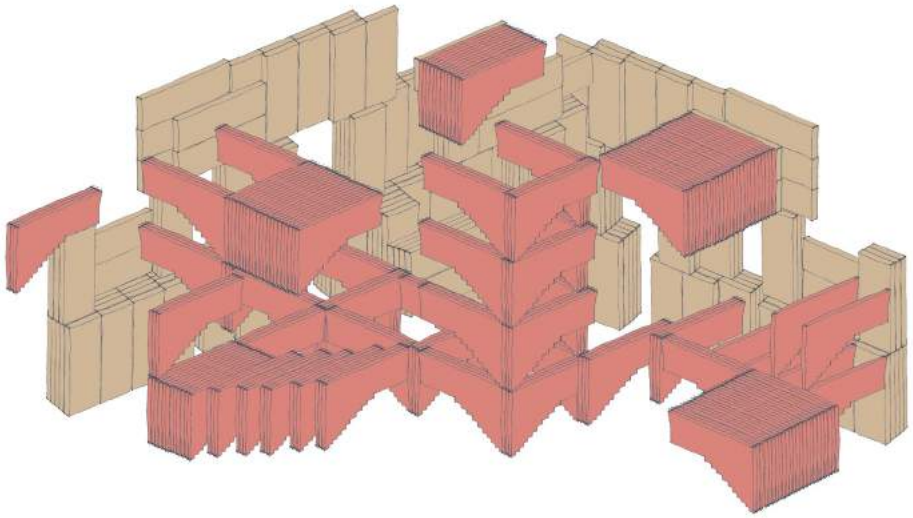
Assemblage: Two Strategies using the solid concrete elements

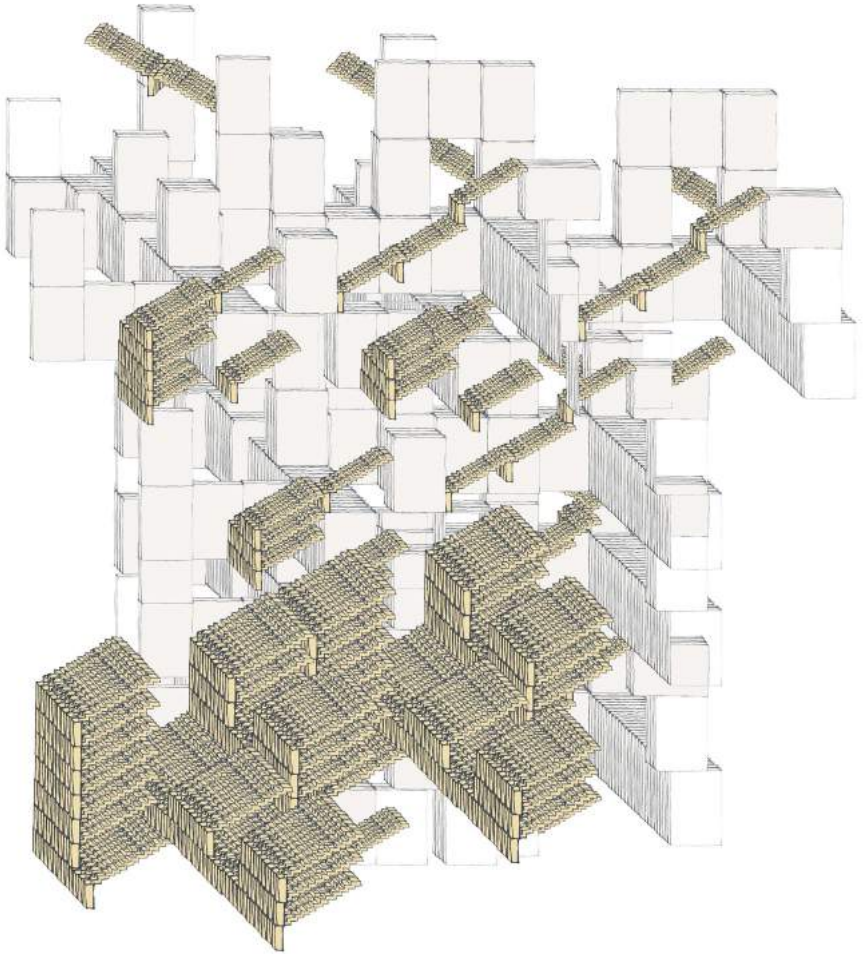


Strategy 2: Repetition of one element and different ways of assembling in order to reveal spatial qualities

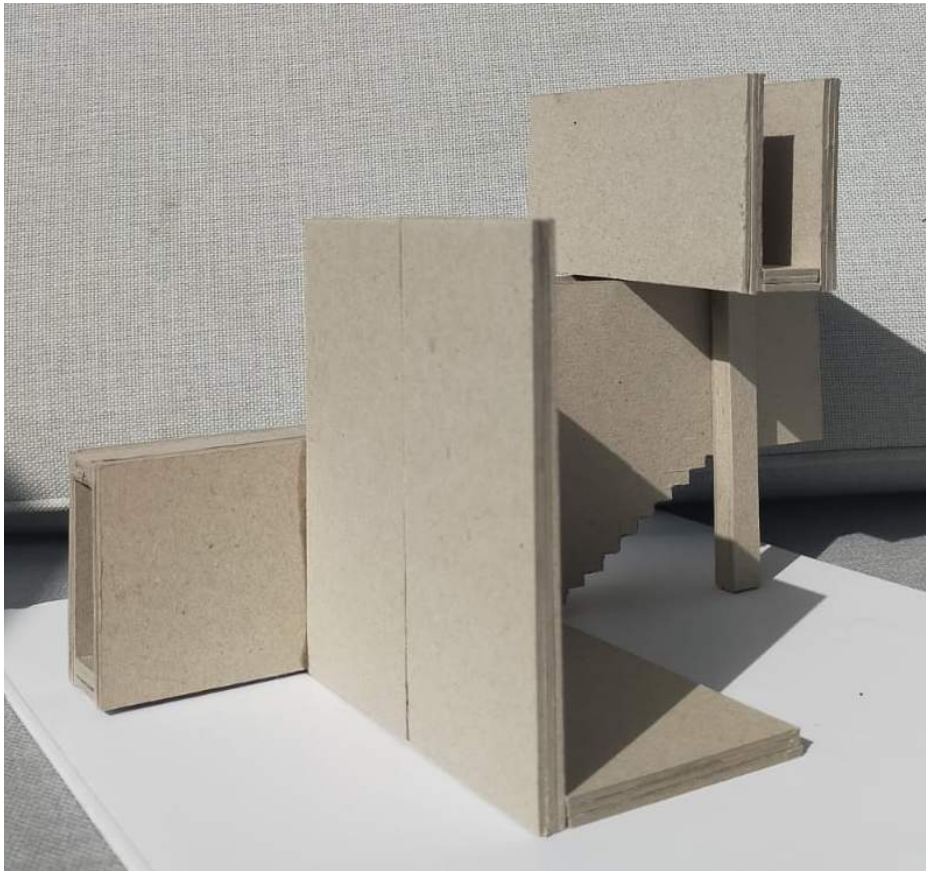


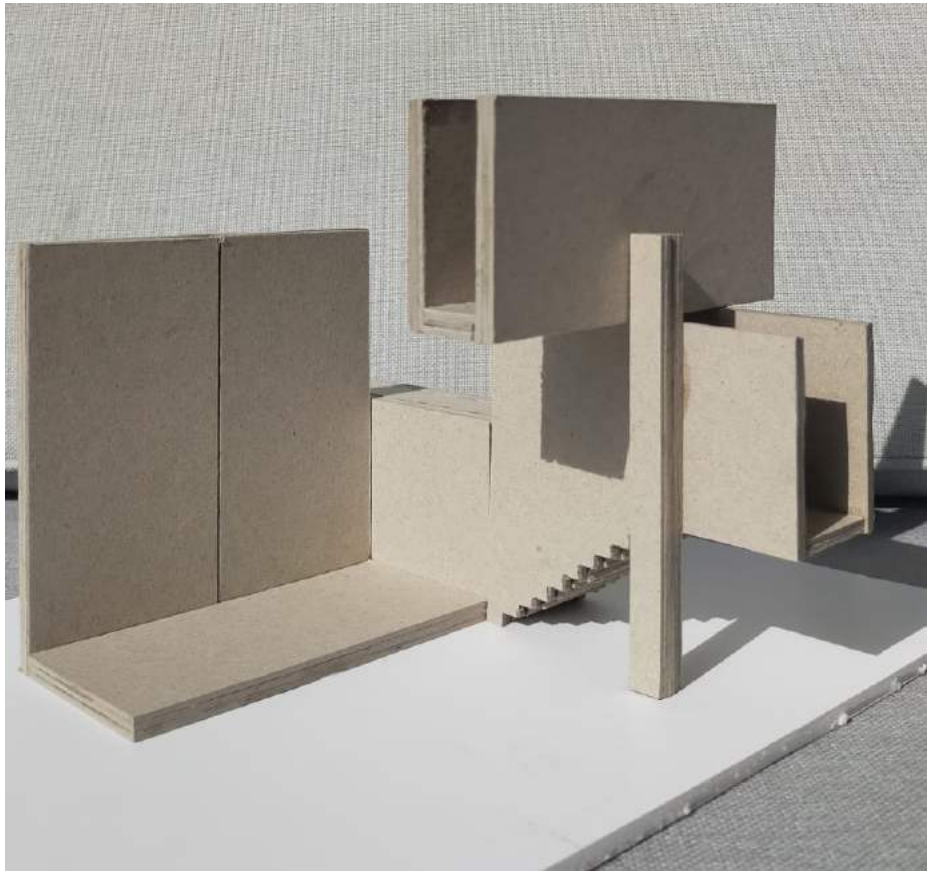
Strategy 1 + Strategy 2
Using two elements in order to test different ways of assemblage and the outcome spatial qualities.
Testing two elements that compose a facade / exterior walls





Strategy 1 + Strategy 2 / two elements





Selection of a few elements and the notion of joint

Digital File uploaded that the Robotic Arm will read

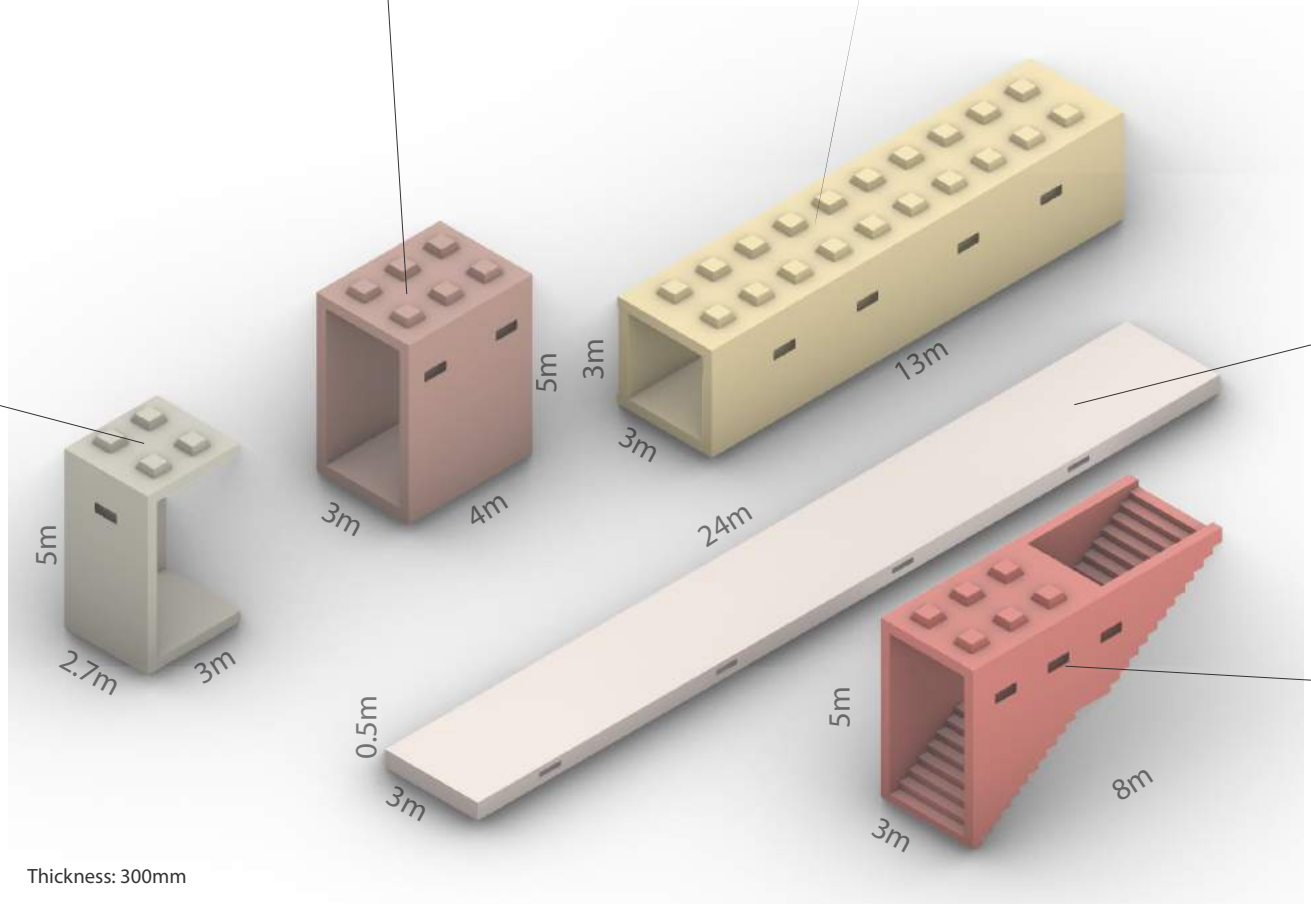
Inhabitable Wall
Standard Element in different pigments

Inhabitable Beam
Adjustable Length / different pigments

Inhabitable Corner
Standard Element in different pigments

Slab
Adjustable Length / different prigments

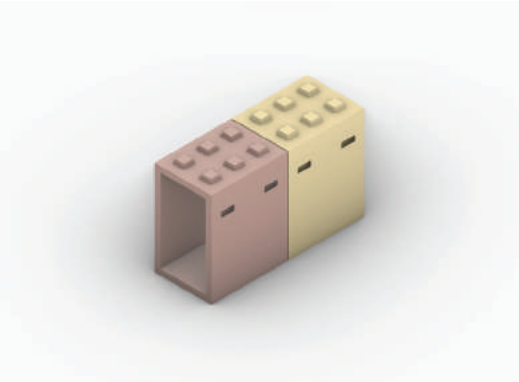
Inhabitable Stairs
Adjustable length / different pigments



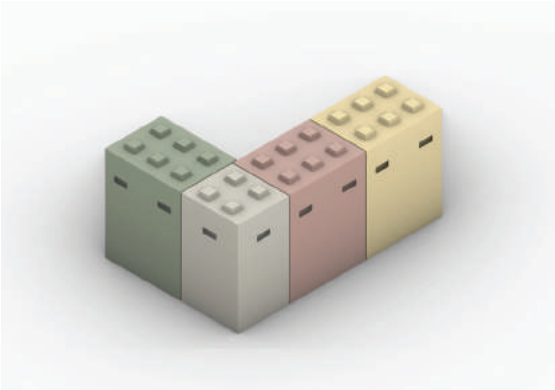
Thickness: 300mm

Main Principles of Assemblage:

