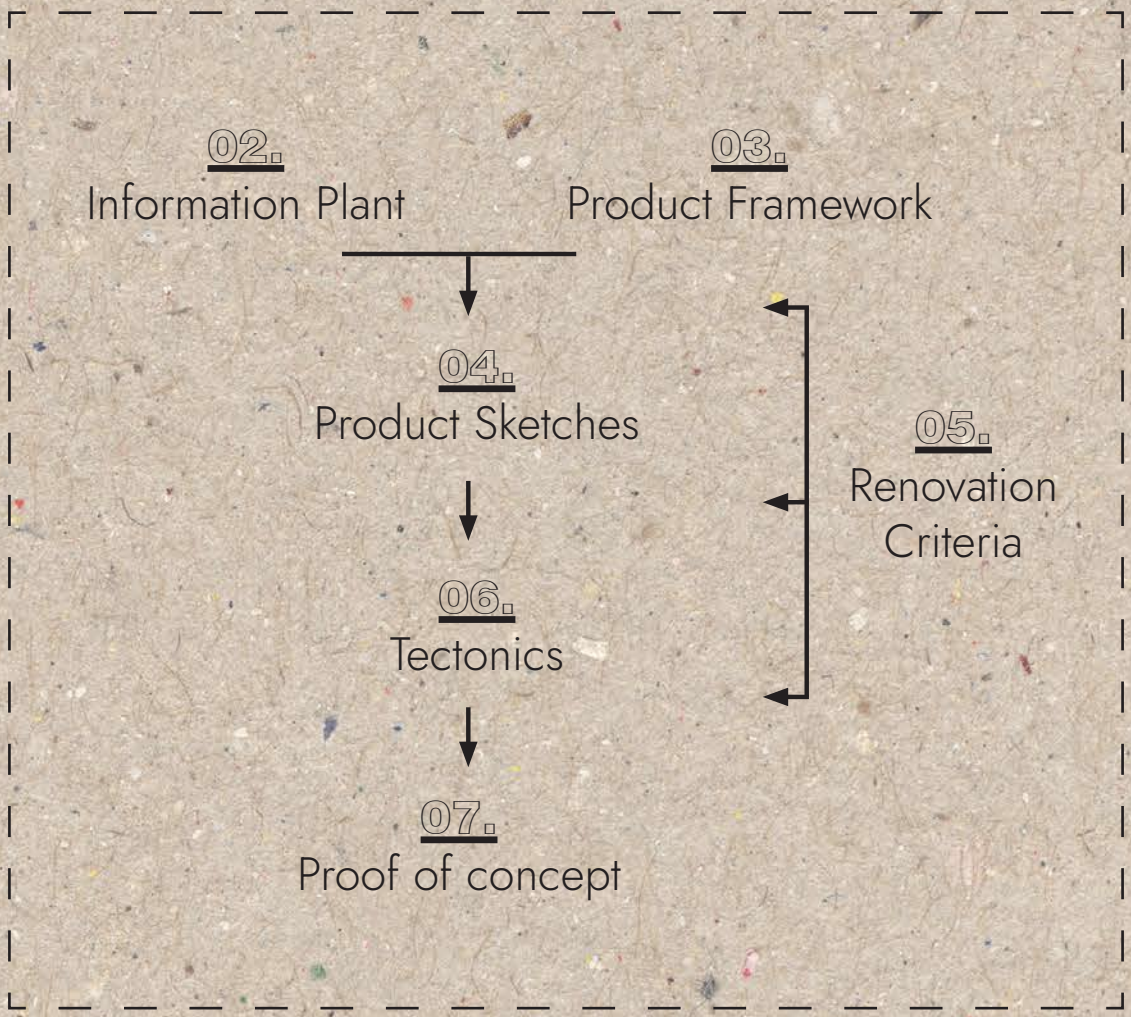
Look
Book
1

PEAT LANDSCAPE

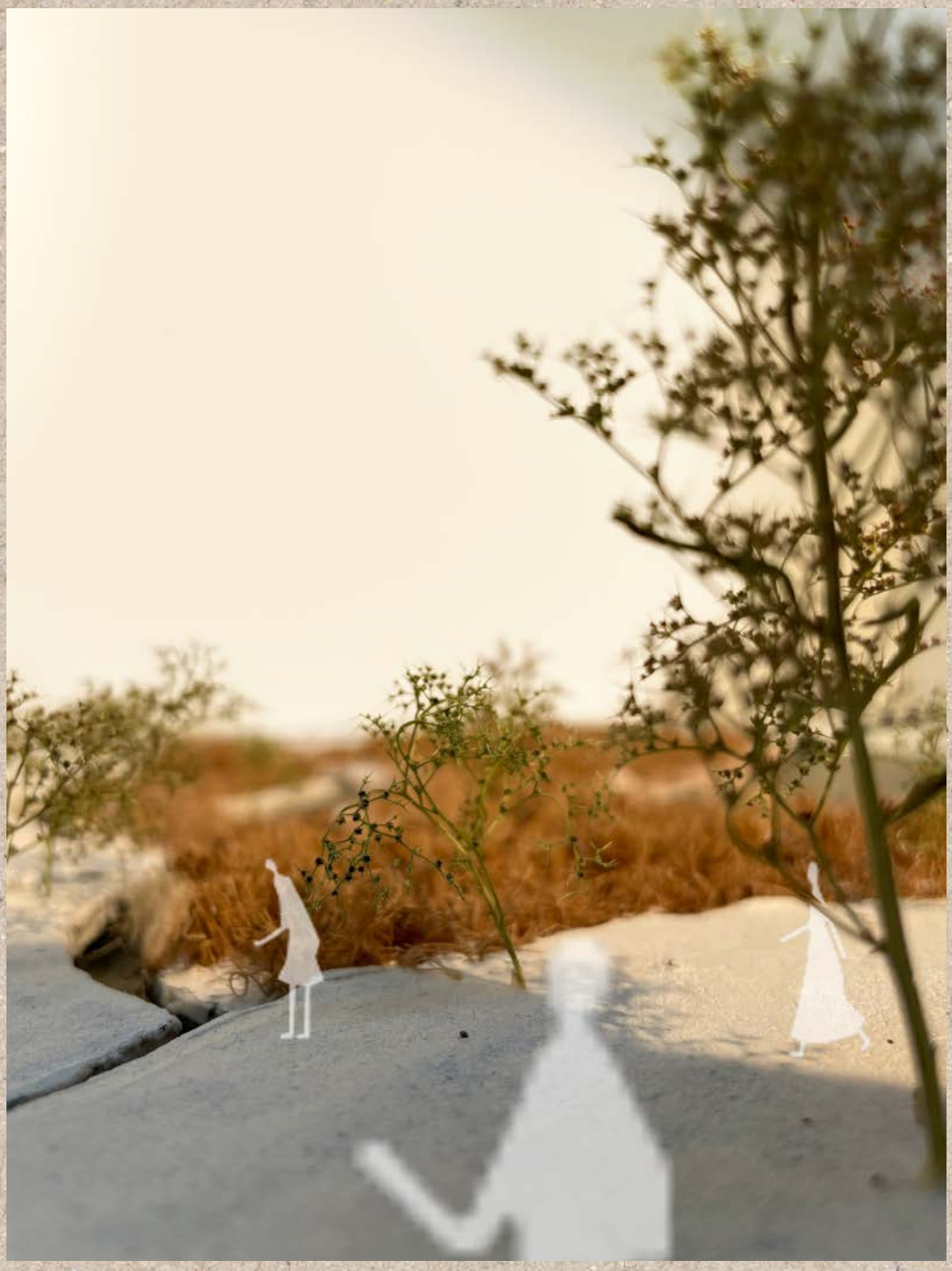
This look-book aims to provide inspiration and showcase the enormous potentials of renovation by utilizing materials that can be harvested from a specific landscape. It is essential to approach this with utmost respect for the environment, by ensuring responsible harvesting practices and minimizing any negative impact. Through this exploration, we can promote the sustainable use of hyper-local bio-based materials, discover their beauty as well as functionality, and contribute to a more environmentally conscious approach in the building industry!

