Bloemkoolwijken - the New Vernacular?

Exploring the potentials of regional bio-based materials for the facade renovation of Bloemkoolwijken in the Netherlands

P5 presentation 23/06/2023

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01.

Introduction

The construction of a Bloemkoolwijk (Rijksdienst vor het Cultureel Erfgoed, n.d.)

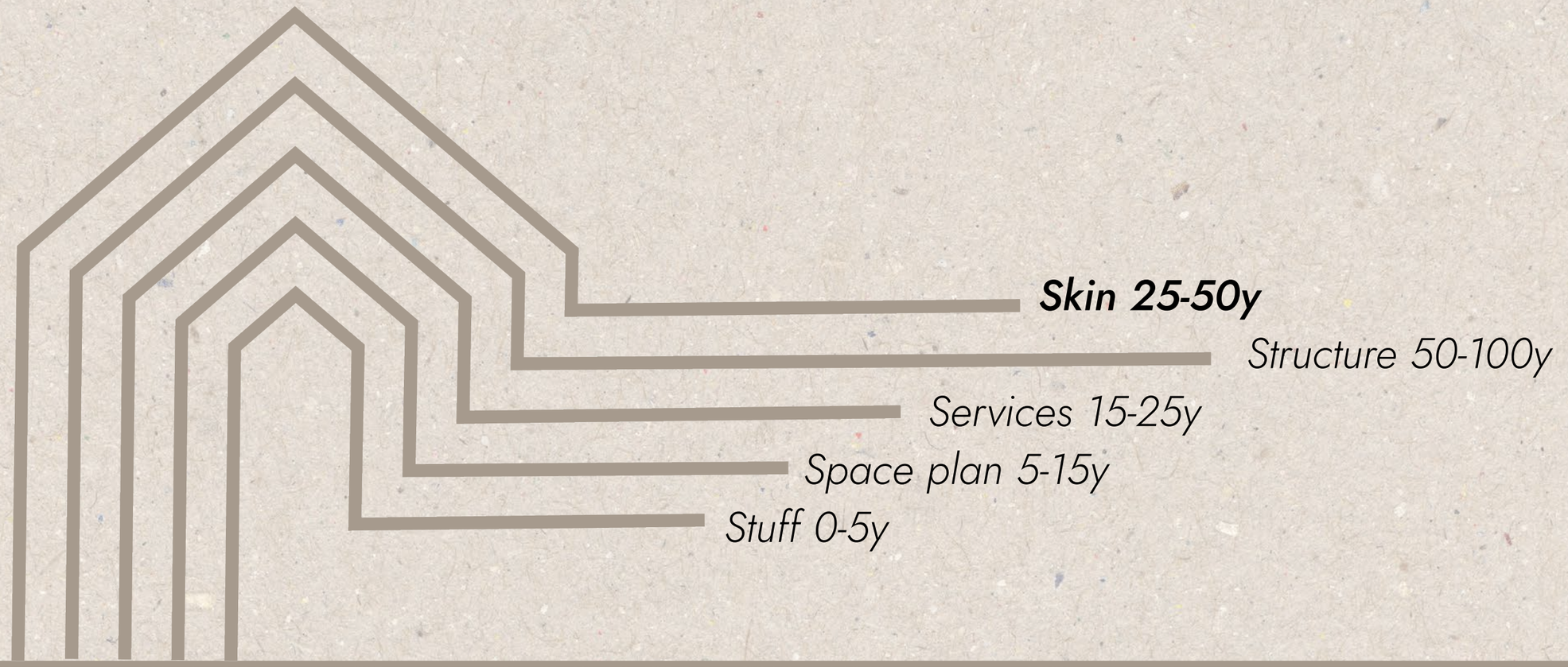
Preface

Post-war housing
1940s-1950s:

Urban
Linear streets
Private
Car

Bloemkoolwijk
1960s-1970s:

Suburban
Organic
Social
Slow traffic

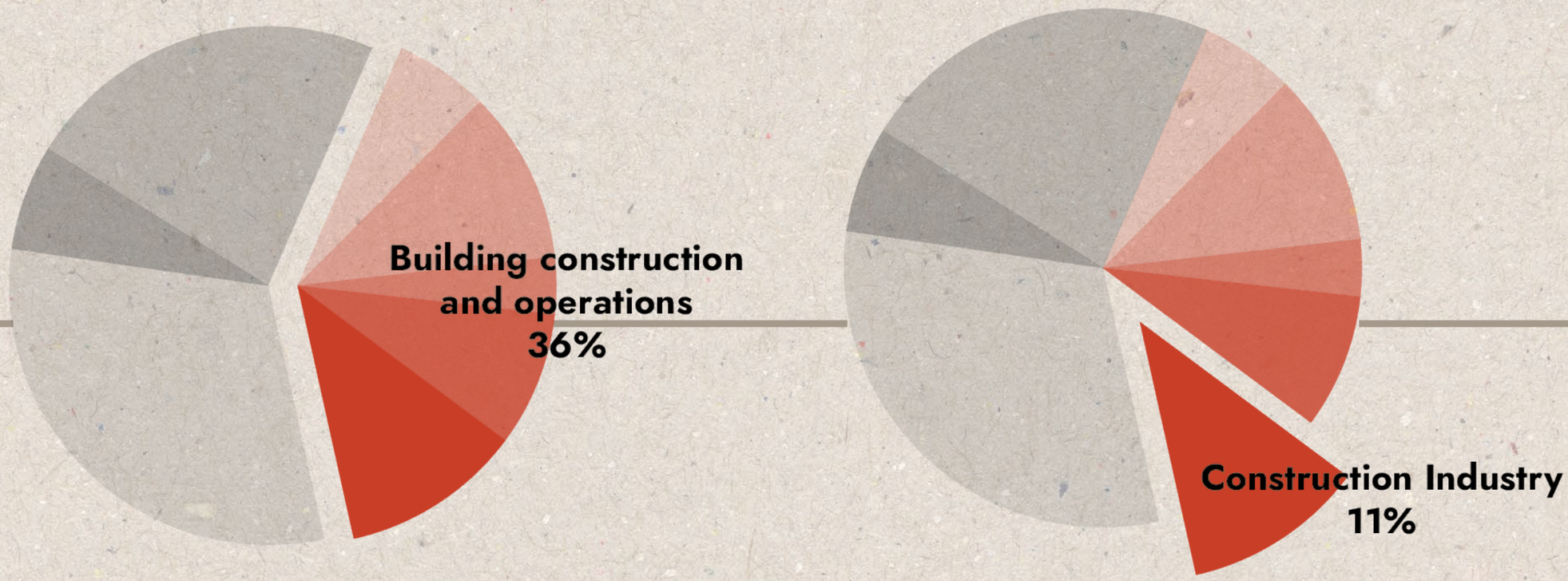


A Building's Shearing Layers
(after Brand, 1994)

1. Need for Renovation

But ...

Emissions building sector
(after IISD, 2022)



2. Emissons of the Building Sector

" Most modern buildings exist in a ''nowhere''; they are not related to a landscape and not to a coherent, urban whole, but live their abstract life in a kind of mathematical-technological space which hardly distinguishes between up and down"

- Cristian Norberg Schulz

3. Little to No Sense of Place

‘‘**Renovation** *by using* **Bio-Based Materials** *from the* **Surrounding Landscape**’’

of ‘Bloemkoolwijken’

01. | Design Assignment

01.
Introduction

02.
Vernacular Architecture

03.
Netherlands as a context

for each Regional landscape

04.
Neighborhoods

05.
Vegetation

06.
Experimentation

07.
Look-books

08.
Proof of concept

09.
Conclusions & Reflection

Literature review

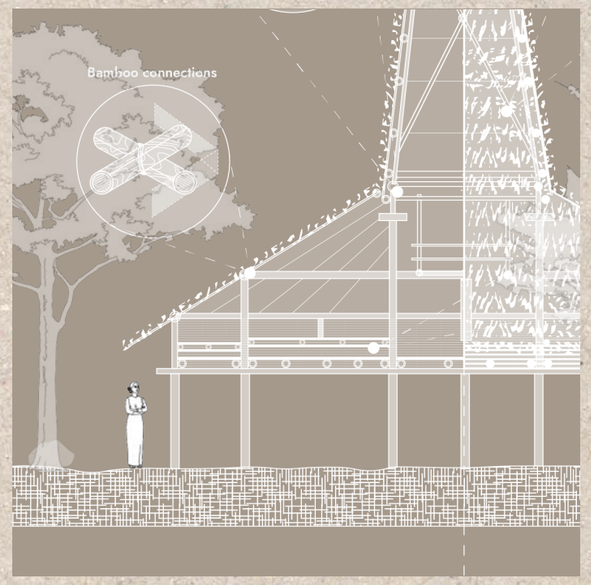
Field research

Research-by-design

.02.

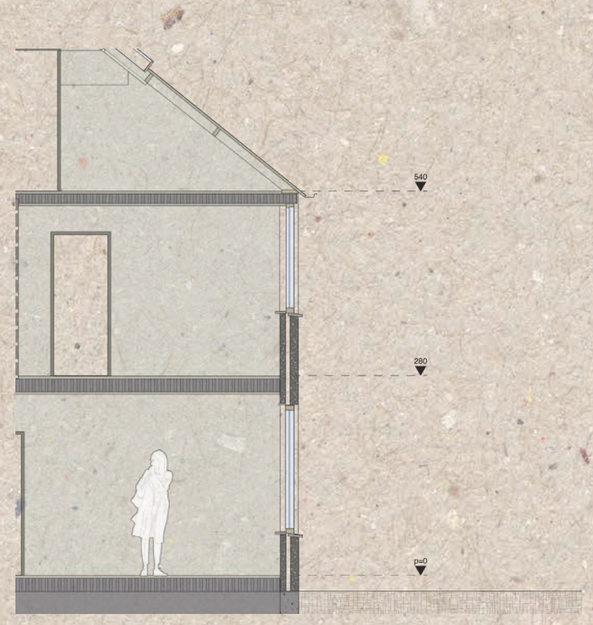
Research

Vernacular Architecture

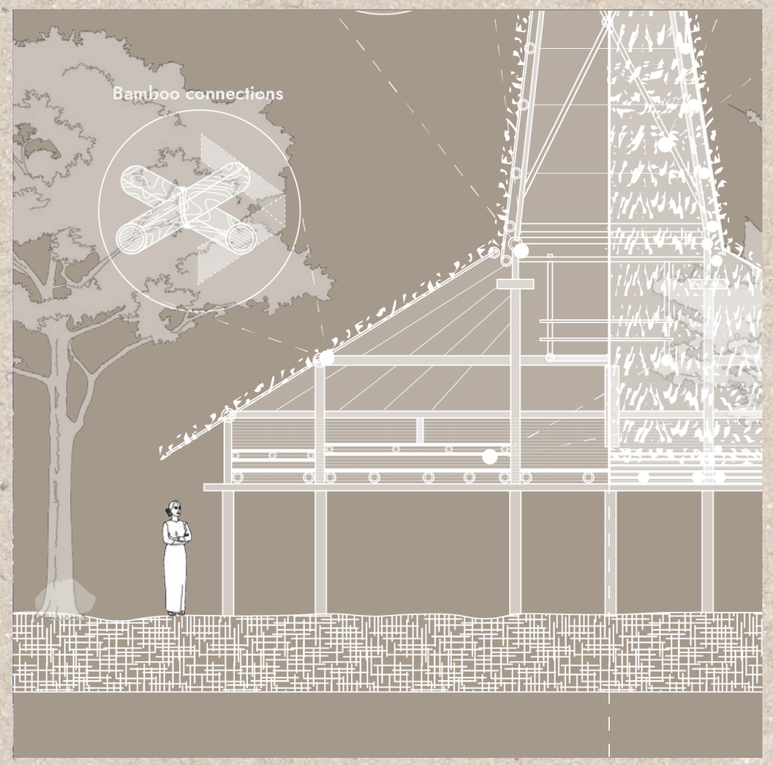


Regional Landscapes

Neighborhoods

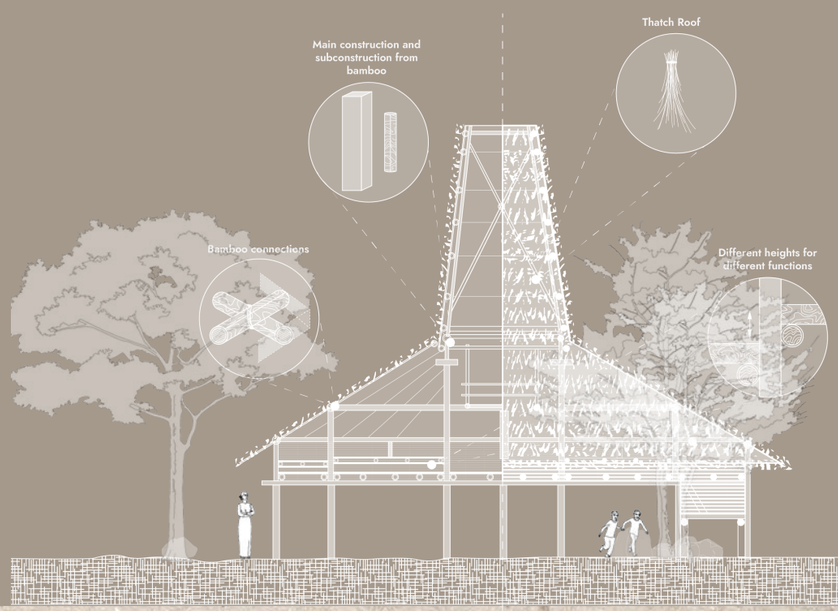


Vernacular Architecture

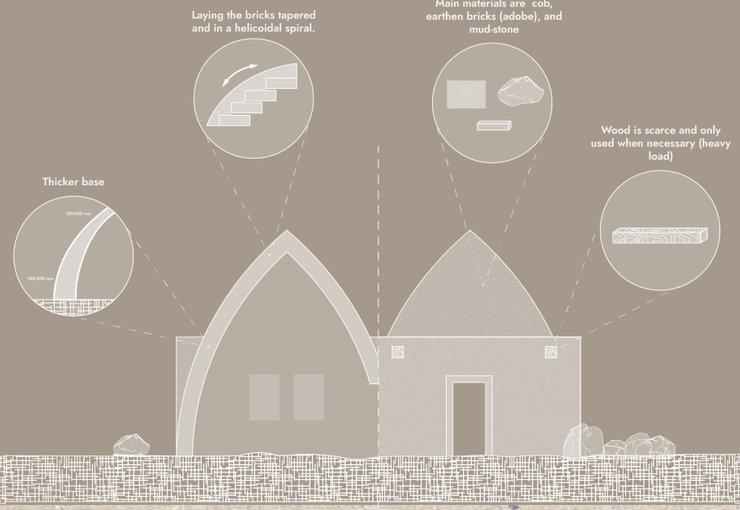


“Gain knowledge on the application of bio-based materials in a low-tech manner.”

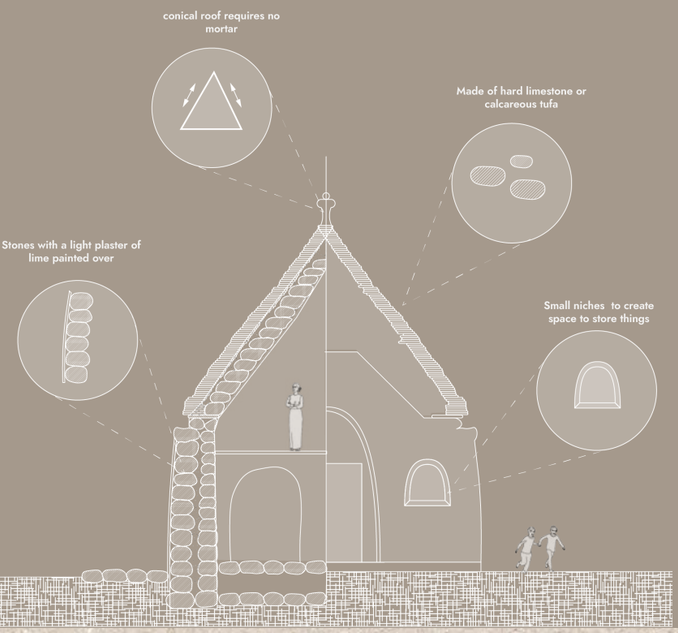
Tropical



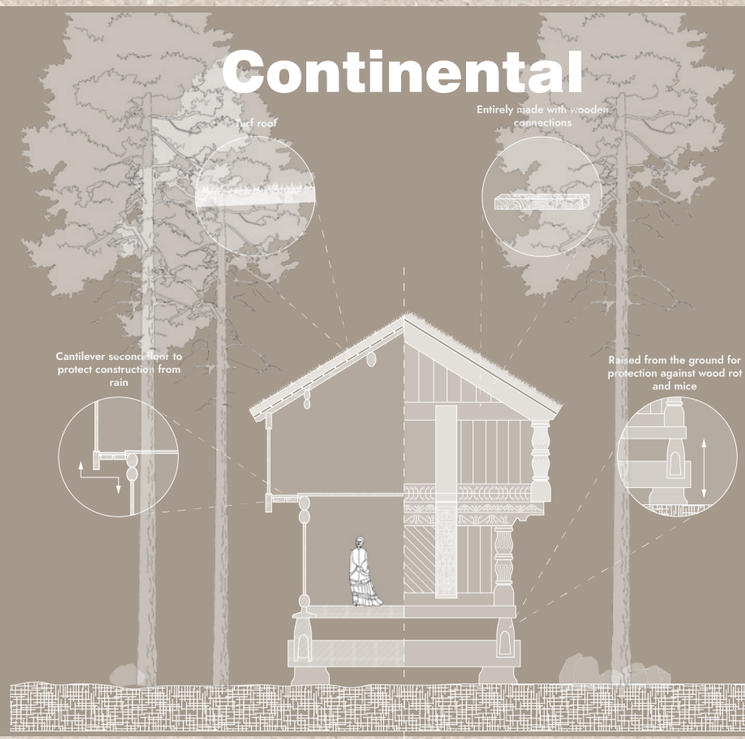
Dry



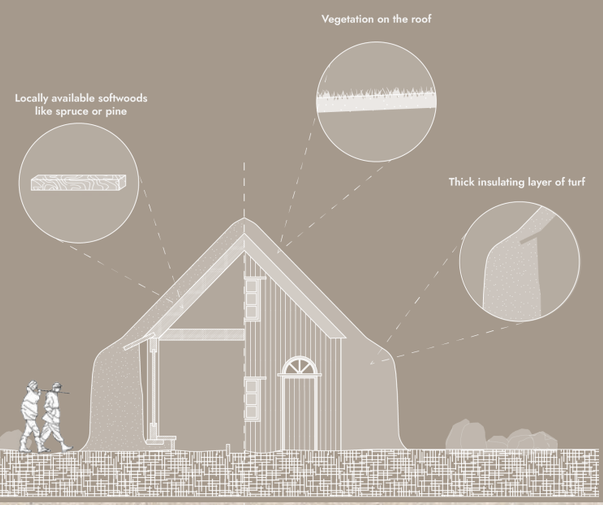
Temperate

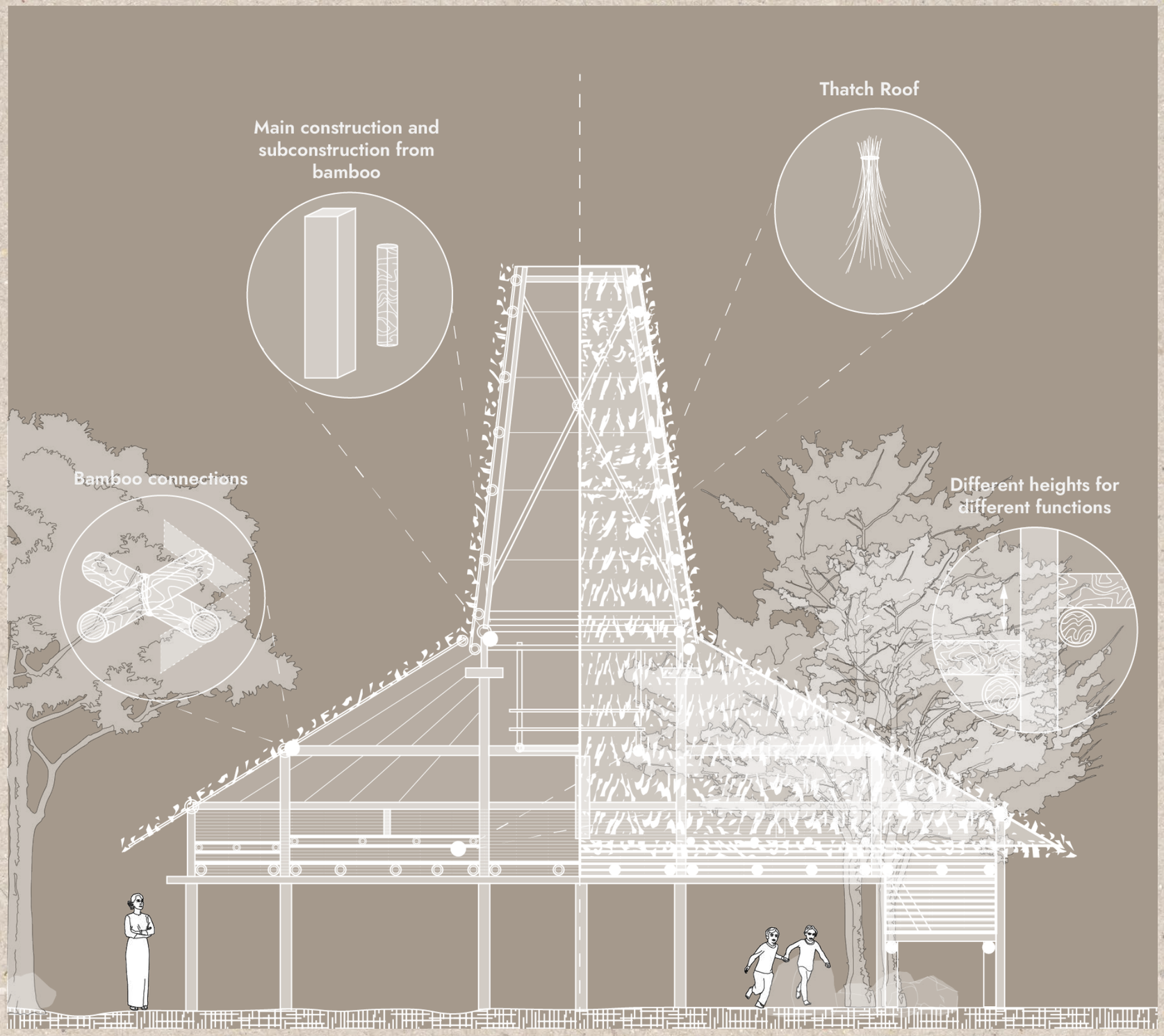


Continental



Polar





02. | Sumbanese Vernacular Indonesia

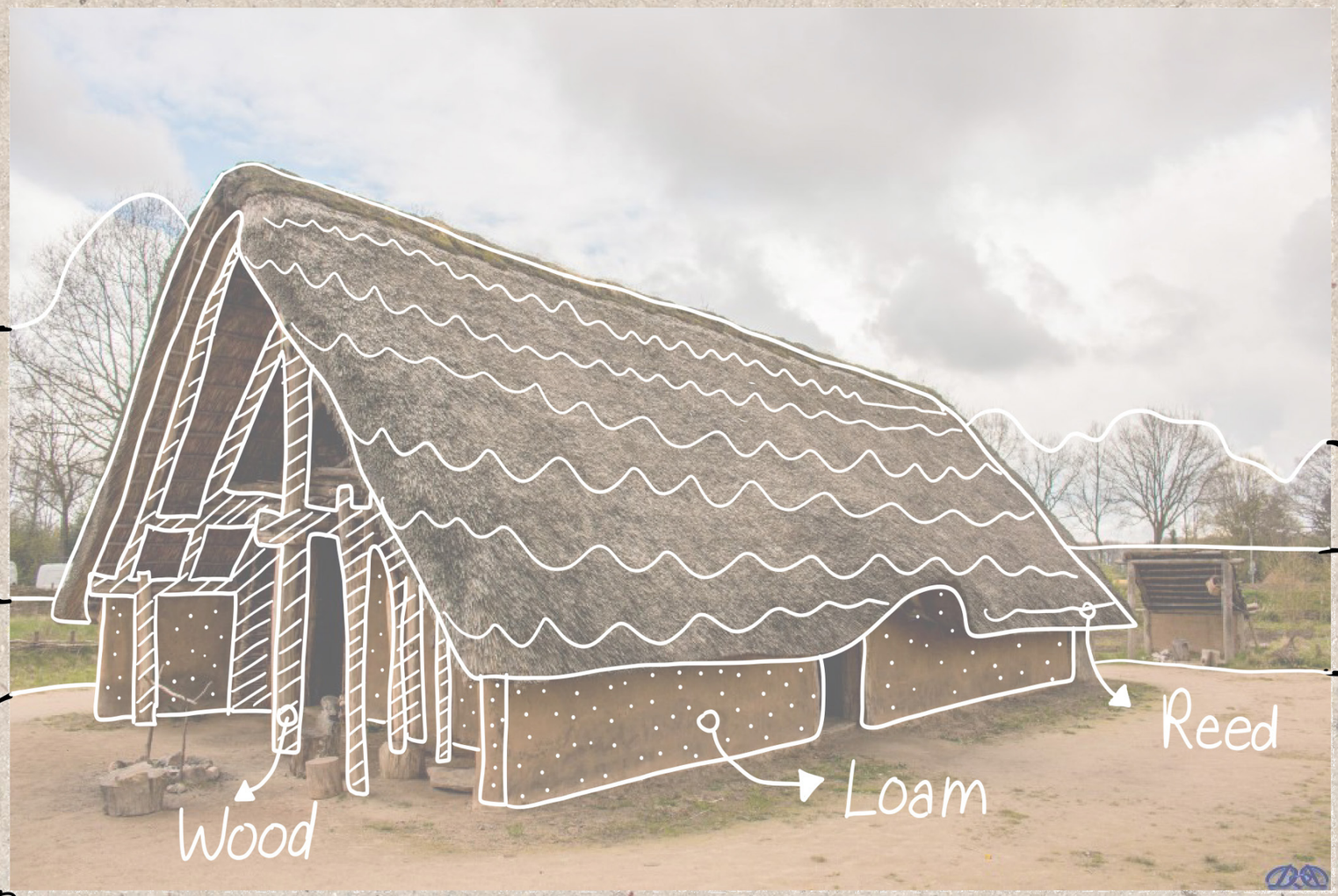
Dependant on climate, available materials, and crafts

Identity still visible today

Under treath

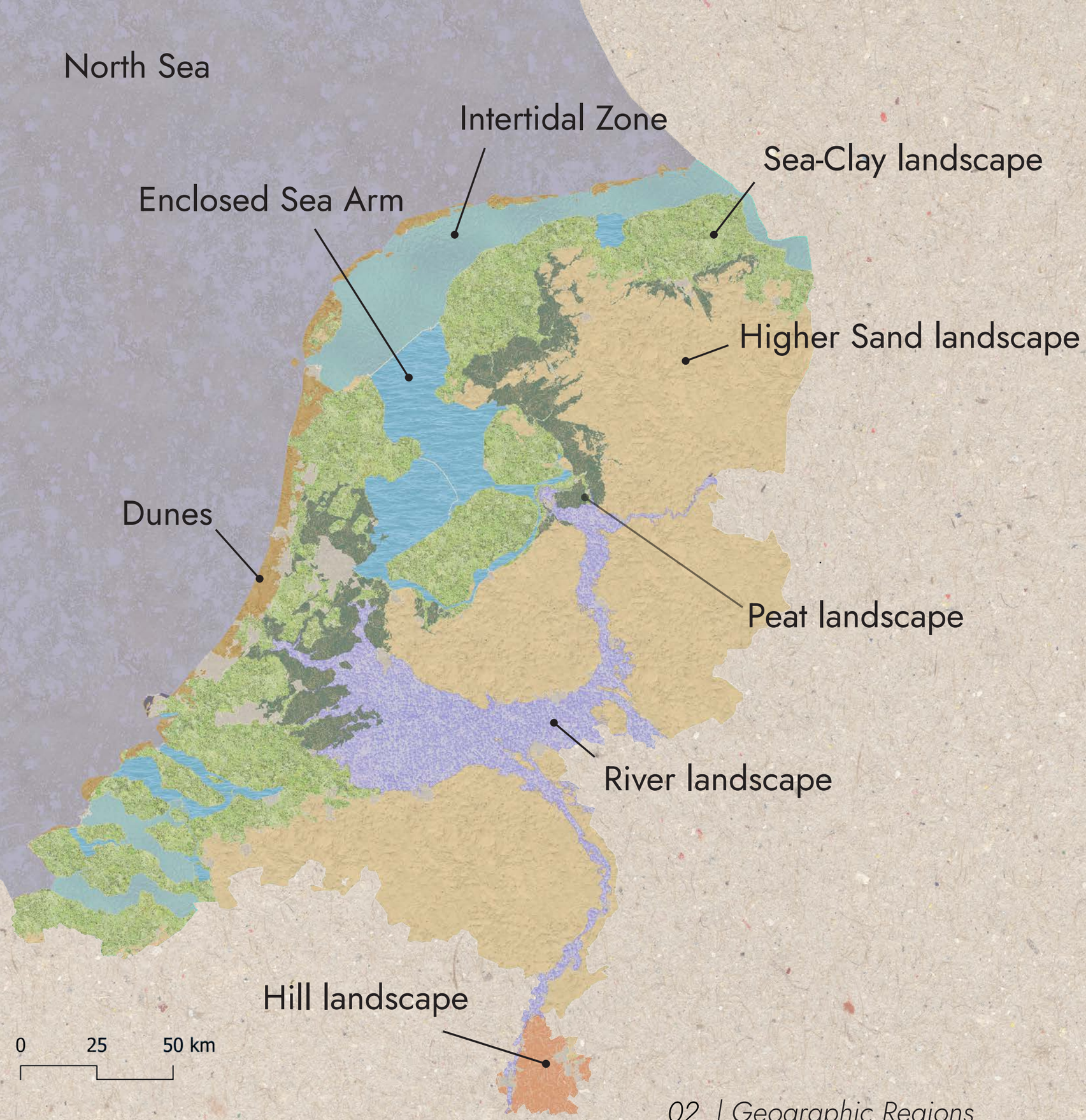
What about the Dutch context?