1. Use five building elements
2. Use basic geometries and straight lines
3. Use a maximum width of 3m
4. Juxtapose / Stack the elements according to primitive architecture
5. Assemble with the use of a crane / elements arrive from above
6. Keep the dimensions of the elements constant and alter length where needed.
7. Use an Earthy colour pallette / smooth colour transition - Concrete possibilities

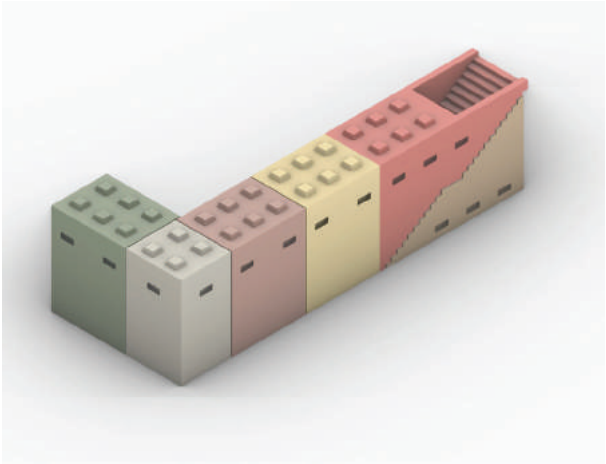


1. Placing vertical elememts (inhabitable walls)
one next to the other

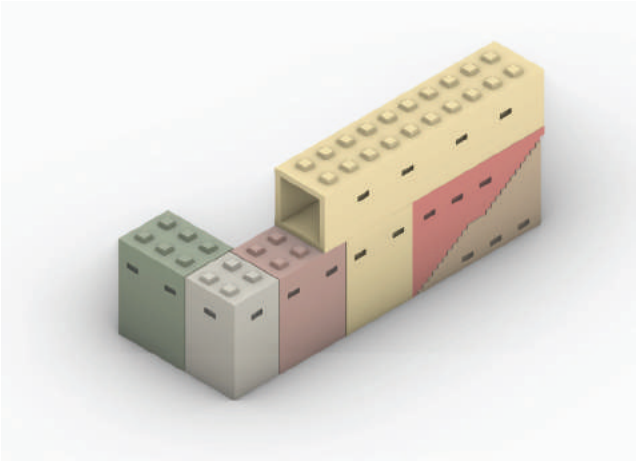


2. Form a corner by placing elememts next to
each other / Define void with hollow elements

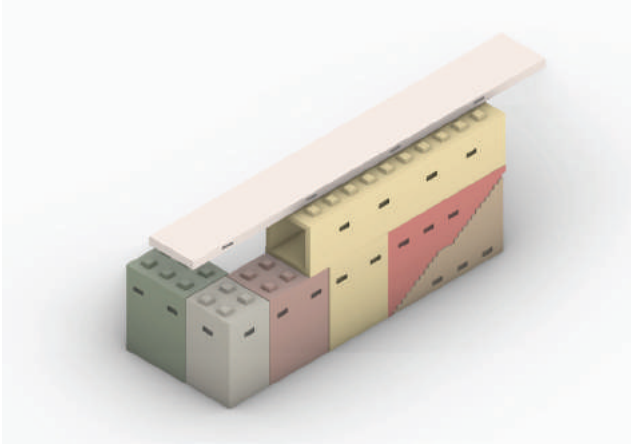
Reference:
Concrete blocks in PC Hoofstraat, Amsterdam



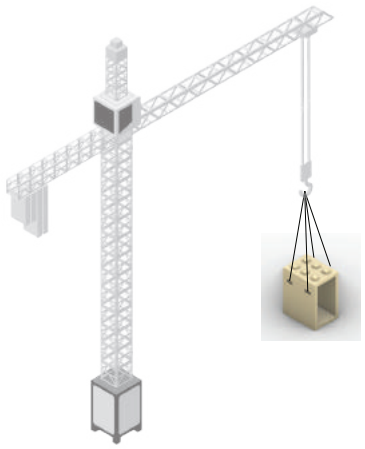
3. Place inhabitable stairs on the ground



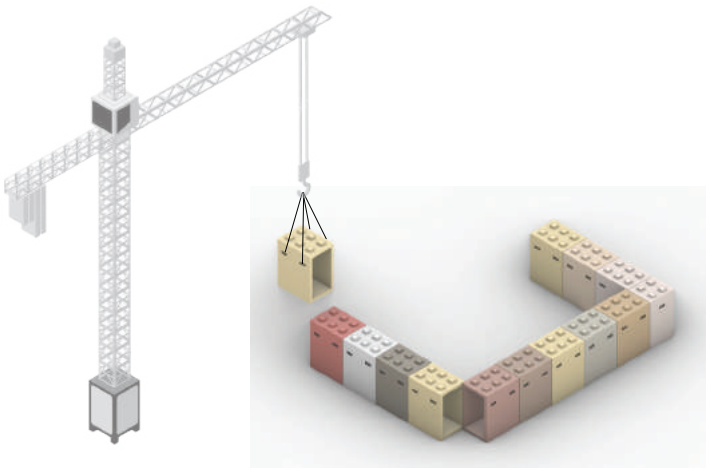
4. Juxtapose horizontal element (inhabitable beams)
on top of the vertical elements and stairs



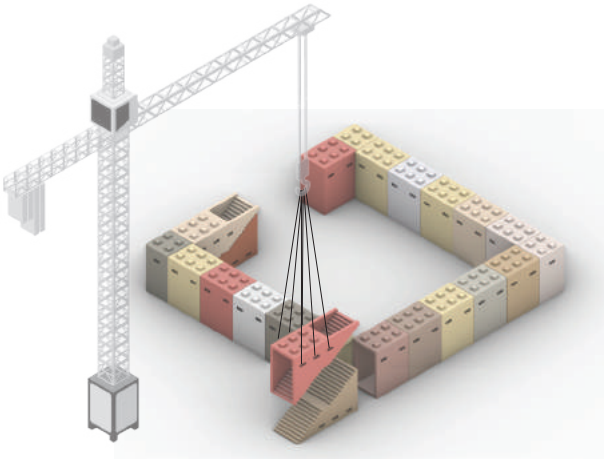
5. Stack orthogonal slab on top of the horizontal
element (inhabitable beam)



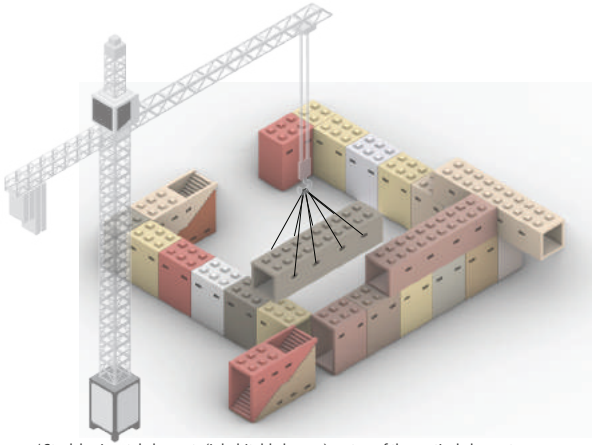
Start placing vertical hollow elements



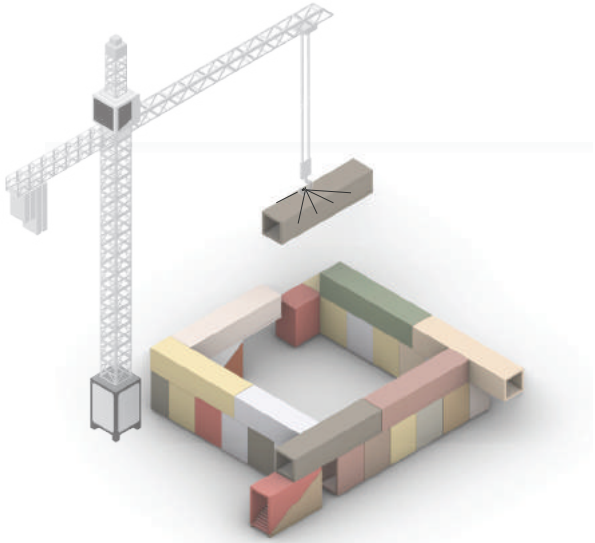
Define Void by placing vertical hollow elements next to each other
Relationship between human scale spaces and machine scale spaces emerges



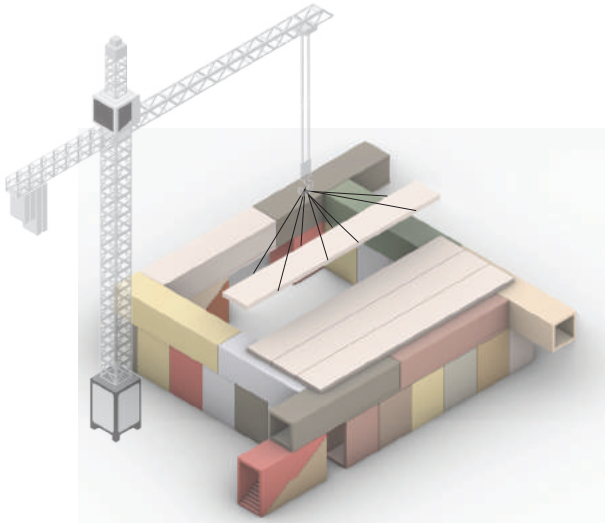
Place hollow stairs on the ground / Top part stacked on the bottom one.



Juxtapose / Stack horizontal elements (inhabitable beams) on top of the vertical elements



Juxtapose / Stack horizontal elements (inhabitable beams) on top of the vertical elements



Juxtapose / Stack slabs on top of the horizontal elements to form the roof of the inner void

Revisiting Existing Projects

Image 1: Kunsthaus Bregenz, Peter Zumthor

Image 2: Saint Benedict Abbey, Dom Hans Van der Laan

Image 3: Serpentine Pavilion 2011, Peter Zumthor

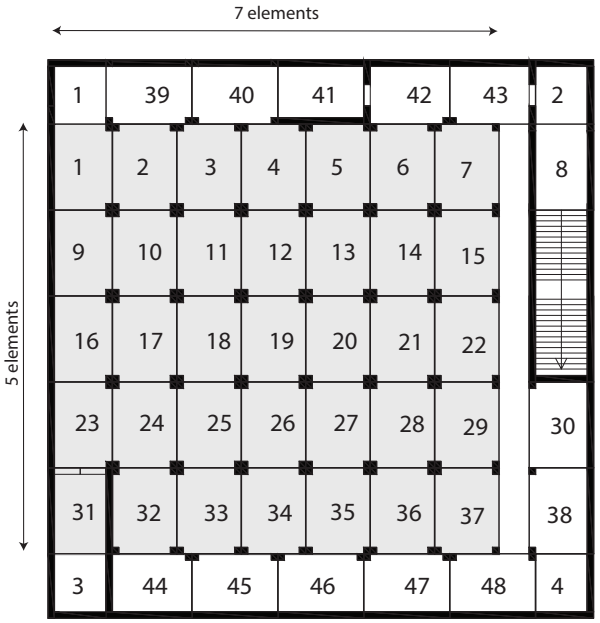
Why?

Speculate on what would it mean for those buildings if they were made out of the prefab concrete elements I have developed.
What architectural thematics / understandings of the space emerge?

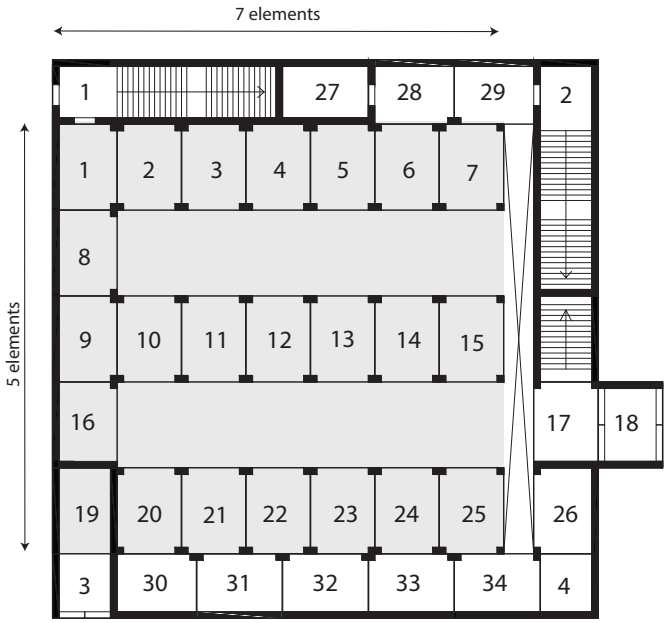
Sources:
Image 1: https://www.google.com/search?q=kunsthaus+bregenz&sxsrf=ALeKk01rKSHXckDK1MoLmW-EyyFcDtDbLw:1621324987640&source=lnms&tbm=isch&sa=X&ved=2ahUKEwj47c-f4tLwAhUTjRQKHXQADYcQ_AUoAXoECAEQAw&biw=1920&bih=969#imgrc=IYIiOt5y_iYi7M
Image 2: https://www.google.com/search?q=saint+benedict+chapel+dom+hans+van+der+laan&tbm=isch&ved=2ahUKEwi_iobZ4tLwAhX9yrsIHY3hBBIQ2-cCegQIABAA&oq=saint+benedict+chapel+dom+hans+van+der+laan&gs_lcp=CgNpbWcQAzoCCAA6BAgAEB46BggAEAUQHjoECAAQGFCASVijYGDfY2gAcAB4AIABng-GIAf8NkgEEMTUuN5gBAKABAaoBC2d3cy13aXotaW1nwAEB&sclient=img&ei=NHWjYL-gA_2V7_UPjcOTkAE&bih=969&biw=1920#imgrc=N4Z_nulNrJYMwM
Image 3: https://www.google.com/search?q=serpentine+pavilion+2011&tbm=isch&ved=2ahUKEwjqn72g4tLwAhXV67sIHdlpB8EQ2-cCegQIABAA&oq=serpentine+pavilion+2011&gs_lcp=CgNpbWcQAzICCAAyAggAMgIIADIGCAAQCBAeMgYIABAIEB4yBggAEAgQHjIECAAQGDoECCMQJzoECAAQQ1DdwQFY6-MBYK-PlAWgAcAB4AIABlwGIAY4PkgEEMTguNpgBAKABAaoBC2d3cy13aXotaW1nwAEB&sclient=img&ei=vXSjYKrNGdXX7_UP0tOciAw&bih=969&biw=1920#imgrc=zJHrTVaWk6Hj6M

Architecture depends on a set of pre-conditions.
For example: Type of material / Properties of the material / Types of activities within the building.
=> Effect on the architecture

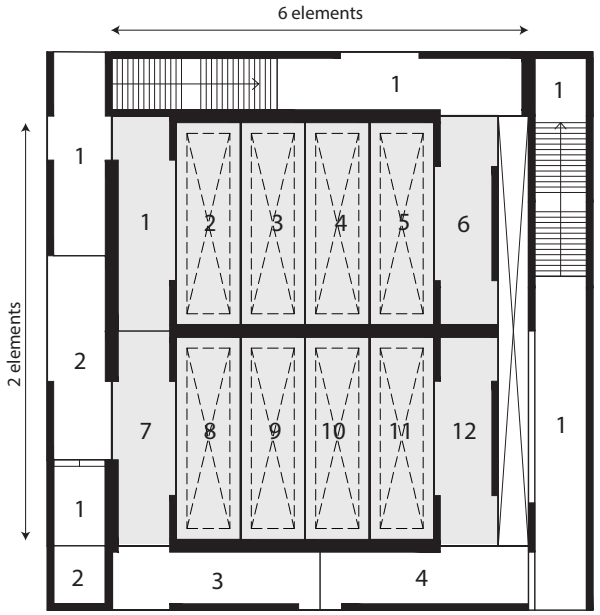
Exploration: Introduces a reverse way of thinking where the pre-condition is the architecture / building.