CONTENT


02.
Information Plant
03.
Product Framework
04.
Product Sketches
05.
Renovation
Criteria
06.
Tectonics
07.
Proof of concept

Each landscape has its own characteristics. These are explained in the model representing the peat landscape in Leeuwarden, located next to the case-study neighborhood 'Camminghaburen. Information about the landscape and vegetation was gathered based on own studies on the regional landscapes and from sources like Stichting Bouwtuin and Boom Landscapes, and applied to the case-study landscape.

01. Character Landscape



Walking through the landscape
(own model)

P1
CATTAIL
Typha latifolia

P2
ELEPTHANT GRASS
Miscanthus giganteus

P4
WILLOW TREE
Salix

P5
ALDER TREE
Salicaceae

P3
REED
Phragmites australis

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.

0 20 40 m

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).

P3

REED

Phragmites australis

Used for:
Insulation
Cladding
Roofing

Reed is characterized by being tall and slender plants that can grow up to 3-4 meters tall. They have long and narrow leaves, and are typically found in wetland habitats. Due to its roots reaching up to 2 meters deep, a helophyte (marsh plant) is well adapted to withstand drought although it can also tolerate a water level of up to 2 meters above ground level (Bestman, et al., 2019). Reed plays an important role in ecosystems because it provides a habitat and food for wildlife and helps against corrosion of waterways. The blooming period is between July and October when the plant produces a big brown plume. At the end of autumn, before the onset of winter, the aboveground parts die off except for the stiff stems. This stem can be harvested and have been used by humans for many purposes, in the building industry for thatching roofs and as a construction material (Flora van Nederland, 2013).

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).

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 various soil types, but thrives better in moist and cool conditions such as riverbanks (Designing Buildings, 2022). They have a high-water absorption capacity and also release a significant amount of it 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

BAILING

CUTTING

PRESSING

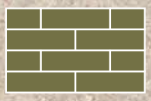
WEAVING

SHREDDING

COMBING

SUPPORT | putting the products on the facade

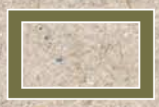
SUB-STRUCTURE



ON FACADE

BETWEEN

BOX



FRAME

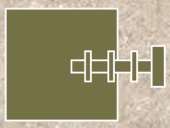
ATTACHING | attachments that are needed in the process

CLAMPING

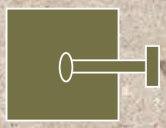
GLUEING

TENSIONING

BINDING



SCREWING

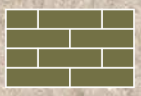
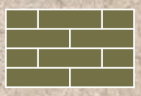


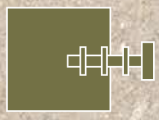
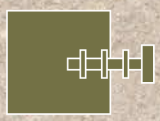
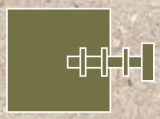
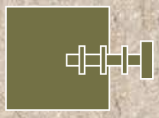
NAILING

LOCKING

03. Production framework

INSULATION

MATERIAL	PROCESSING	SUPPORT
ELEPHANT GRASS *Miscanthus giganteus* 	 SHREDDING	 PRESSING	 ON FACADE
	 BAILING	 BETWEEN
REED *Phragmites australis* 	 CUTTING	 BOX
TYPHA *Typha latifolia* 	 SHREDDING	 PRESSING	 ON FACADE
	 SHREDDING	 PRESSING	 BETWEEN

ATTACHING	FRAGMENT	
 SCREWING		*Miscanthus pressed panel directly on facade*
 CLAMPING  SCREWING		*Miscanthus bailed on sub-structure*
 TENSIONING  SCREWING		*Reed in box*
 SCREWING		*Typha pressed panel directly on facade*
 CLAMPING		*Typha pressed panel be-tween frame*

CLADDING

MATERIAL	PROCESSING	SUPPORT
	CUTTING	FRAME, SUB-STRUCTURE
REED *Phragmites australis* 	CUTTING	SUB-STRUCTURE
	CUTTING	SUB-STRUCTURE
	CUTTING	SUB-STRUCTURE
	CUTTING, WEAVING	FRAME, SUB-STRUCTURE
WILLOW *Salicaceae* 	CUTTING	SUB-STRUCTURE
	CUTTING	SUB-STRUCTURE

ATTACHING

FRAGMENT

CLAMPING SCREWING

Reed clamped in frame

CLAMPING SCREWING

Reed clamped by wooden slat

BINDING

Reed binded together

BINDING

Reed bundled together

BINDING CLAMPING

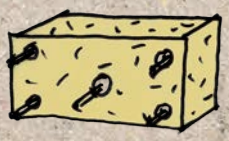
Willow withies weaved on frame

NAILING SCREWING

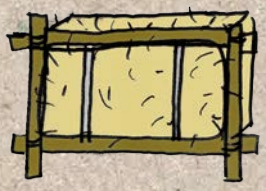
Willow withies nailed on frame

NAILING SCREWING

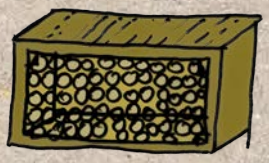
Willow withies ramdomly nailed on substructure