(Lemmers, 2018)


Wood
Loam
Reed

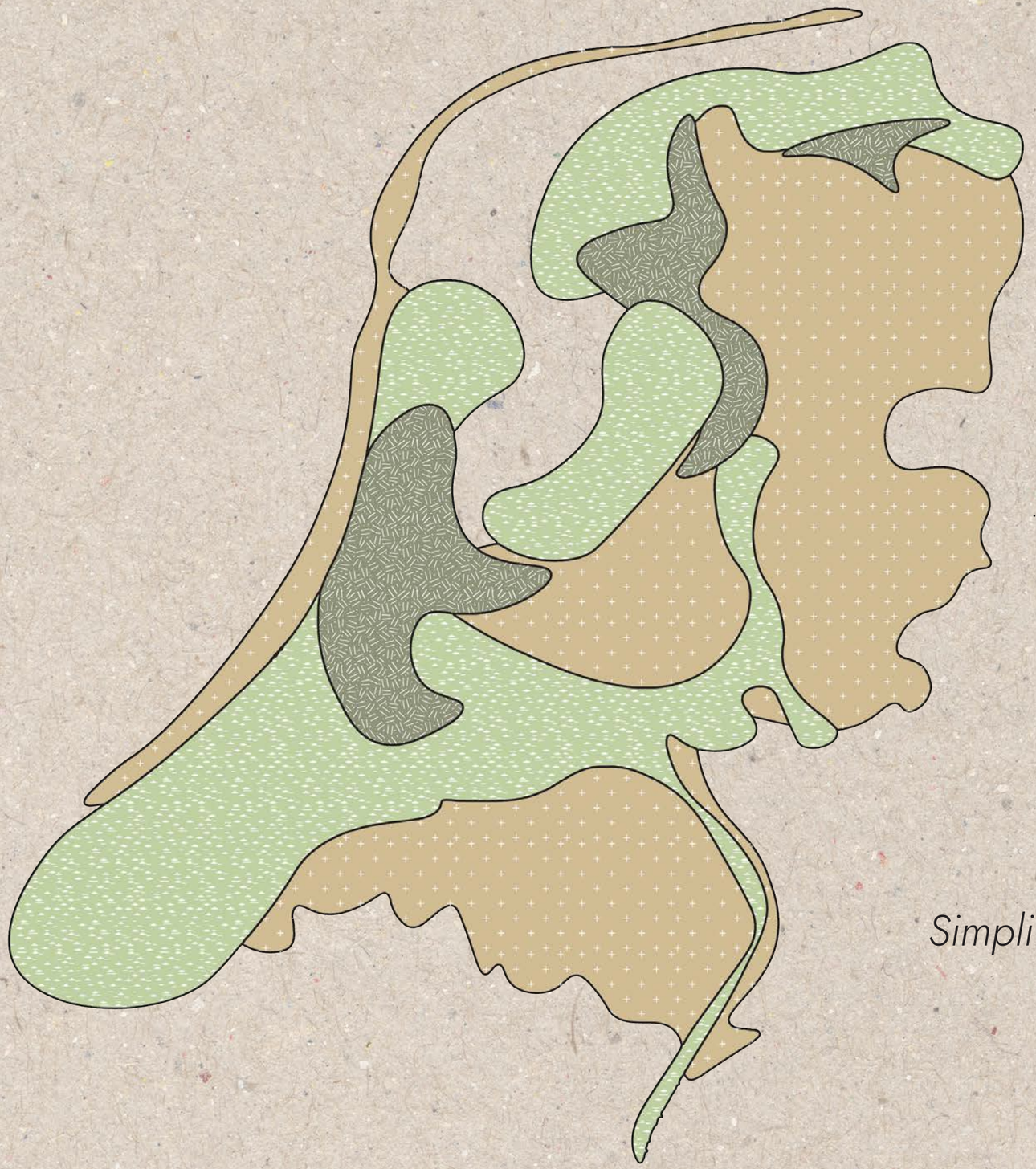
Regional Landscapes

‘‘Gain knowledge on the the different regional landscapes that can be found in the Netherlands.’’



02. | Geographic Regions

Data: (PDOK, Dataset: Fysisch Geografische Regio's)



Simplified map based on (Smit, Groenendijk, Köbben, & Vélu, 2022), (Boom Landscapes, n.d.)

02. | Simplified Geographic Regions

Peat

Sand

Clay

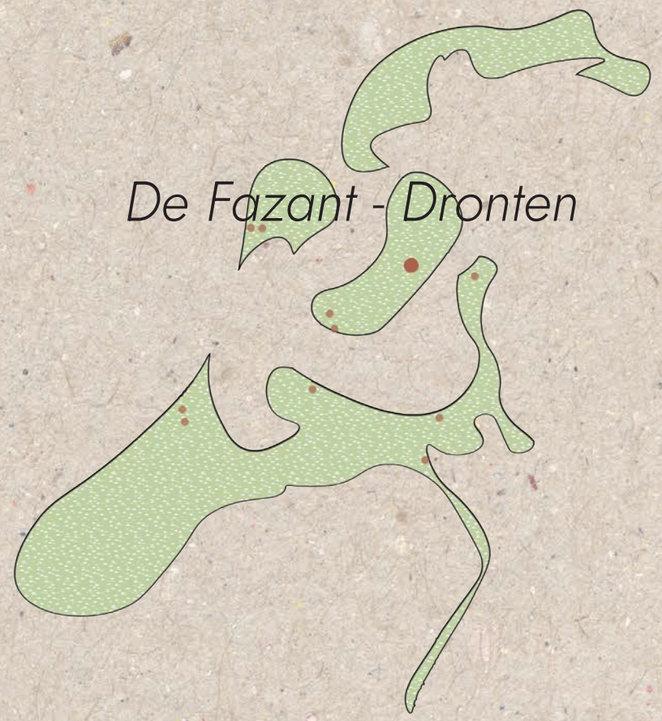
02. | Study bloemkoolwijken in each landscape

Selection of a case-study in each landscape

Camminghaburen - Leeuwarden

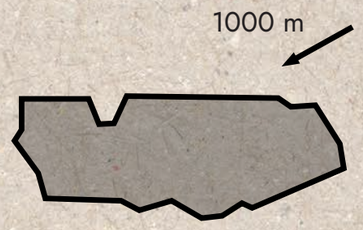
Duinpark - Noordwijk

De Fazant - Dronten

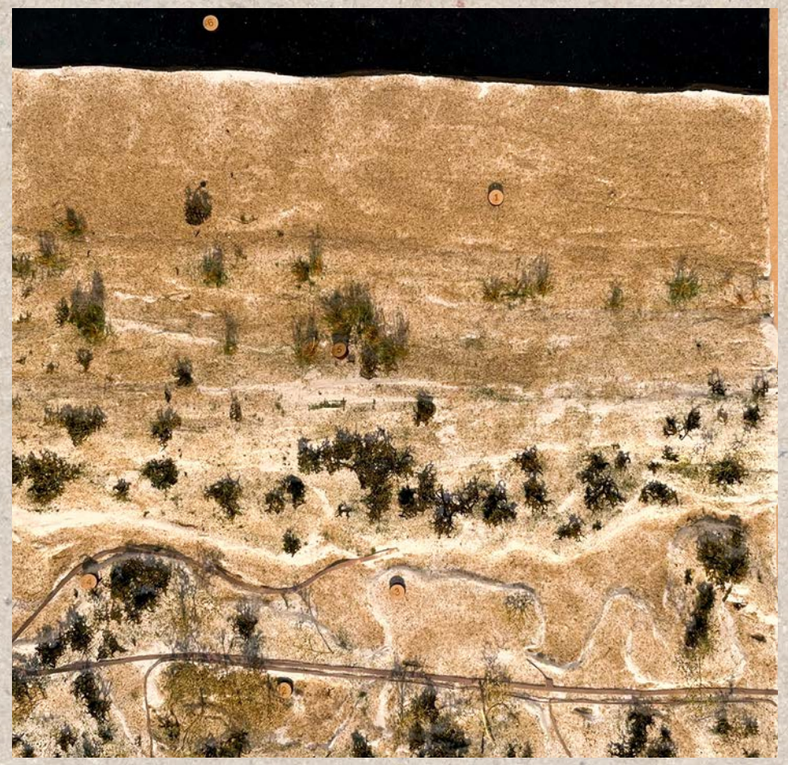


Peat

Camminghaburen - Leeuwarden

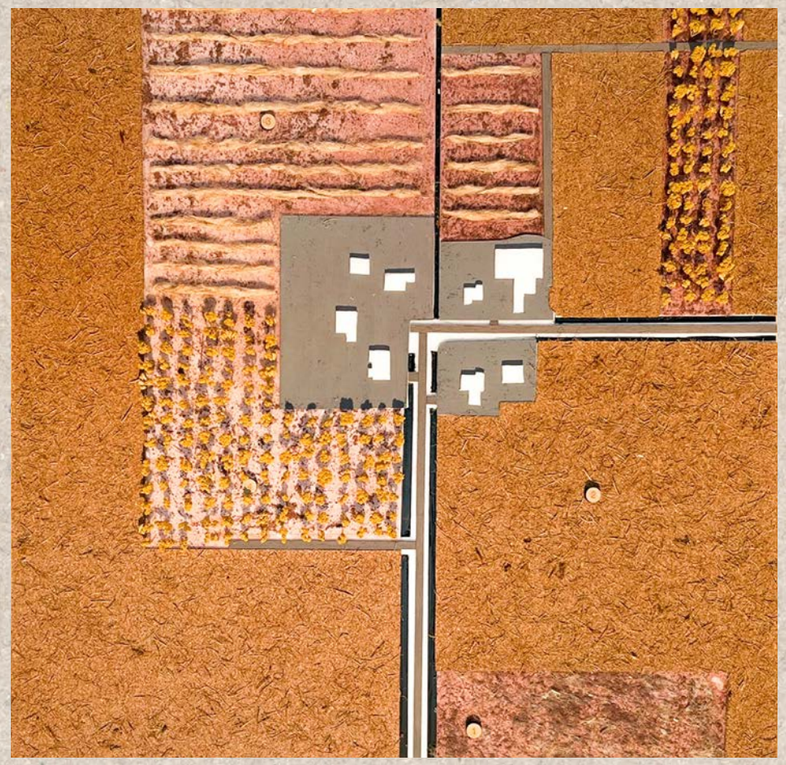


Sand



Duinoord - Noordwijk

Clay

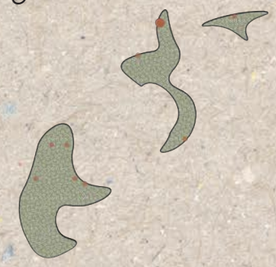


De Fazant - Dronten

02. | Landscape model surrounding landscape

Peat

Camminghaburen - Leeuwarden

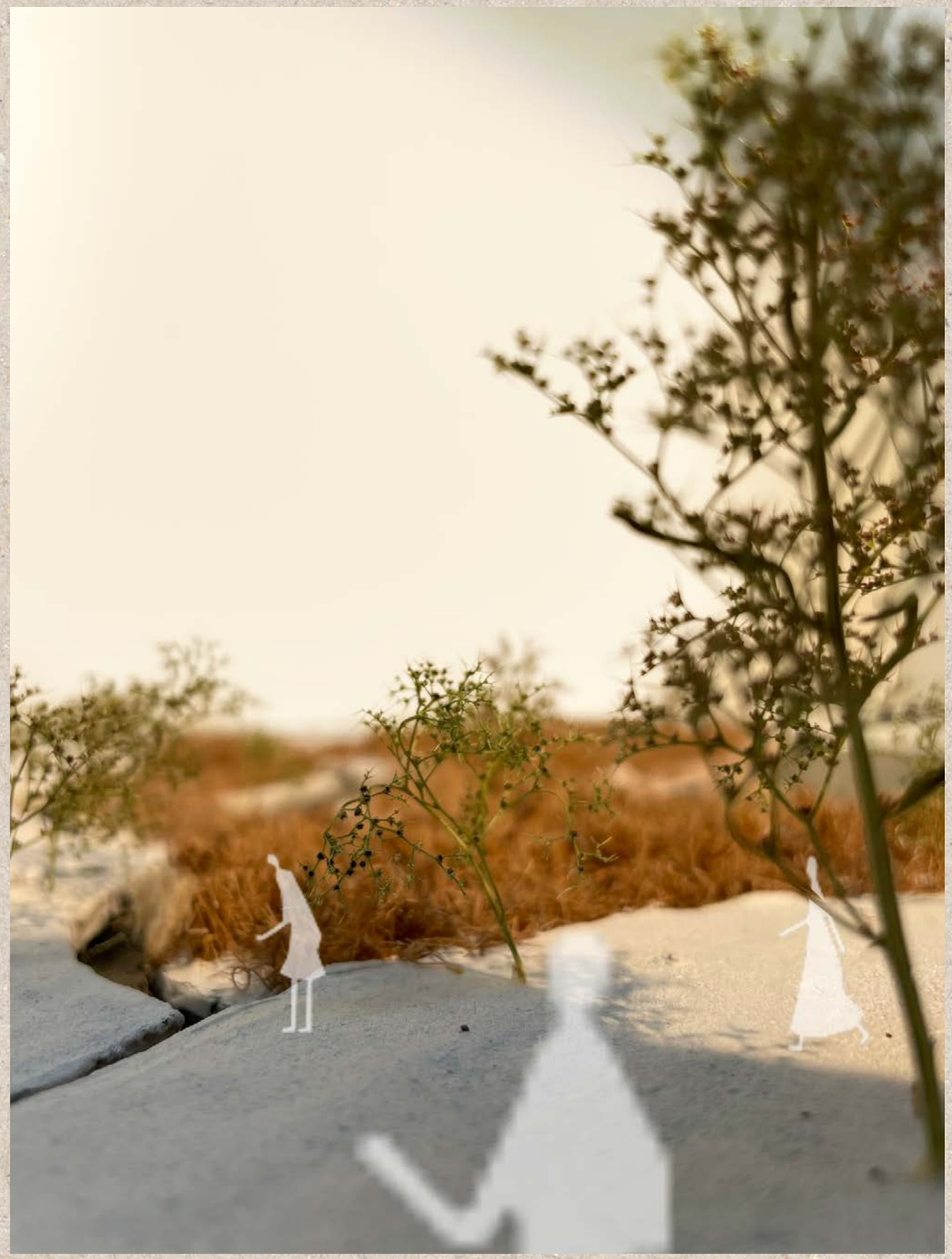


Reedlands

Small and bigger pathes of water

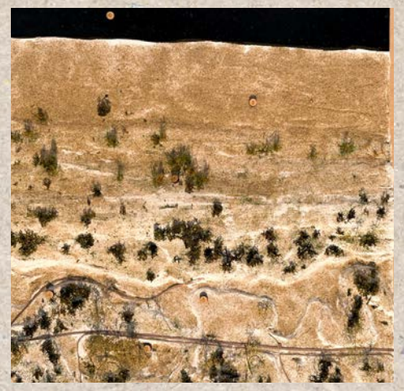
Vegetation adapted to wet soil

Peatlakes



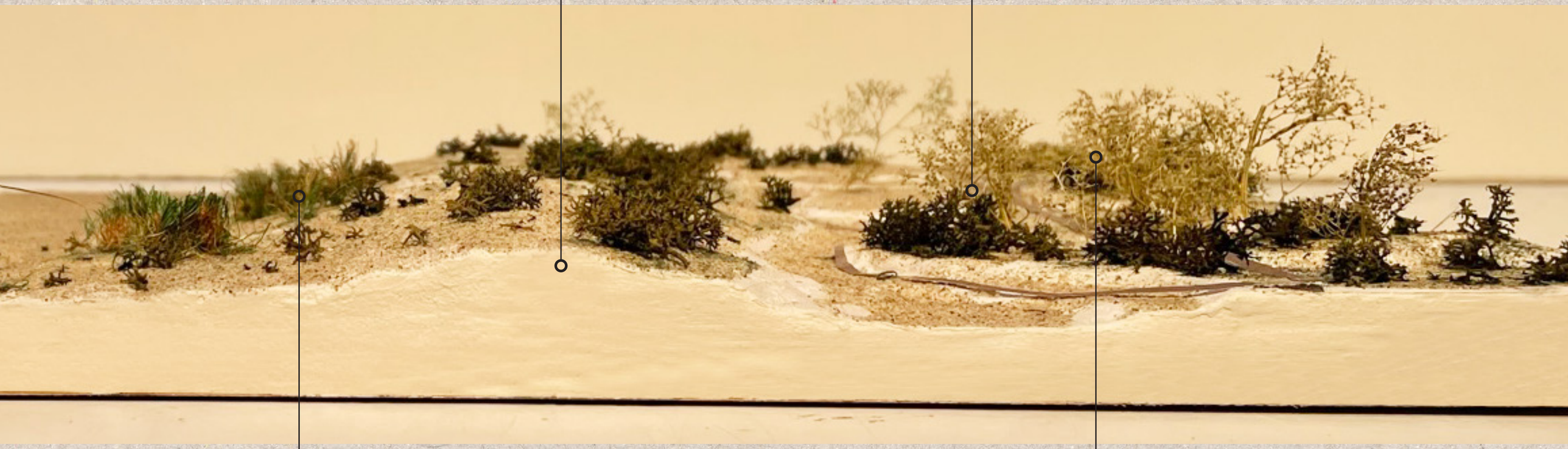
02. | Impression

Sand



Height differences

Vegetation that is adapted to nutrient-poor soil

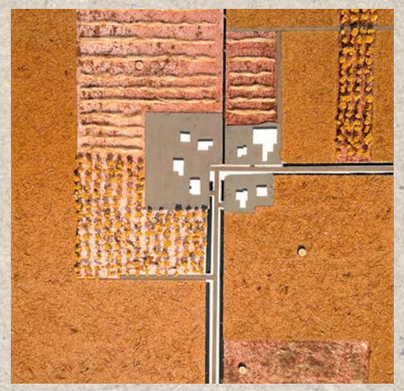


Lower vegetation towards beach

Patches of pine trees

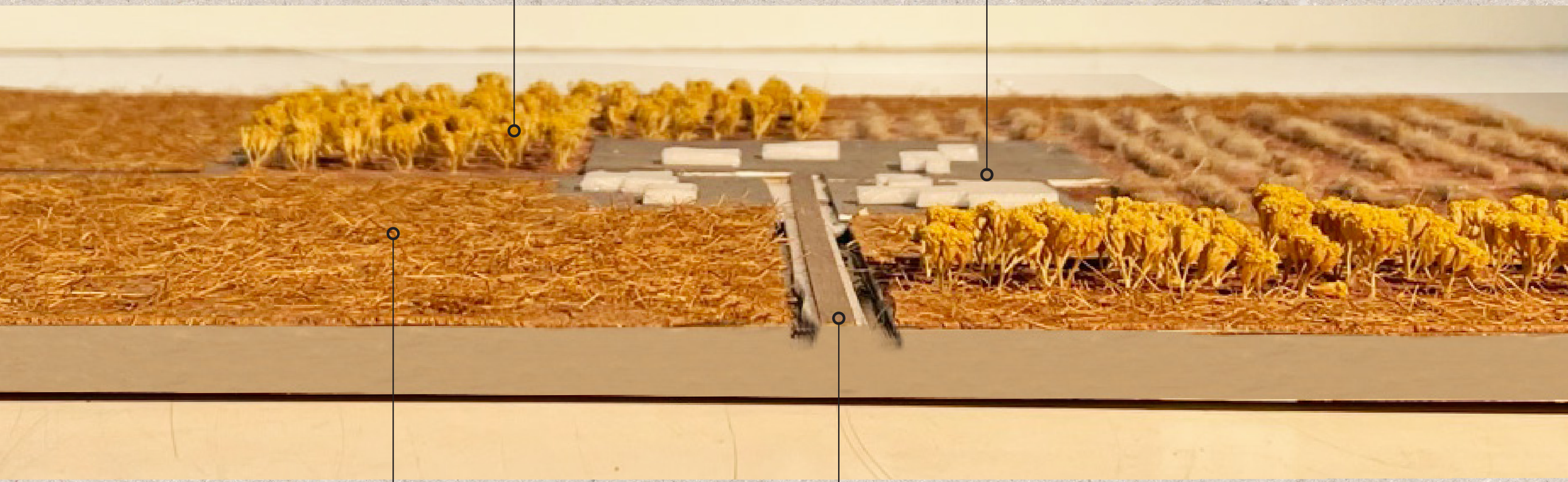

Duinpark - Noordwijk

Clay



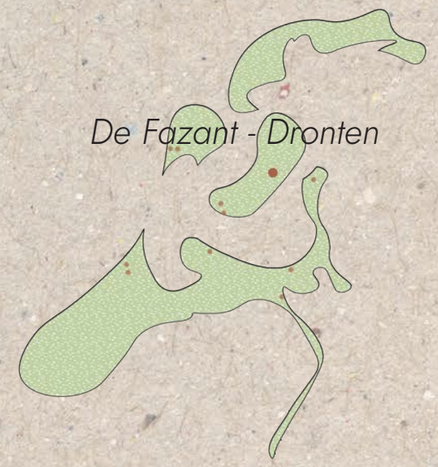
Agricultural practices

Farmhouses



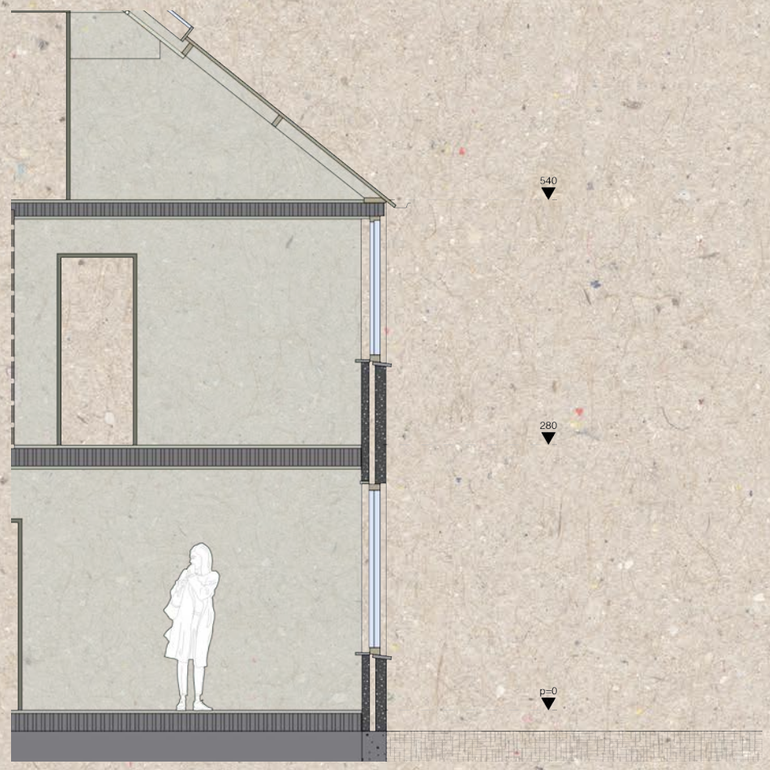
Monoculture

Rectangular grid



02. | Impression

Neighborhoods



‘‘Gain knowledge on the characteristics of the neighborhoods’’