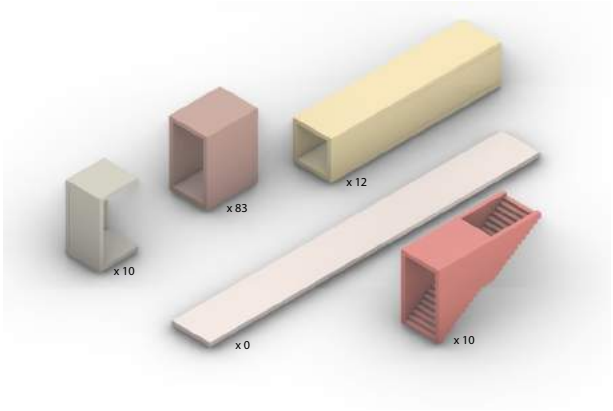
Basement Floor Plan



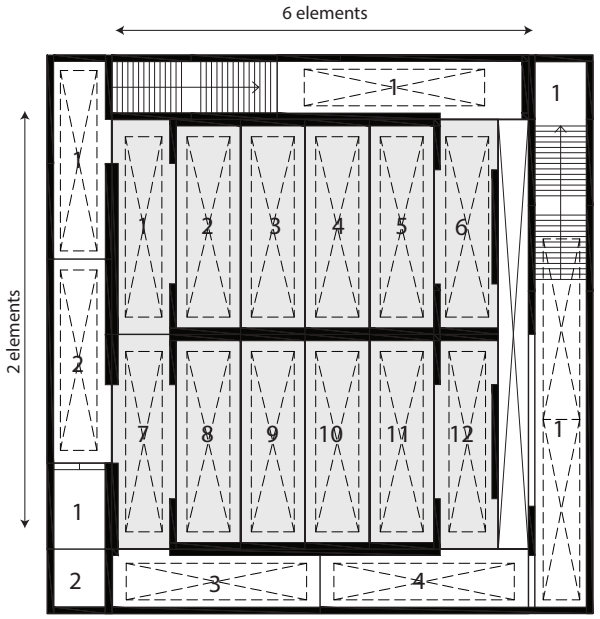
Ground Floor Plan



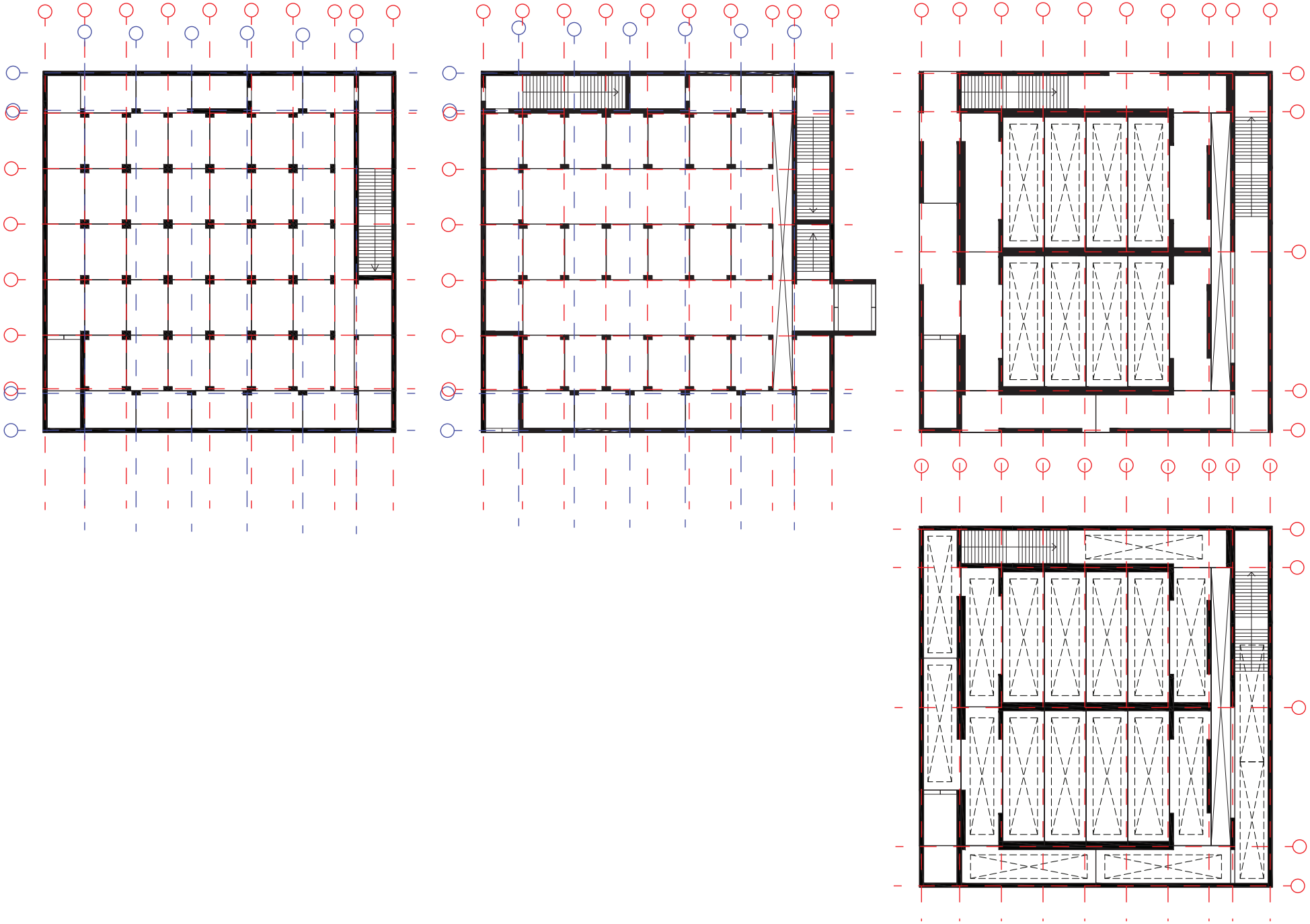
First Floor Plan #1



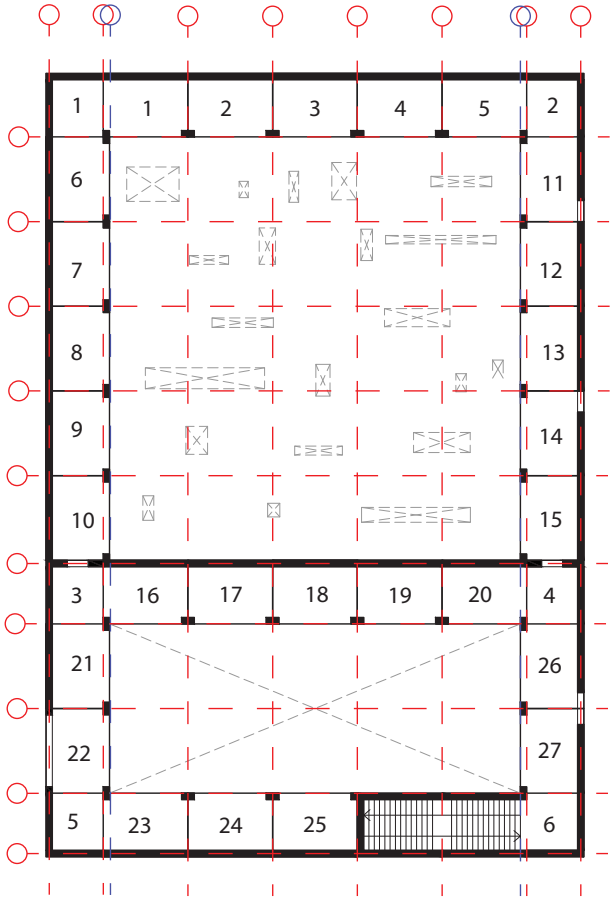
Understanding the space by counting



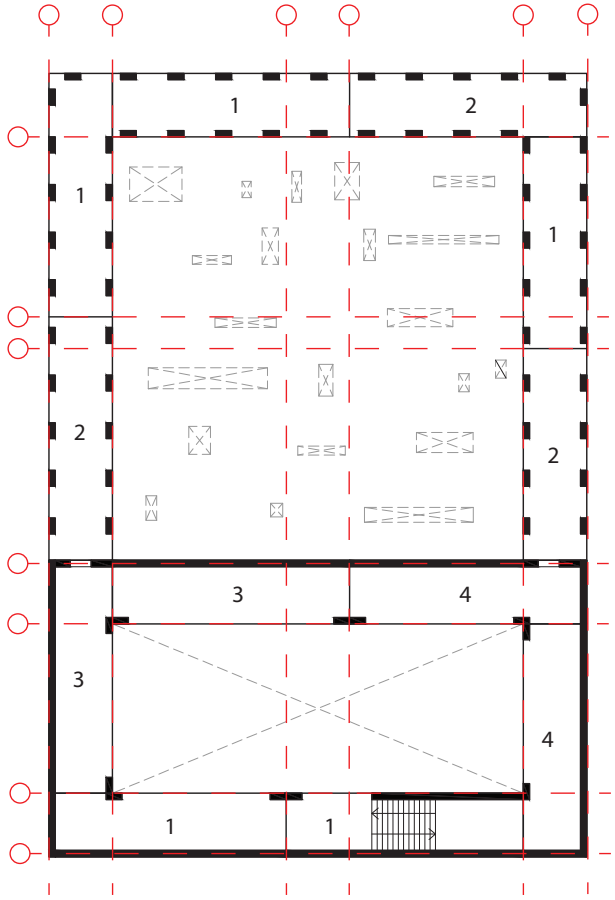
First Floor Plan #2



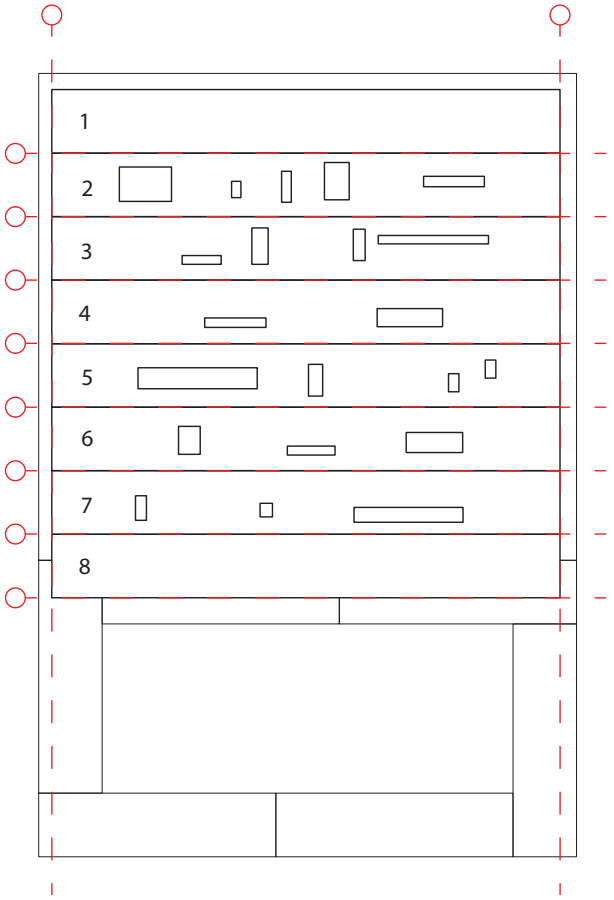
Understanding the space as a set of grids