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

Cladding

Reed clamped in frame

Reed clamped by wooden slat

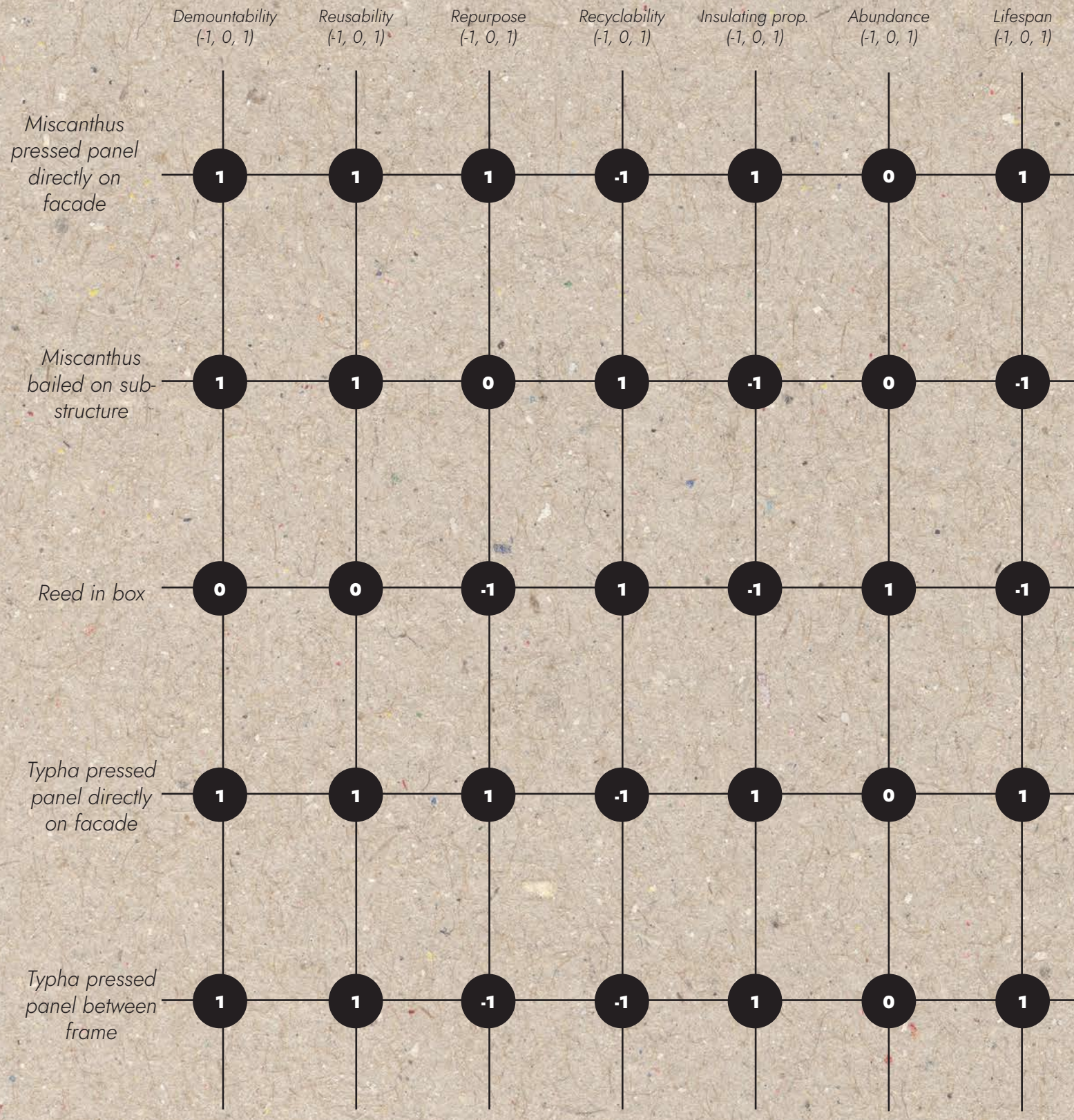
Reed binded together

Reed bundled together

Willow withies weaved on frame

Willow withies nailed on frame

Willow withies ramdomly nailed on substructure



05. Renovation criteria

TOTAL

4

1

-1

4

2

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

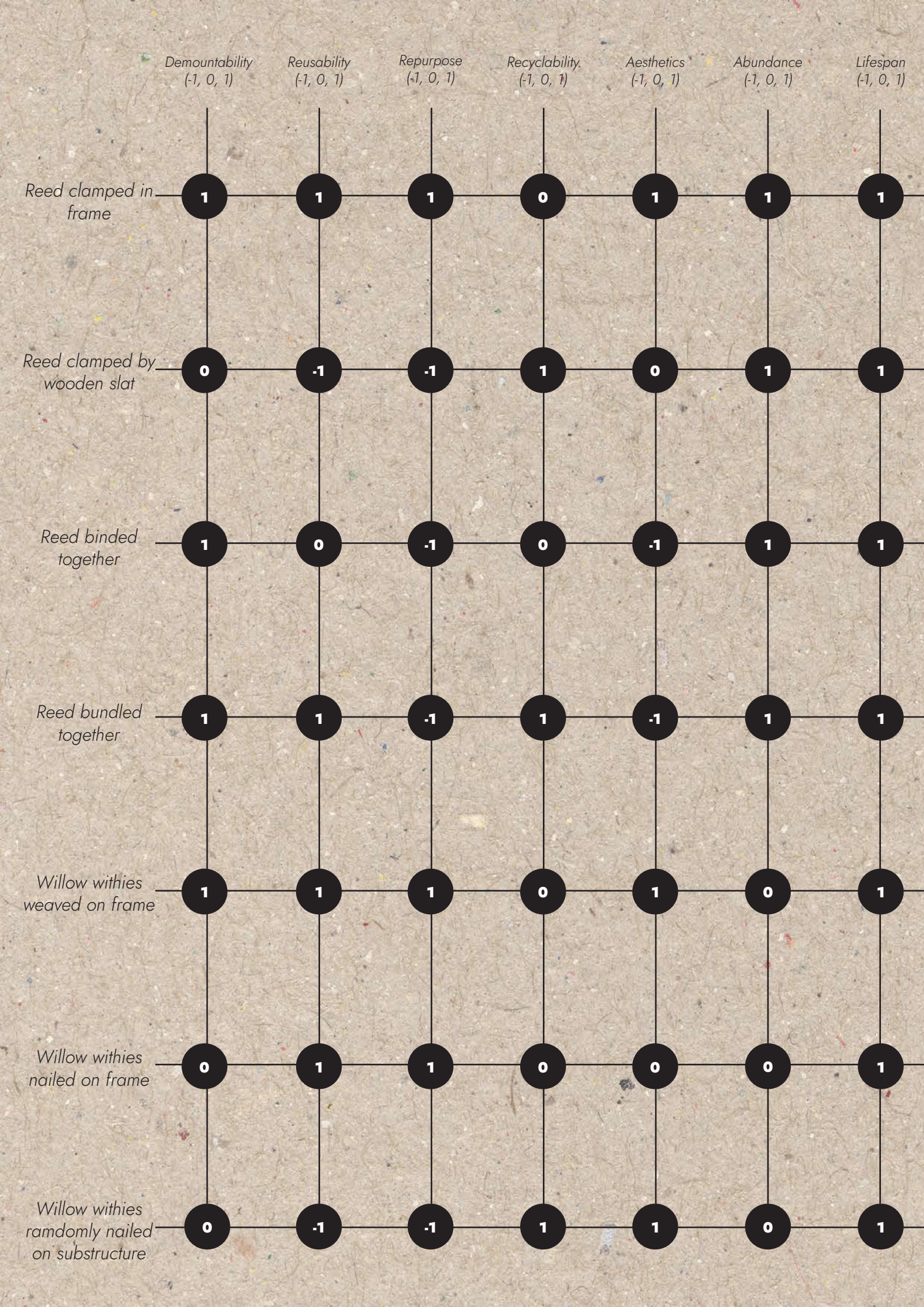
3. Repurpose
-1: It is not possible to find another purpose for the element after use
0: It is hard but possible to find another purpose for the element after use
1: It is possible to find another purpose for the element after use

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


Demountability (-1, 0, 1)
Reusability (-1, 0, 1)
Repurpose (-1, 0, 1)
Recyclability (-1, 0, 1)
Aesthetics (-1, 0, 1)
Abundance (-1, 0, 1)
Lifespan (-1, 0, 1)
Reed clamped in frame
1 1 1 0 1 1 1
Reed clamped by wooden slat
0 -1 -1 1 0 1 1
Reed binded together
1 0 -1 0 -1 1 1
Reed bundled together
1 1 -1 1 -1 1 1
Willow withies weaved on frame
1 1 1 0 1 0 1
Willow withies nailed on frame
0 1 1 0 0 0 1
Willow withies ramdomly nailed on substructure
0 -1 -1 1 1 0 1

TOTAL

6

Scoring

1

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 for the same purpose after use
0: It is possible to re-use the element for the same purpose after use, but with less quality
1: It is possible to re-use the element for the same purpose after use

1

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 possible to take the whole element apart to recycle after use

3

5. Aesthetic
-1: The element is less aesthetically appealing compared to the other options
0: The element is averagely aesthetically appealing compared to the other options
1: The element is more aesthetically appealing compared to the other options

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

5

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

3

1

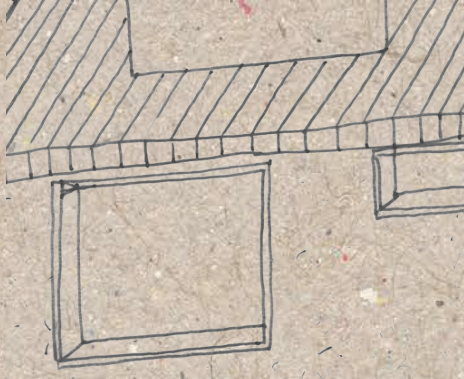
Once various vegetation options have been identified, they can be combined in different variations on the facade. These combinations can be explored through various layouts and arrangements. This section showcases a range of these possibilities and provides conceptual sketches to illustrate what they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