Noordwijk




Dronten




Leeuwarden




Noordwijk



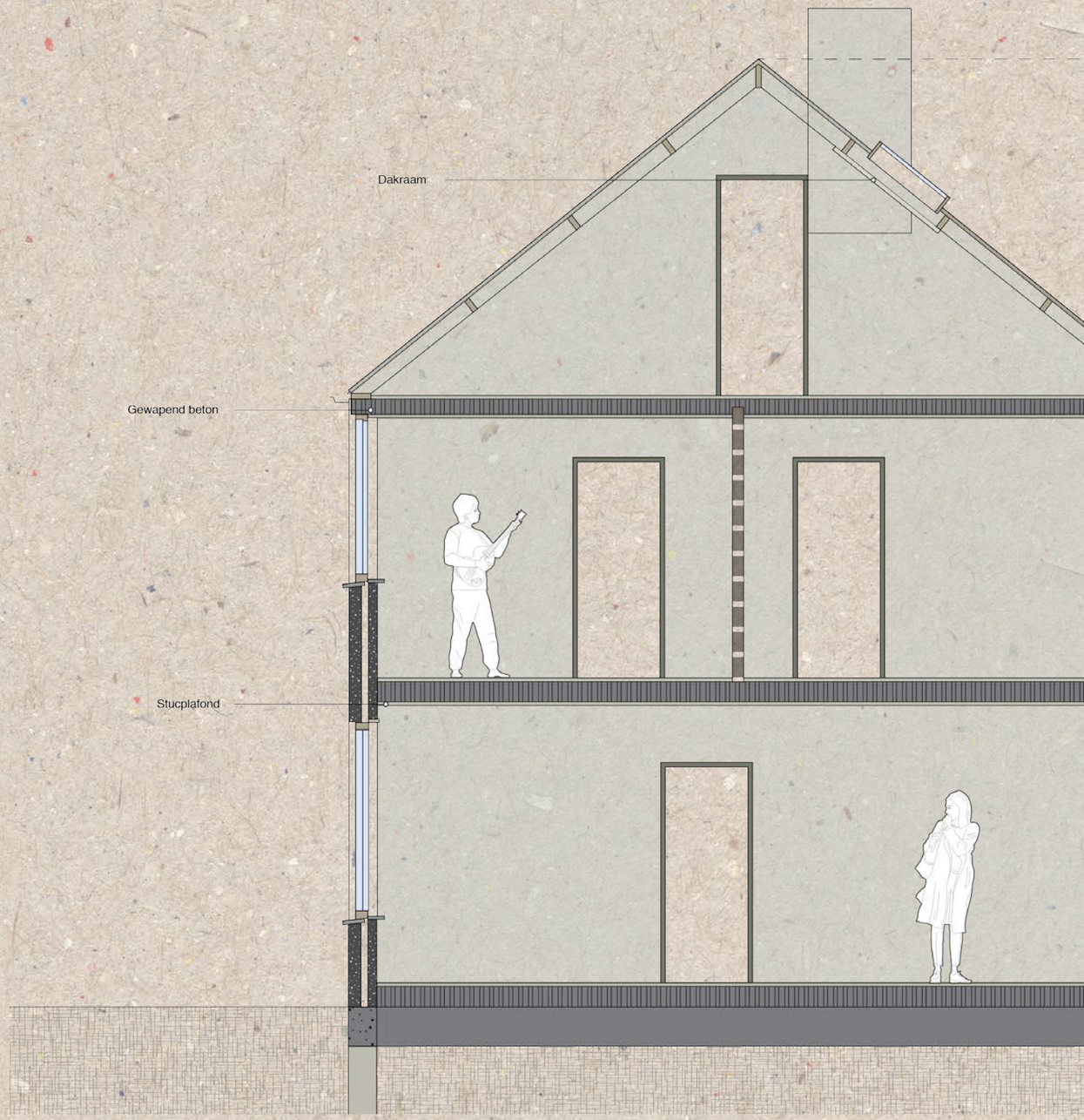

Dronten




Leeuwarden



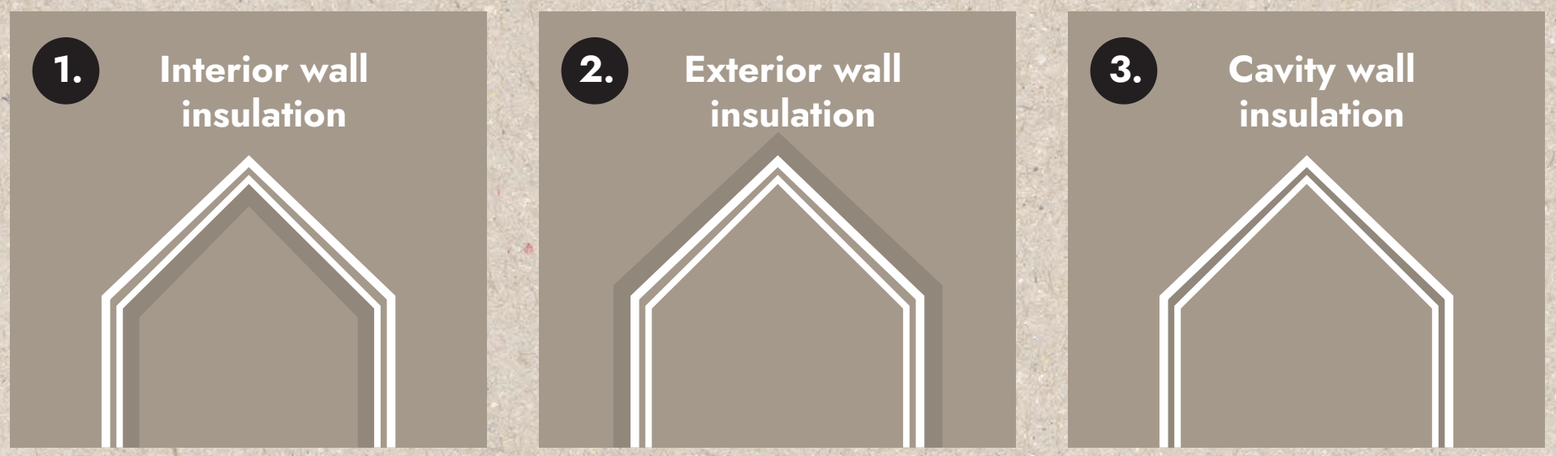

01. Exterior



02. Insulation

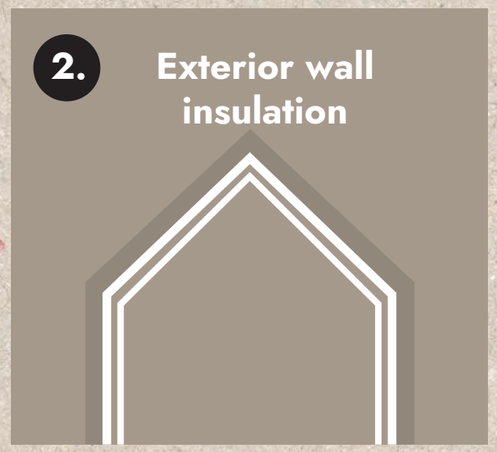
Renovation strategies

Facade Renovation Strategies



Renovation strategies

Facade Renovation Strategies



.03.

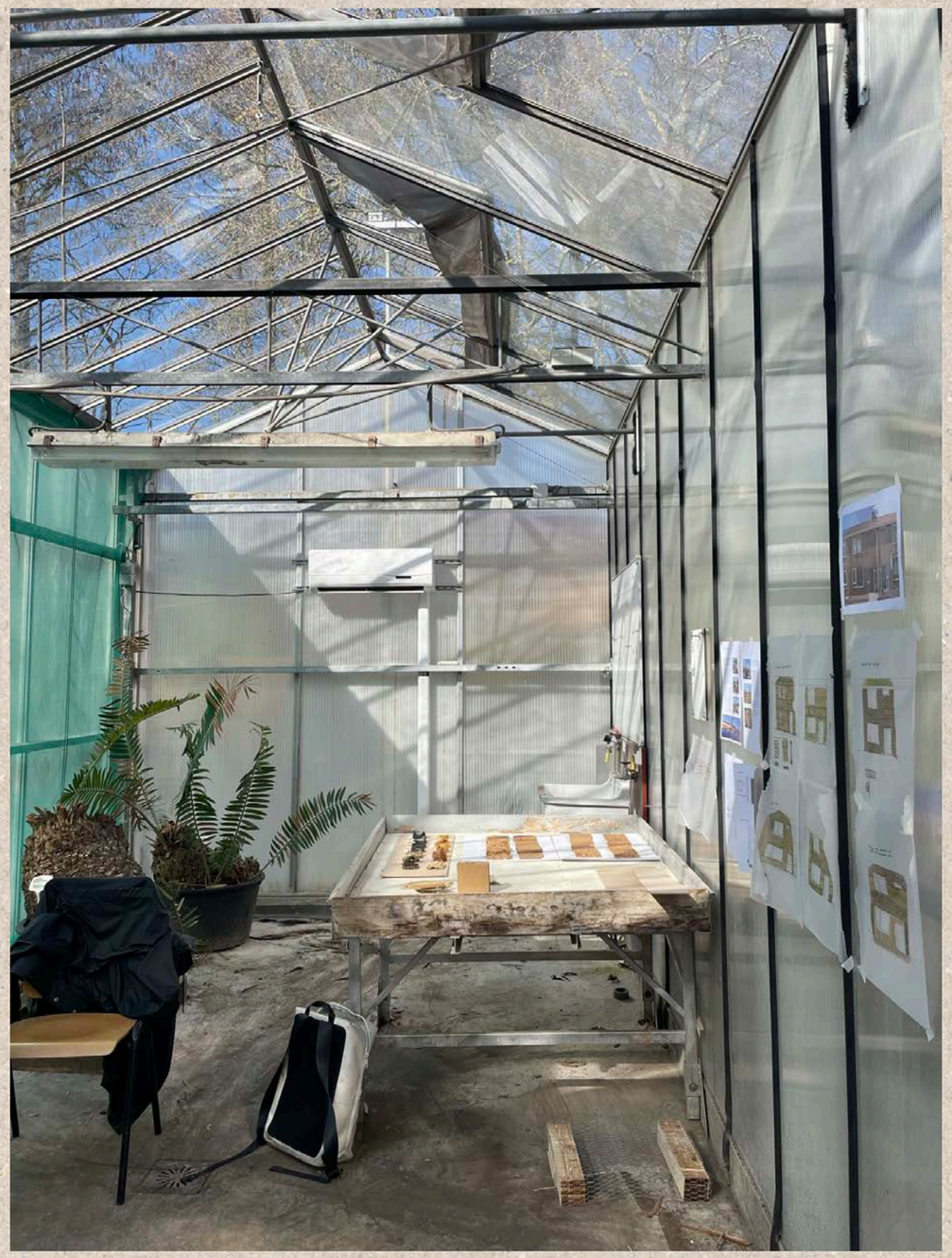
Experimentation

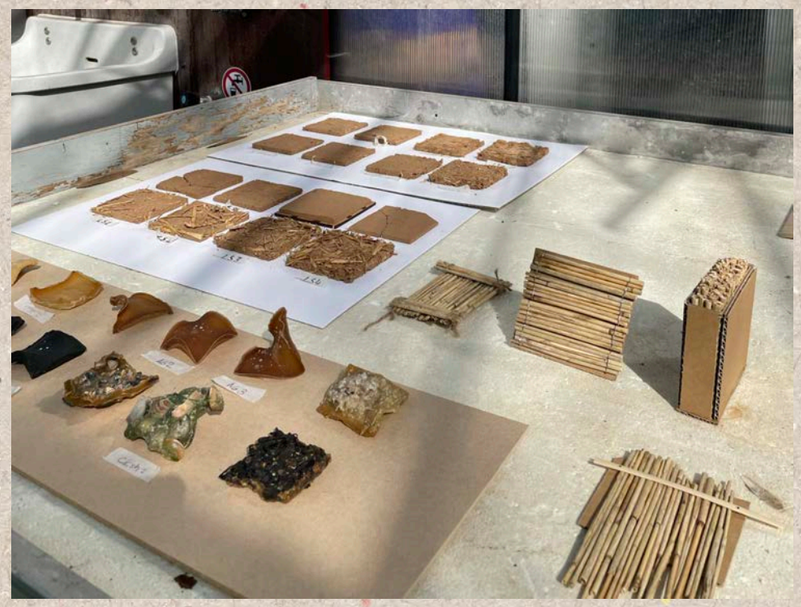
''Gain knowledge on the application and properties of the different materials''

Reed from
a reedcutter

Loam from a
company in
Lekkerkerk

Flax from
Marktplaats

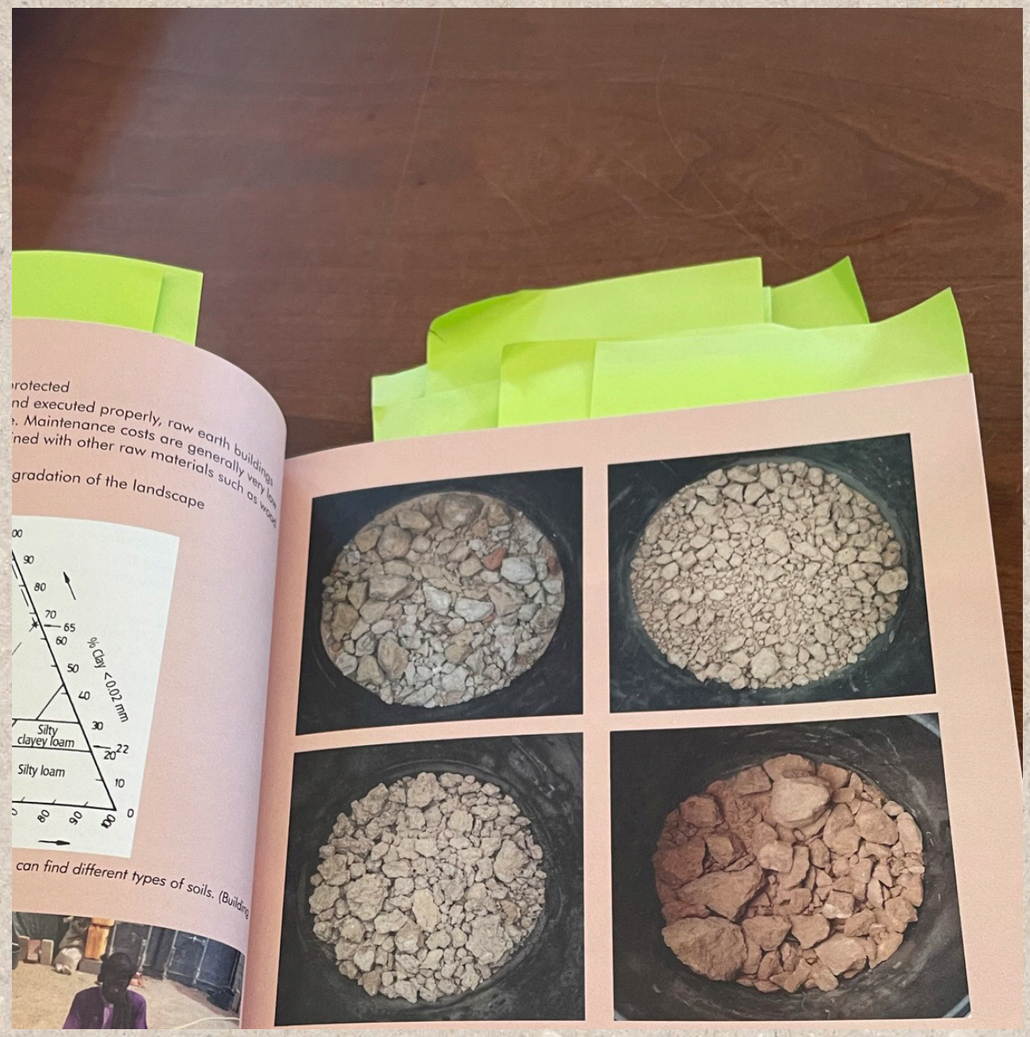




Workspace at the Botanical Garden

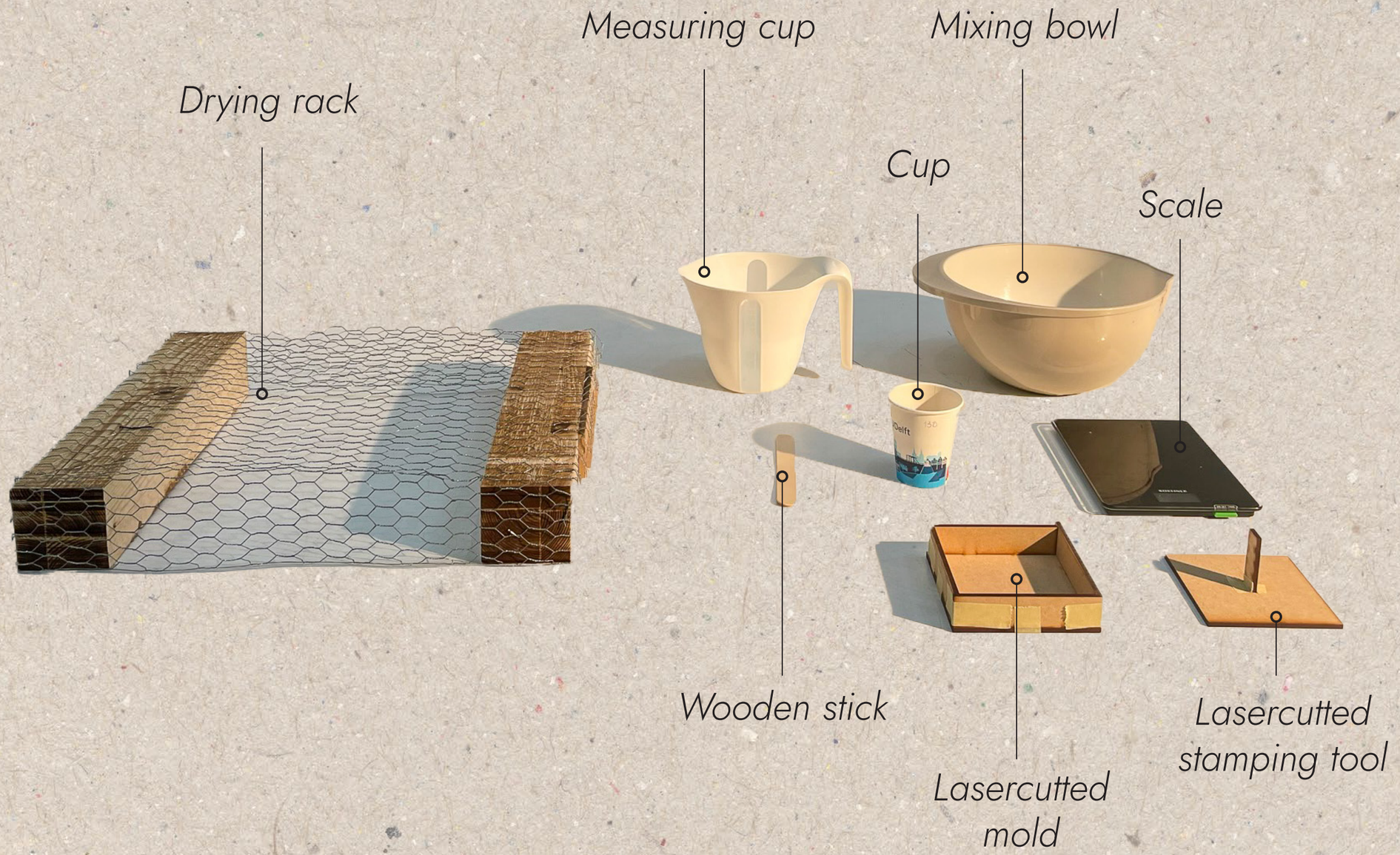
Reedcutting with Wout v/d Belt in the Wieden

03. | Learning from experts



Visiting Oskam in Lekkerkerk, experts in Loam construction

03. | Learning from experts


Drying rack
Measuring cup
Mixing bowl
Cup
Scale
Wooden stick
Lasercutted mold
Lasercutted stamping tool

03. | Tools

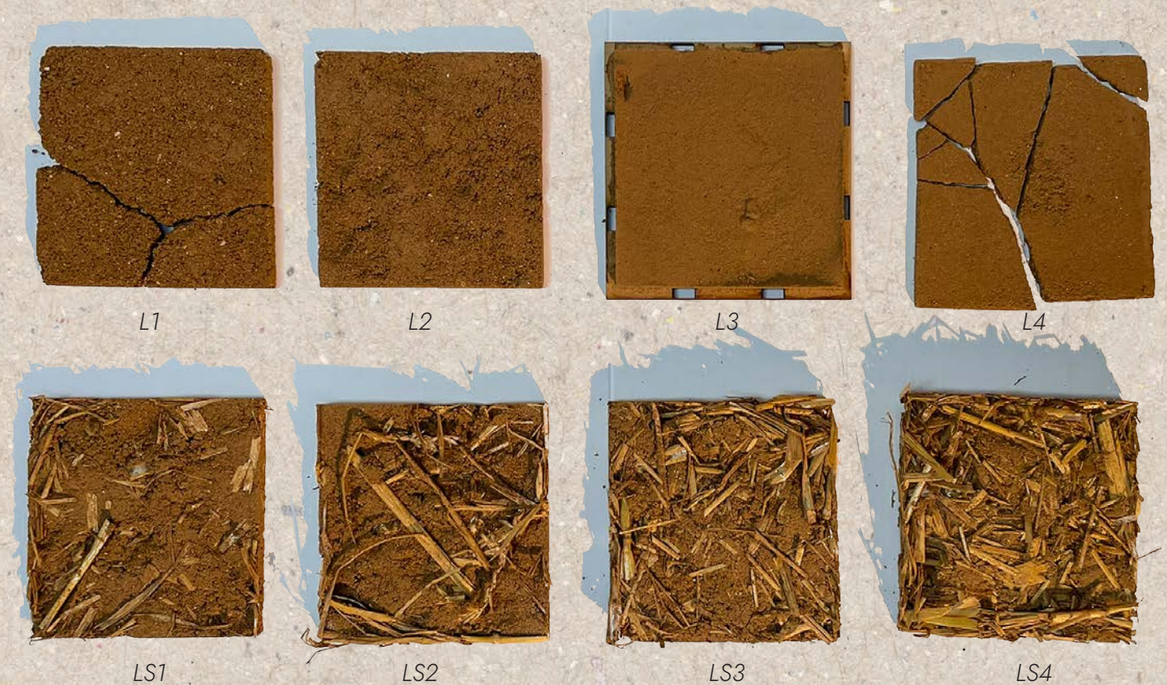
03. | Diffrent experiments

Clay Landscape

Sand Landscape

Peat Landscape

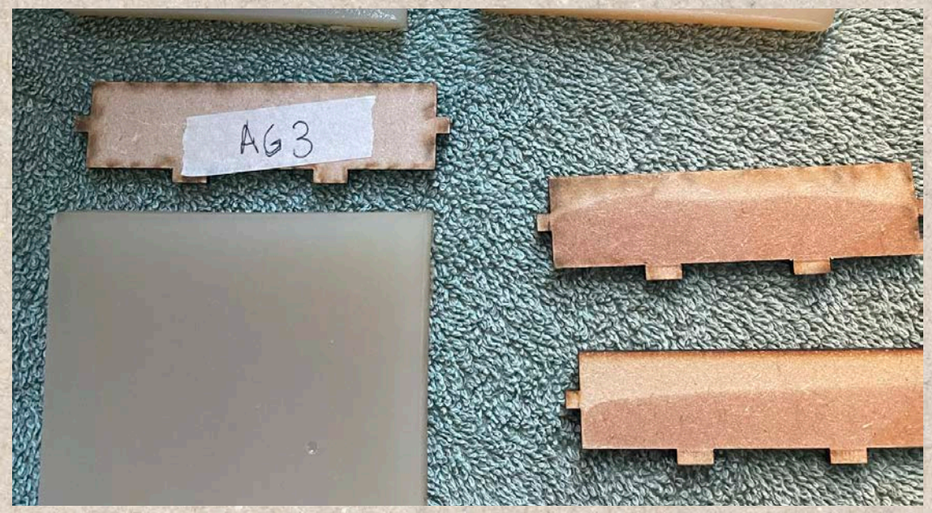
03. | Loam experiments



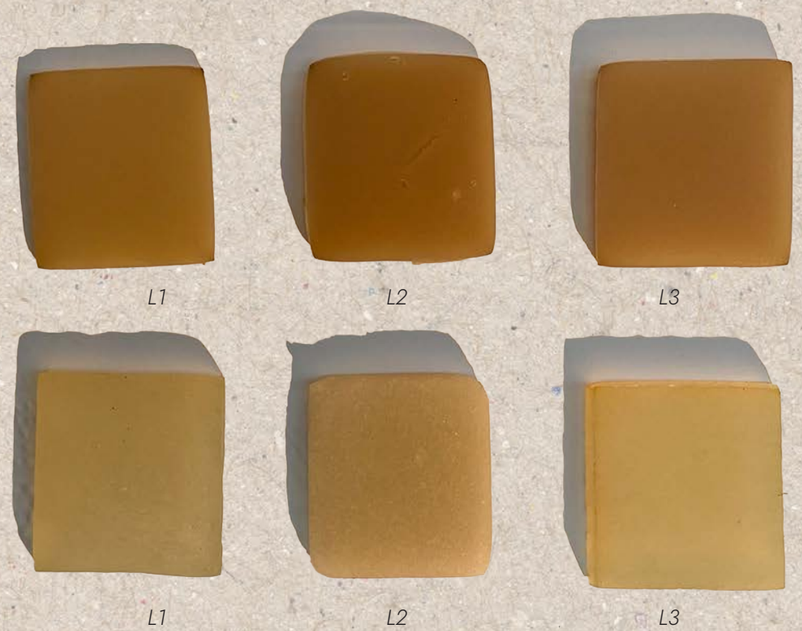
- Very little water necessary, otherwise it becomes brittle
- Adding straw, flax or hemp gives it more structural strength
- Which of those did not really make a difference, only in looks

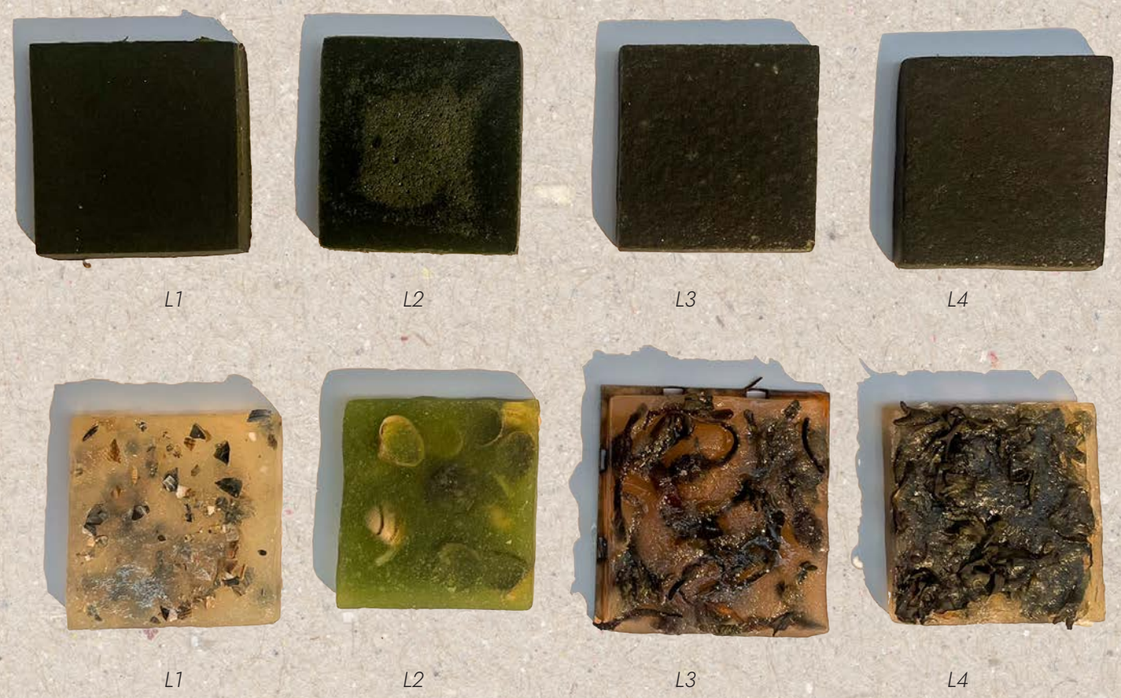
03. | Loam experiments

03. | Loam experiments



03. | Algea experiments





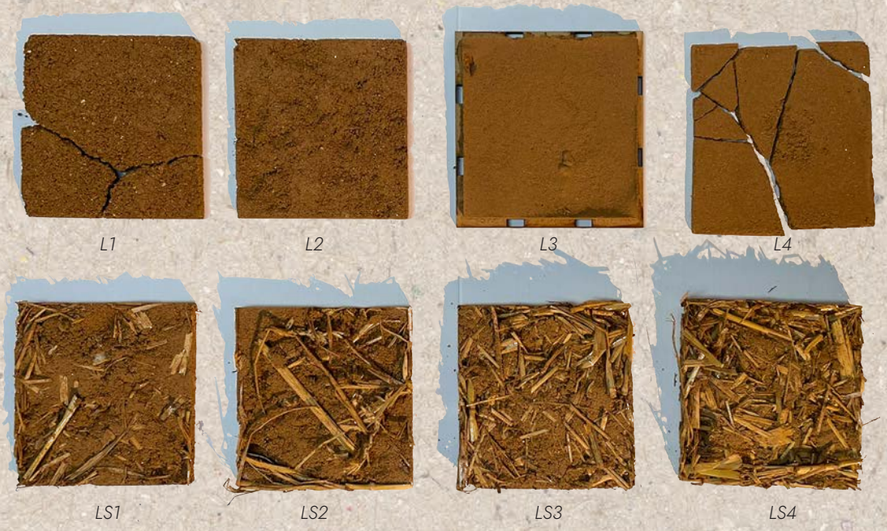
- Molding, especially first ones
- Shrinkage by 50%
- Sides started to curl
- Smell of the seaweed
- Very little spirulina necessary
- Crushed shells work well for aesthetics