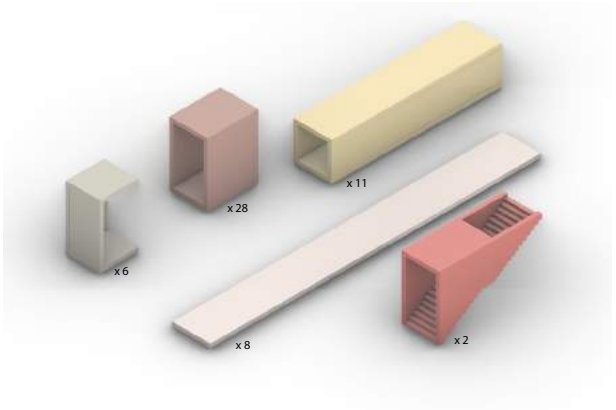
Ground Floor Plan



1st Floor Plan

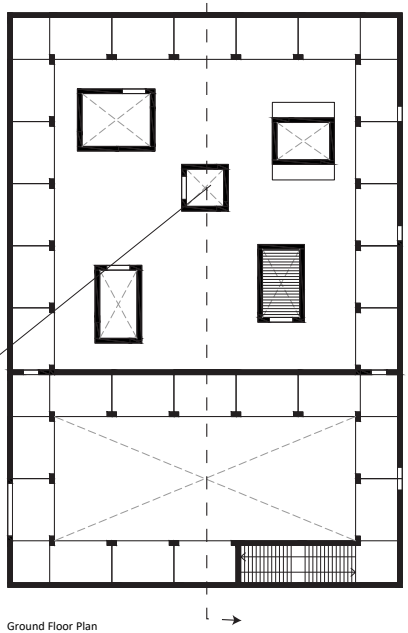


Roof Plan

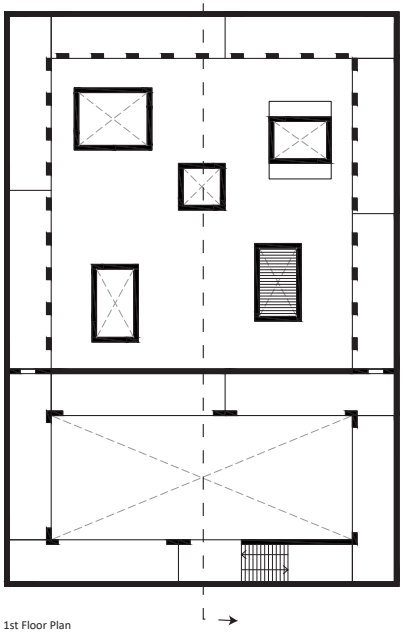


Understanding the space by counting & as a set of grids

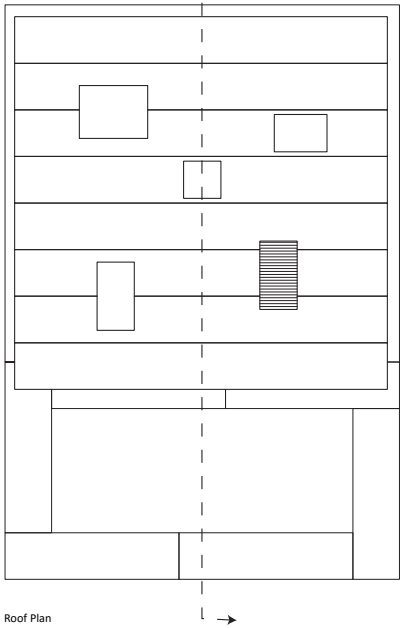
90°



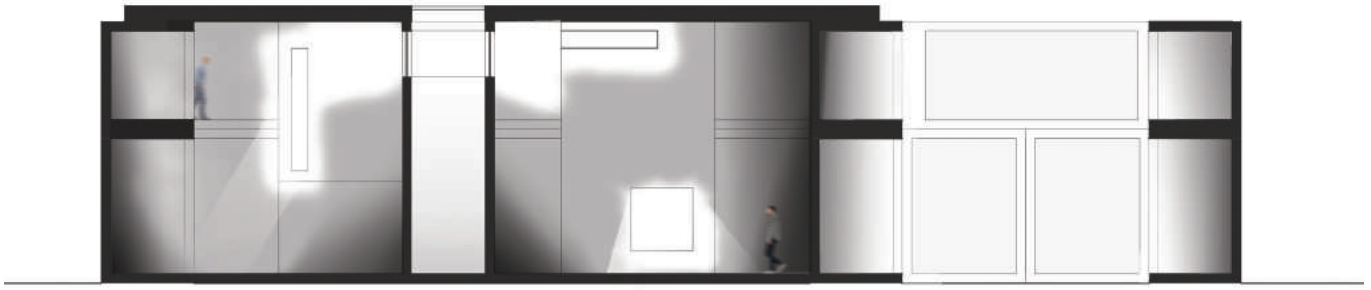
Ground Floor Plan



1st Floor Plan



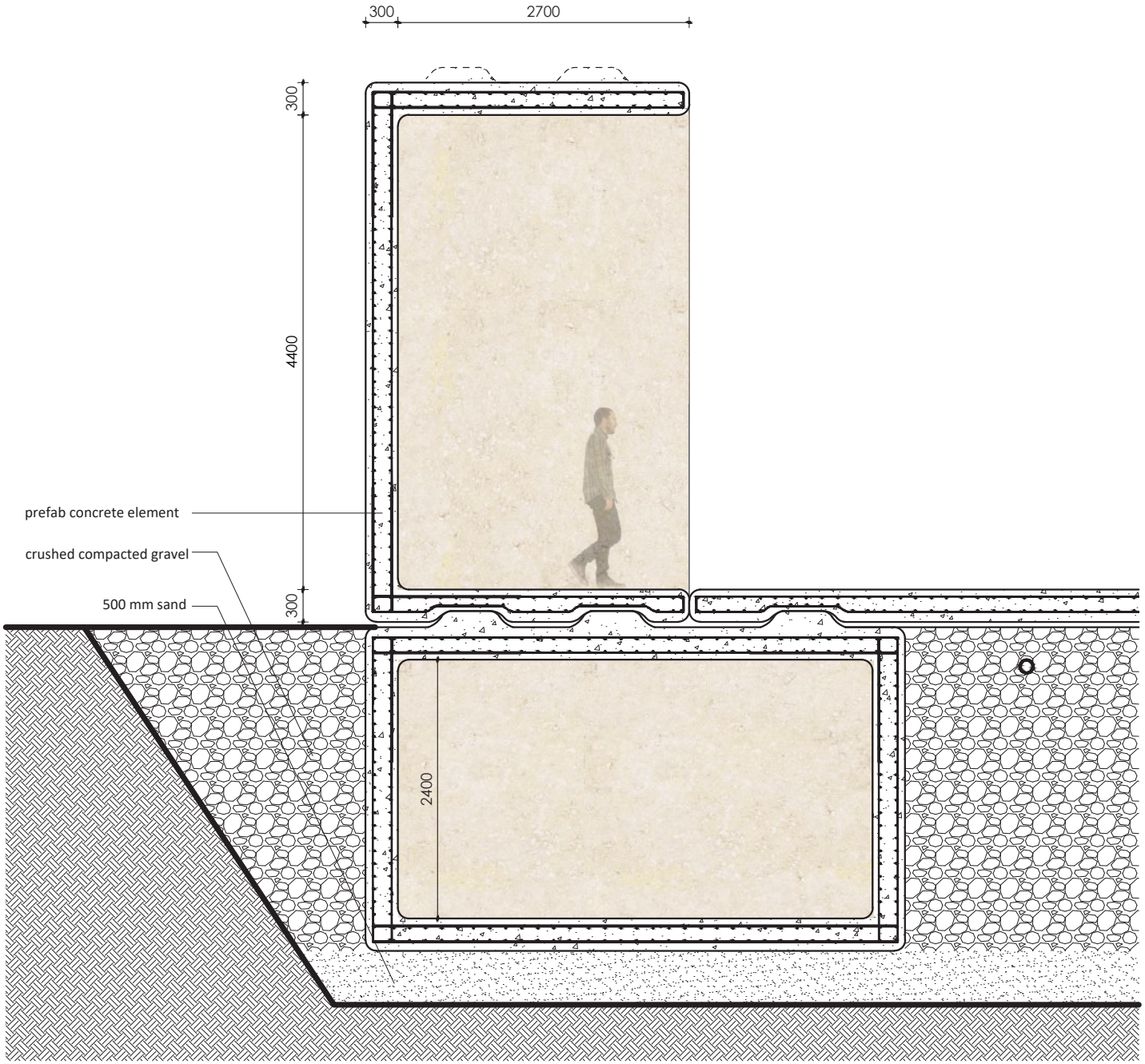
Roof Plan



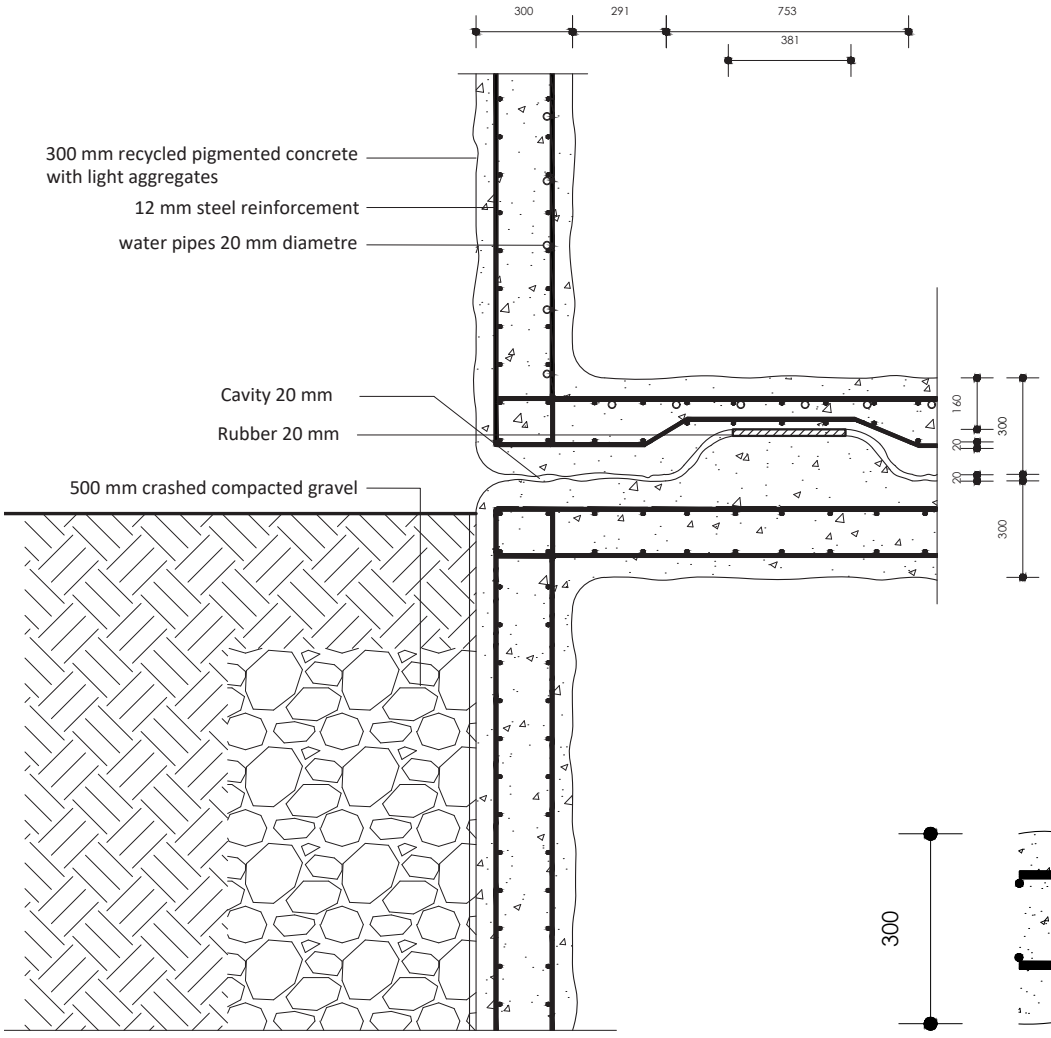
An understanding of space which is about the light conditions / transitions

Technical Aspects:

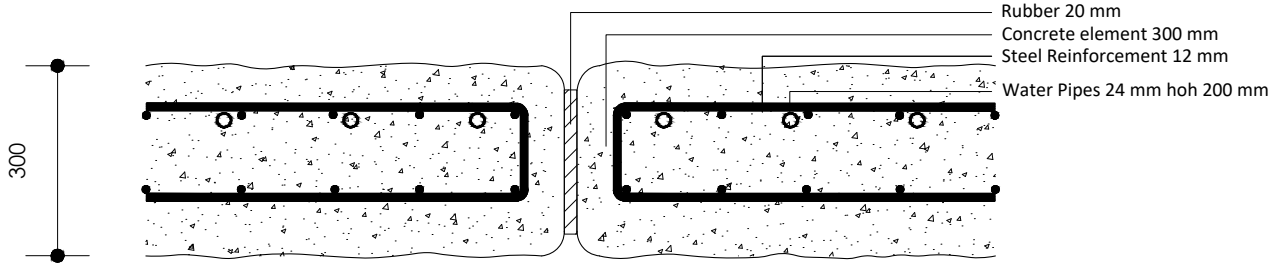
Structure, Fabrication Process, Customization,
Climate & Comfort



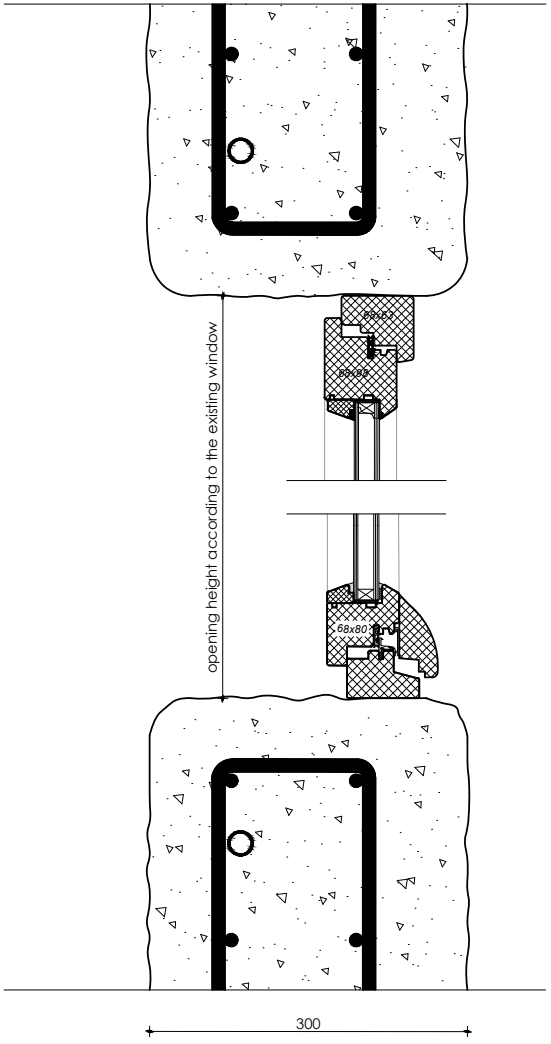
detail: Interlocking Structure
scale 1:20



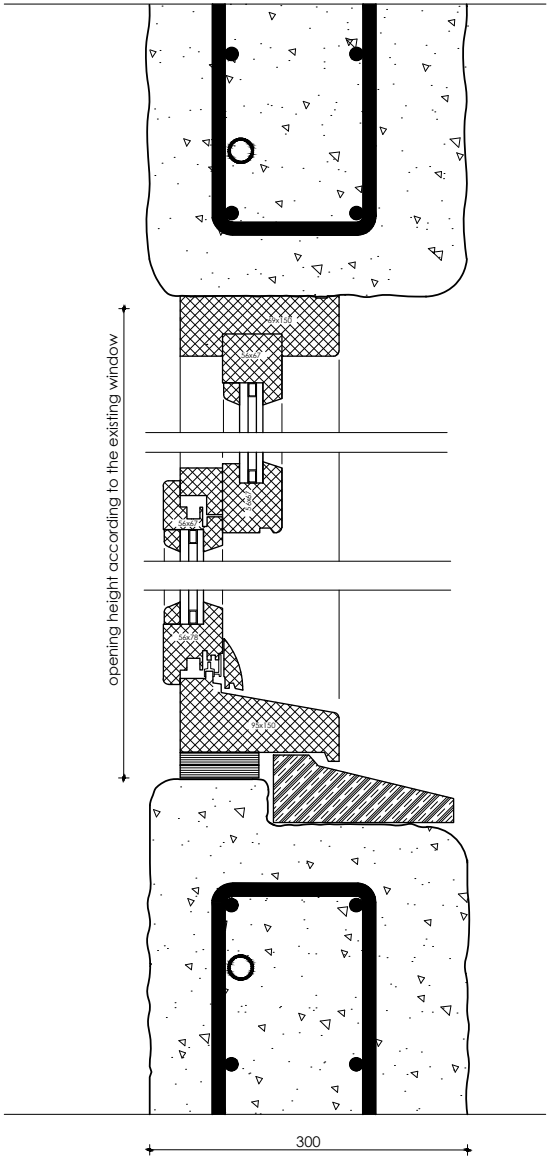
detail floor - foundation
scale 1:10

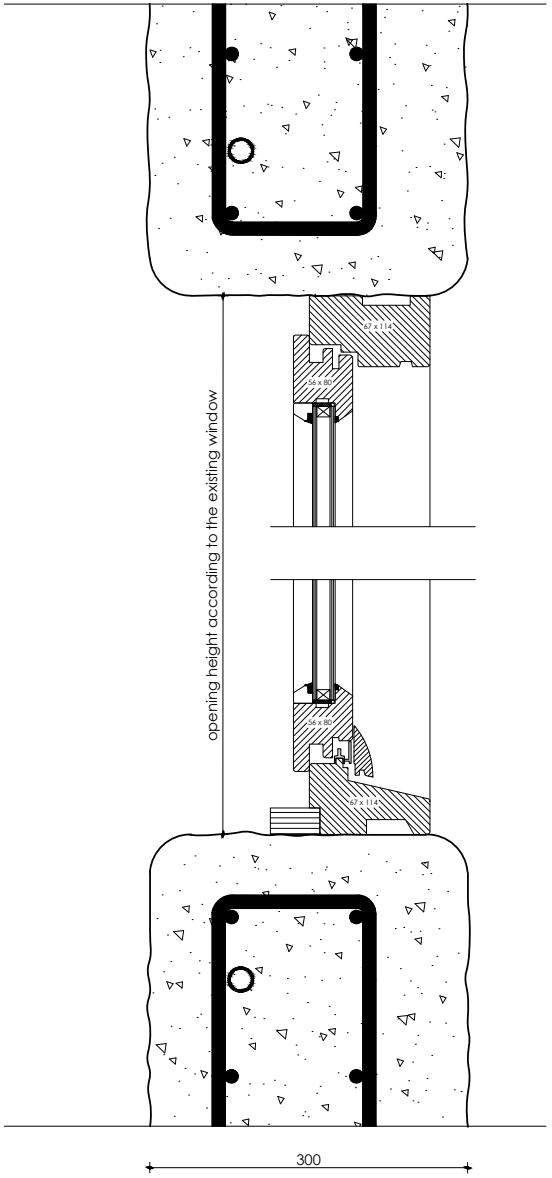


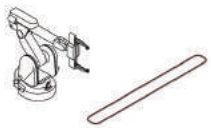
Horizontal Detail
1:5



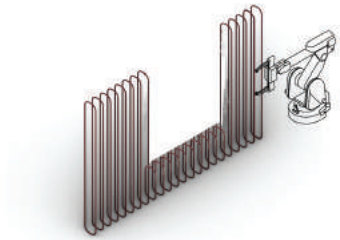
Opening Details
Scale 1:5



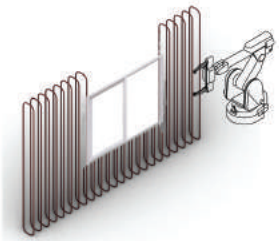




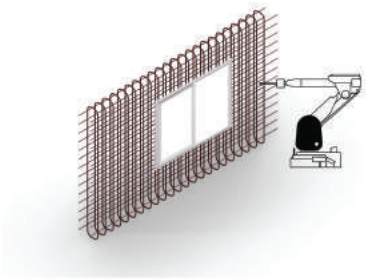
Prefabrication of vertical reinforcement