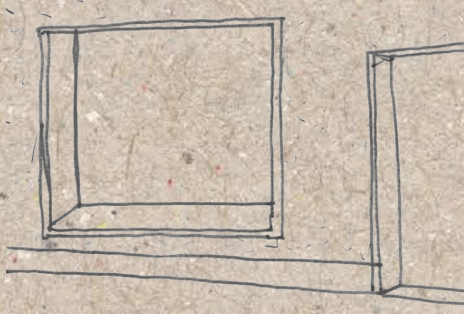
MOZAIC

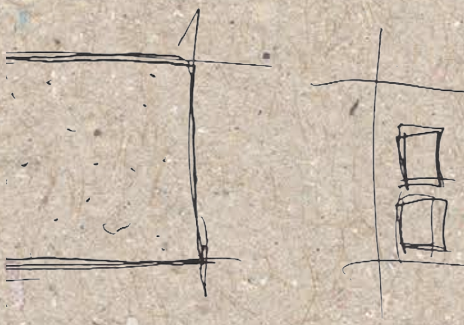
HORIZONTAL

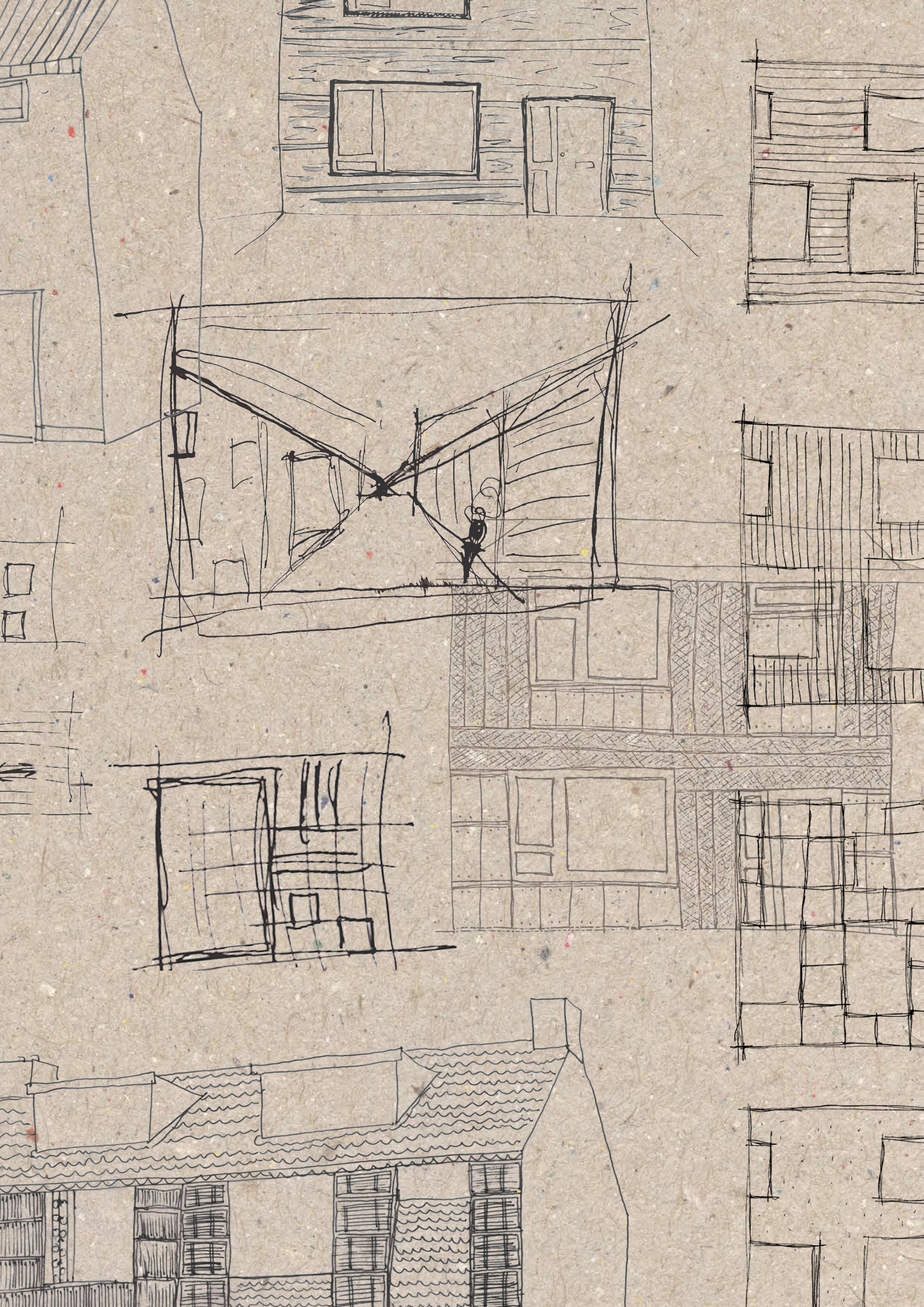
SURFACE

VERTICAL



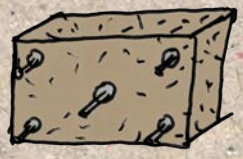






MOZAIC

‘Panelled Willow’



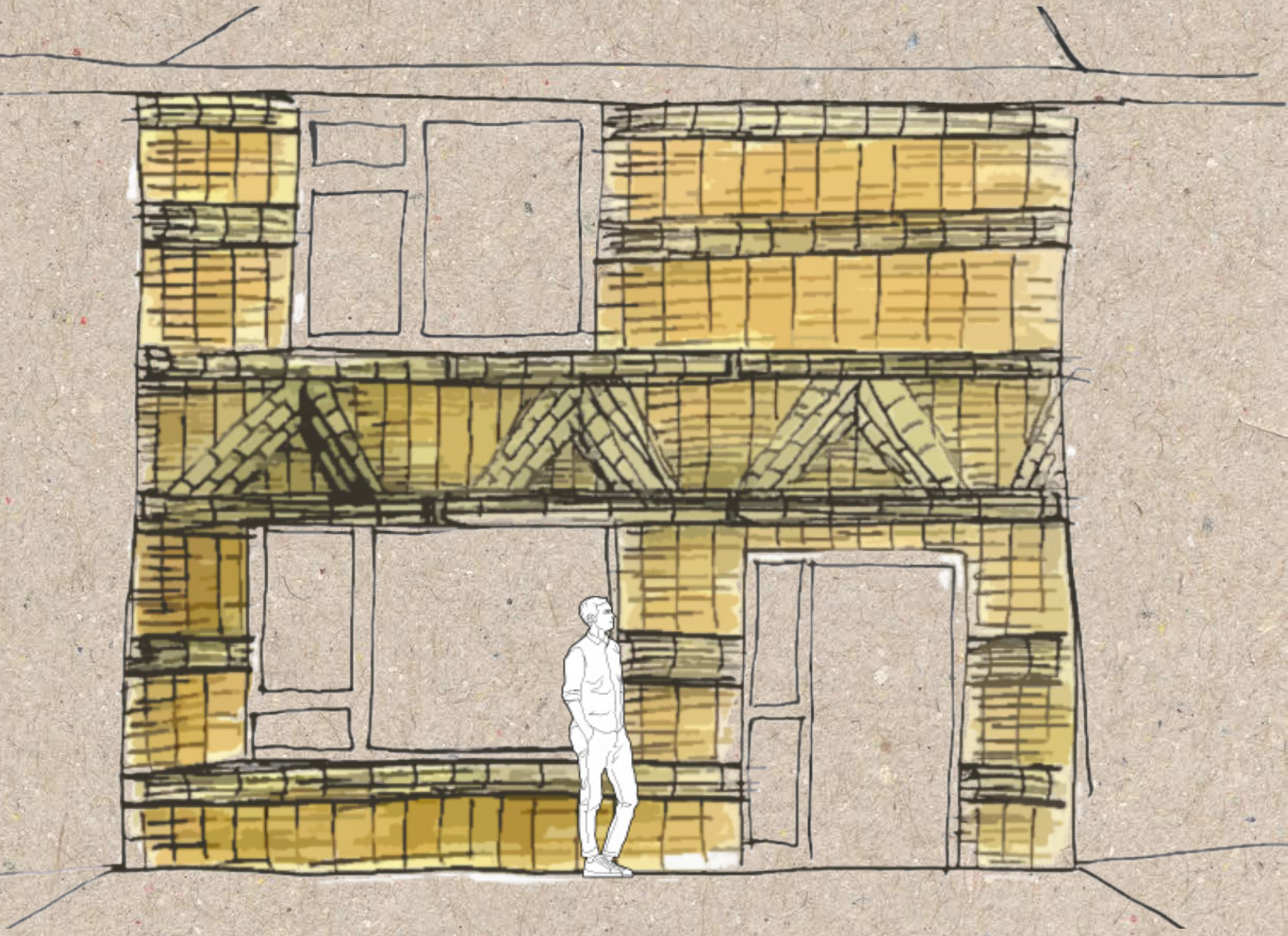
Typha pressed panel directly on facade

Willow withies weaved on frame

Willow withies nailed on frame

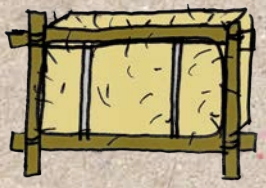
HORIZONTAL

‘Binded Reed’