03. | Algea experiments

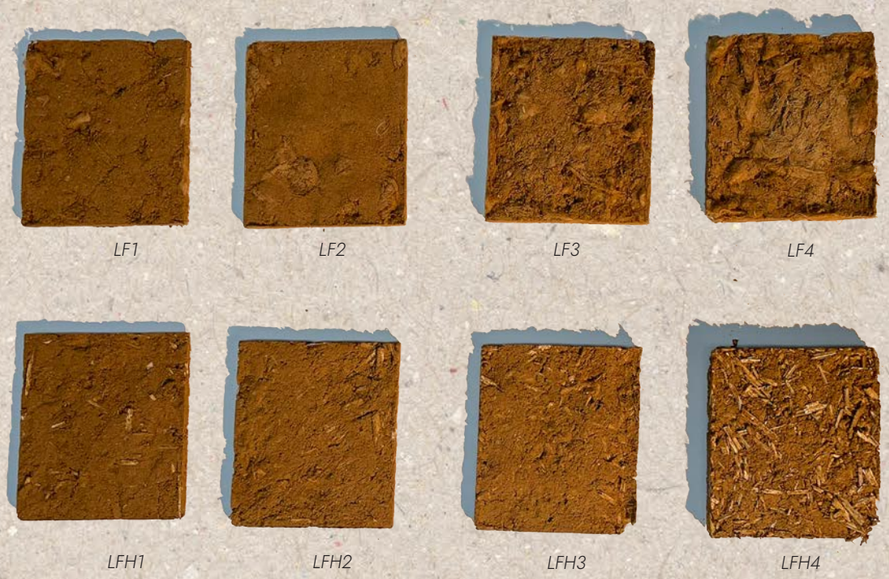
03. | Algea experiments

- Reed can be tight in different ways
- Time consuming
- Pushing it down with wood works easiest
- Clamping it in between a frame could work as cladding

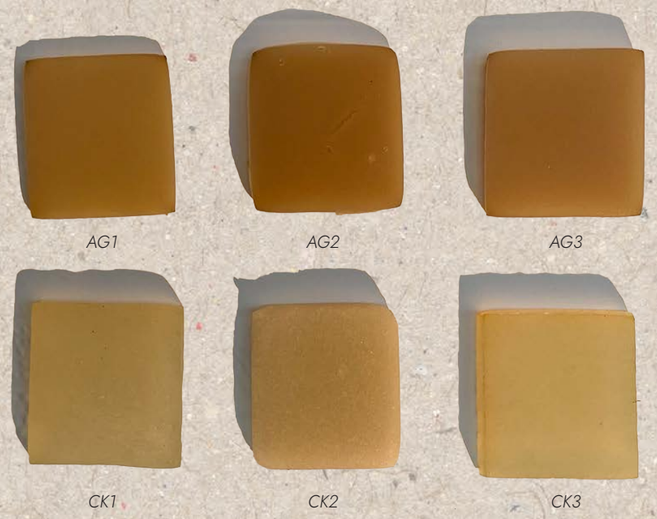
03. | Reed experiments


L1 L2 L3 L4

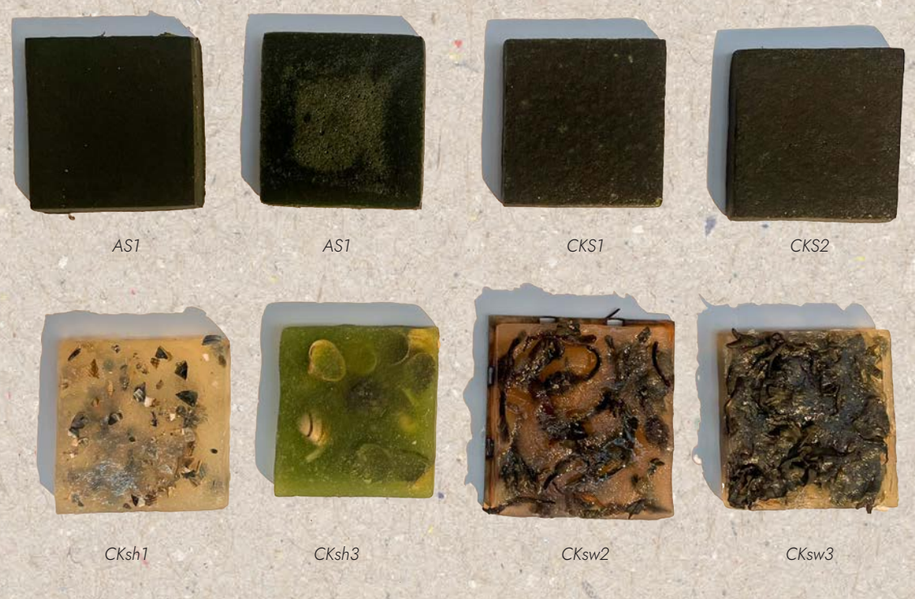
LS1 LS2 LS3 LS4


LF1 LF2 LF3 LF4

LFH1 LFH2 LFH3 LFH4


AG1 AG2 AG3

CK1 CK2 CK3


AS1 AS1 CKS1 CKS2

CKsh1 CKsh3 CKsw2 CKsw3

03. | Reed experiments

Research

Vernacular Architecture

Bio-based materials in vernacular designs

Regional Landscapes

Different regional landscapes & characteristics

Neighborhoods

Characteristics & renovation needs

Experimentation

Hands-on knowledge materials

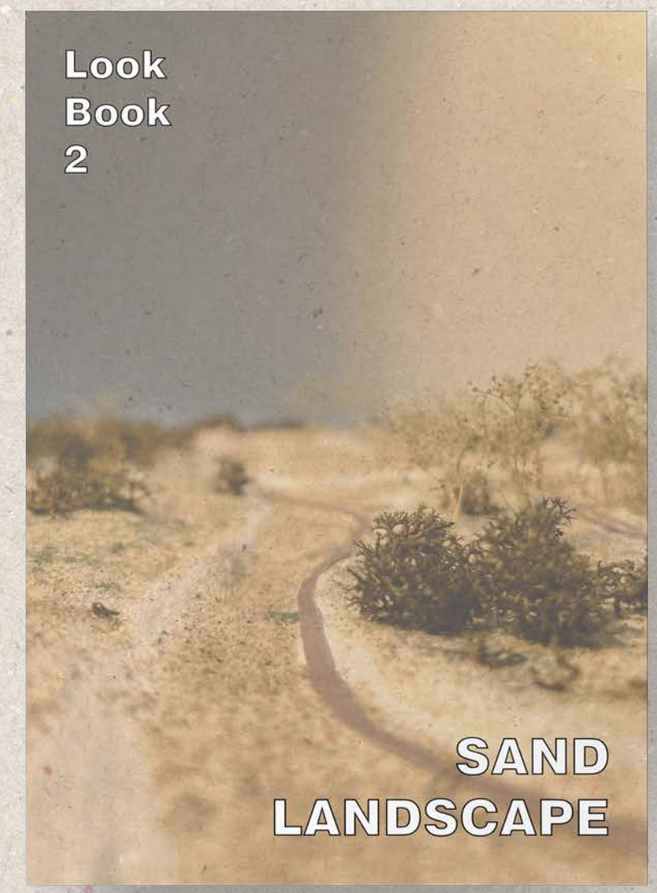
Translation to

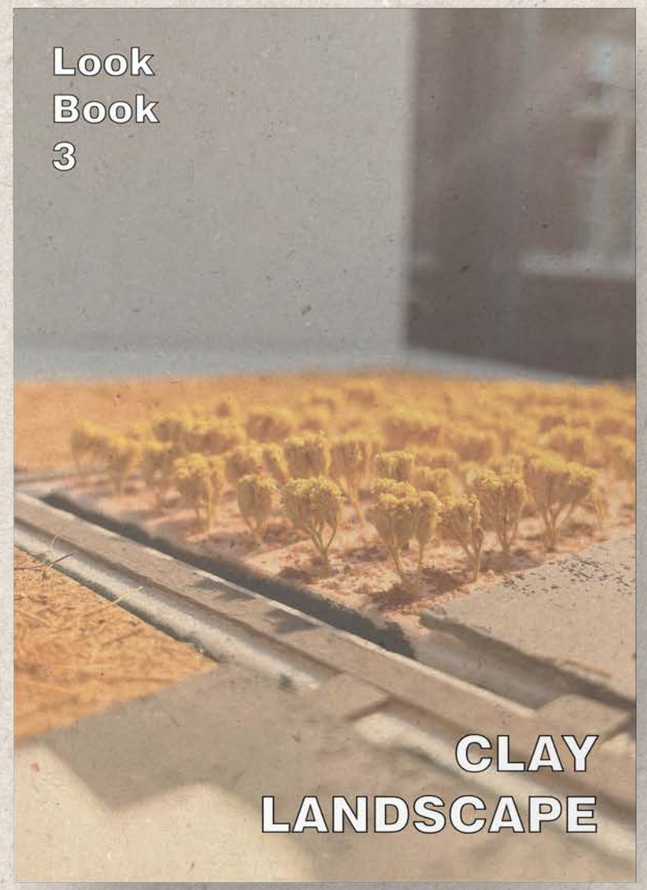
Look-books

Bundled renovation possibilities per landscape

.04.

Look-books

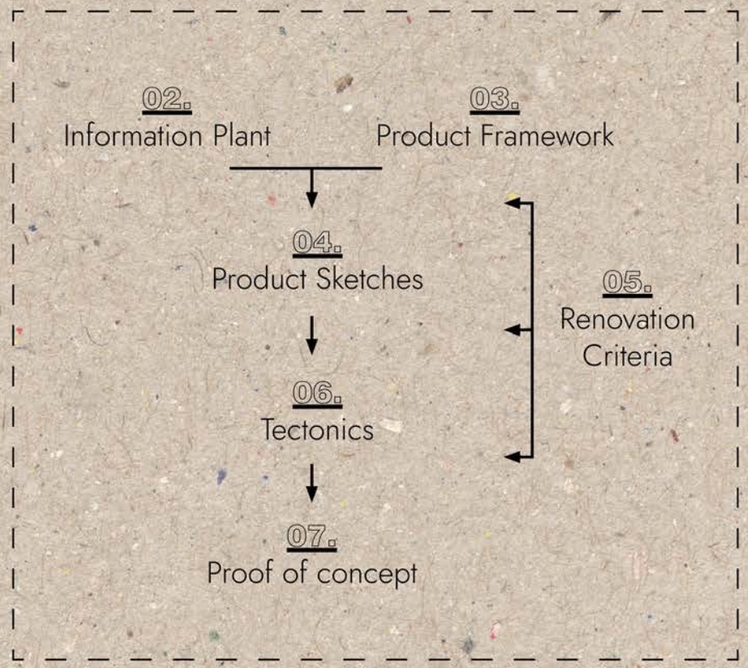




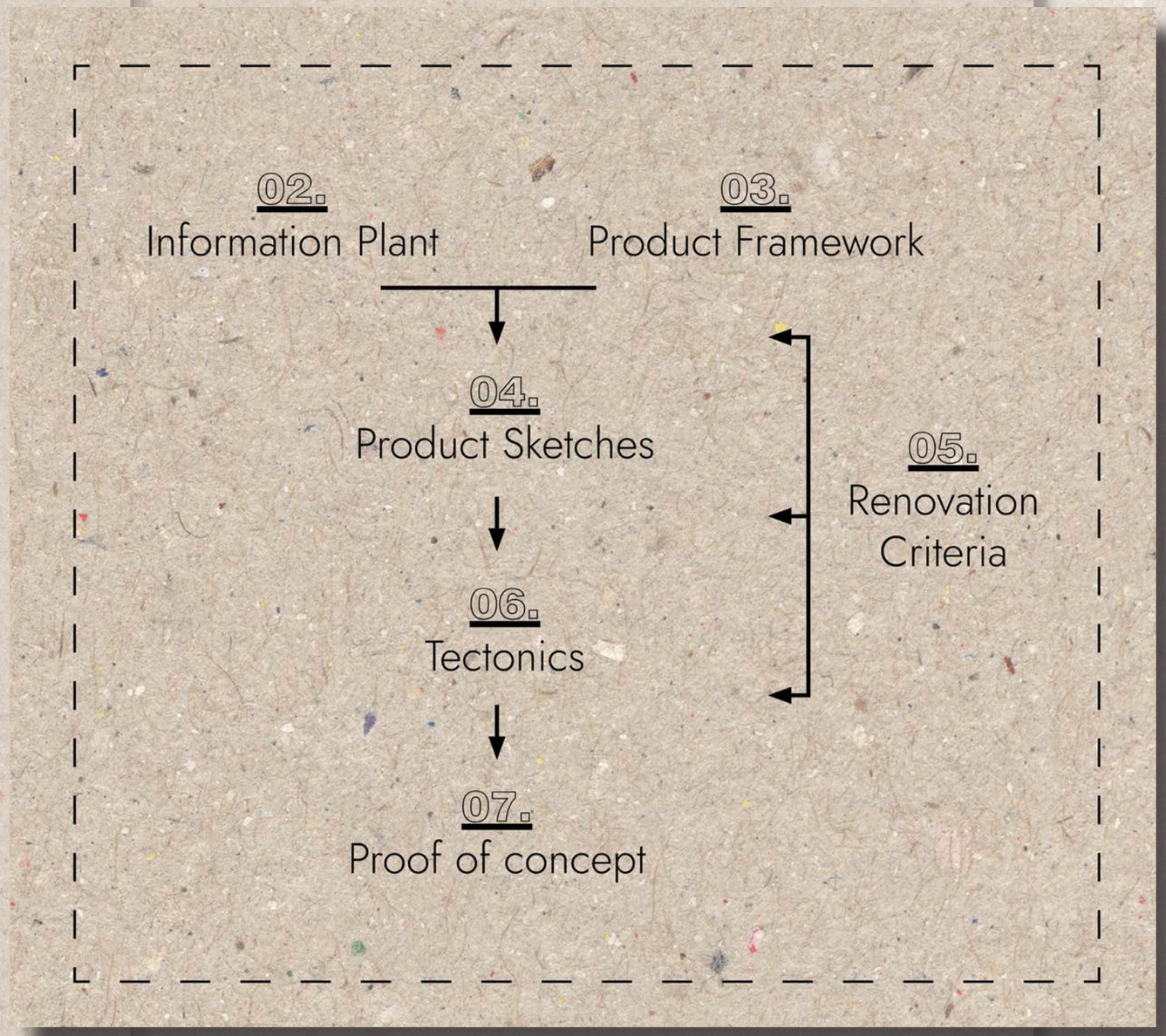
04. | Three look-books

04. | Peat Landscape

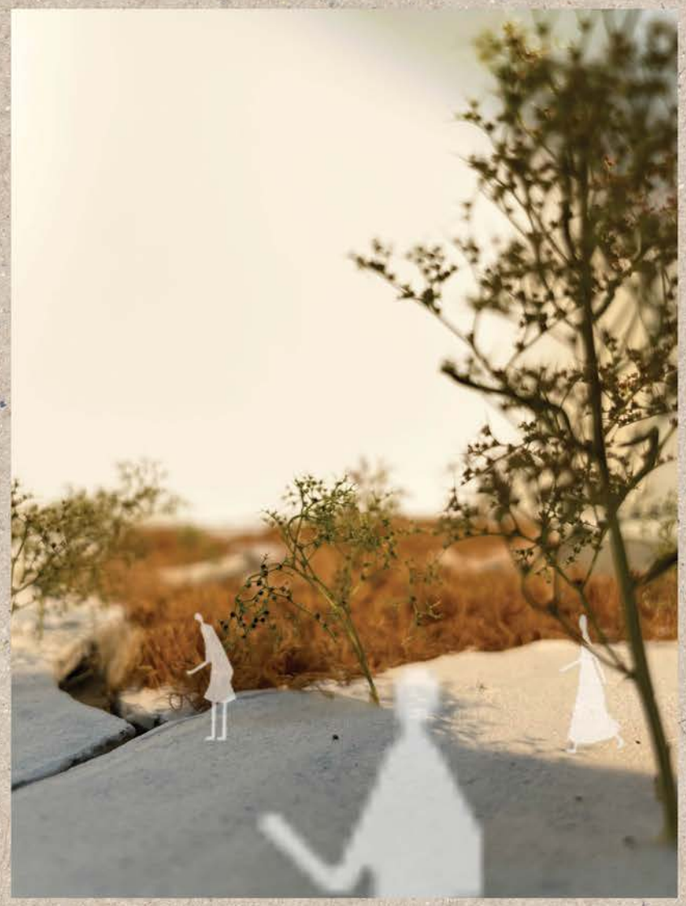
CONTENT



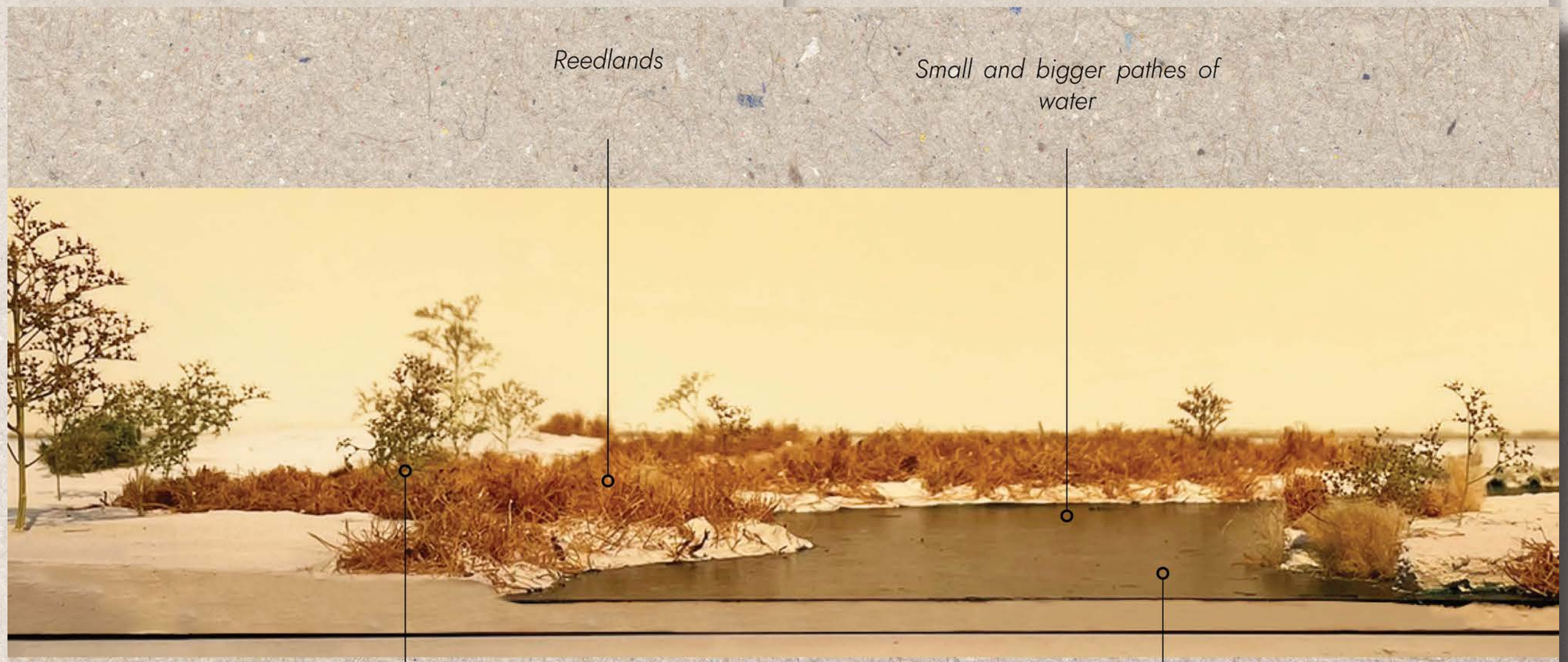
CONTENT

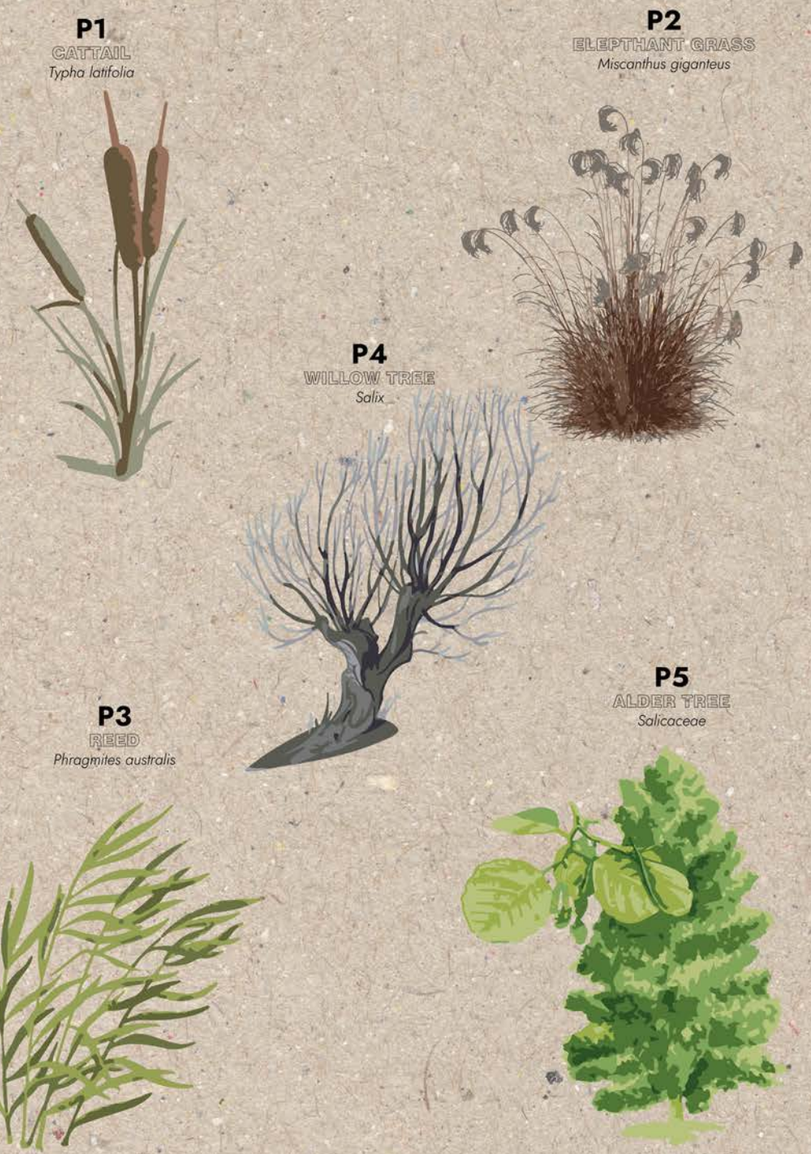


01. Character Landscape



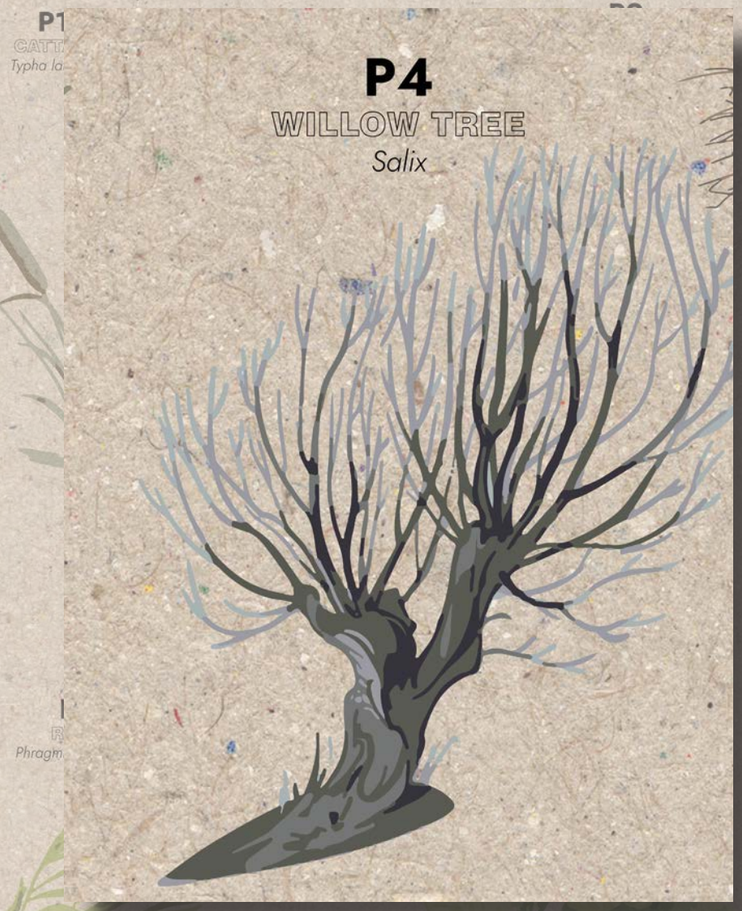
Walking through the landscape (own model)


Reedlands
Small and bigger pathes of water
Vegetation adapted to wet soil
Peatlakes

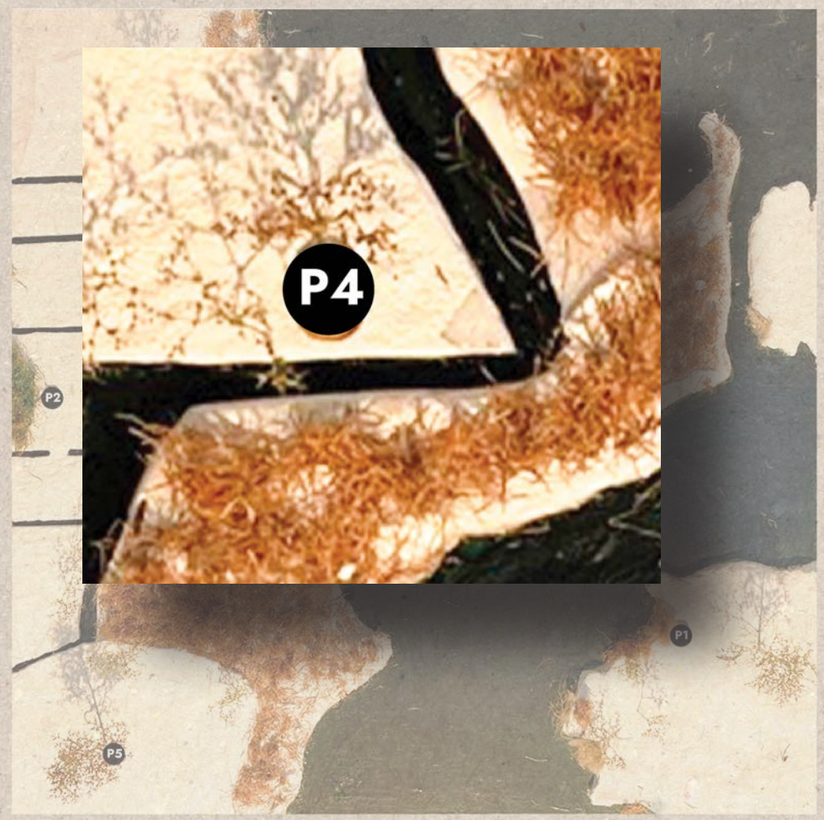


02. Materials information

While studying the landscape, various bio-based materials were discovered that hold great potential. The following are the most promising materials for use in construction purposes.