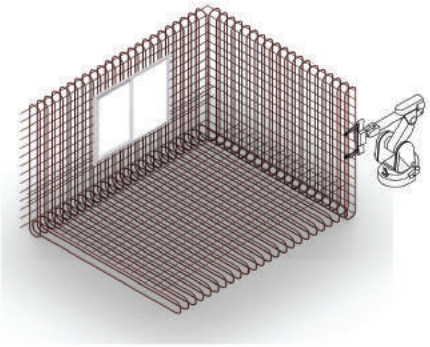
Assemblage of vertical reinforcement forming a specific size opening



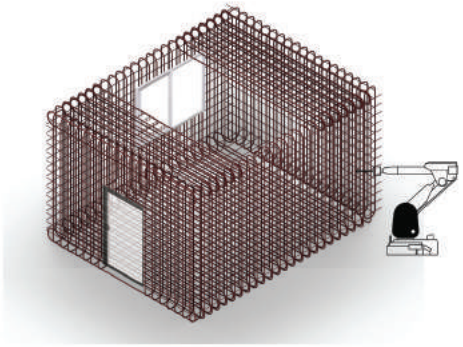
Existing window re-used and places within the fabricated opening



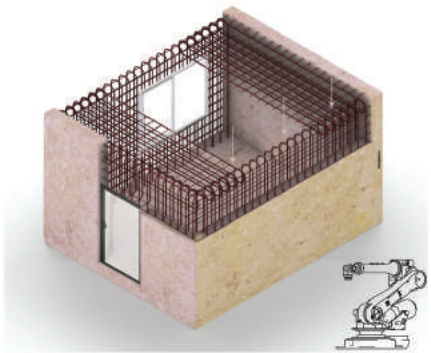
Prefabrication of horizontal reinforcement via Novel robotic wire application



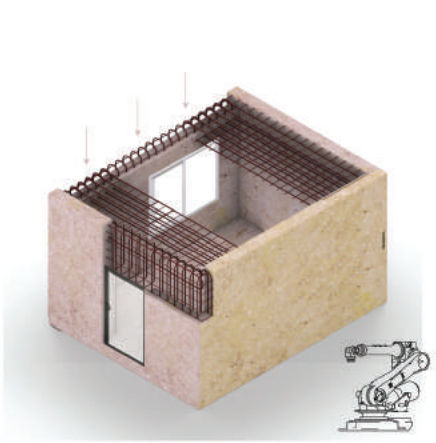
Assemblage of the different sides of the concrete element



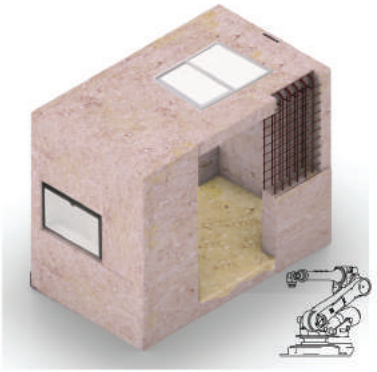
Prefabrication of the last horizontal reinforcement after door installation



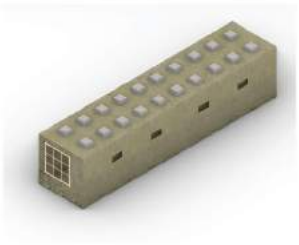
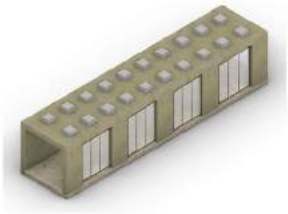
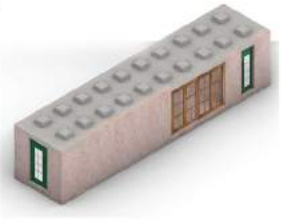
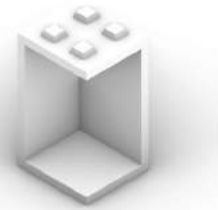
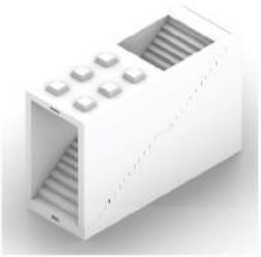
Concrete spraying using the robotic arm. The robot first applies the concrete on the inside of the element and customises each side according to a specific colour

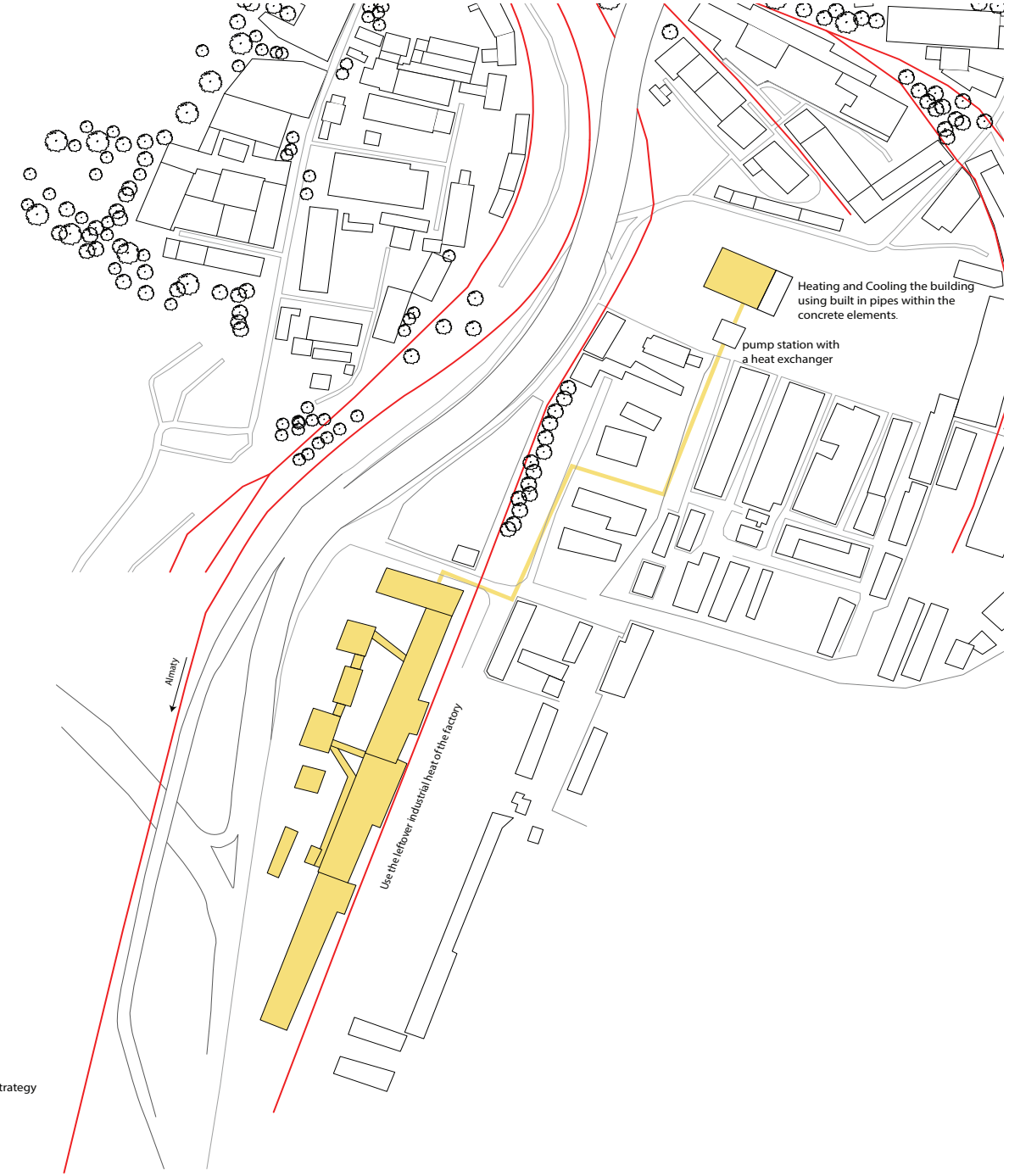


Concrete spraying using the robotic arm from the outisde. The inside and outside concrete differ in their aggregates size.



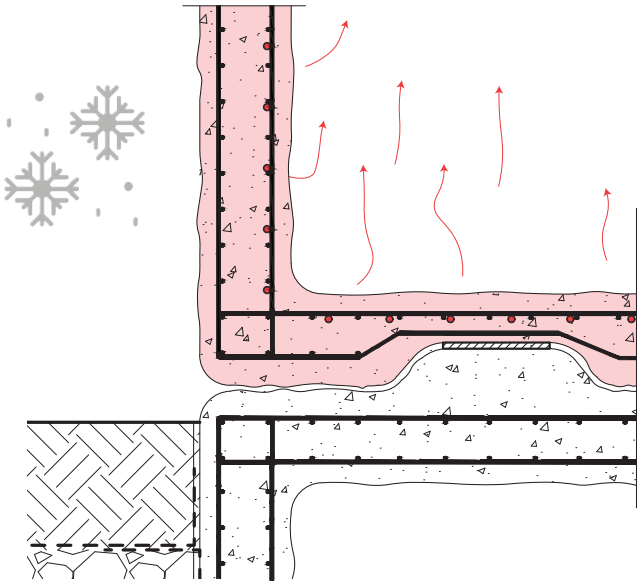
After the concrete is dried, the element is flipped 90 degrees in order to apply concrete on the roof

digital elements	∞ Possible Customised Outcomes / Varibles: Openings, Colour of concrete, size of aggregates, rotation				
1. 	1a. 	1b. 	1c. 	1d. 	1e. 
2. 	2a. 	2b. 	2c. 	2d. 	2d. 
3. 	3a. 	3b. 	3c. 	3d. 	3d. 
4. 	4a. 	4b. 	4c. 	4d. 	4e. 
5. 	5a. 	5b. 	5c. 	5d. 	5e. 

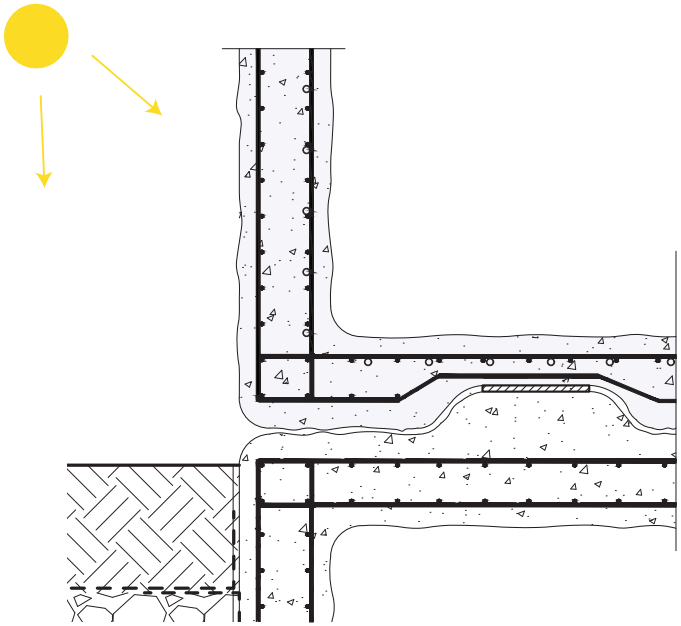


Heating / Cooling strategy

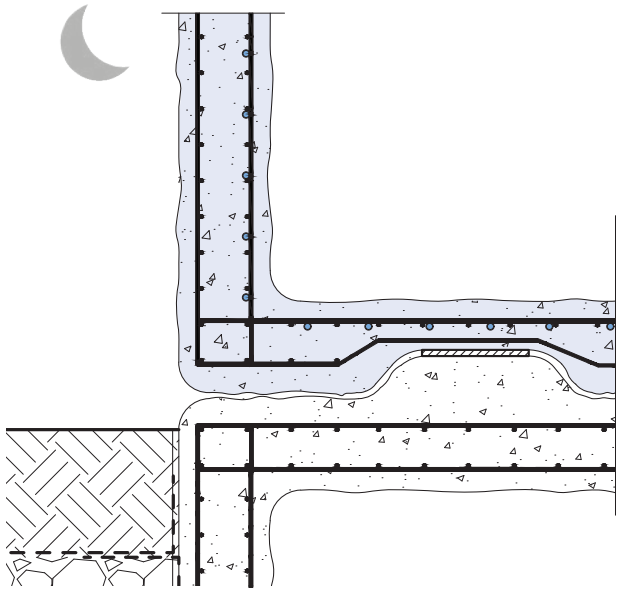
Thermal Comfort: Active Insulation: Re-use of excessive heat



Thermal Comfort: Winter
Active Insulation / Using the mass of the concrete to heat up the space