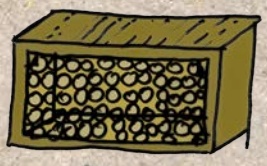
Reed bundled together

Reed binded together



Miscanthus bailed on sub-structure

‘Thatched reed’

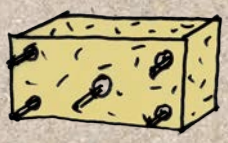


Reed in box

Reed clamped by wooden slat

VERTICAL

‘Combined thatched and paneled reed’



Miscanthus pressed panel directly on facade

Reed clamped by wooden slat

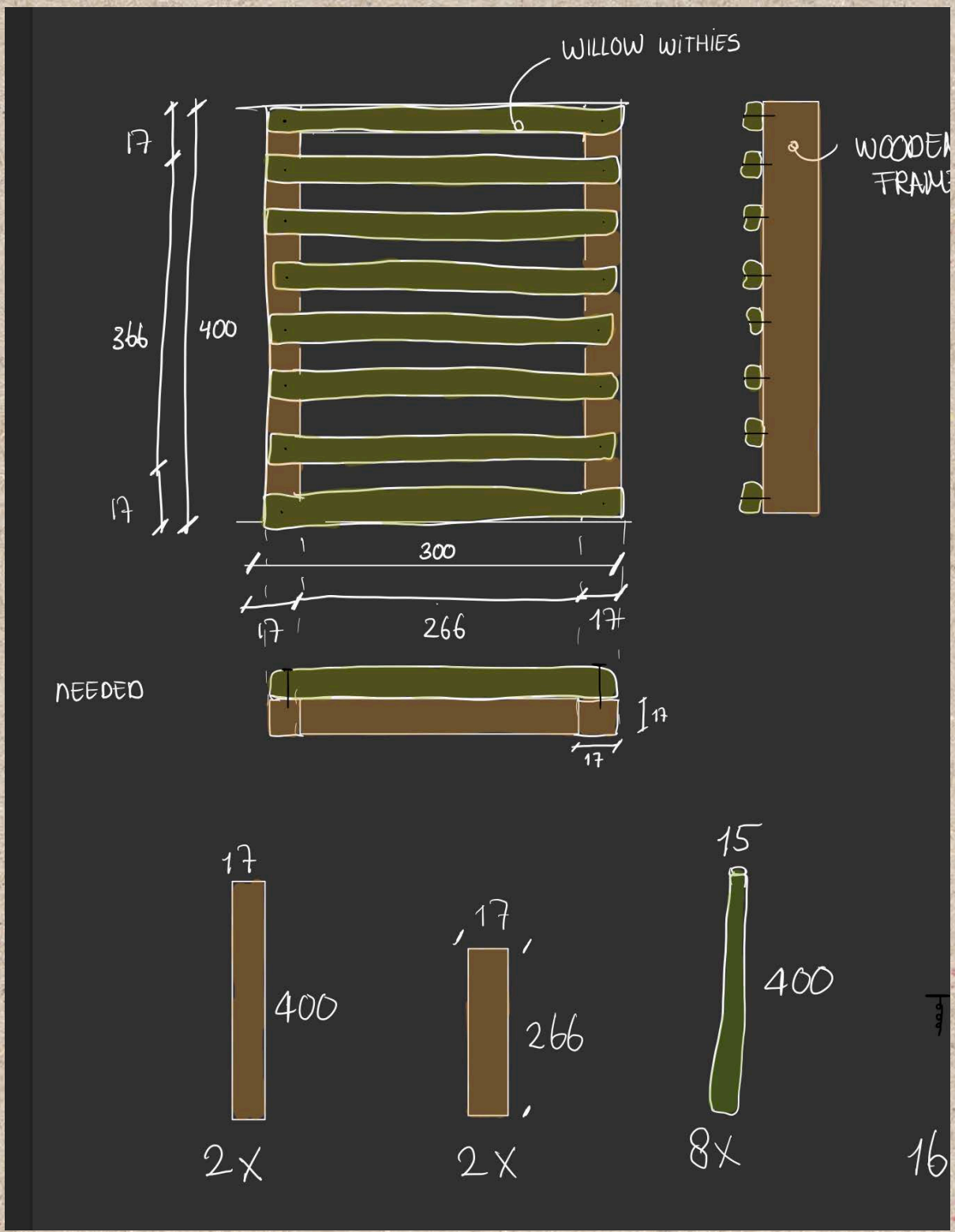
Reed clamped in frame

Willow withies nailed on frame

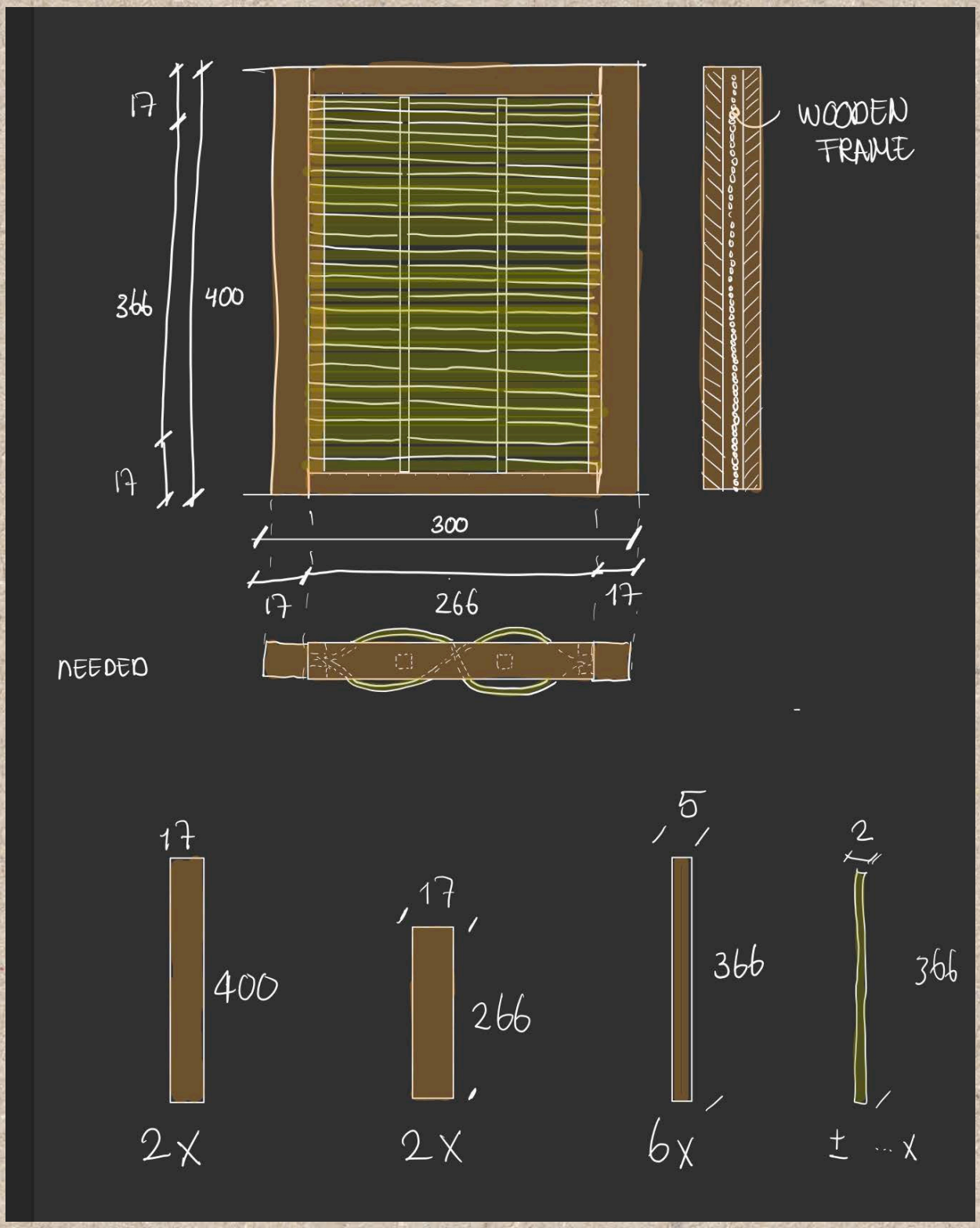
Willow withies weaved on frame

Reed clamped in frame

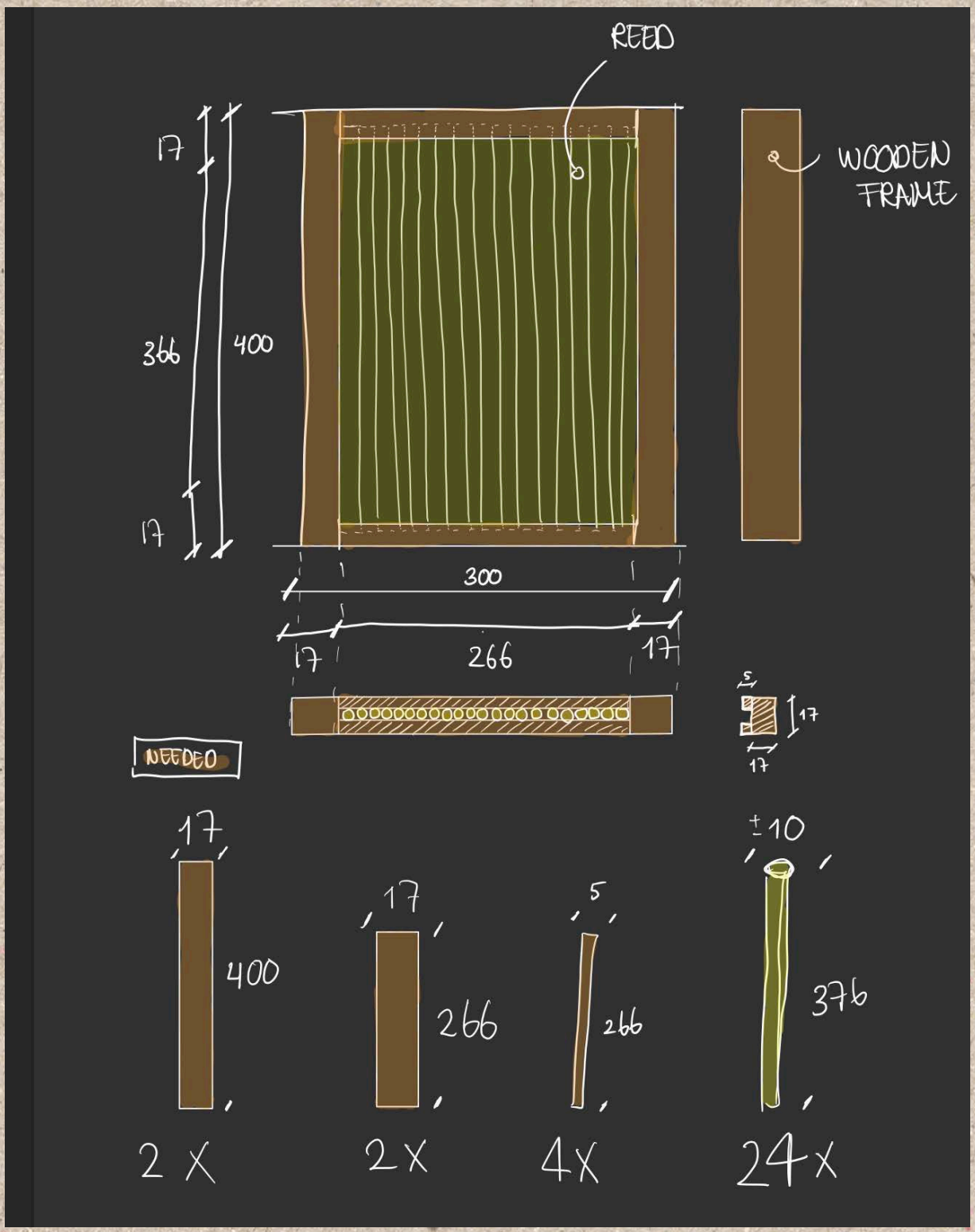