While studying the landscape, various bio-based materials were discovered that hold great potential. The following are the most promising materials for use in construction purposes.



02. Materials information

04. | Material Information

P1

CATTAIL

Typha latifolia

Used for:
Insulation

Cattail is a perennial herbaceous plant, meaning the part above ground dies each winter but the roots remain alive. It is native to wetlands on wet soils or shallow waters like rivers, marsches and lakes in temperate regions of the world. The plant is tall and slender with long leaves that can grow between 1.5- and 3-meters height. The plant is known for its distinctive brown, cylindrical flower spike, which is actually made up of thousands of small, densely-packed flowers (Flora van Nederland, 2023). Cattails can grow extensively in favorable conditions and are sometimes even considered a pest (Bestman, et al., 2019).

Yield:
20t of dry mass/ha (1)

Growing time:
24 weeks (1)

Insulation properties:
Lambda = 0.052 W/mK (2)

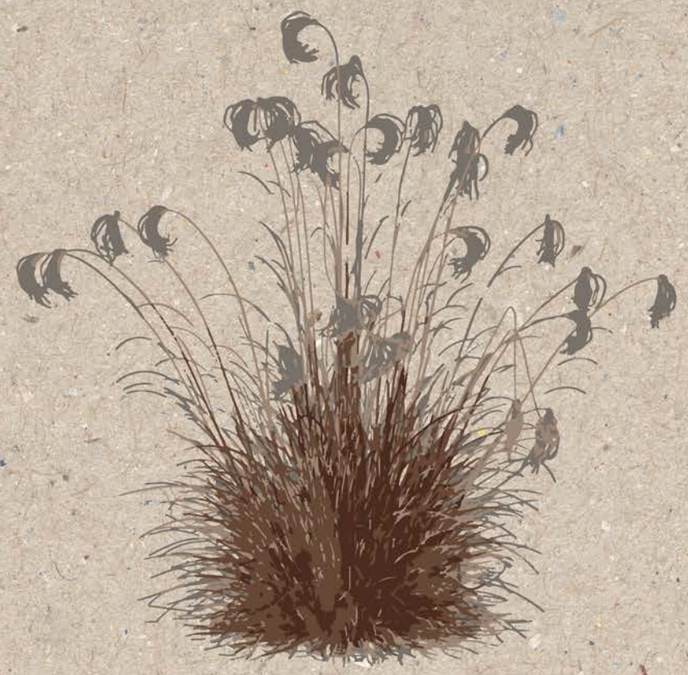
Thickness:
*144 mm**

1: (Wichtmann, Schröder, & Joosten, 2016)
2: (Frauenhofer Institute, 2013)

P2

ELEPHANT GRASS

Miscanthus giganteus



Used for:
Insulation

Miscanthus, also known as elephant grass, is a perennial grass which can grow up to 4 meters high. The crop propagates itself through rhizomes which are horizontal stems that grow underground. It can be harvested yearly for around 20-25 years without the use of herbicides and weed management (Econcreed, n.d.). Miscanthus has been found to have beneficial effects on soil health and has low nutrient requirements making it easy to grow (Bestman, et al., 2019). .

Yield:
20 tons dry mass/ ha (1)

Growing time:
1 year (1)

Insulation properties:
Lambda = 0.04 W/mK (2)

Thickness:
*180mm**

1: (Wichtmann, Schröder, & Joosten, 2016)
2: (Dias, Jayasinghe, & Waldmann, 2021).

P1

CATTAIL

Typha latifolia

native to wetlands on wet soils or shallow waters

Cattail is a perennial herbaceous plant, meaning the part above ground dies each winter but the roots remain alive. It is native to wetlands on wet soils or shallow waters like rivers, marsches and lakes in temperate regions of the world. The plant is tall and slender with long leaves that

1.5- and 3-meters height.

The plant is tall and slender with long leaves

which is actually made up of thousands of small, densely-packed flowers (Flora van Nederland, 2023). Cattails can grow extensively in favorable conditions and are sometimes even considered a pest (Bestman, et al., 2019).

distinctive brown, cylindrical flower spike,

Yield:
20t of dry mass/ha (1)

24 weeks (1)

Insulation properties:
Lambda = 0.052 W/mK (2)

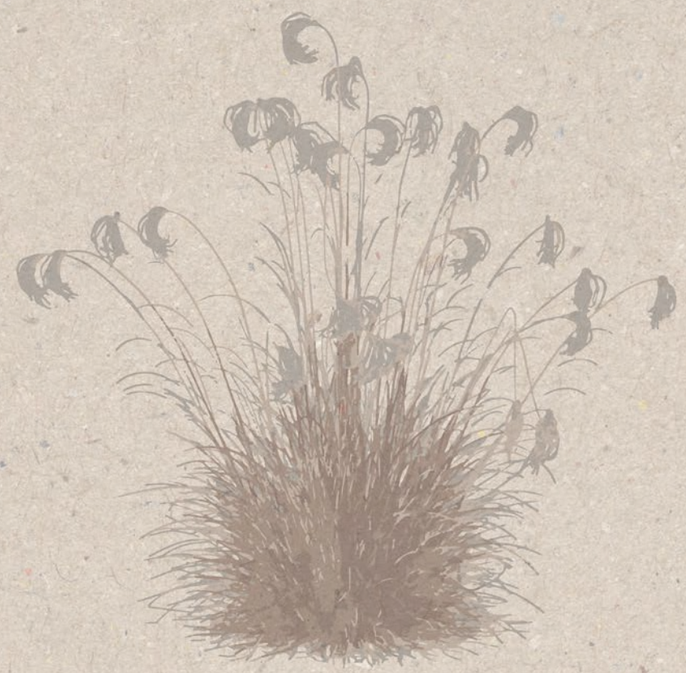
Thickness:
*144 mm**

1: (Wichtmann, Schröder, & Joosten, 2016)
2: (Frauenhofer Institute, 2013)

P2

ELEPHANT GRASS

Miscanthus giganteus



Used for:
Insulation

Miscanthus, also known as elephant grass, is a perennial grass which can grow up to 4 meters high. The crop propagates itself through rhizomes which are horizontal stems that grow underground. It can be harvested yearly for around 20-25 years without the use of herbicides and weed management (Econcreed, n.d.). Miscanthus has been found to have beneficial effects on soil health and has low nutrient requirements making it easy to grow (Bestman, et al., 2019).

Growing time:
1 year (1)

20 tons dry mass/ ha (1)

Insulation properties:
Lambda = 0.04 W/mK (2)

Thickness:
*180mm**

1: (Wichtmann, Schröder, & Joosten, 2016)
2: (Dias, Jayasinghe, & Waldmann, 2021).

P3

REED

Phragmites australis

Yield:
6-24 tons dry mass/ ha (1)

Growing time:
1 year (1)

Insulation properties:
Lambda = 0.06 W/mK (2)

Thickness:
*270 mm**

1: (Wichtmann, Schröder, & Joosten, 2016)
2: (Malheiro, et al., 2021).

1: (Wichtmann, Schröder, & Joosten, 2016)
2: (Malheiro, et al., 2021)

P4

WILLOW TREE

Salix

Used for:
Cladding
Binding material

The willow belongs to the Salix genus which includes around 400 different species. It has a preference for moist soil and is known for its ability to tolerate flooding. The willow tree is one of the fastest growing trees and can grow up to 30 centimeters per year. The branches of willow trees, known as willow withes, are slender, flexible and grow rapidly. Annual pollarding of the willow trees generates large quantities of willow withies (Flora van Nederland, 2013).

Yield:
6 - 13 tons dry mass/ ha (trees 7y of age) (1)

Growing time:
1 year (1)

1: (Bestman, et al., 2019)

P5

ALDER TREE

Alnus glutinosa

Used for:

Sub-structure
Foundation
Cabinetry
Doors

The Alder tree grows in vari
moist and cool conditions suc
2022). They have a high-w
release a significant amount of in through transpiration. The tree
can grow up to 24m in height, although this is rare. They usually have multiple trunks, and the bark is black-brown and strongly grooved (Flora van Nederland, 2013). The tree is able to host the nitrogen-fixing bacterium Frankia alni in its roots. This enables the plant to grow in otherwise unsuitable, low-nutrient areas such as wastelands, where it can serve as a pioneer species and help improve the quality of the soil over time (Designing Buildings, 2022).

Yield:
2.56-4.75 m3 / ha dry matter (1)

Growing time:
15-20 years (1)

1: (Aosaar, Varik, & Uri, 2012)

** Estimated thickness based on R= 4.5 m2K/W*
*** If left blank, no information available*

The process of converting vegetation into a building material follows a structured approach, which involves three key steps leading to the creation of a final building component.

PROCESSING | initial process after harvesting

SUPPORT | putting the products on the facade

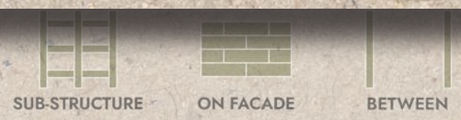
ATTACHING | attachments that are needed in the process

03. Production framework

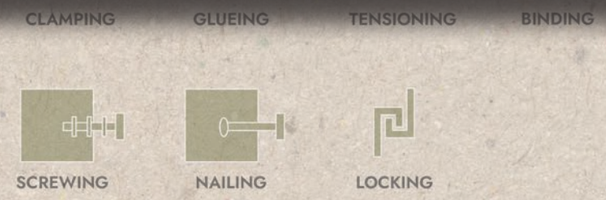
The process of converting vegetation into a building material follows a structured approach, which involves three key steps leading to the creation of a final building component.

PROCESSING | initial process after harvesting

SUPPORT | putting the products on the facade



ATTACHING | attachments that are needed in the process



03. Production framework

04. | Production Framework

INSULATION

MATERIAL	PROCESSING	SUPPORT	ATTACHING	FRAGMENT	
ELEPHANT GRASS *Miscanthus giganteus*	SHREDDING, PRESSING	ON FACADE	SCREWING		*Miscanthus pressed panel directly on facade*
	BAILING	BETWEEN	CLAMPING, SCREWING		*Miscanthus bailed on sub-structure*
REED *Phragmites australis*	CUTTING	BOX	TENSIONING, SCREWING		*Reed in box*
TYPHA *Typha latifolia*	SHREDDING, PRESSING	ON FACADE	SCREWING		*Typha pressed panel directly on facade*
	SHREDDING, PRESSING	BETWEEN	CLAMPING		*Typha pressed panel between frame*

INSULATION

MATERIAL | PROCESSING | SUPPORT | ATTACHING | FRAGMENT

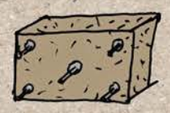
MATERIAL	PROCESSING	SUPPORT	ATTACHING	FRAGMENT
ELEPHANT GRASS *Miscanthus giganteus*	SHREDDING, PRESSING	ON FACADE	SCREWING	*Miscanthus pressed panel directly on facade*
	BAILING	BETWEEN	CLAMPING, SCREWING	*Miscanthus bailed on sub-structure*
	SHREDDING, PRESSING	BETWEEN	CLAMPING	*Typha pressed panel between frame*

Insulation

Miscanthus pressed panel directly on facade

Miscanthus bailed on sub-structure

Reed in box



Typha pressed panel directly on facade

Typha pressed panel between frame

Cladding

Reed clamped in frame

Reed clamped by wooden slat

Reed binded together

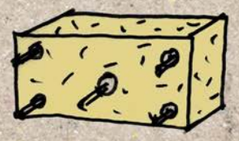
Reed bundled together

Willow withies weaved on frame

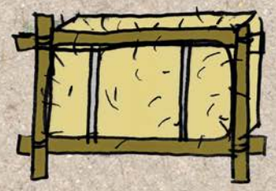
Willow withies nailed on frame

Willow withies ramdomly nailed on substructure

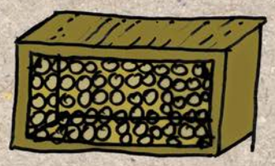
Insulation



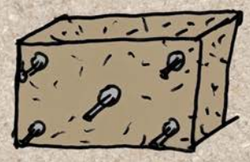
Miscanthus pressed panel directly on facade



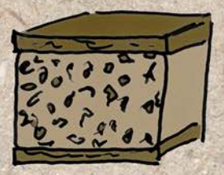
Miscanthus bailed on sub-structure



Reed in box



Typha pressed panel directly on facade



Typha pressed panel be-tween frame

Cladd

Reed clamped in frame

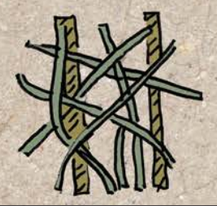
Reed clamped by wooden slat

Reed binded together

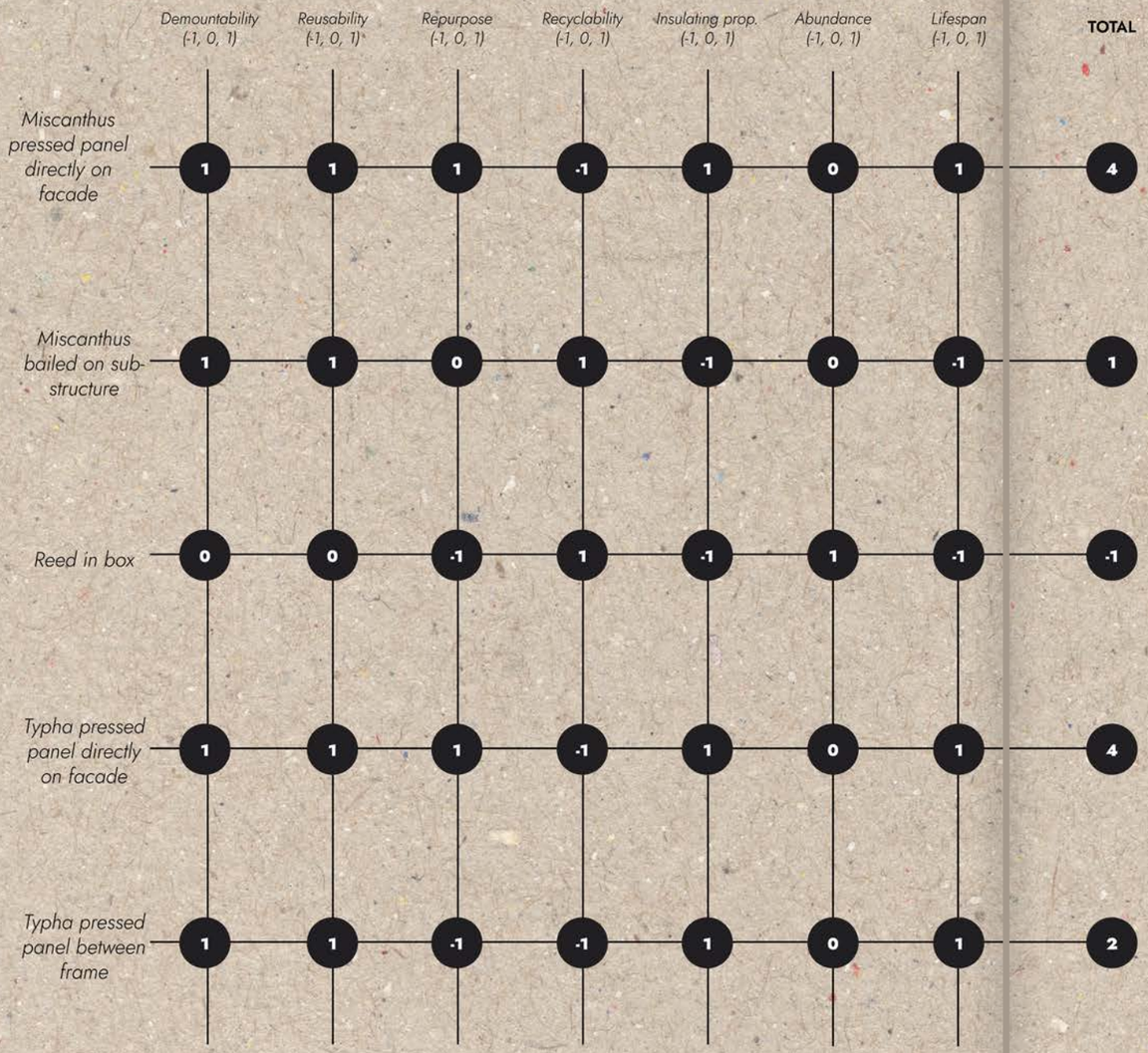
Reed bundled together

Willow withies weaved on frame

Willow withies nailed on frame



Willow withies ramdomly nailed on substructure



05. Renovation criteria

The different options can be evaluated based on factors that are important for sustainable renovation. The Pugh chart method can be employed to assign scores ranging from -1, 0, or 1 to each option. This scoring serves as a rough estimation of their performance in relation to the chosen criteria.

Scoring

1. Demountability (take away from the facade)
-1: The element can not be taken away from the facade
0: The element can be taken away from the facade, but requires more work
1: The element can easily be taken away from the facade

2. Reusability
-1: It is hard to re-use the element as insulation after use
0: It is possible to re-use the element as insulation after use, but with less quality
1: It is possible to re-use the element as insulation after use

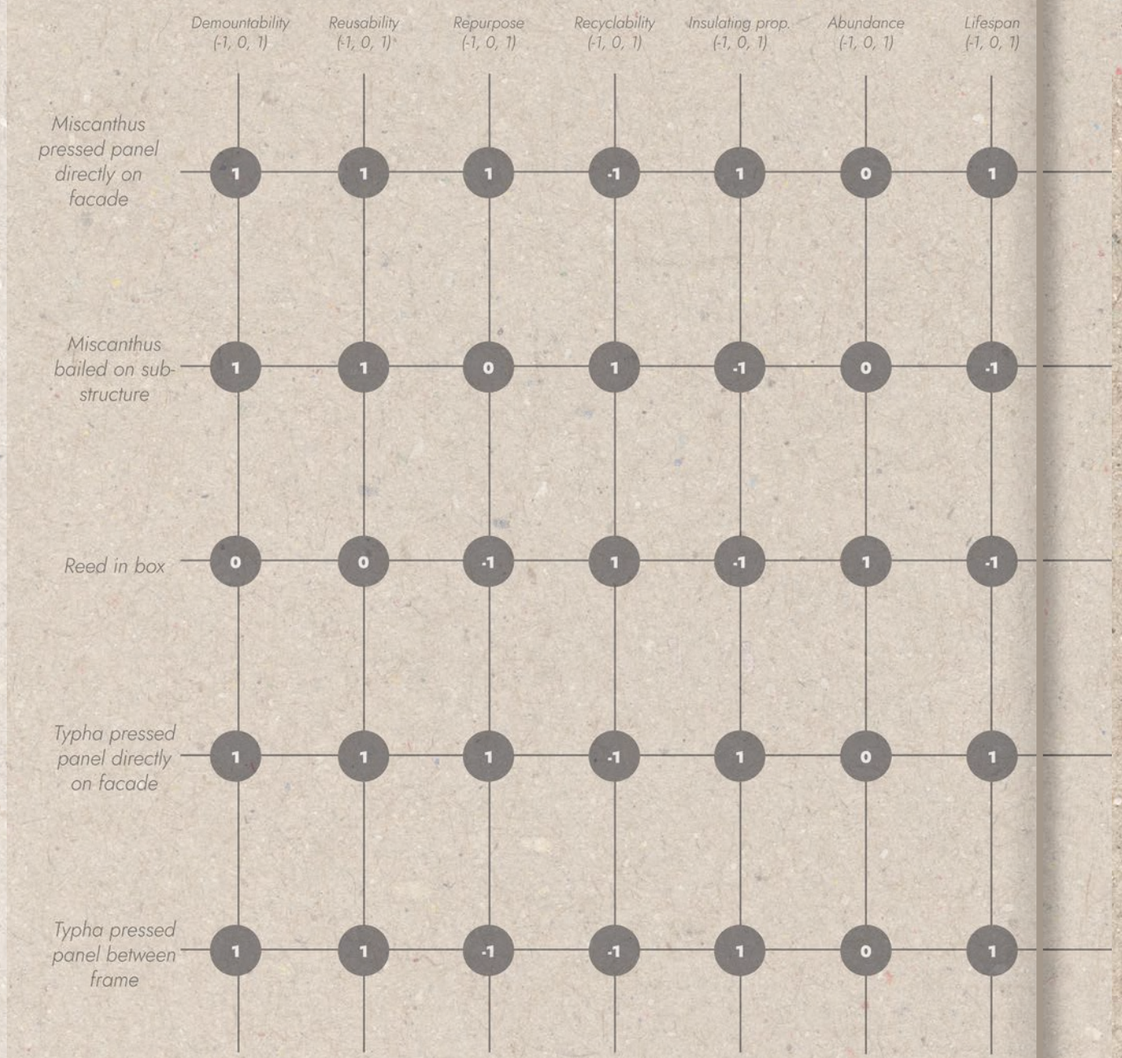
3. Repurpose
-1: It is not possible to find another purpose for the element after use
0: It is hard but possible to find another purpose for the element after use
1: It is possible to find another purpose for the element after use

4. Recyclability (take apart)
-1: It is not possible to take the whole element apart to recycle after use
0: It is partly possible to take the whole element apart to recycle after use
1: It is possile to take the whole element apart to recycle after use

5. Insulating properties
-1: The element preforms worse compared to other insulation materials
0: The element performs average compared to other insulation
1: The element performs better compared to others

6. Abundance
-1: The material is not abundant in the landscape
0: The material is present in the landscape
1: The material is abudant in the landscape

7. Lifespan
-1: The lifespan of the product is short compared to others in the category
0: The lifespan of the product is average compared to others in the category
1: The lifespan of the product is good compared to others in the category



05. Renovation criteria

Scoring

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Once various vegetation options have been identified, they can be combined in different variations on the facade. These combinations can be explored through various layouts and arrangements. This section showcases a range of these possibilities and provides conceptual sketches to illustrate what they could look like.

