Graduation Report

SCULPTING SENSATIONS

Crafting Emotional Narratives through Sensory Synergy in Architectural Spaces

Kim van den Bosch

In front of you lies my graduation project, ***Sculpting Sensations:*** *Crafting Emotional Narratives through Sensory Synergy in Architectural Spaces.* This project represents the culmination of an incredible year of learning and discovery. At the start of this project, I was uncertain about my research topic, but I gradually found a deep interest and passion in exploring the psychological dimensions of architecture through sensory and even emotional perception.

I would like to extend my heartfelt gratitude to my tutors, Geert Coumans, Peter Koorstra, and Claudia van Leest, for their support throughout this year. It was a fun journey, but there were also some rough moments where I struggled to find my own passion and confidence. Fortunately, with their guidance and the freedom they provided me to explore, I was able to discover a topic that truly excites me. Their support has been valuable, and I deeply appreciate their encouragement.

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Form Studies Graduation Studio: Technologies & Aesthetics

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Graduation Report

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01.

PROLOGUE

To start with, I have always been interested in the psychological side of architecture: people's behavior and how we as architects can influence this behavior. I am someone who (by my own admission) experiences many emotions, both positive and negative. Tears sometimes flow freely down my cheeks, but I also like to cherish happy memories. Memories, another thing. I have many, and I also have many associations with them. A certain smell from my mother's makeup box from the past that I will never forget, to the taste of the cactus tea I drank in my brother's football canteen that has not been sold in stores for years. I can recall it all in a moment.

As an architect I hope to do exactly that: evoke emotions and create memories that will last for years to come. This research is me dipping my toes into that world, exploring architecture as a potential tool to engage and stimulate all the senses.

INTRODUCTION

Human beings are inherently visually-oriented creatures, predominantly thinking, reasoning, and imagining through visual stimuli. Architect Juhani Pallasmaa, in his influential work The Eyes of the Skin: Architecture and the Senses (1996), highlights the prevailing emphasis on designing primarily for visual perception within the architectural realm. However, in recent decades, there has been a notable shift, with architects and designers increasingly recognizing and integrating other sensory modalities such as sound, touch, smell, and occasionally even taste into their work (Spence, 2020). Despite this progress, the evolving understanding of the multisensory nature of human perception from cognitive neuroscience research has been relatively underappreciated.

This research, conducted as part of the graduation studio *Technologies and Aesthetics*, aims to explore the role of human senses in architectural design, investigating both individual senses and their collective impact. In this thesis, the exploration goes beyond the traditional concept of aesthetics as primarily visual. It seeks to expand the notion of 'aesthetics' by questioning whether it is confined to the visual realm or if there exists a concept of multisensory aesthetics. By examining how architecture engages various senses, the research aims to illuminate the broader implications of aesthetics, particularly in a field where beauty is understood to encompass a rich tapestry of sensory experiences. Each interaction with architectural structures entails a comprehensive engagement with multiple sensory dimensions, including visual, auditory, olfactory, tactile, and gustatory elements. Architecture not only enriches our existential encounter with the world but also contributes significantly to self-awareness by intricately weaving together diverse modes of sensory experiences.

Exploring the phenomenology of spatial perception, this research focuses on understanding how individuals physically and emotionally experience their surroundings. This includes considerations of tactile surface qualities and the evocative power of specific sounds in invoking memories. These interconnected sensory experiences create a nuanced fabric of emotions that collectively influence the interpretation and understanding of architectural spaces. Sensory synergy is not merely an end goal but a method for architects to intentionally craft emotional experiences and narratives in architectural spaces.

Adopting a multisensory approach aims to foster the development of buildings and urban spaces that actively enhance social, cognitive, and emotional well-being. This research seeks to address the fundamental question: How can architecture enrich the overall user experience by actively engaging each of the human senses?

Fg. 1 collage (own work)

THEORETICAL FRAMEWORK

The theoretical framework forms the primary review of existing theories, serving as a guideline for developing arguments within the research. To establish a strong foundation, key concepts will be defined.

User perception

According to J.J. Gibson's ecological perception theory (1981), individuals perceive their environment solely based on the information it offers and make precise judgments according to the sensory information they receive. It suggests that perception is an active process influenced by the properties of the environment (Ben-Ze'ev, 1981).

In the context of the research, this theory could emphasize the importance of sensory qualities to the user's perception.