L1


WILLOW WITHIES
17
366
400
17
300
17
266
17
WOODEN FRAME
NEEDED
17
400
2X
17
266
2X
15
400
8X
16

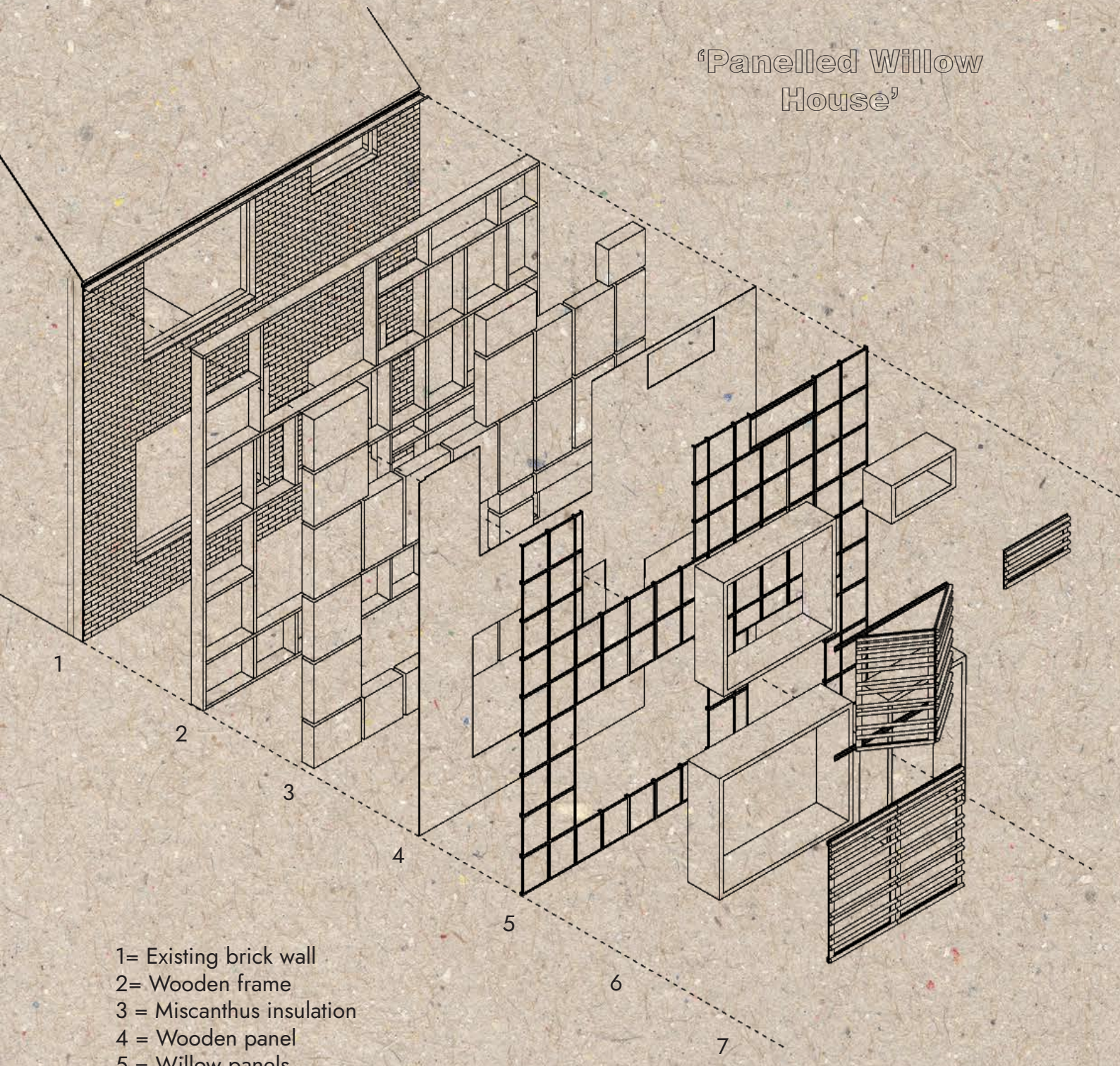
L2


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

L3

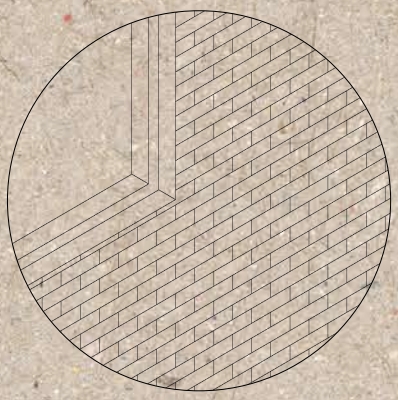

REED
WOODEN FRAME
17
366
400
17
300
17
266
17
5
17
17
NEEDED
17
400
2 X
17
266
2X
5
266
4X
±10
376
24X

‘Panelled Willow House’

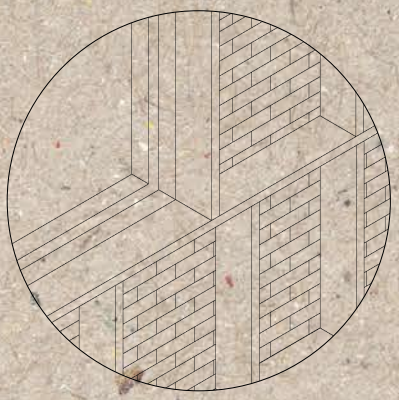


1= Existing brick wall
2= Wooden frame
3 = Miscanthus insulation
4 = Wooden panel
5 = Willow panels
6 = Window sills
7= Willow branch louvres