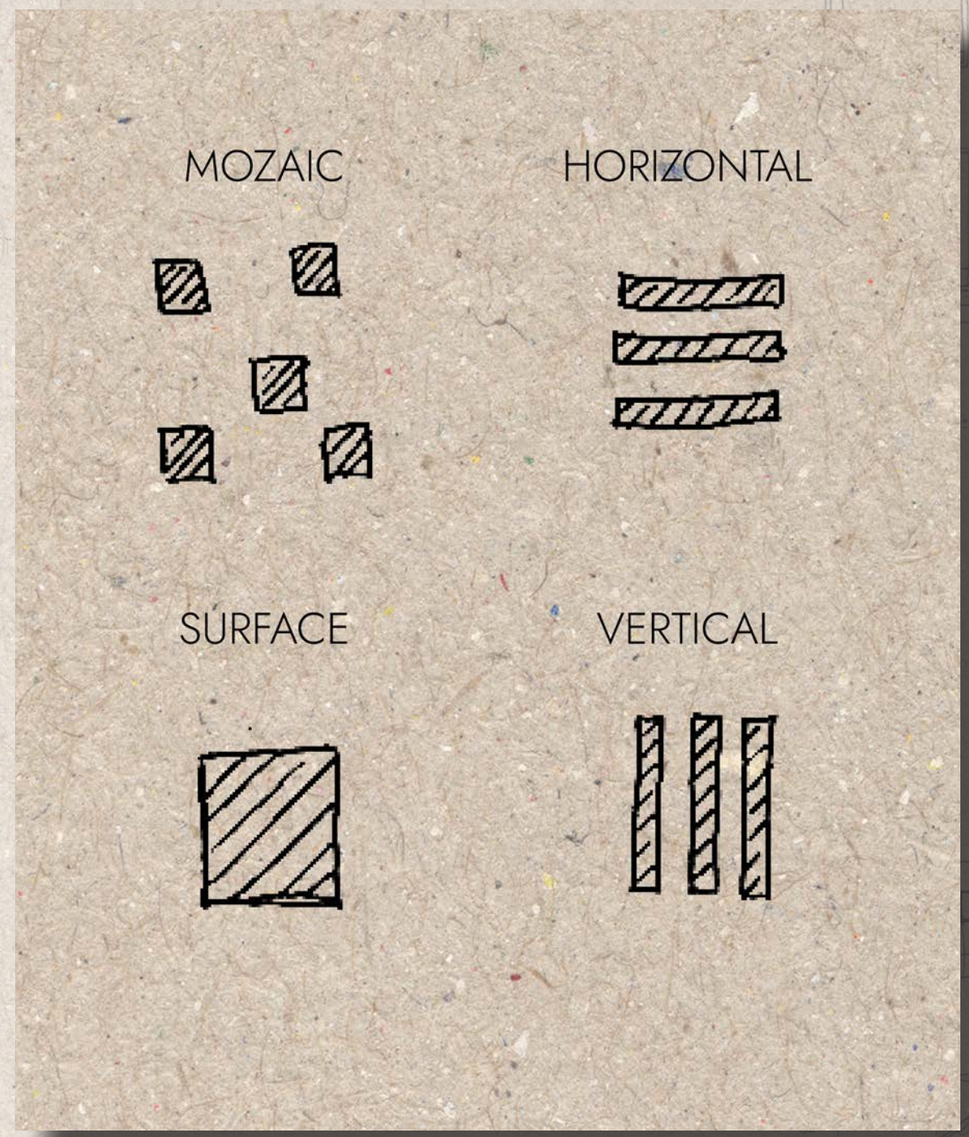
MOZAIC

HORIZONTAL

SURFACE

VERTICAL

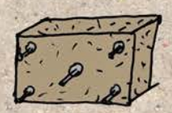
05. Tectonics



04. | Tectonics

MOZAIC

'Panelled Willow'



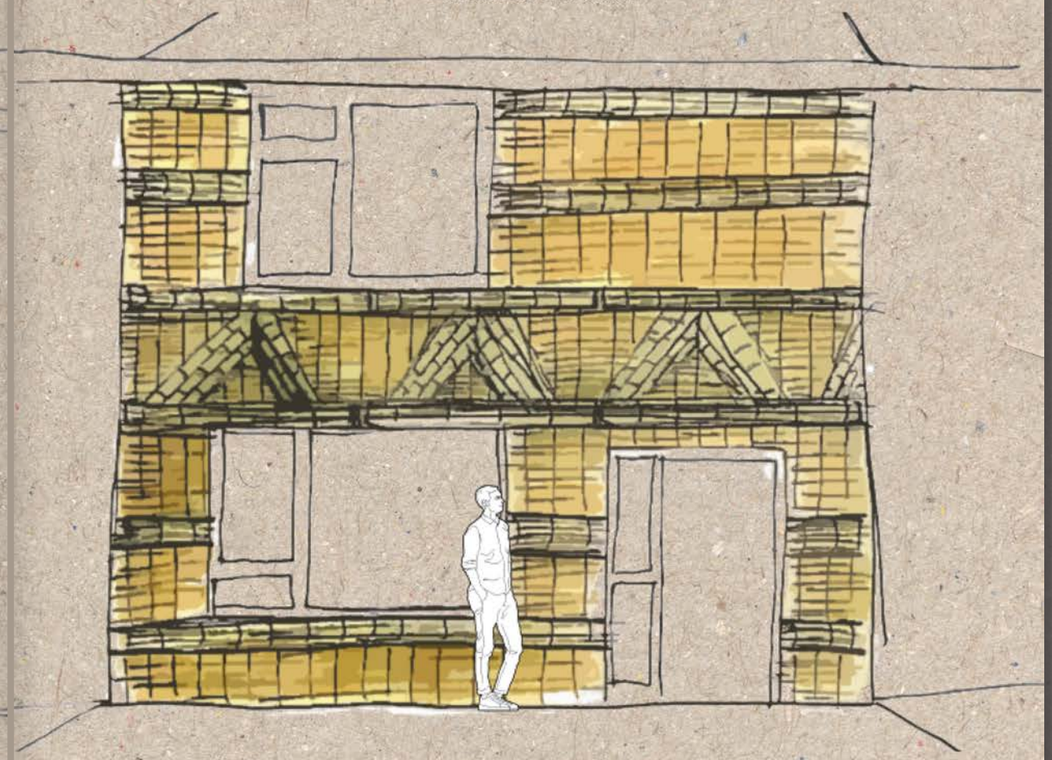
Typha pressed panel directly on facade

Willow withies weaved on frame

Willow withies nailed on frame

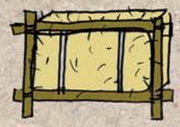
HORIZONTAL

'Binded Reed'



Reed bundled together

Reed binded together



Miscanthus bailed on sub-structure

SURFACE

‘Thatched reed’

Reed in box

Reed clamped by wooden slat

VERTICAL

‘Combined thatched and paneled reed’

Miscanthus pressed panel directly on facade

Reed clamped by wooden slat

Reed clamped in frame

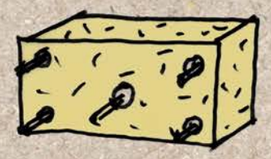
SURFACE

‘Thatched reed’

Reed in box

VERTICAL

‘Combined thatched and paneled reed’



Miscanthus pressed panel directly on facade

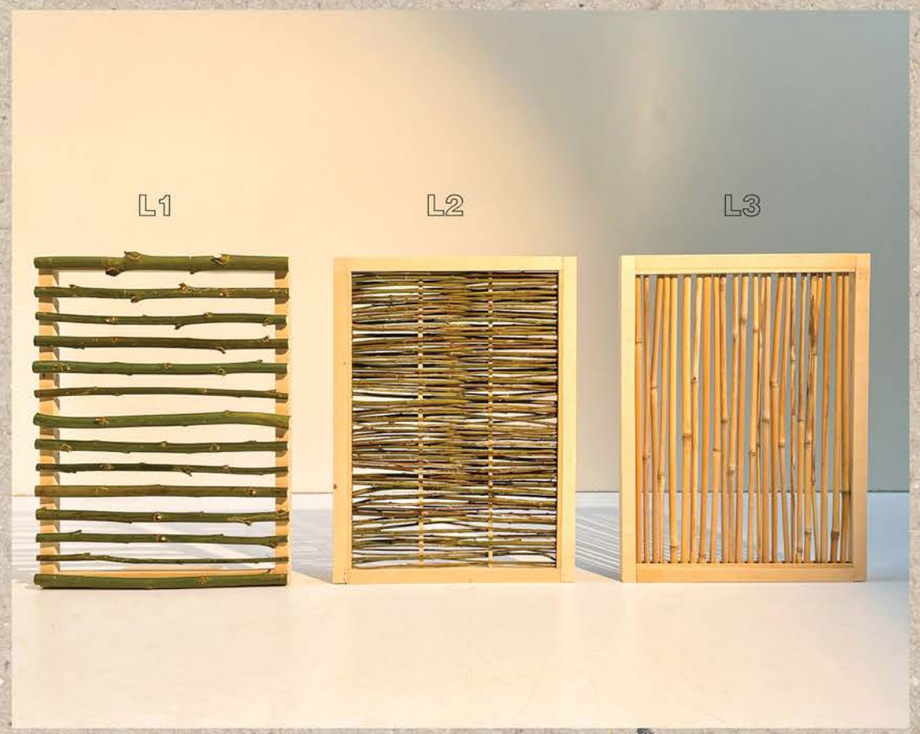
Reed clamped by wooden slat

Reed clamped in frame

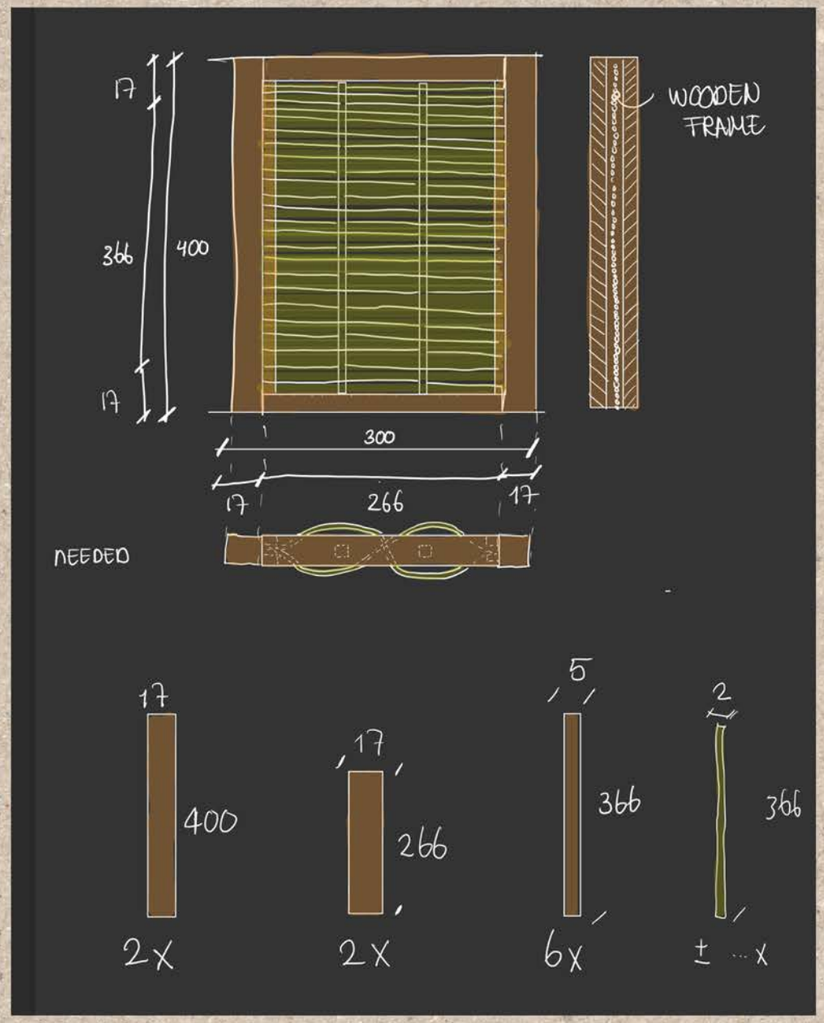
Willow withies nailed on frame

Willow withies weaved on frame

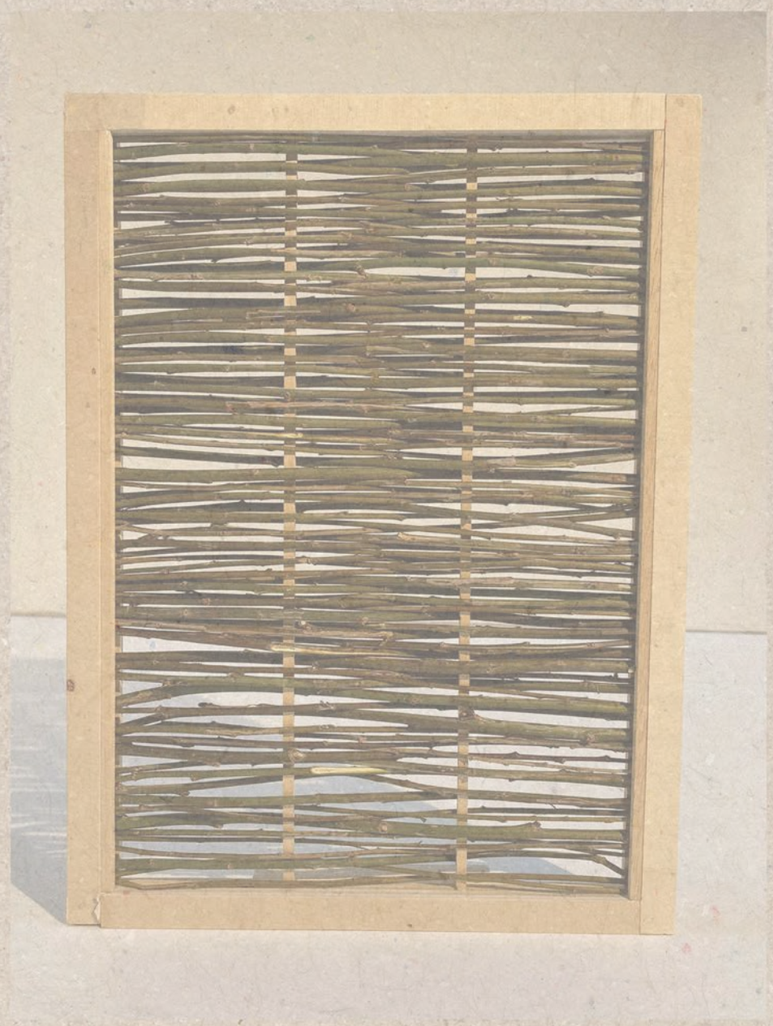
Reed clamped in frame

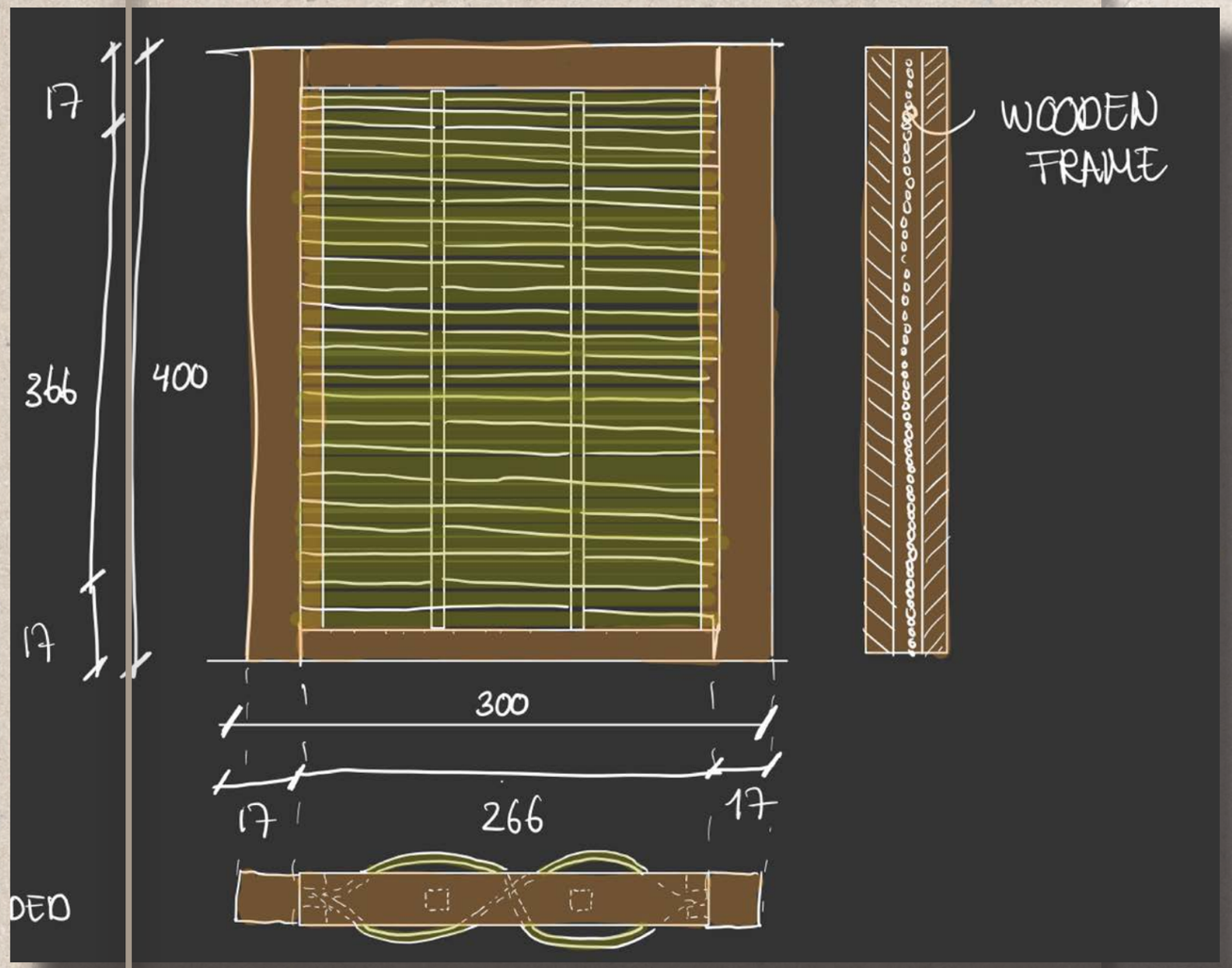


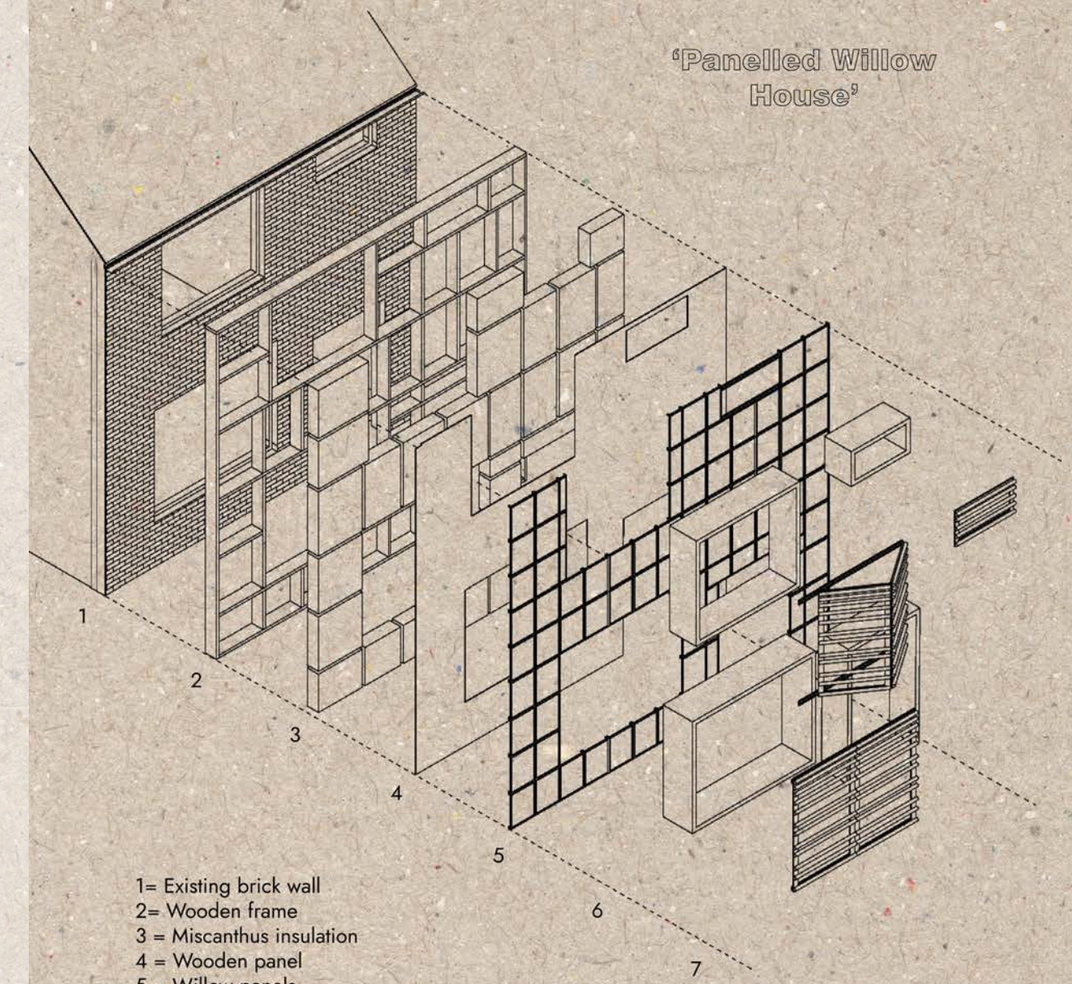
L2


17
366
400
17
300
17
266
17
WOODEN
FRAME
NEEDED
17
400
2X
17
266
2X
5
366
6X
2
366
± ... X

L2







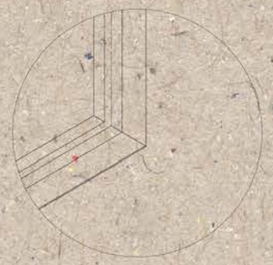
‘Panelled Willow House’

1= Existing brick wall
2= Wooden frame
3 = Miscanthus insulation
4 = Wooden panel
5 = Willow panels
6 = Window sills
7= Willow branch louvres

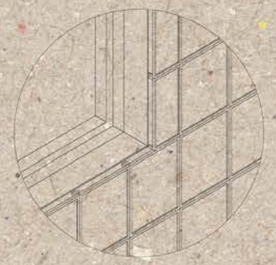
1.0 | Existing brick wall

2.0 | Wooden frame

3.0 | Miscanthus insulation

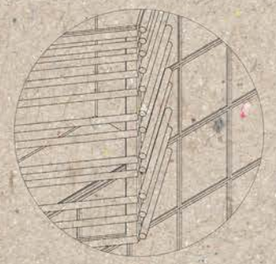


4.0 | Wooden plate



5.0 | Willow panels

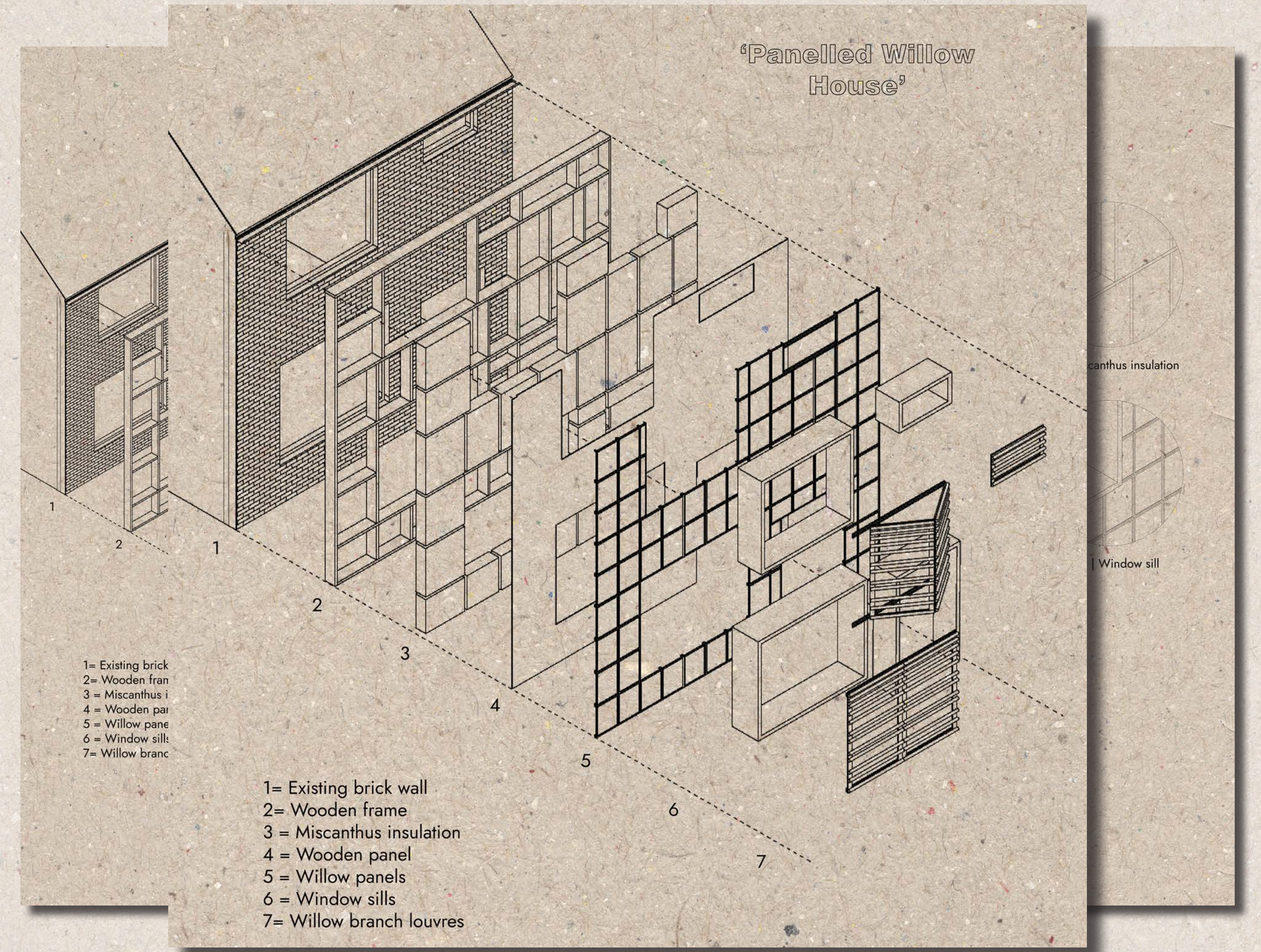
6.0 | Window sill



7.0 | Willow branch louvres

06. Proof of concept

04. | Proof of concept



04. | Proof of concept

Peat

04. | Sketch Impression - Peat Landscape

Sand

04. | Sketch Impression - Sand Landscape

Clay

04. | Sketch Impression - Clay Landscape

.05.