Multi-sensory

The term multi-sensory is, according to Vermeersch's PhD dissertation *Less Vision, More Senses. Towards a More Multisensory Design Approach* (2013), expanded from adding various senses together to the interplay of those senses. These senses can be understood as the five traditional main senses: "the sense of sight, the sense of hearing, the sense of touch, the sense of taste, and the sense of smell." (Maclachlan 1989, p. 3) Though other senses have been added, such as the sense of temperature, the sense of pain, the kinaesthetic sense, which involves various parts of our bodies.

Multi-sensory design

Multi-sensory design is defined by Schifferstein's plublication *Multi sensory design* (2011) and claims that designers are more likely to achieve success in creating deliberate experiences for individuals, such as feelings of delight, trust, or care, when they possess an awareness of the messages communicated through various senses and understand how these messages contribute to the overall experience.

Sensory quality

Quality refers to the extent to which an object or entity meets a defined set of characteristics or standards. According to the research of Dümen et al. *Unfolding the material: A proposal of a multi-sensory experience oriented material exhibition medium* (2022), sensory evaluation methods can be used to determine if a materials meets these sensory qualities.

Many philosophers, however, doubt that one can provide any successful explanation of sensory qualities - of how things look, feel, or seem to a perceiving subject.

User experience

User experience can be defined as a user's perceptions and response, resulting from the user or anticipated use of a product, service, system, or space. User experience includes user's emotions, beliefs, responses, preferences, responses, and accomplishments before, during and after use (Vermeersch, 2013).

Experience with a product or a space occurs via various interfaces and one significant interface is the material (Dümen et al., 2022). Material experience can be defined into experiential levels: sensorial (sensory properties of materials), interpretive (associated values), affective (evoked emotions) and performative (referring to the human interaction).

Sensory synergy

Sensory synergy refers to the deliberate integration and harmonization of multiple sensory modalities within a designed environment to evoke cohesive and immersive experiences. In architecture and design, sensory synergy entails strategically combining elements such as visual aesthetics, auditory ambiance, tactile textures, olfactory scents, and gustatory sensations to create environments that resonate deeply with users on emotional, cognitive, and experiential levels.

Sensory synergy acknowledges that each sense contributes uniquely to the overall experience, emphasizing their combined effect in shaping how individuals perceive, interact with, and derive meaning from architectural spaces.

Emotional experience

An emotional experience refers to the subjective feelings, reactions, and responses evoked in individuals in response to various stimuli, situations, or environments. In the context of architecture and design, emotional experiences encompass a wide spectrum of affective states, ranging from joy, serenity, and awe to melancholy, agitation, and curiosity.

These experiences are shaped by the interplay of sensory stimuli, personal associations, cultural backgrounds, and situational contexts. Designers seek to craft emotional experiences by intentionally manipulating spatial qualities, materials, lighting, colors, and other elements to evoke specific emotional responses in users.

METHODOLOGY

This research will be carried out using multiple research methods. As mentioned in the theoretical framework, existing theories will serve as a guideline for developing arguments and defining key concepts within the research. Literature review will be conducted to gain insights into these existing theories and to gather information regarding sensory perception. Given the experience based nature of the subject matter, a part of the research will be executed through a carefully designed experiment.

Literature Review

The literature review to be undertaken in this research is used to gain a basic understanding in sensory perception. Furthermore, the defining of guidelines for multi-sensory user experience will rely on established theories, such as J.J. Gibson's influential work on ecological perception theory (1981).