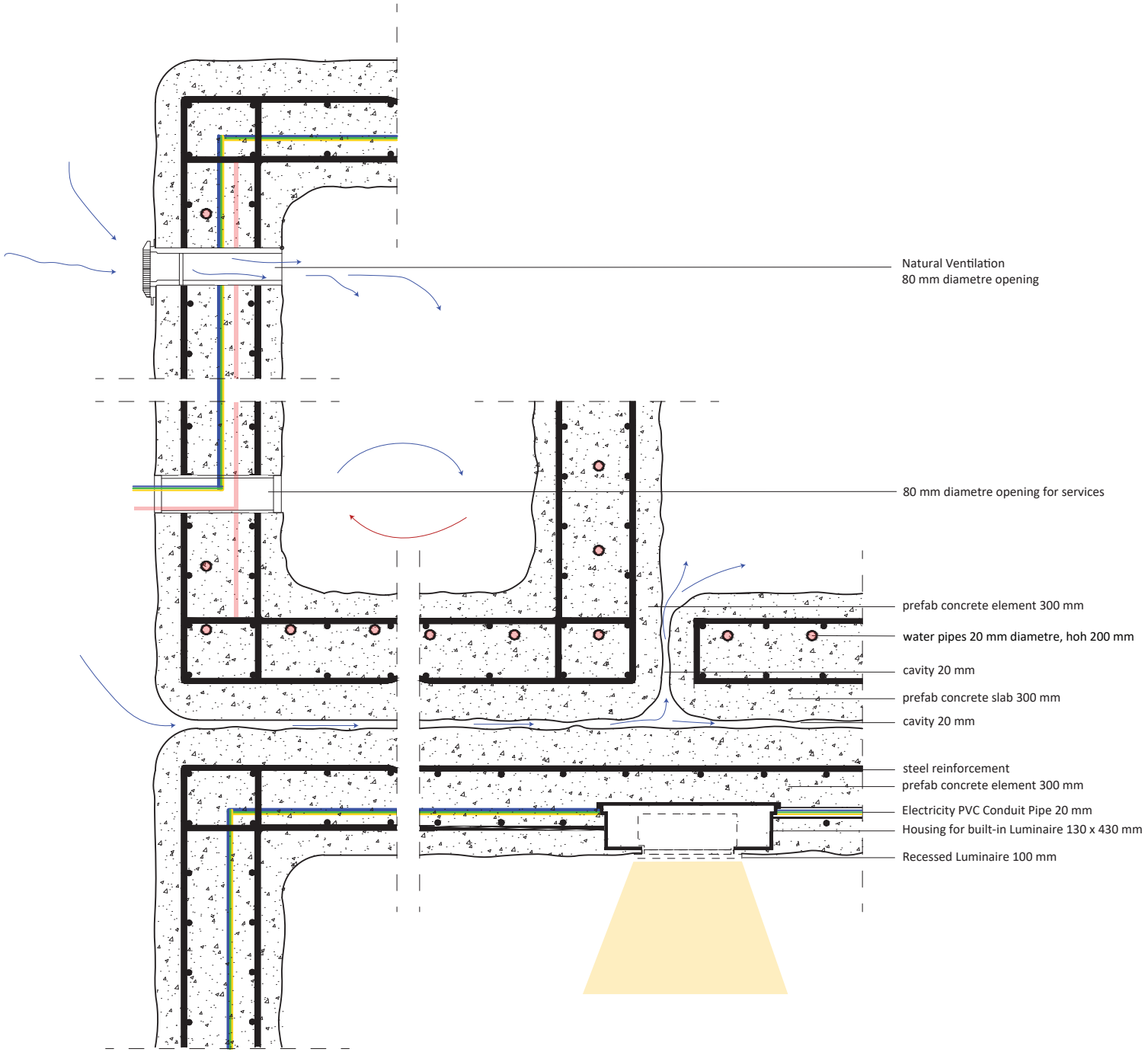


Thermal Comfort: Summer - Daytime
Active Insulation: Using the mass of the concrete to cool down the space

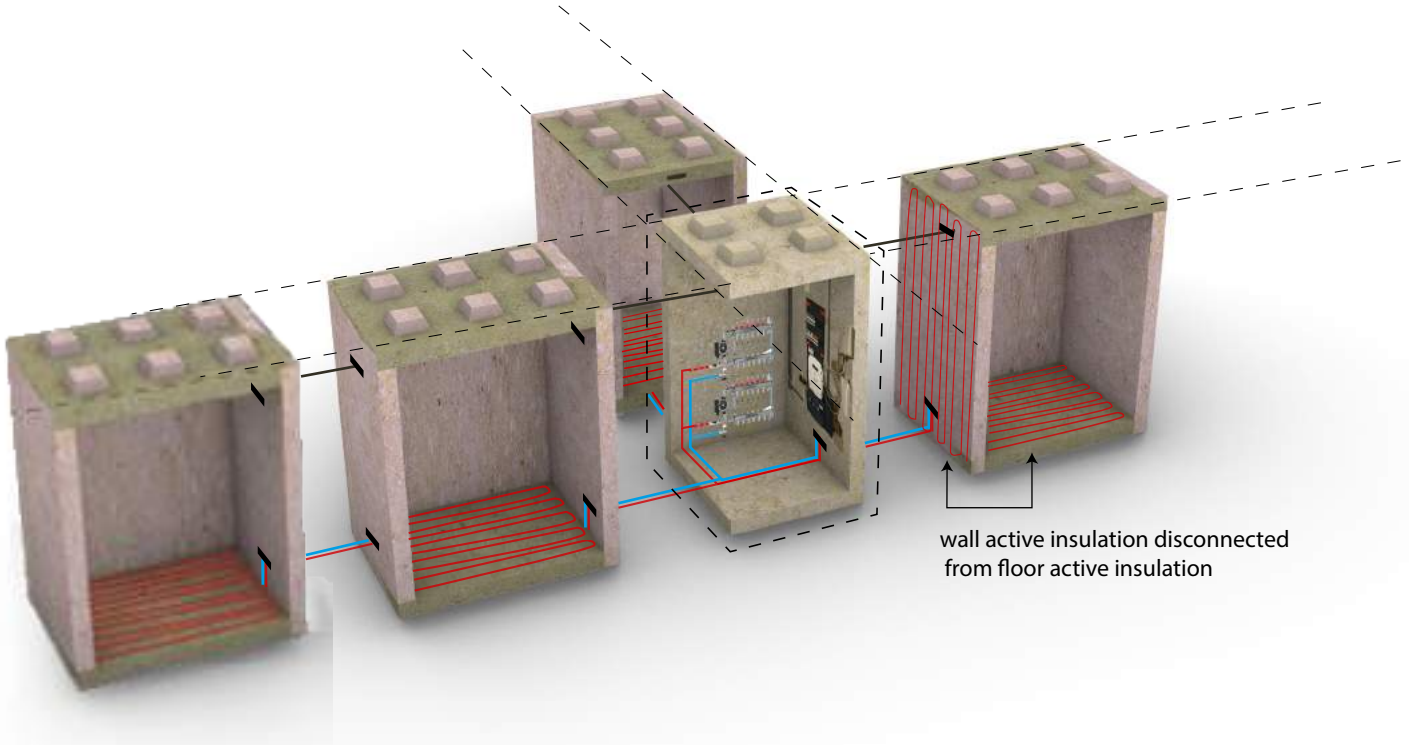


Thermal Comfort: Summer - Nighttime
Active Insulation: Using the mass of the concrete to cool down the space

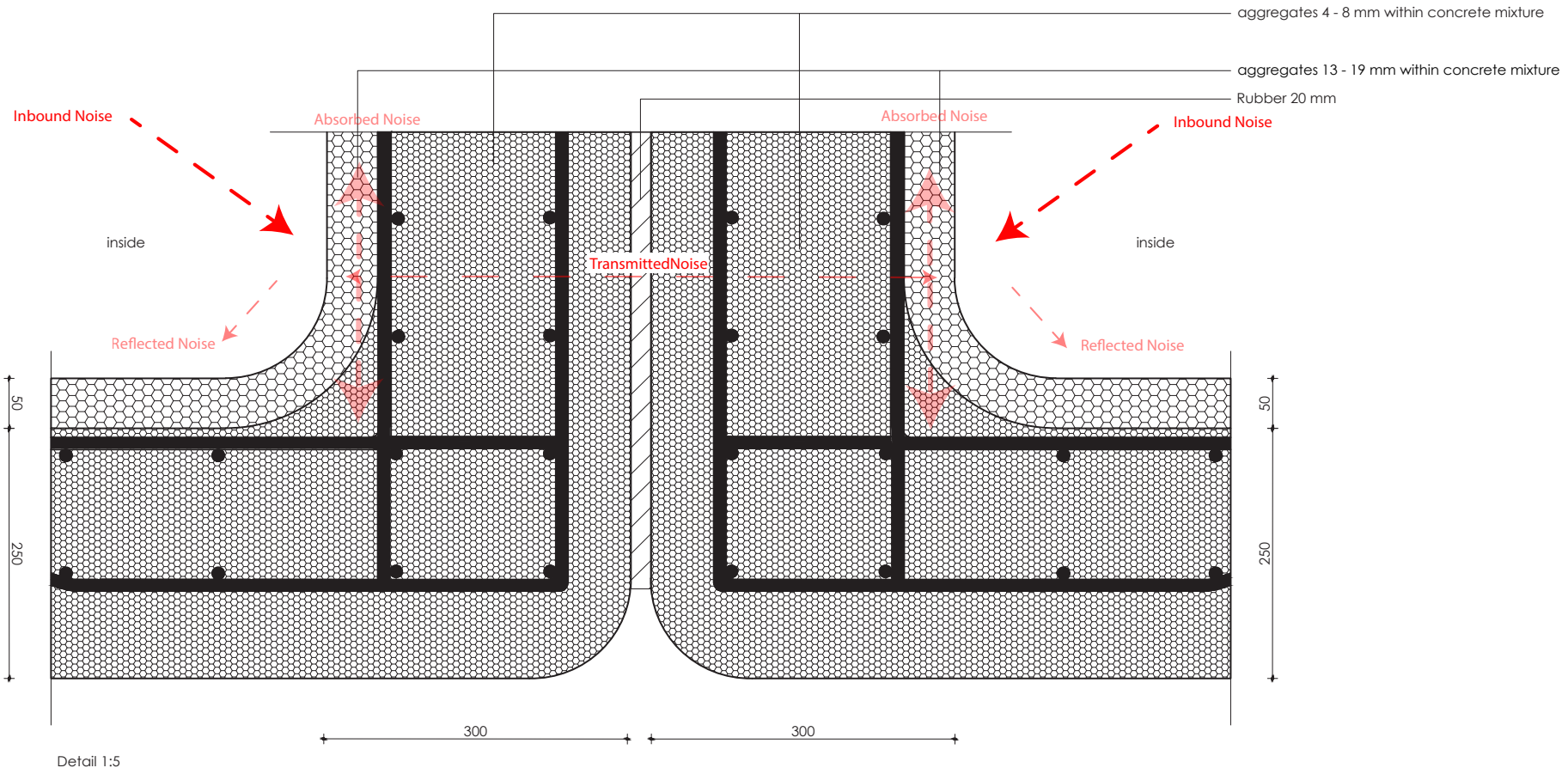
Thermal Comfort: Active Insulation: Re-use of excessive heat


Natural Ventilation
80 mm diametre opening
80 mm diametre opening for services
prefab concrete element 300 mm
water pipes 20 mm diametre, hoh 200 mm
cavity 20 mm
prefab concrete slab 300 mm
cavity 20 mm
steel reinforcement
prefab concrete element 300 mm
Electricity PVC Conduit Pipe 20 mm
Housing for built-in Luminaire 130 x 430 mm
Recessed Luminaire 100 mm

detail 1:10

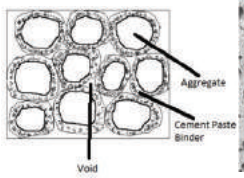


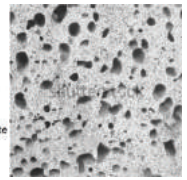
One concrete element can be used as a technical room.
Water pipes and electricity instllations are connected to the technical room via openings on the concrete
Openings can be used for servises or ventilation


aggregates 4 - 8 mm within concrete mixture
aggregates 13 - 19 mm within concrete mixture
Rubber 20 mm
Inbound Noise
Absorbed Noise
Absorbed Noise
Inbound Noise
inside
TransmittedNoise
inside
Reflected Noise
Reflected Noise
50
250
50
250
300
300

Detail 1:5

Porus Concrete





Porus Soil

Composition:
Gap-graded aggregates
Thin layer of cement paste
Void

Porus Concrete: 15 - 22% void space
Conventional Concrete: 3 - 5% void space

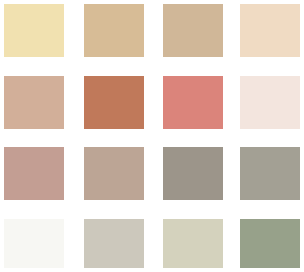
Application: Light duty uses

Consequences:
Increase in void => Decrease in weight
=> Increase in Noice Absorption (changing when changing the ingredients) (size of aggregates, size of gaps and amount of cement flow in between. - Max sound absorption when: aggregates are smaller (4-19mm), when decreasing the cement flow and when using double layered porous concrete: front side 4 - 8 mm lightweight aggregates and the back 8-13 or 13-19 mm normal aggregates.
=> Increase in natural ventilation / heat exchnge / decentralised ventilation (sizes / number of voids)
=> Decrease in Strength

Increase of porosity => decrease of thermal conductivity.