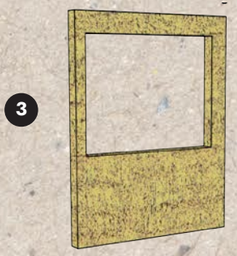
Proof of concept

Broad Overiew

Detail

Willow louvres window

Thatched reed cladding



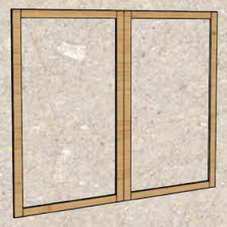
Willow panel

Wooden frame

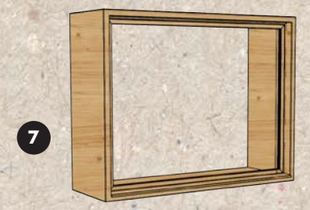
Reed panel

Typha insulation

Wooden frame louvres



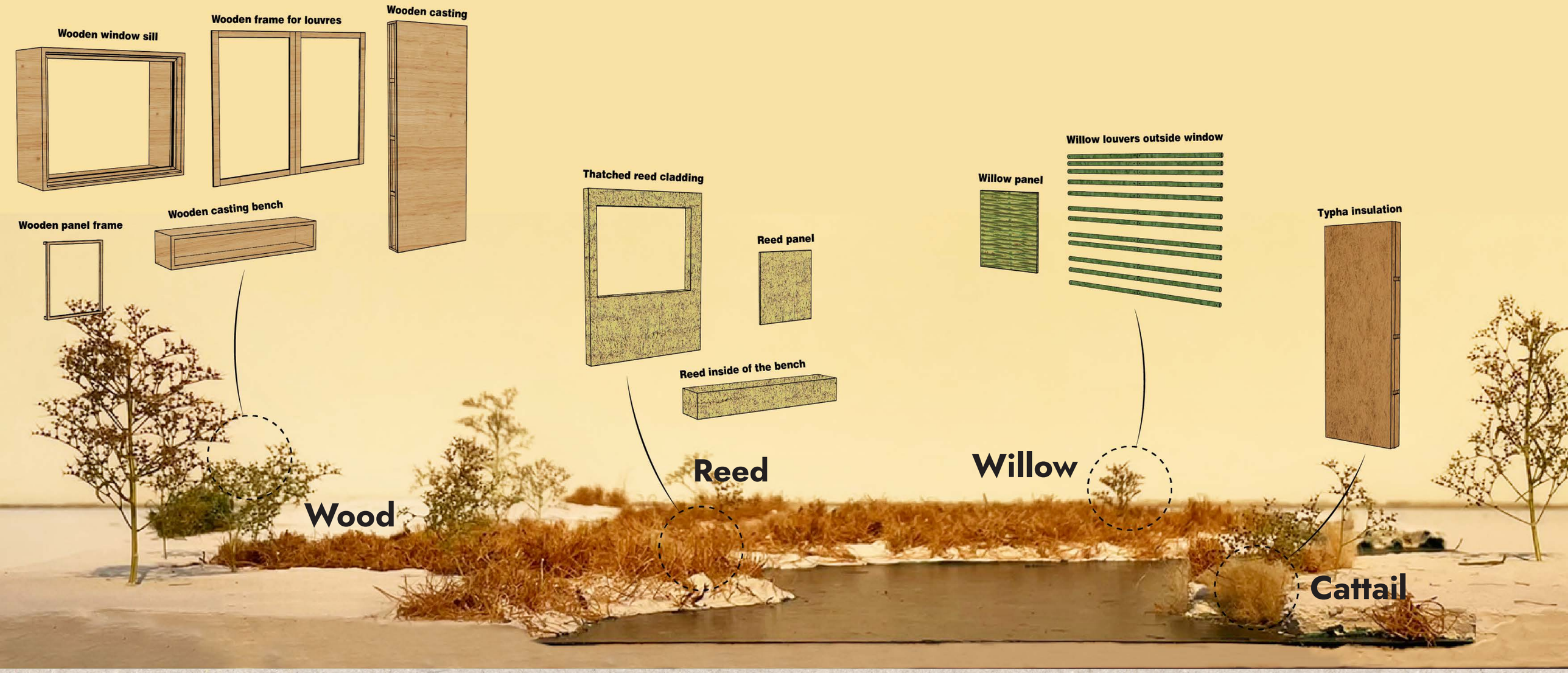
Wooden window sills

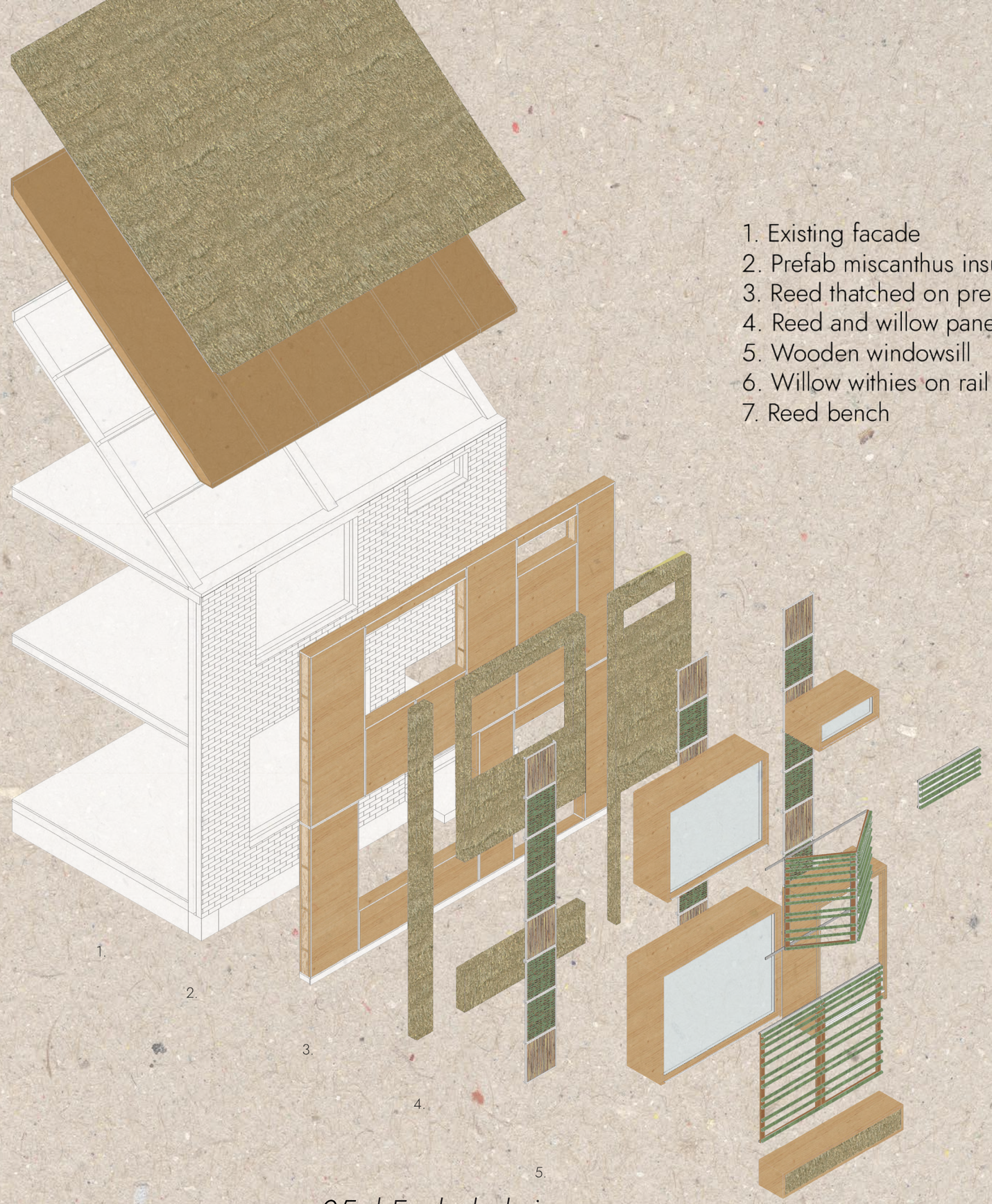


Wooden casting

Wooden casting bench

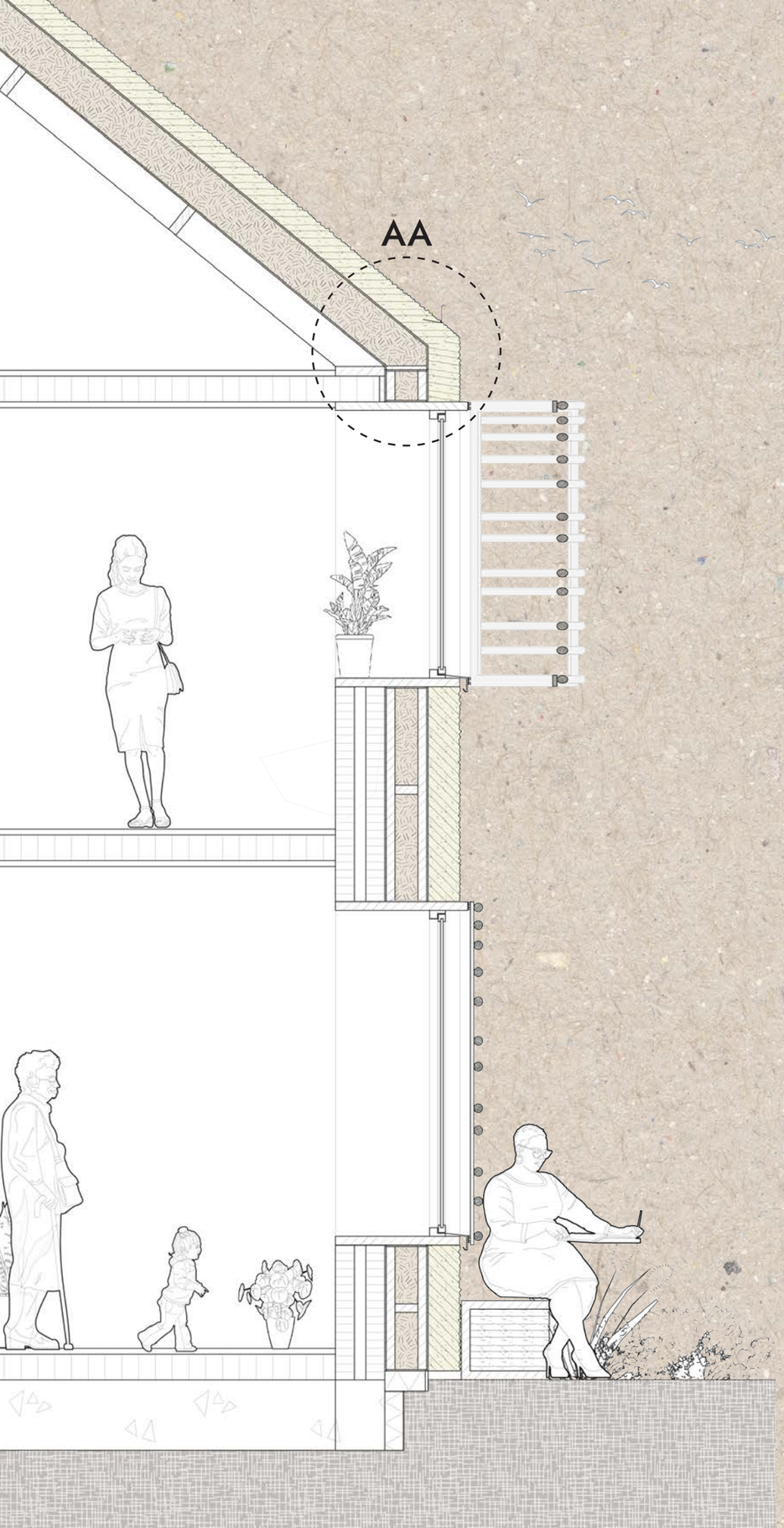
Reed inside bench

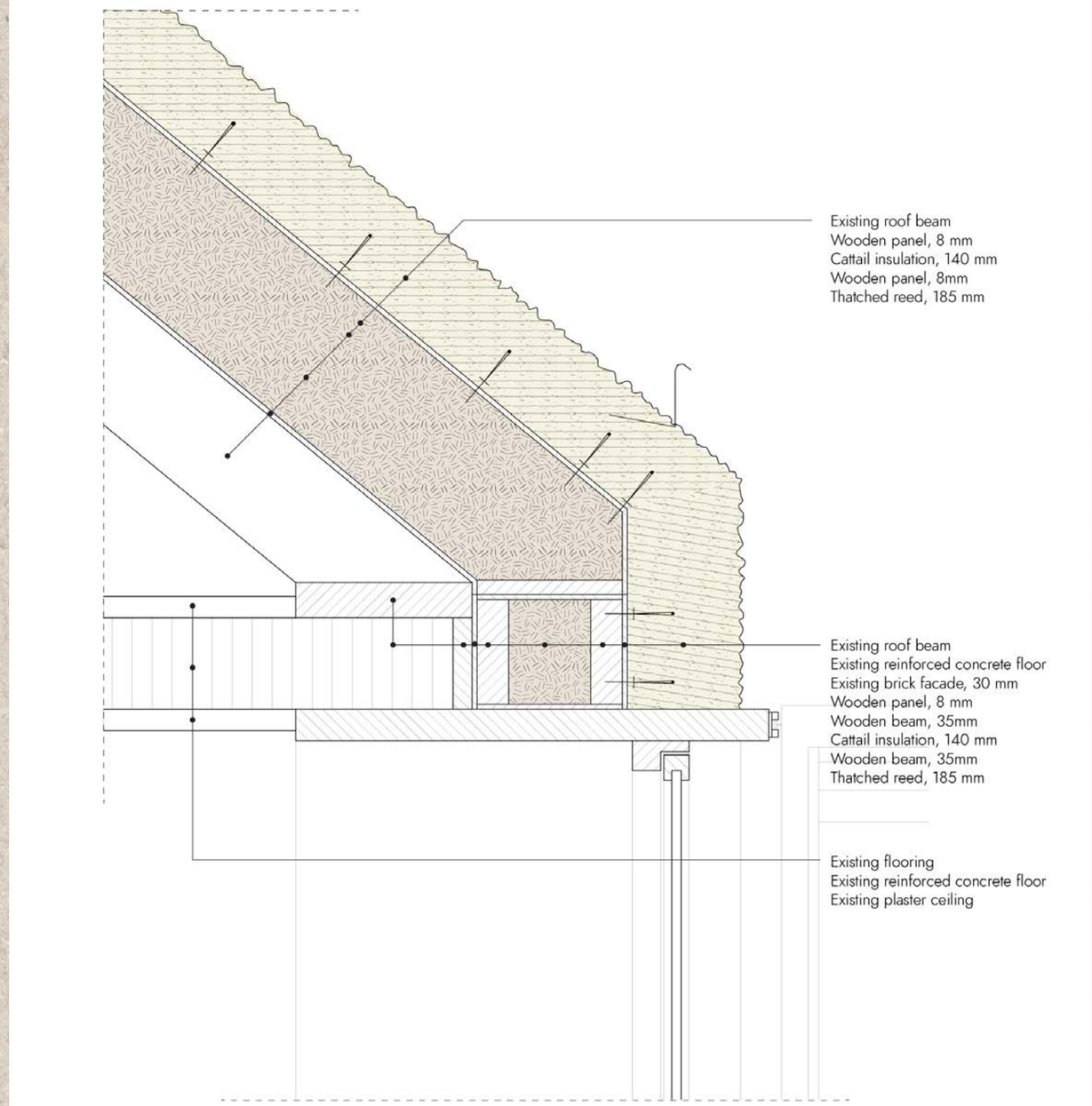

Wooden window sill
Wooden frame for louvres
Wooden casting
Wooden panel frame
Wooden casting bench
Thatched reed cladding
Reed panel
Reed inside of the bench
Willow panel
Willow louvers outside window
Typha insulation
Wood
Reed
Willow
Cattail



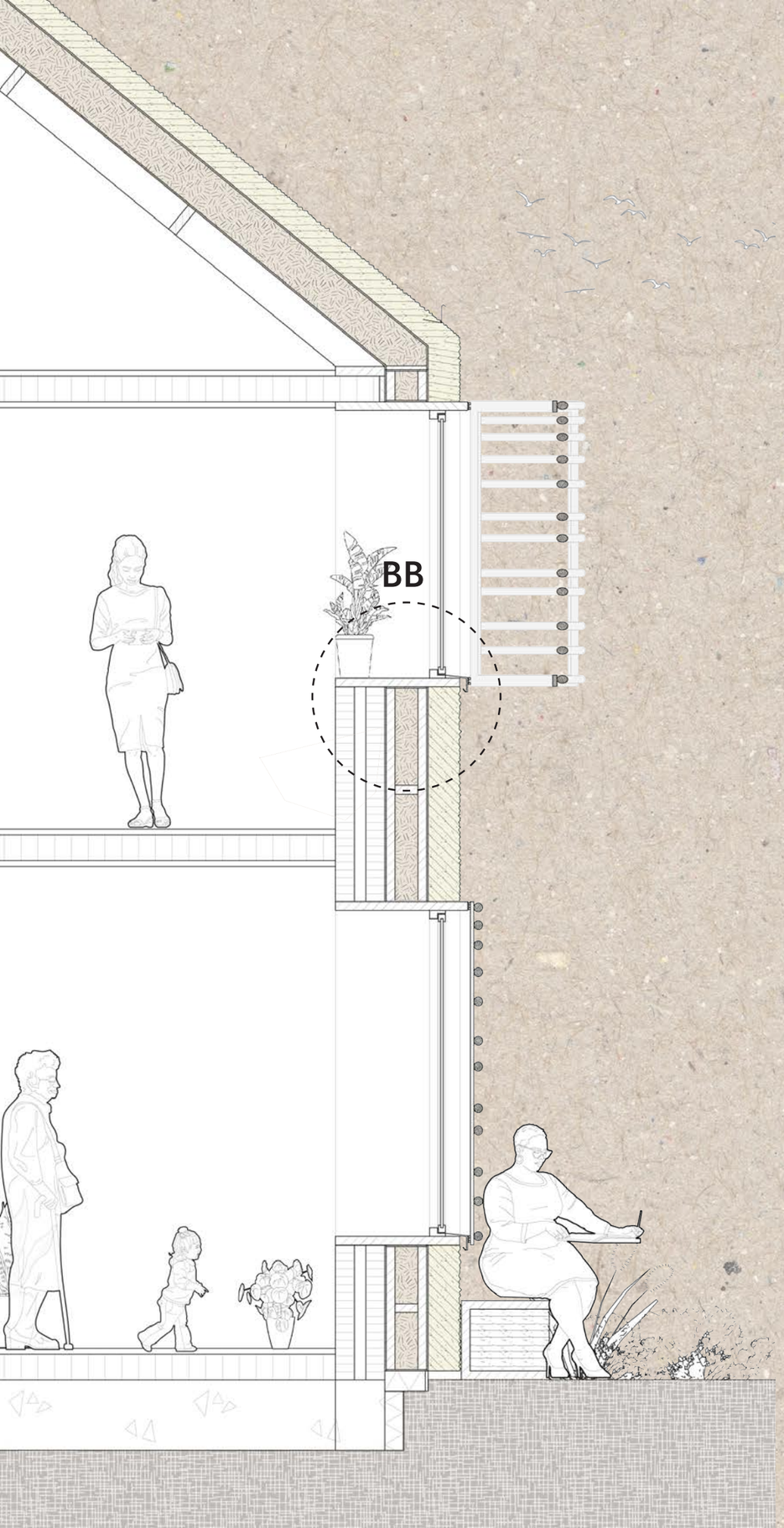
1. Existing facade
2. Prefab miscanthus insulation elements
3. Reed thatched on prefab elements
4. Reed and willow panels screwed on prefab element
5. Wooden windowsill
6. Willow withies on rail
7. Reed bench

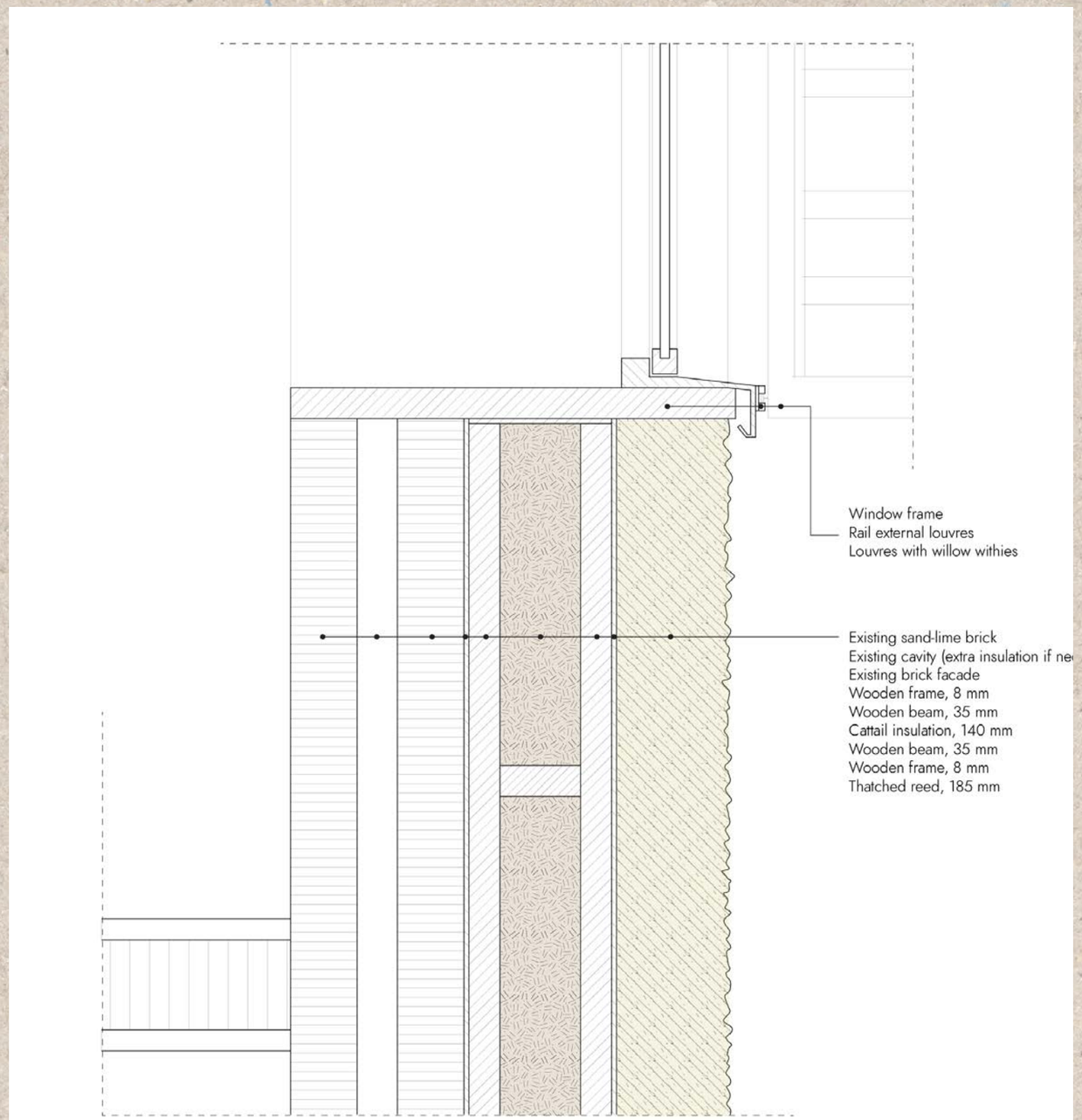
05. | Exploded view



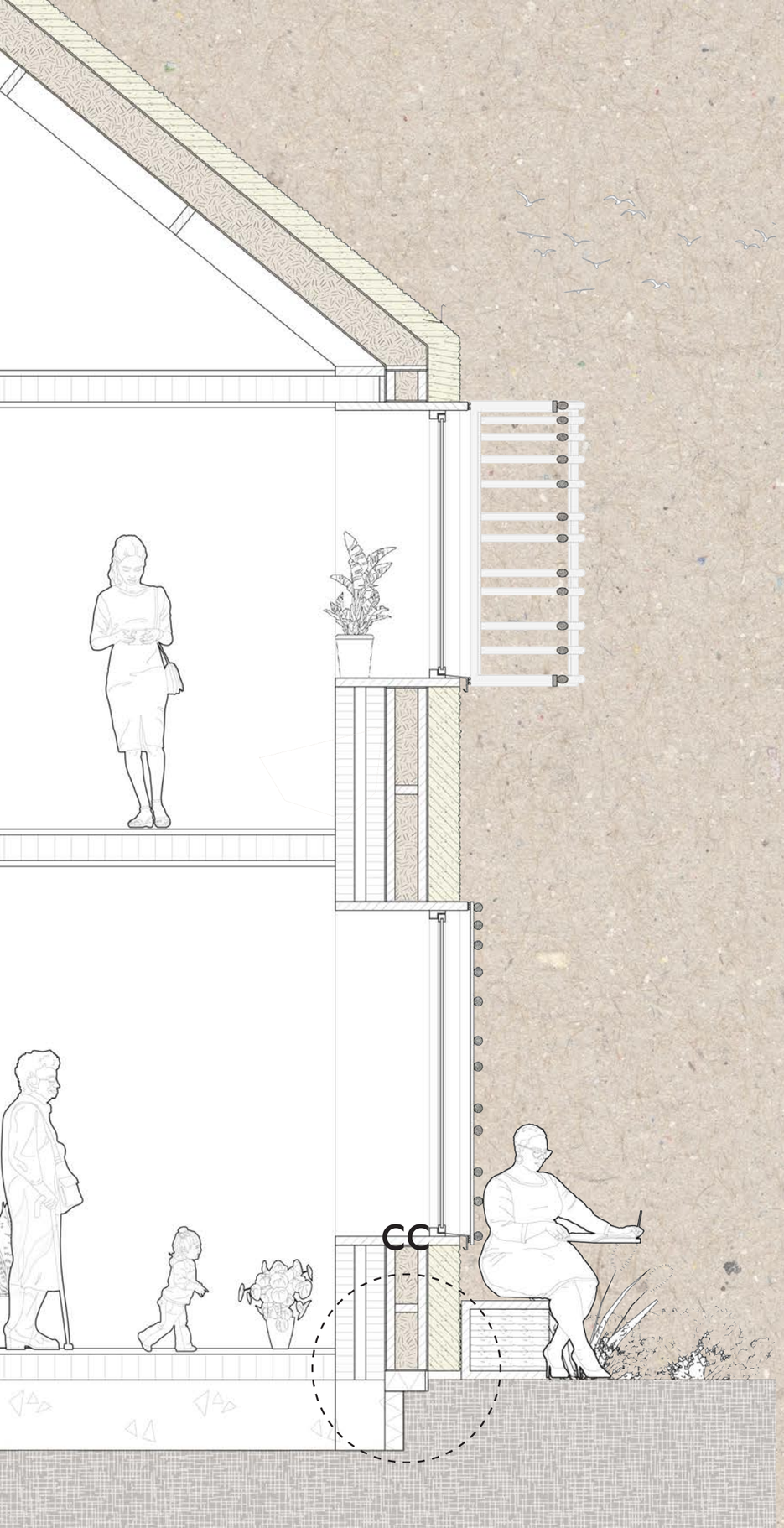


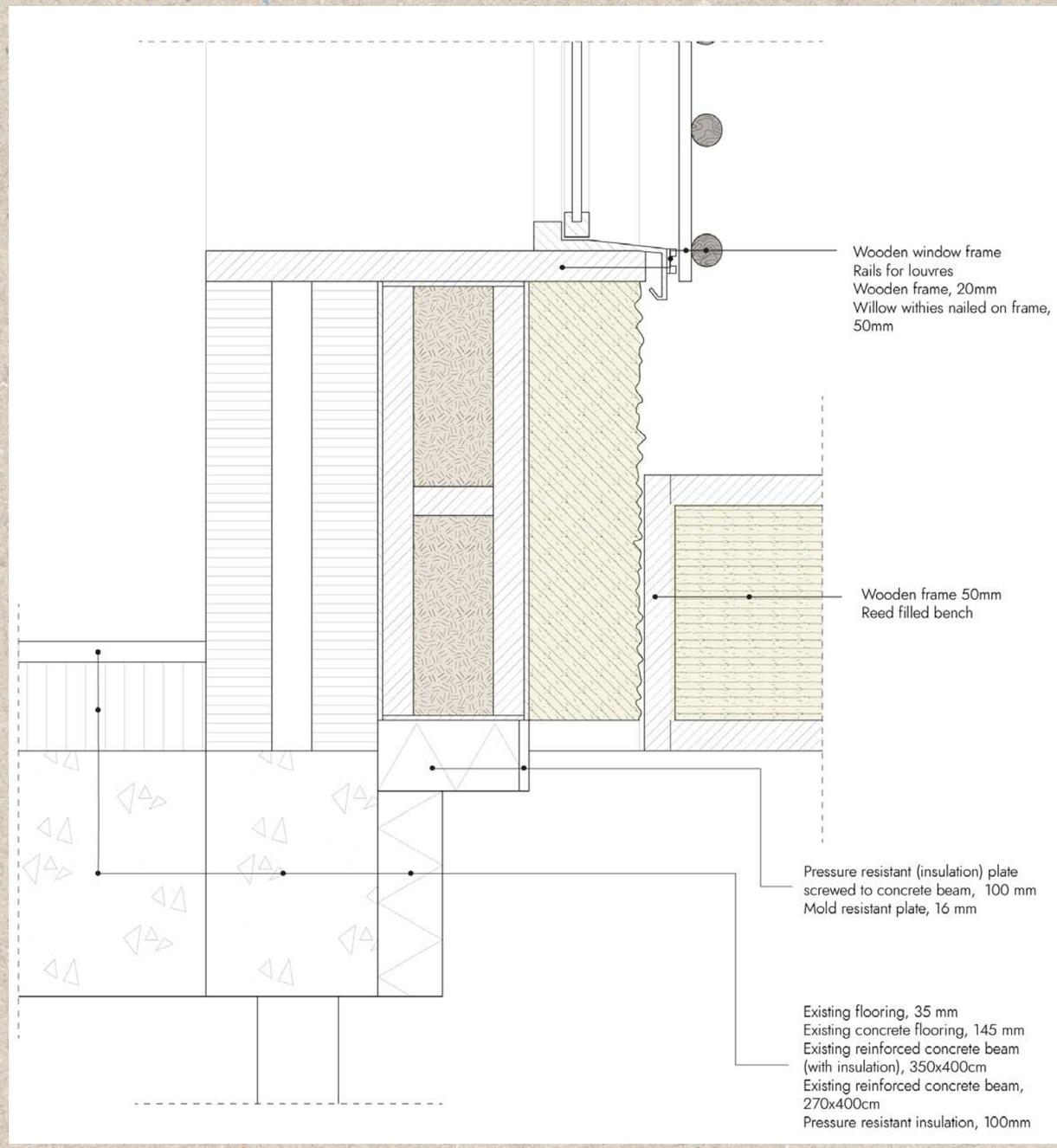
05. | Technical Drawings





05. | Technical Drawings





05. | Technical Drawings

Heat transfer coefficient (U)
W/(m2K)

<u>U-value without renovation</u>:
R_t=2.65 [m²K/W]
U= 0.38 W/(m²K)

<u>Bio-based renovation</u>

Rt=9.70 [m2K/W]
U= 0.10 W/(m2K)

Meets passive housing requirements (U<0.15 W/(m2K))

Environmental Impact (GWP)*

CO2-eq./m2 wall

New Construction

(New bricks, aerated concrete, mineral wool, PE foil, mortar, calvanized steel)

+ 84 kg CO2 eq./m2

Conventional Renovation

(mineral wool, PE foil, mortar, calvanized steel)

+ 10.41 kg CO2 eq./m2

Bio-Based Renovation

(cattail insulation, construction wood, reed cladding, screws)

-62,14 kg CO2 eq./m2

*Based on LCA from CINARK,the German database, Ökobaudat and for reet from ''Nachwachsende Rohstoffe e.V'' *(Beim et. al., 2023)*.