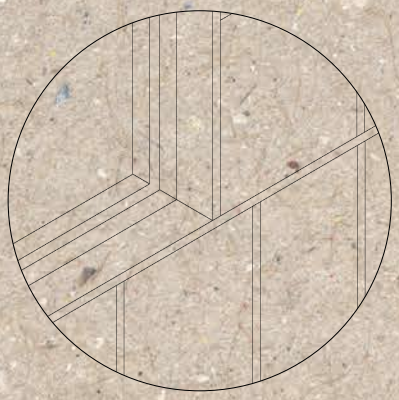
06. Proof of concept



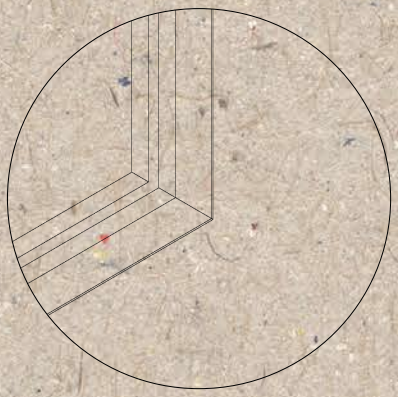
1.0 | Existing brick wall



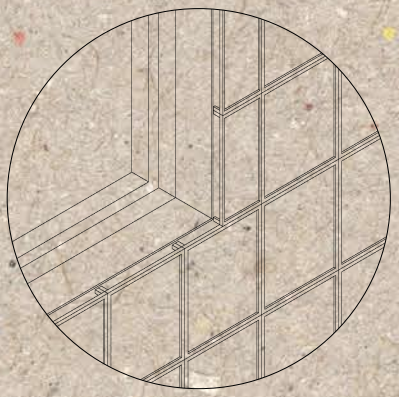
2.0 | Wooden frame



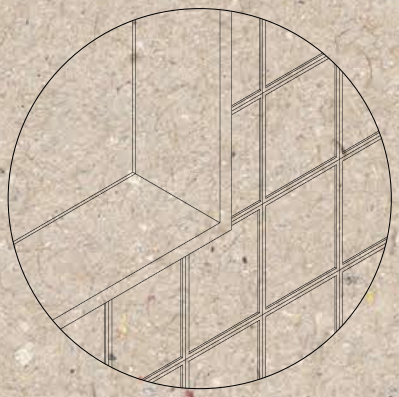
3.0 | Miscanthus insulation



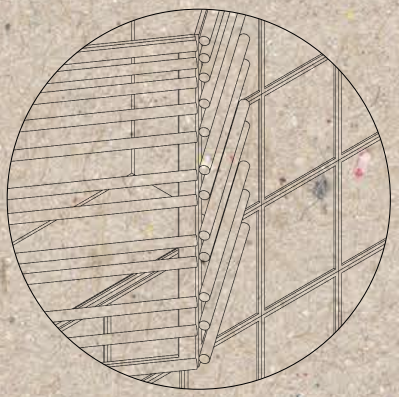
4.0 | Wooden plate



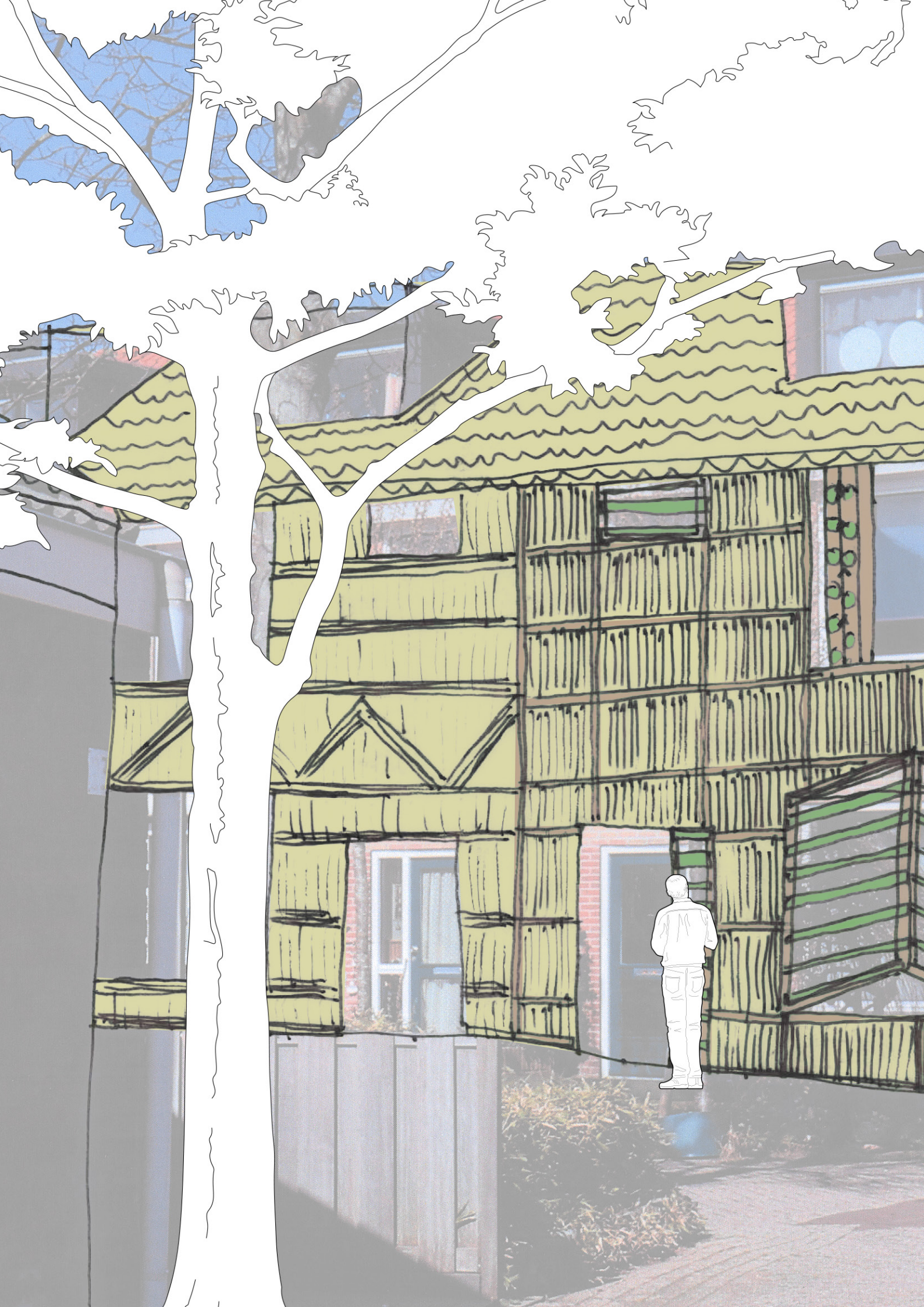
5.0 | Willow panels

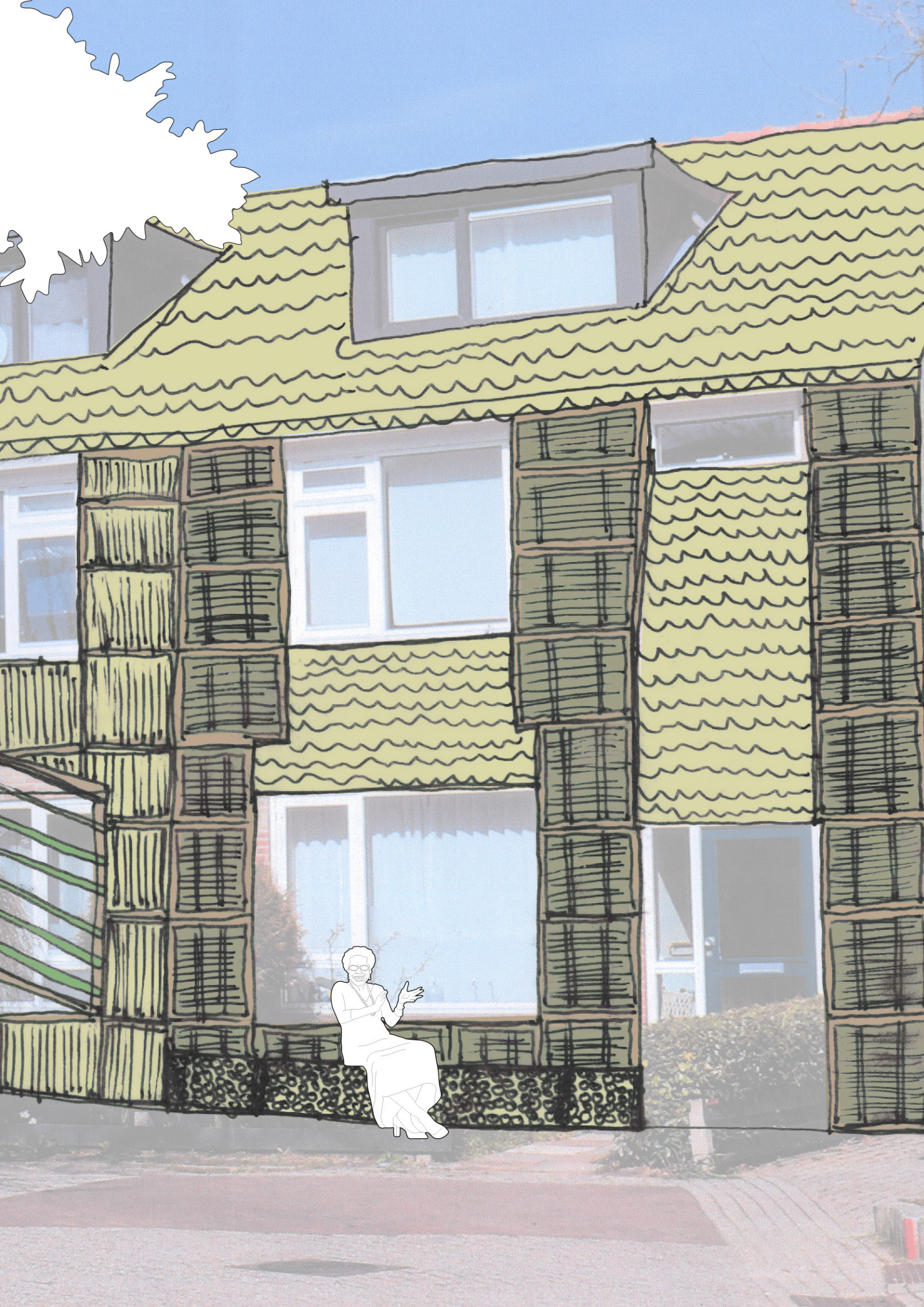


6.0 | Window sill



7.0 | Willow branch louvres





References

Bestman, M., Geurts, J., Egas, Y., van Houwelingen, K., Lenssinck, F., Koornneef, A., van Eekeren, N. (2019). *Natte teelten voor het veenweidengebied.* Bunnik: Louis Bolk Instituut.

Boom Landscape. (n.d.). *Bio-Based Building, Zuid-Holland.* Retrieved from Boom landscape: https://boomlandscape.nl/en/work/bio-based-building-zuid-holland/

Designing Buildings. (2022, October 4). *Alder wood in construction.* Retrieved from Designing Buildings - The Construction Wiki: https://www.designingbuildings.co.uk/wiki/Alder_wood_in_construction

Dias, P. P., Jayasinghe, B. L., & Waldmann, D. (2021). *Investigation of Mycelium-Miscanthus composites as building insulation material.* Materials, 10.

Econcreed. (n.d.). *A CO2 reduction innovation in construction.* Retrieved from Econcreed: https://econcreed.com/en/

Flora van Nederland. (2013, Juli 28). *Riet - Phragmites australis.* Retrieved from Flora van Nederland: https://www.floravannederland.nl/planten/riet