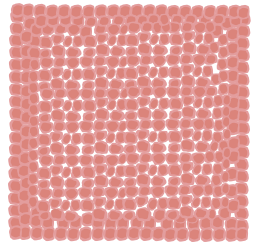
Pigmented concrete

Pigment Pallette - Earth Tones inspired by soil / rocks

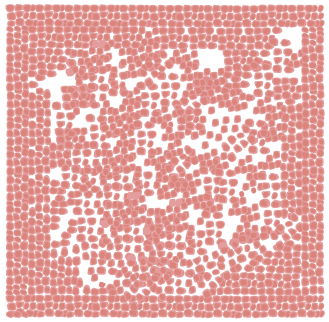


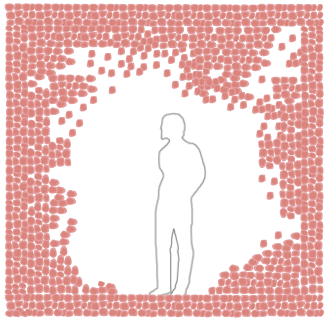
Pigmented Porous Concrete

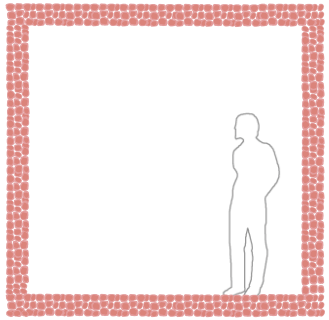
Pigmented Porous Solid Concrete Beam



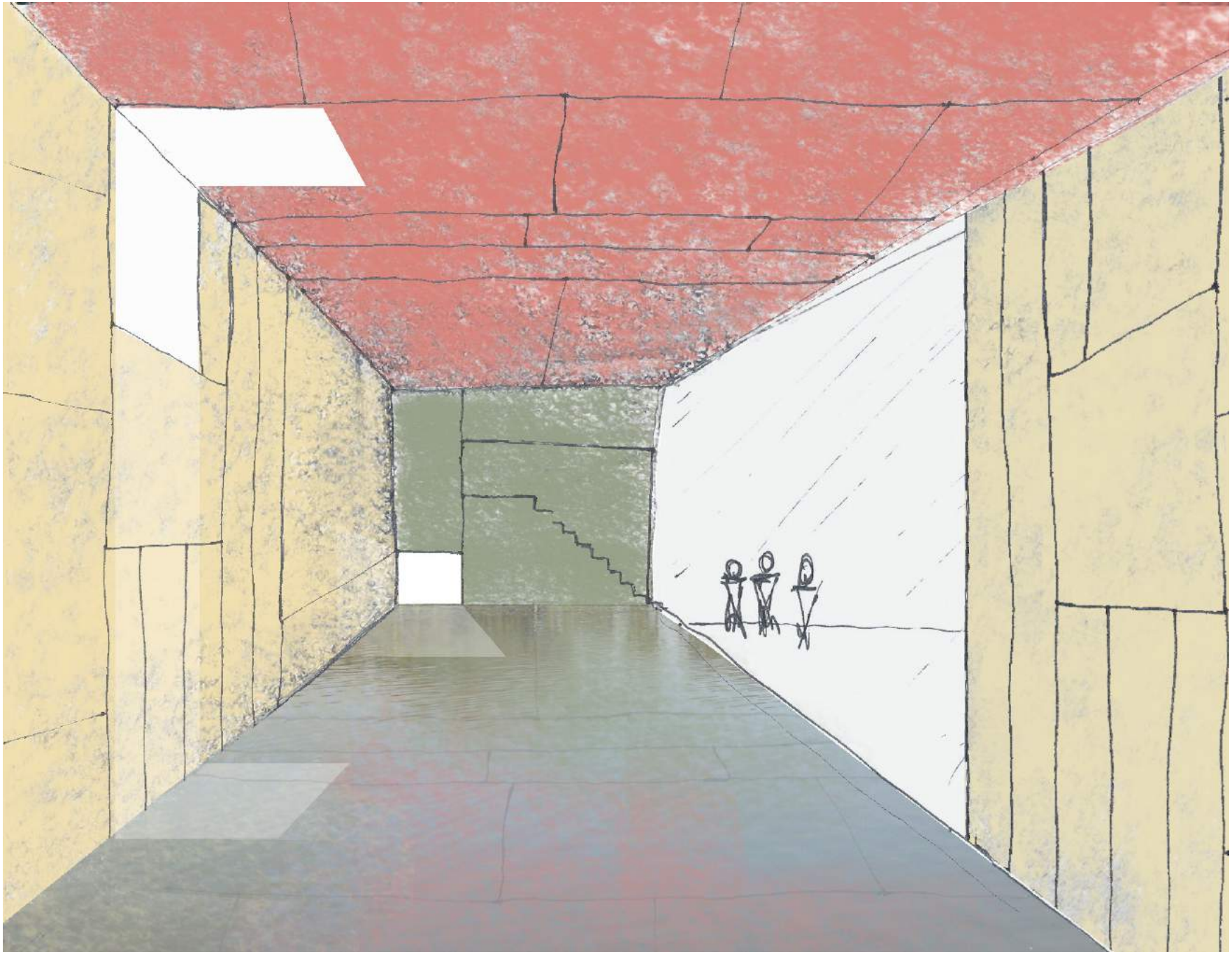
Inhabitable Pigmented Porous Concrete Beam

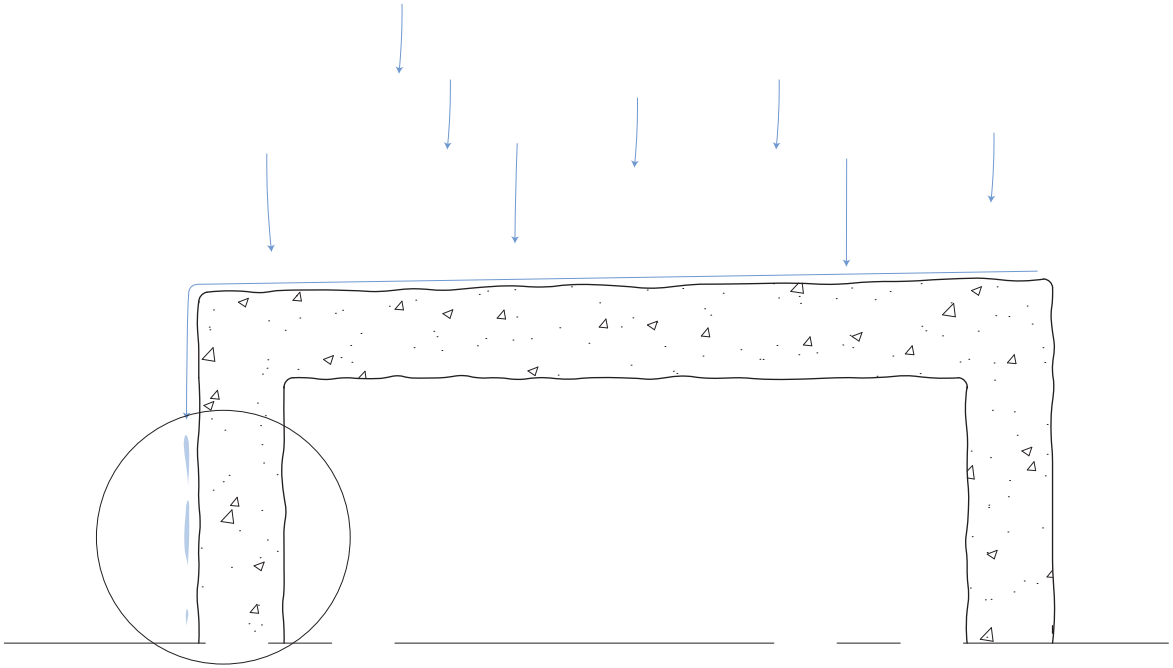






Porosity and colour pallette

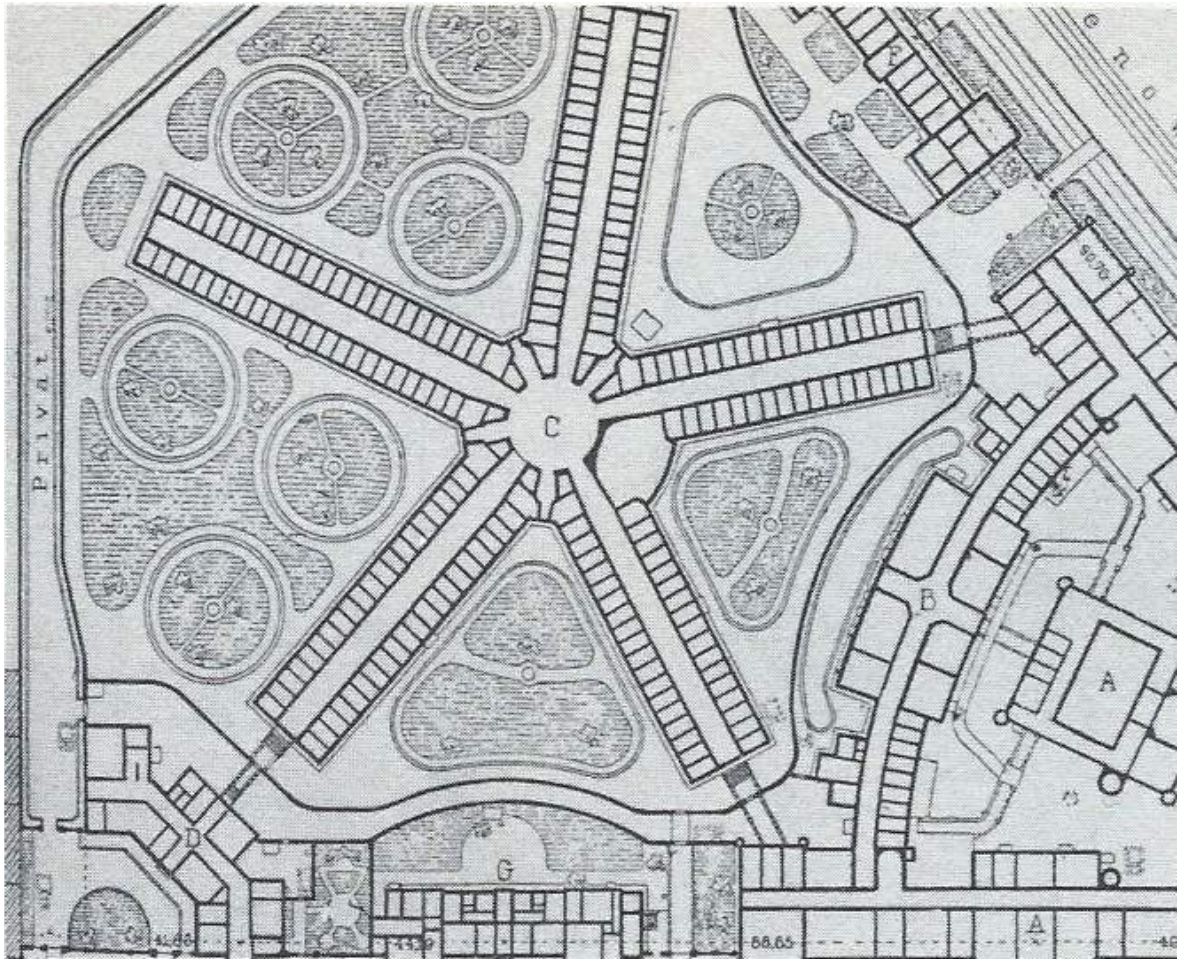




Roof has an inclination of 1 degree in order for the rain water to leave the roof of the concrete element and fall on the ground

Wet concrete Surface

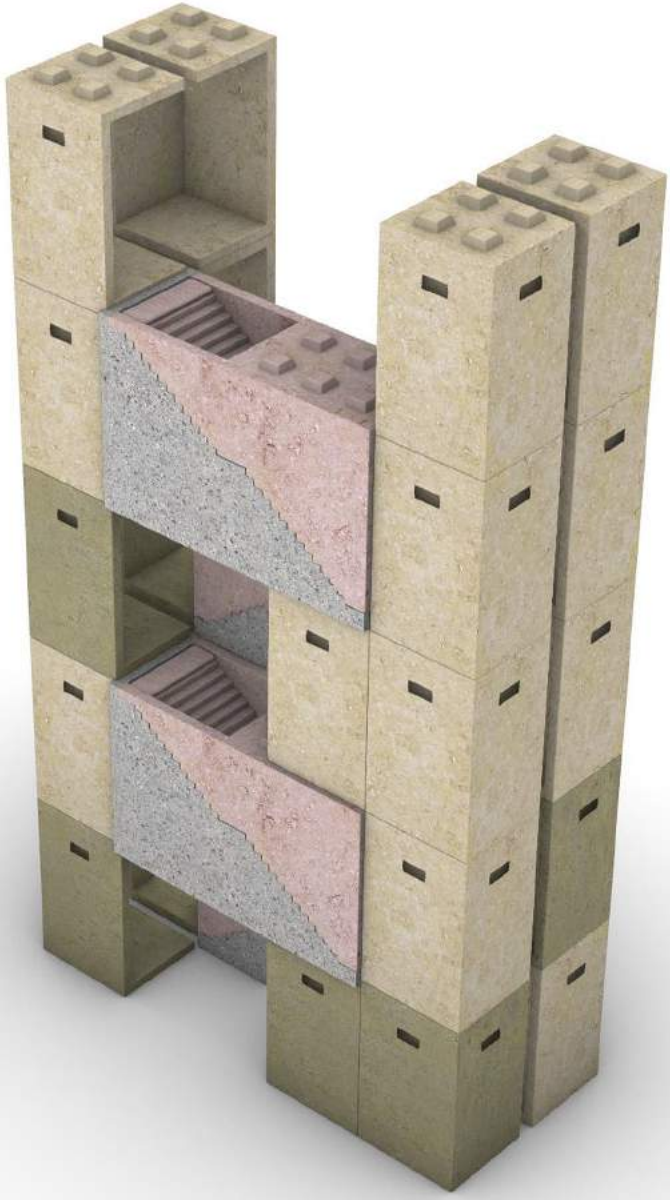
Part 3a: Reflections & Conclusions



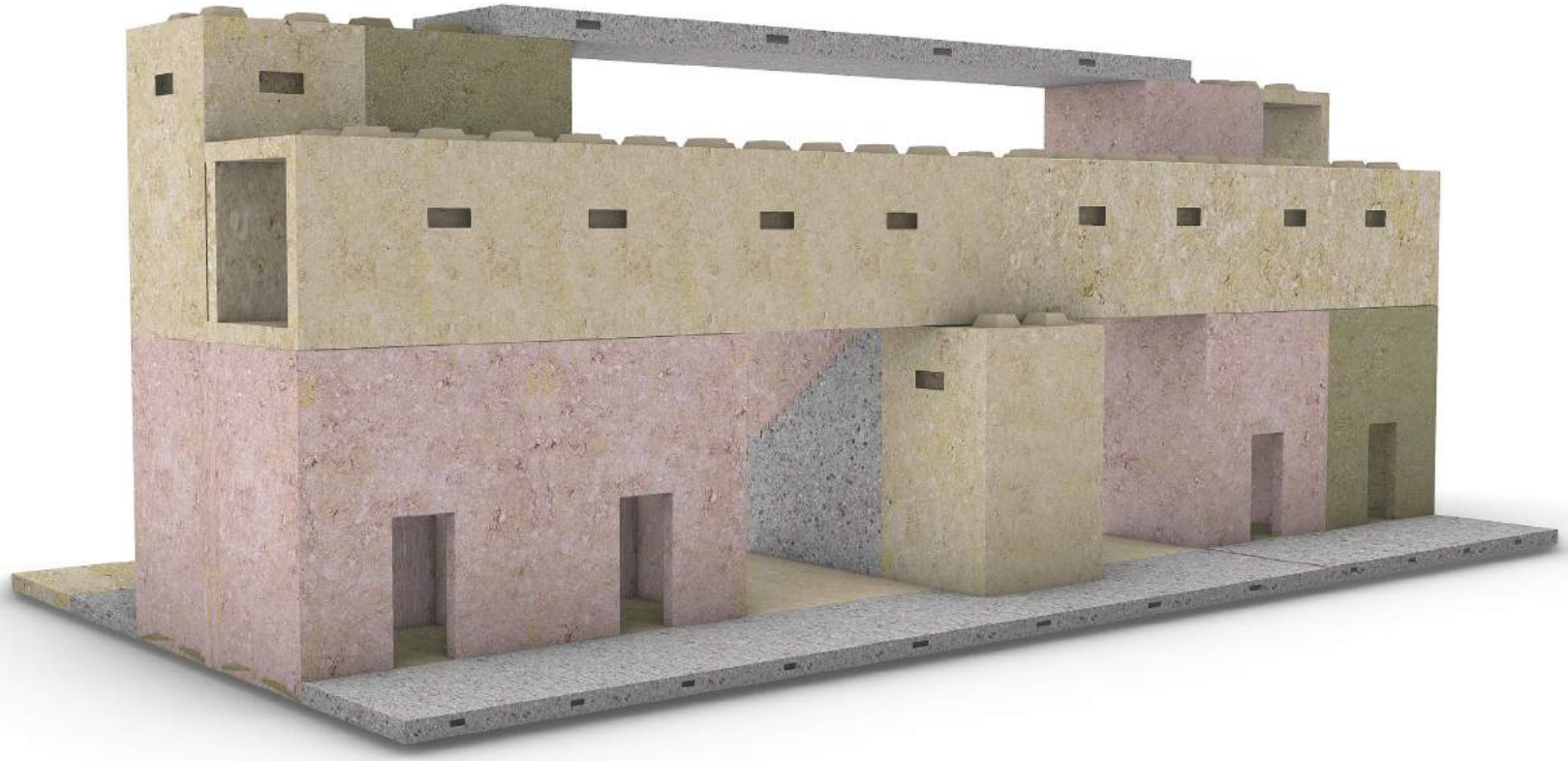
Second Moabit Prison, Berlin, 1869 - 79 by Hermann
Source: A History of Building Types, Nikolaus Pevsner