Costs
€/m2 wall

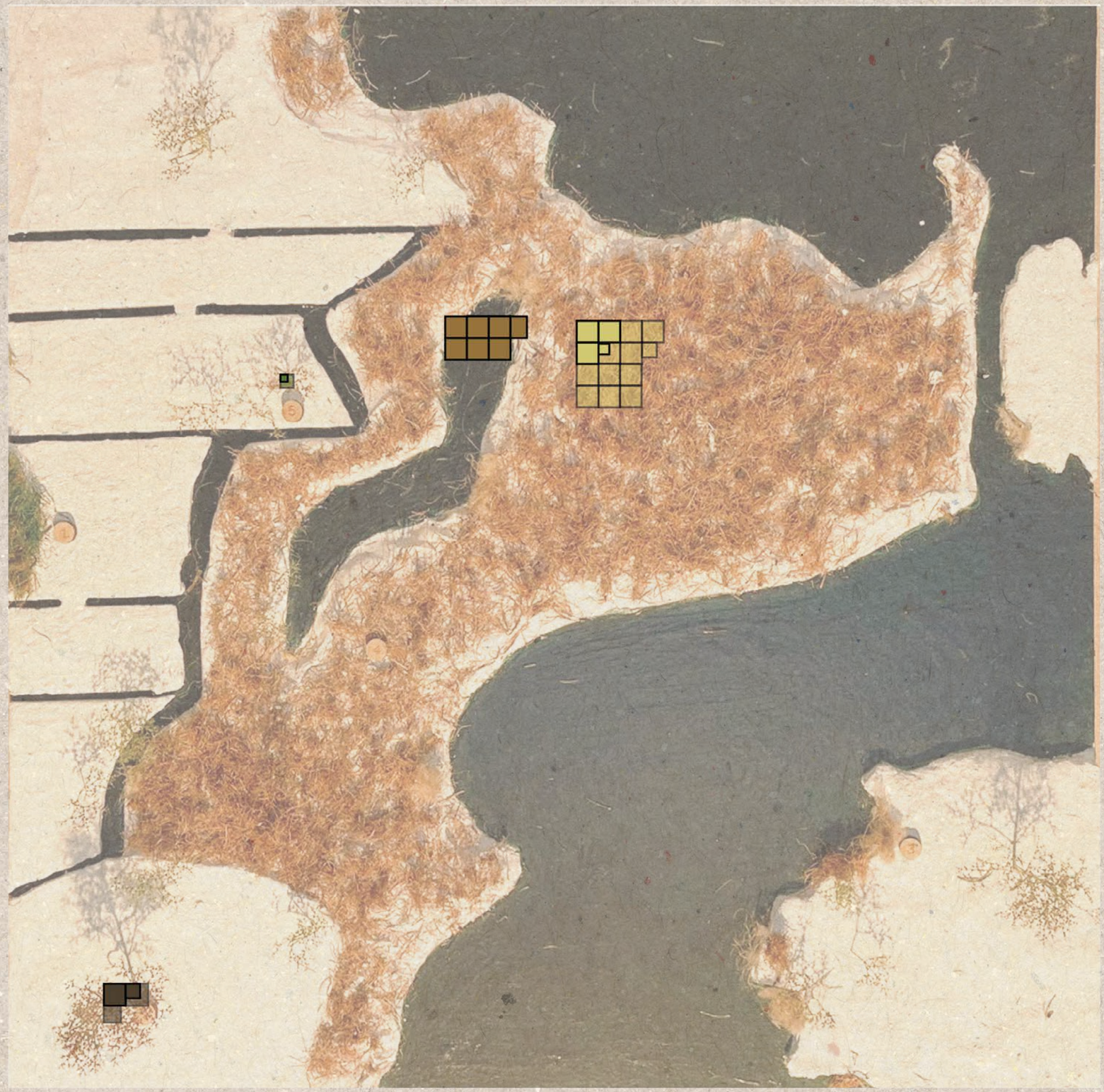
<u>Conventional Renovation</u>
(mineral wool, PE foil, mortar, calvanized steel)

€ 76.78/m2

<u>Bio-Based Renovation</u>
(cattail insulation, construction wood, reed cladding, screws)

€ 128,76 /m2

-Can not only be measured in price
-Still a small production
-Carbon tax



Space Requirements
One house
Based on m3 needed, yield, density crop and hectares/m3

TYPHA = 0.68 ha

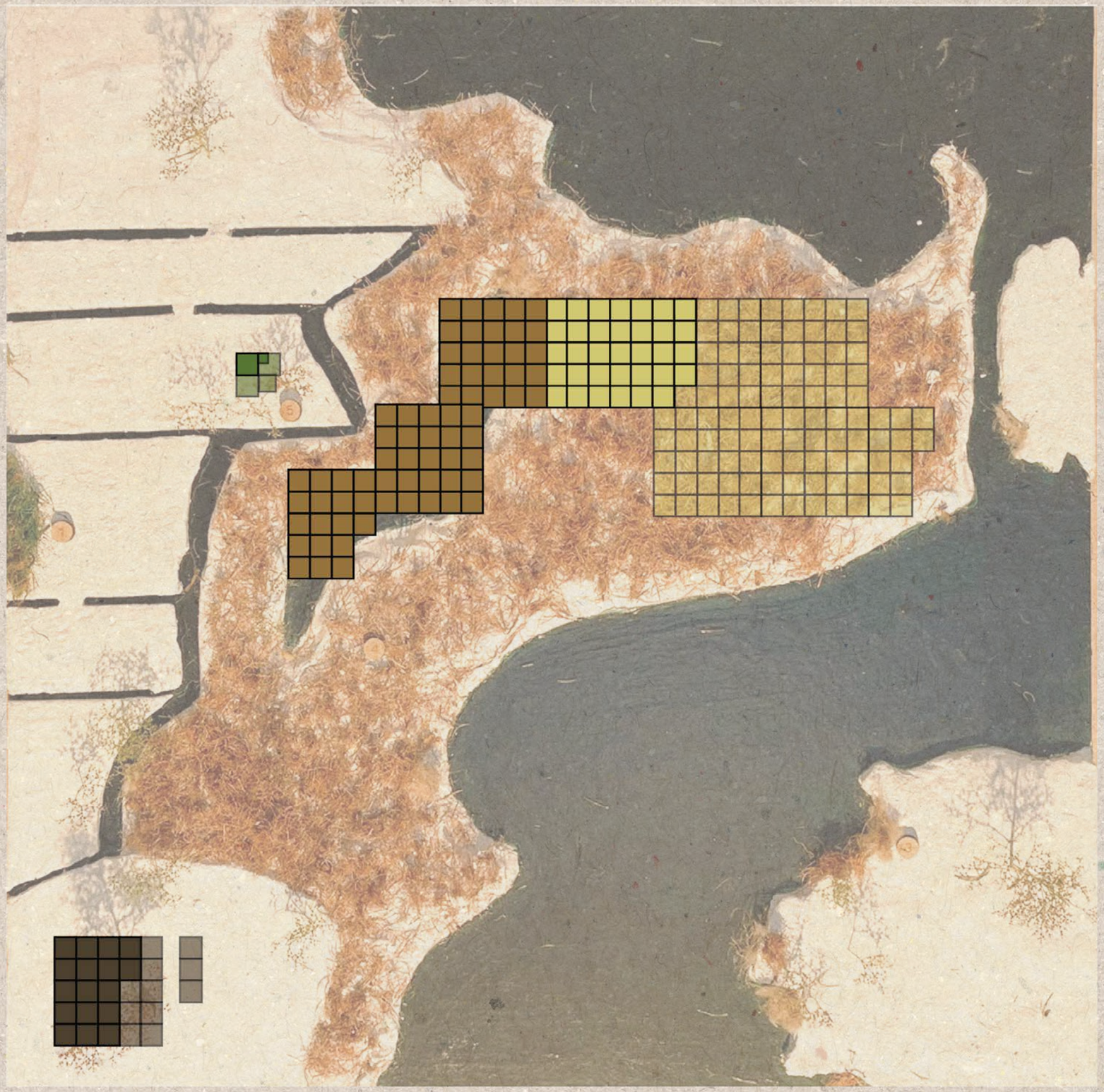
REED = 0.34 - 1.37 ha

WILLOW = 0.012-0.038 ha

(ALDER) WOOD = 0.17 - 0.28 ha

0 20 40 m

= 10 x 10 = 100 m2 = 0.1 ha



Space Requirements
One street
Based on m3 needed, yield, density crop and hectares/m3

TYPHA x 10

REED x 10

WILLOW x 10

(ALDER) WOOD x 10

0 20 40 m

= 10 x 10 = 100 m2 = 0.1 ha

Heat transfer coefficient (U)
0.10 W/(m2K)

Environmental Impact (GWP)
-62,14 kg CO2 eq./m2

Costs
€ 128,76 /m2

Space requirements
1.2 ha/house

Housing coorperation

We want to provide our residents with comfortable housing that fits within our budget

Residents

The building needs to fit the needs of all generations and be comfortable to live in

Municipalities

We want to make sure all actors are happy and the quality of life in the whole municipality is maintained

Environmental organisations

We want to make sure that construction happens in a sustainable manner and protect our natural resources

Architect

We want to be pioneers when it comes to energy-neutral and bio-based building

Builders

The construction needs to be easy and standardized

Housing coorperation

The social cohesion in the neighborhood is better than ever before!

Residents

The better insulation and renovated exterior makes me appreciate the house and meets the needs for all generations!

Municipalities

By working together the social cohesion in the neighborhood improved which improved the overall quality of life!

Environmental organisations

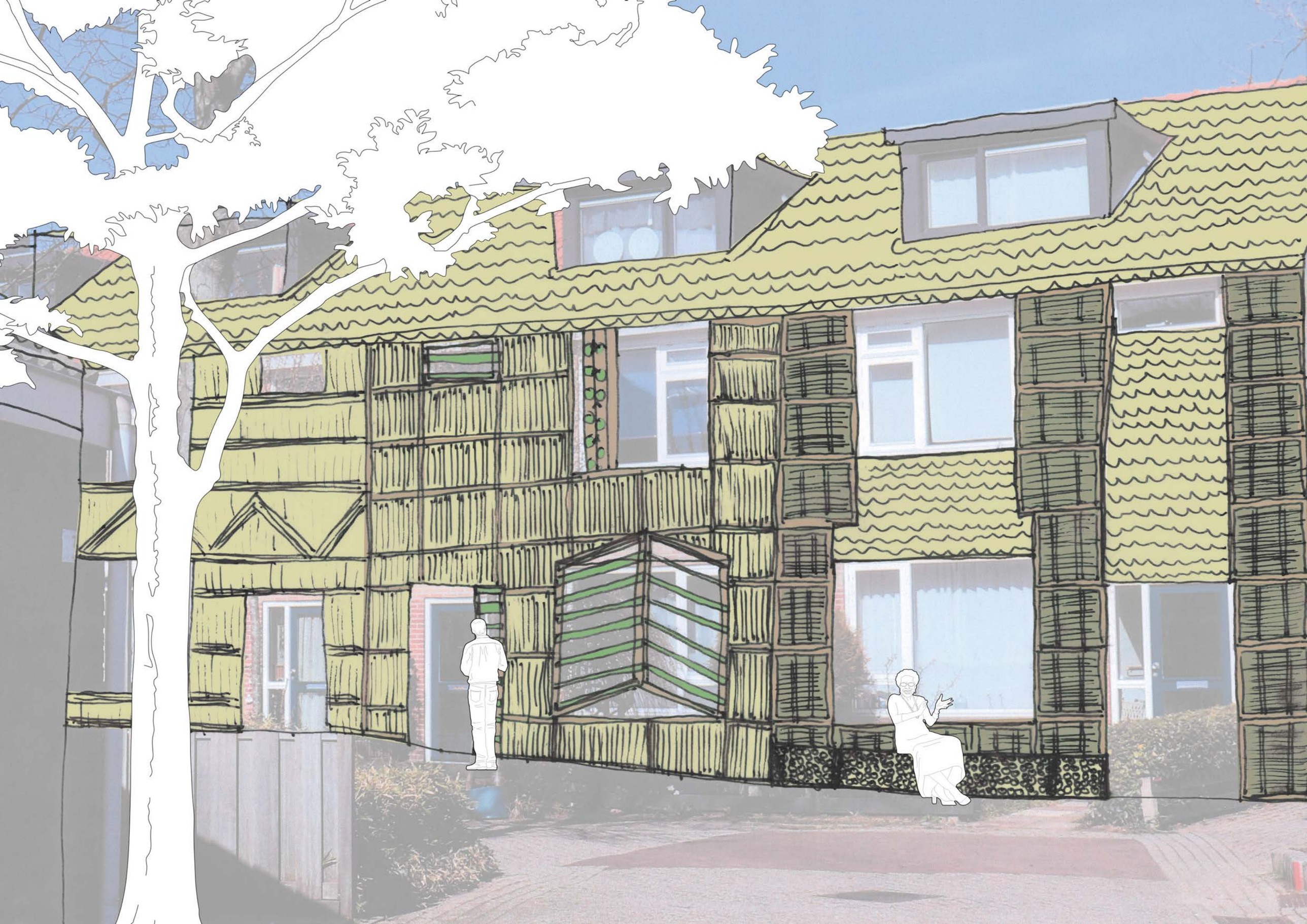
Bio-based materials reduce the reliance on fossil fuels and promote the use of renewable resources!

Architect

This project can put our office on the map when it comes to bio-based building!

Builders

Bio-based materials can be lighter, easier to work with, and require less specialized equipment!



.05.

Conclusions

*''What are the potentials of **regional bio-based materials** for add-on **facade renovation** of **Bloemkoolwijken** in the Netherlands?''*

1. Need for Renovation

2. Emissons of the Building Sector

3. Little to No Sense of Place

Bio-based materials from the regional landscape can be used to renovate, resulting in minimal to no emissions compared to conventional building materials, while also creating a region-specific identity.

- *Every landscape and material has it's* **own qualities**
- *Important to consider the* **specific needs** *of the building, vegetation available and their properties.*

- **Look-books** *provide a* **comprehensive overview**
- **Proof of concept** *showed more* **in-depth knowledge**

- *Still some* **obstacles in implementation** *like costs and uncertainties.*
- *But* **research and pioneers are crucial** *in making this feasible and successful!*

Thanks for listening!

Questions?

Regional bio-based materials

Vernacular architecture

- Highly influenced by climate, available materials and craftmanship in the area

Regional landscapes

- Three main categories being: clay, sand and peat landscapes.

Vegetation

- Peat landscape: vegetation that thrives in wet and marschy conditions
- Sand landscape: vegetation that is adapted to nutrient poor soil
- Clay landscape: fertile soil with vegetation often for agricultural practices

Cauliflower neighborhoods

Defining features

- Defining features include: organic shape, ‘woonerf’ principle, single family homes and aesthetically modest.
- Add-on renovation most suitable because of improvement insulation and aesthetics

Case-studies

- ‘Camminghaburen’ Leeuwarden in peat landscape
- ‘Duinoord’, Noordwijk in sand landscape
- ‘De Fazant’, Dronten in clay landscape

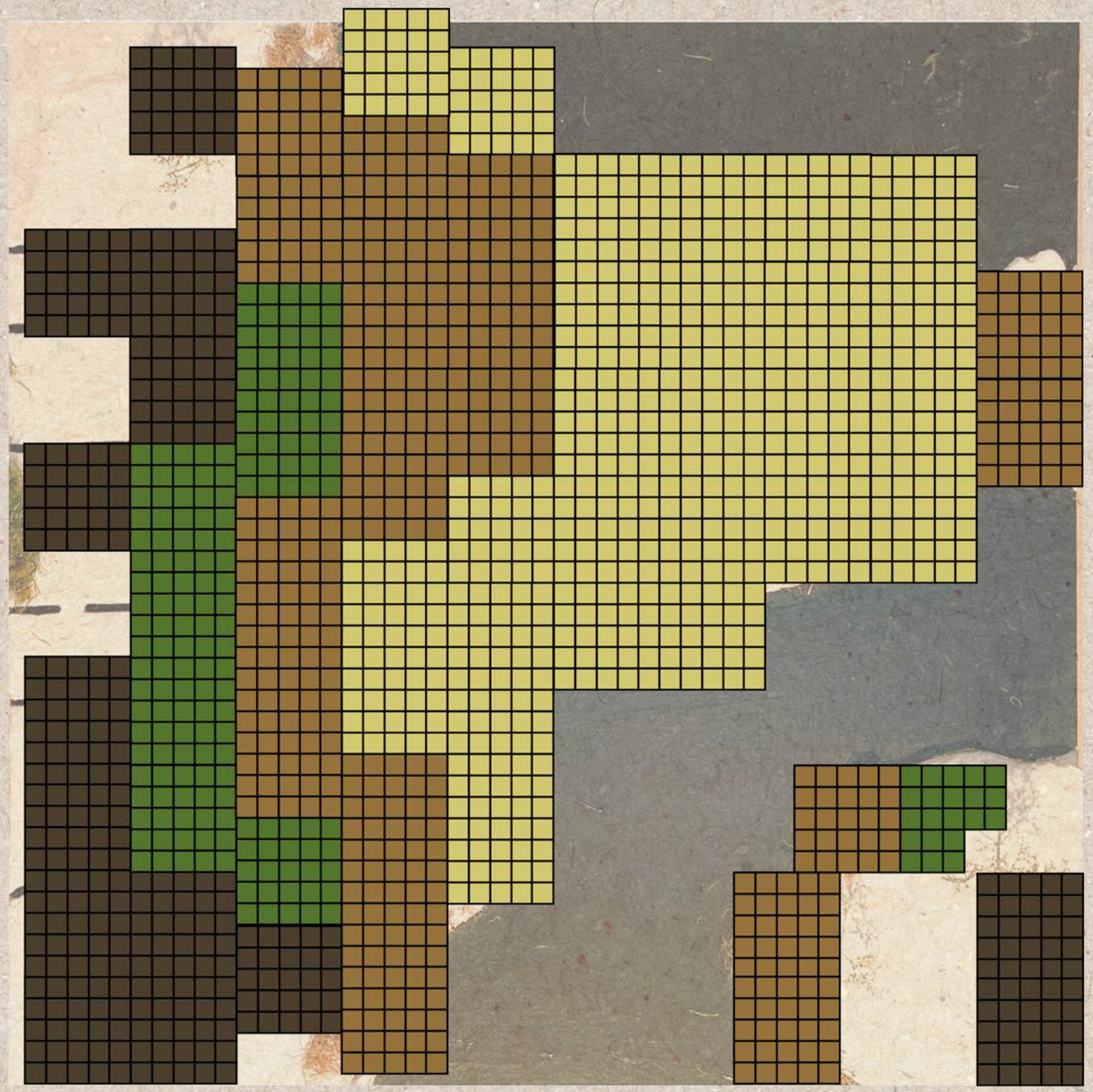
Facade renovation

Key considerations and requirements

- Improving the insulation and aesthetics
- Futureproofing by making the design as demountable and circular as possible

configurations regional

- Numerous possibilities, therefore organized in a framework of processing, structure, attaching and teconics



= 10 x 10 = 100 m2 = 0.1 ha

Materials possible on this plot?

TYPHA		x 70
REED		x 47 - 191
WILLOW		x 526- 1.667
(ALDER) WOOD		x 125 - 206

0 20 40 m

U-Value

Materials (in-out)	**Thickness** (mm)	**Lambda** Conductivity (λ) [W/mK]	**Isolans** Resistivity (R) [m²K/W]
Brick facade	**110**	**0.8**	**0.1344**
Cavity (air)	**60**	**0.024-0.026**	**2.40**
Sand-lime brick	**110**	**0.8-1.0**	**0.1194**
Wooden plate	**10**	**0.02**	**0.5**
Typha insulation	**210**	**0.052**	**4.0384**
Wooden plate	**10**	**0.02**	**0.5**
Reed cladding	**180**	**0.08-0.1**	**2.0**
Total (R_t)			**9.6922**

Existing:
R_t=2.65 [m²K/W]
U= 0.38 W/(m²K)

Bio-based renovation:
R_t=9.70 [m²K/W]
U= 0.10 W/(m²K)

Environmental impact (GWP)
CO2-eq./m2 wall

Simplified to only wall element
Based on the LCA of CINARK using on the basis of LCA phases
A1: Extraction & harvesting
A2: Transportation to factory
A3: Manufacturing product

New construction

New bricks	**108**	**+ 34.5 kg**
Aerated concrete	**200**	**+ 39.4 kg**
Mineral wool	**200**	**+ 2.76 kg**
PE foil	**0.05**	**+ 0.4 kg**
Mortar		**+ 2.75 kg**
Calvanized steel	**5 pcs/m²**	**+ 4.5 kg**

+ 84 kg CO_2 eq./m²

Conventional Renovation

Mineral wool	**200**	**+ 2.76 kg**
PE foil	**0.05**	**+ 0.4 kg**
Mortar		**+ 2.75 kg**
Calvanized steel	**5 pcs/m²**	**+ 4.5 kg**

+ 10.41 kg CO_2 eq./m²

Bio-based renovation

Plywood	**20**	**-10.3**
Typha insulation	**210**	**+ 0.0067***
Reed cladding	**180**	**- 41.2**
Construction wood	**2**	**- 13.52**
Galvanized steel screws		**+ 2.87**

-62.14 kg CO_2 eq./m^2

*** by .. for the entire production chain if the long term carbon storage is also considered with 0.31 ton co2-eq./ha**

Costs materials

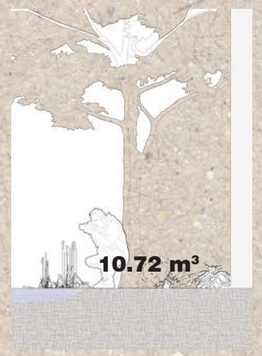
Conventional Renovation

	Thickness mm	Cost	Source	Total
Mineral wool	200	9.79 (m2)	(Gamma, 2023)	9,79
PE Foil	0.05	39.89 (10m2)	(Gamma, 2023)	3.99
Steel cladding	5 pcs / m2	(Starting at) 50 (m2)	(Gamma, 2023)	50
Screws	25 pcs.	25,99 50 pcs.	(Gamma, 2023)	13
				76.78 /m2

Bio-Based Renovation

	Thickness mm	Cost	Source	Total
Plywood	20	12,99 (1x1x0.01m)	(Gamma, 2023)	25,98
Cattail insulation	210	310 (1x1x1m)	(Frauenhofer,2013)	65,1
Reed cladding	180	27-36 (1x1m)	(Federatie Rietdekkers, 2023)	30
Construction wood	2	21,49 (0.045x0.07x3)	(Gamma, 2023)	7,16
Galvanized steel screws	5 pcs.	25,99 50 pcs.	(Gamma, 2023)	0,52
				128,76 /m2

Material needed



TYPHA

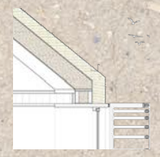
Facade
7.5 panels: 7.5 x 0.579 = 4.35 m3
Roof
roof 11 panels:11 x 0.579 = 6.37 m3

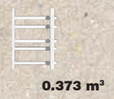
total: 10.72 m3

REED

Thatch
facade: 2.36 m3
roof: 4.30 m3
Panels
10*0.004 m3 = 0.04 m3
Bench
0.373 m3

total: 7.073 m3





WILLOW

Facade Panels
14 * 0.04 = 0.056 m3
Window Panels
52 * 0.0025 = 0.133 m3

total: 0.19 m3

WOOD

Window Sill
0.888 m3
Frame Facade Panels
24 * 0.00137 = 0.03288 m3
Frame Louvres
0.0047 + (2*0.0072) + (2*0.01) = 0.0391 m3
Frame Bench
0.182 m3
Frame Insulation
facade: 7.5 * (0.0235 + 2 * 0.0262) = 0.057m3
roof: 5.5* 0.479 = 2.63 m3

total: 3.45 m3

Yield Vegetation

Cattail: 20t of dry mass/hectare *(Frauenhofer Institute, 2013)*
Reed: 6 - 24 tons dry mass/ hectare *(Wichtmann, Schröder, & Joosten, 2016)*
Willow: 6 - 13 tons dry mass/ hectare (trees 7y of age) *(Bestman, et al., 2019)*
(Alder)Wood: 17 tons dry mass / hactare / year *(Aosaar, Varik, & Uri, 2012)*

Density

Cattail: 63 kg / m3 *(Material District, 2013)*
Reed: 583 kg / m3 *(Malheiro, et al., 2021)*
Willow: 400 -600 kg / m3 *(Engineering ToolBox, 2004)*
(Alder)wood: 420 - 680 kg / m3 *(Engineering ToolBox, 2004)*

Hectares/m3 Material

Cattail: 20.000 kg / hectare -> 31.74 m3 / hectare
Reed: 6.000-24.000 kg / hectare -> 10.29 - 41.17 m3 / hectare
Willow: 6.000-13.000 kg/ hectare -> 10.00 - 32.5 m3 / hectare
(Alder)wood: 17.000 kg / hectare -> 25 - 40.48 m3 / hectare

Hectares Needed ((Hectares/m3) / (Material needed))

Cattail: 21.44 m3 -> 0.68 hectare / entire house
Reed: 2 * 7.073 m3 / 10.29-41.17 = 0.34 -1.37 hectare / entire house
Willow: 2* 0.19 m3 / 10.00 - 32.5 = 0.038 - 0.012 hectare / entire house
(Alder)Wood: 2*3.45 m3 / 25-40.48 = 0.17-0.28 hectare / entire house

1 ha = 10.000 m2

Cattail: 0.68* 10.000= **6 800 m2**
Reed: 0.34 -1.37* 10 000 = **3 400 - 13 700 m2**
Willow: 0.038 - 0.012 * 10 000 = **120 - 380 m2**
(Alder)Wood: 0.17-0.28 hectare * 10 0000= **1 700 - 2 800 m2**