Flora van Nederland. (2013, September 30). *Schietwilg - Salix alba.* Retrieved from Flora van Nederland: https://www.floravannederland.nl/planten/schietwilg

Flora van Nederland. (2013, Maart 19). *Zwarte els - Alnus glutinosa.* Retrieved from Flora van Nederland: https://www.floravannederland.nl/planten/zwarte_els

Flora van Nederland. (2023). *Grote lisdodde - Typha latifolia.* Retrieved from Flora van Nederland: https://www.floravannederland.nl/planten/grote_lisdodde

Frauenhofer. (2013). *Using cattails for insulation.* Retrieved from Cordis - EU research results: https://cordis.europa.eu/article/id/130870-using-cattails-for-insulation

Malheiro, R., Ansolin, A., Guarnier, C., Fernandes, J., Amorim, M. T., Silva, M. S., & Mateus, R. (2021). *The Potential of the Reed as a Regenerative Building Material—Characterisation of Its Durability, Physical, and Thermal Performances.* Energies, 4276.

Smit, M., Groenendijk, R., Köbben, R., & Vélu, D. (2022). *Naar een Nieuwe Streekarchitectuur.* Stichting Bouwtuin.

Wichtmann, W., Schröder, C., & Joosten, H. (2016). *Paludiculture – productive use of wet peatlands.* Stuttgart: Schweizerbart Science Publishers.

Julia Ravensbergen

Look-book (1/3) as part of the Thesis Research: Bloemkoolwijken - the New Vernacular?

MSc in Architecture, Urbanism and Building Sciences (Building Technology)
Technical University of Delft (TU Delft)

TU Delft