Second Moabit Prison, Berlin, 1869 - 79 by Hermann
Source: A History of Building Types, Nikolaus Pevsner

Nakagin Capsule Tower, Kisho Kurokawa, Japan
Source: https://www.google.com/search?q=Nakagin+Capsule+Tower&sxsrf=ALeKk028SV337YZESrhHH-It--C1RPhR-A:1621328217398&source=lnms&tbm=isch&sa=X&ved=2ahUKEwjw-9ij7tLwAhWHMBQKHaGUDBoQ_AUoAXoECAEQAw&biw=1920&bih=969#imgrc=aggzPrp4uQhbRM



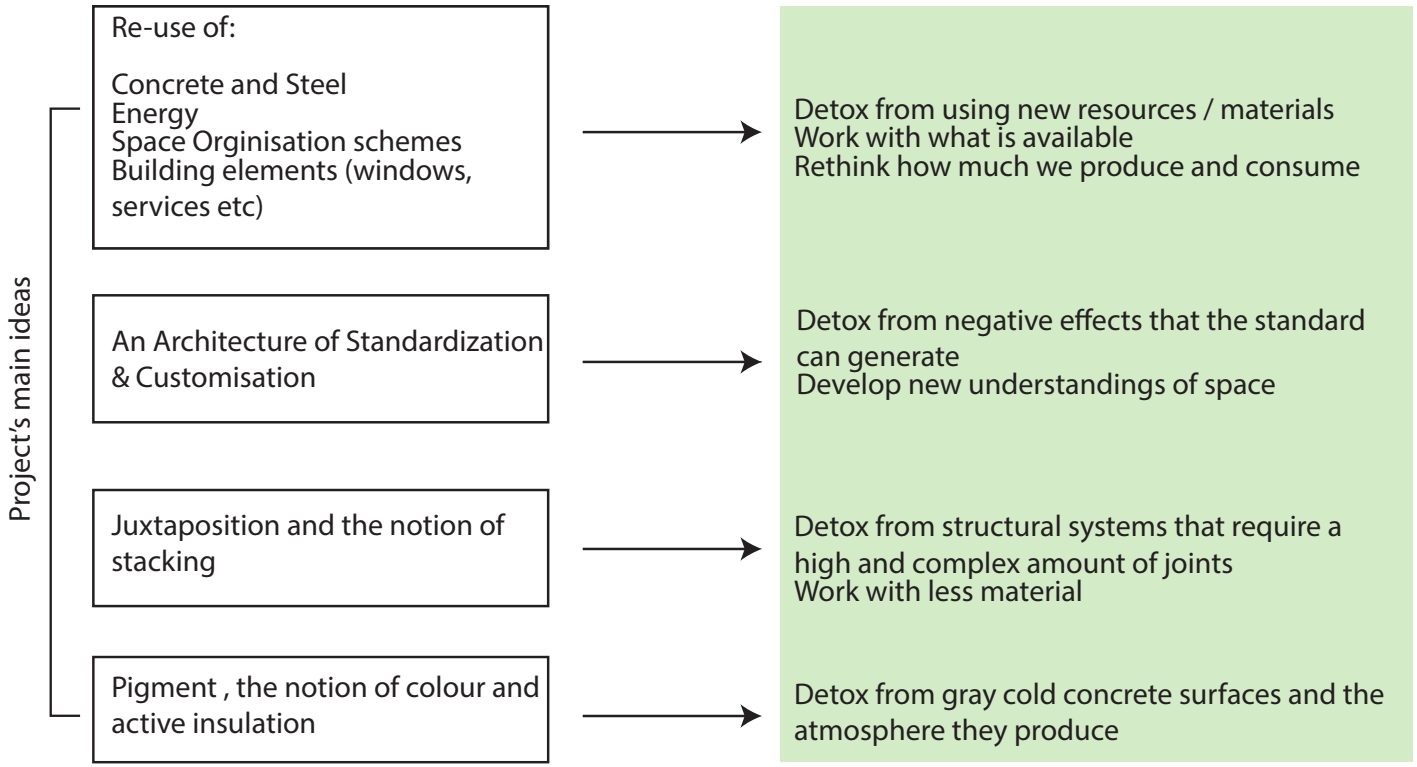
Speculating on a type of architecture made out of reycled pigmented concrete elements



Speculating on a type of architecture made out of reycled pigmented concrete elements

Interior atmosphere and mold growth

Exterior facade and vegetitation


Project's main ideas
Re-use of:
Concrete and Steel
Energy
Space Orginisation schemes
Building elements (windows, services etc)
An Architecture of Standardization & Customisation
Juxtaposition and the notion of stacking
Pigment , the notion of colour and active insulation
Detox from using new resources / materials
Work with what is available
Rethink how much we produce and consume
Detox from negative effects that the standard can generate
Develop new understandings of space
Detox from structural systems that require a high and complex amount of joints
Work with less material
Detox from gray cold concrete surfaces and the atmosphere they produce

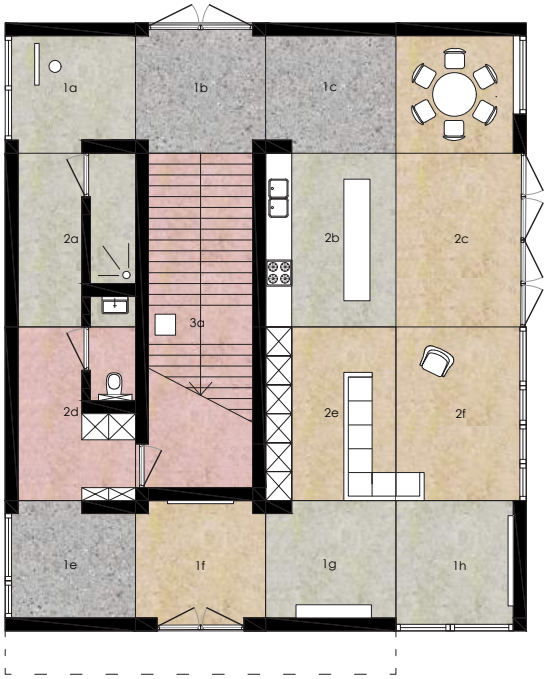
Inspiration: DIY [Do It Yourself] Housing - Kurokawa

Part 3b: Design It Yourself (D.I.Y) House - A House By and For an Architect

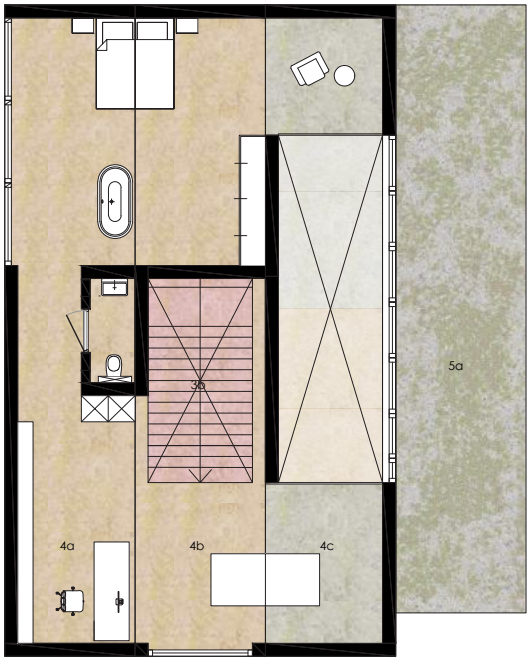
A house prototype using the concrete elements I have developed.
The design will be based on the principles and understandings explained earlier.

Site: Almaty, Kazakhstan.

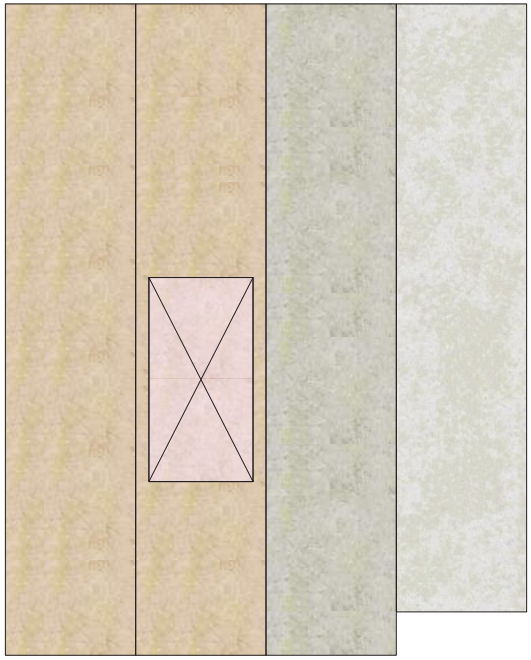
Site: Alatau, Almaty



Ground Floor Plan
scale 1:100



First Floor Plan
scale 1:100



Roof Plan
scale 1:100

Floor plans of D.I.Y House in Alatau

Default elements

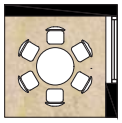
Customized outcomes

Element 1: 3 x 3 m
Height: 5 m

1a:
painting element

1b:
circulation element

1c:
circulation element



1d:
dining element

1e:
circulation element

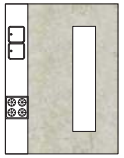
1f:
entrance element
with painting

1g:
circulation element
with furniture

1h:
circulation element
with mirror

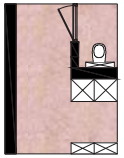
Element 2: 3 x 4 m
Height: 5 m

2a:
circulation / shower /
toilet element

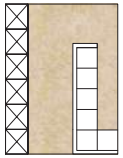


2b:
kitchen element

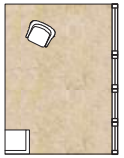
2c:
circulation element



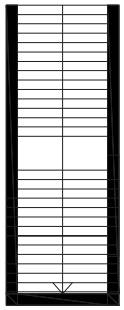
2d:
circulation / toilet /
closet element



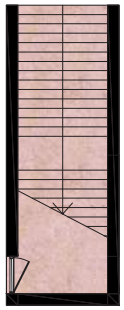
2e:
kitchen / living element



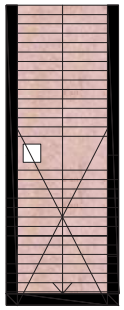
2f:
living / circulation
element



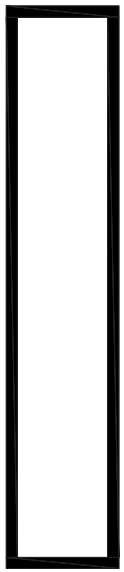
Element 3: 3 x 8 m
Height: 5 m



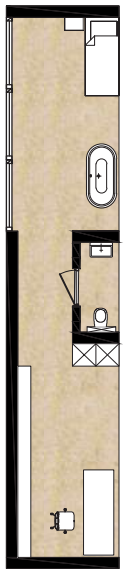
3a:
storage / stairs
element



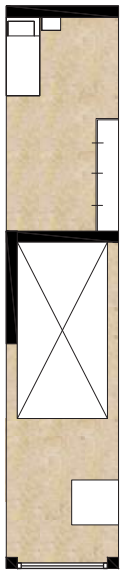
3b:
stairs element



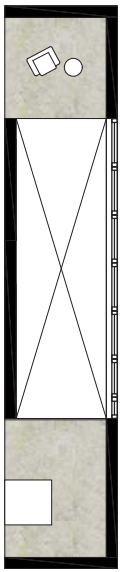
Element 4: 3 x 15 m
Height: 3,6 m



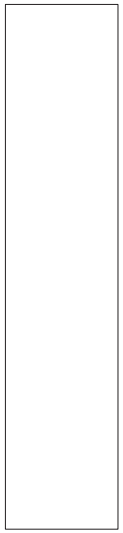
4a:
studio / toilet /
bedroom element



4b:
studio / bedroom
element

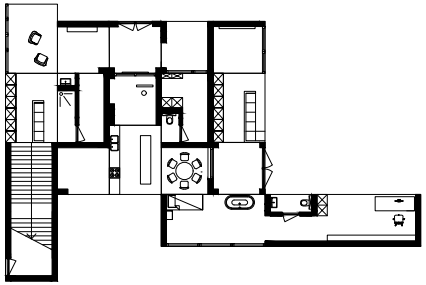


4c:
studio / bedroom
element

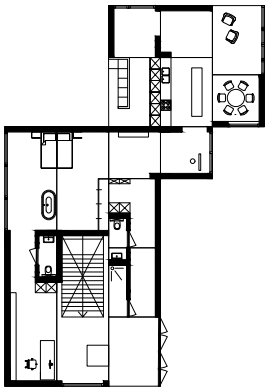


Element 5: 3 x 15 m
Thickness: 0,3 m

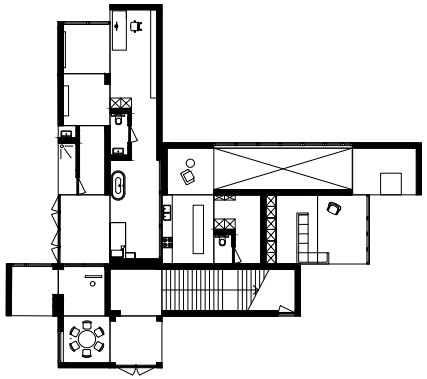
5a:
roof slab element



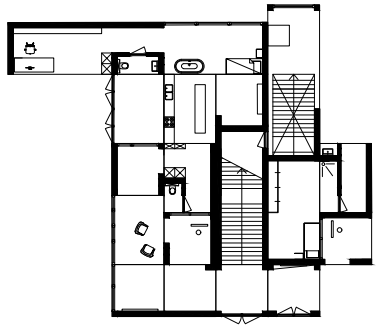
Ground Floor Plan example 1



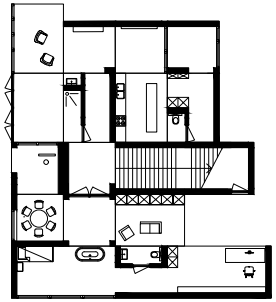
First Floor Plan example 1



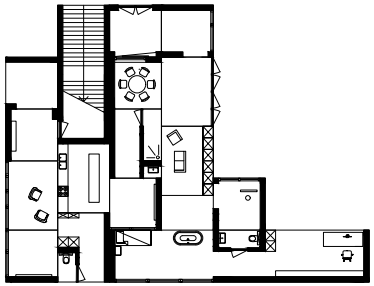
Ground Floor Plan example 4



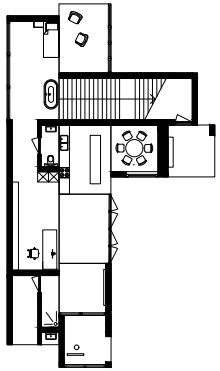
First Floor Plan example 2



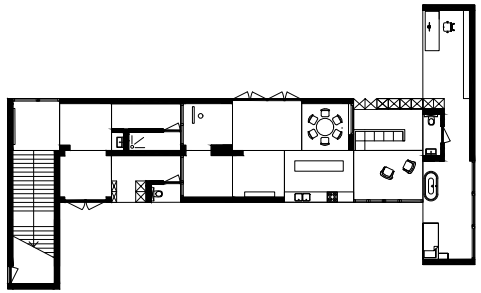
Ground Floor Plan example 2



Ground Floor Plan example 3



Ground Floor Plan example 5



Ground Floor Plan example 6