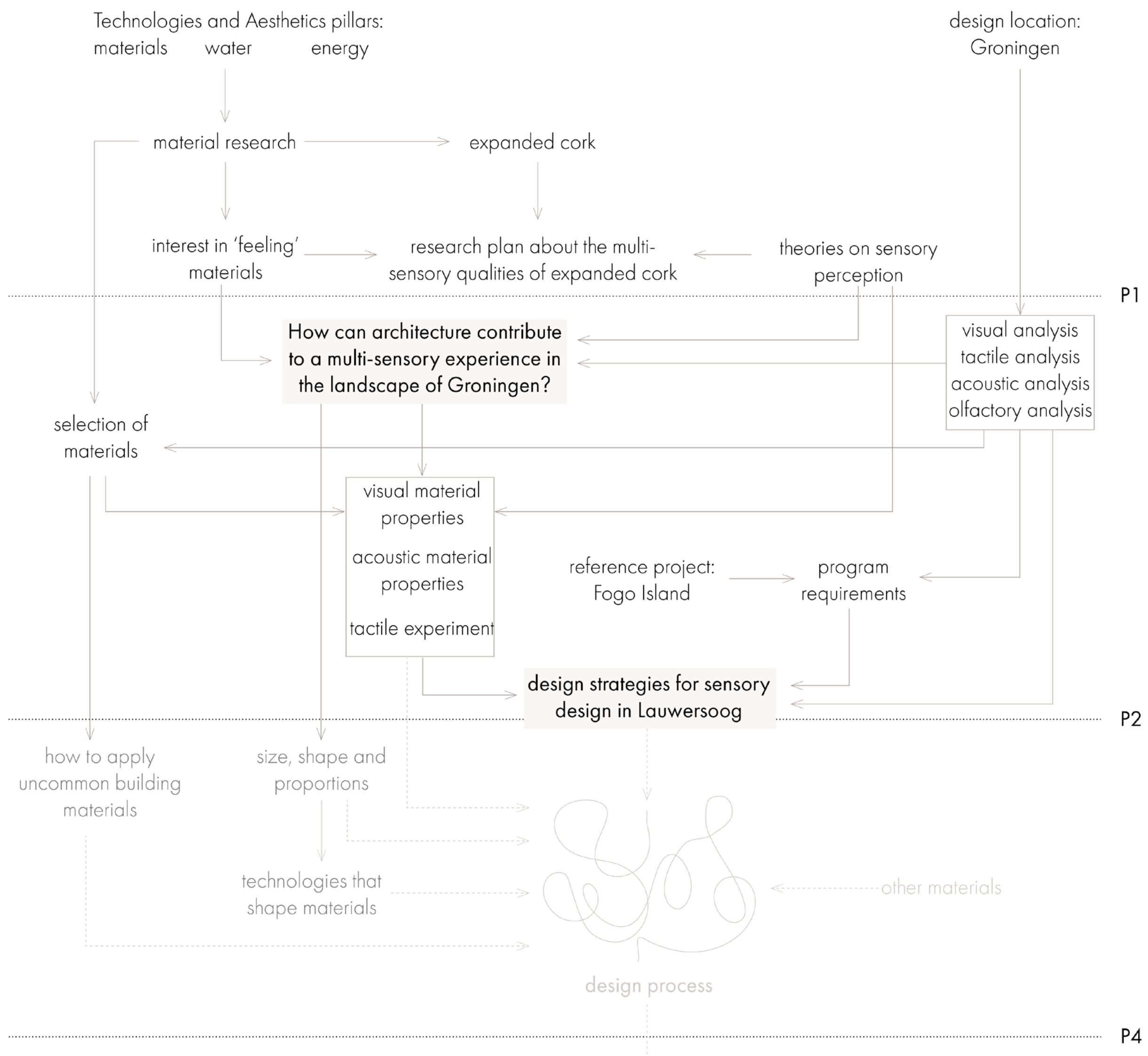
Finally, multi-sensory design strategies will be examined to facilitate the translation of these theoretical foundations into practical design strategies. This comprehensive literature review will provide a knowledge base for the forthcoming research, bridging the domains of material science, sensory perception, and architectural design.

Experimenting

An experiment will be conducted to gain deeper insights into the tactile experience of several carefully selected materials. The research of Dümen et al. (2022) offers a method for evaluating haptic or tactile material qualities. Participants can touch, lift or apply pressure to the material samples, therefore experiencing its texture, temperature, hardness, stiffness, elasticity and weight. Therefore, a total of 30 participants, from varying ages, will be presented with 18 material samples. The participants will have al other senses shielded, so that the results are fully based on tactile perception. The findings could provide insights for designing with a focus on the tactile sense.

Site Analysis

When endeavoring to integrate sensory qualities into a design, understanding the specific sensory characteristics of the design location is crucial. In this context, the design location of Lauwerslake in Groningen underwent a comprehensive analysis. Utilizing sensory mapping as a valuable tool, the location was examined for sounds, views, touch, smells, and tastes. This holistic approach ensures a nuanced understanding of the sensory landscape, aiding in the effective incorporation of these qualities into the overall design.



Fg. 2 conceptual diagram of research (own work)

02.

SENSORY PERCEPTION

The following chapter will offer a deeper understanding on the five human senses and their perceptual capabilities. In this research, the intersection of sensory perception and architecture takes place within the realm of materials. Material selection stands as a pivotal aspect in the architectural design process, influencing everything from the aesthetics of a building to the technical durability and environmental footprint.

Consequently, this study centers on a curated selection of materials, evaluating and categorizing them based on various visual, acoustic, olfactory, and gustatory attributes. Additionally, an experiment will be undertaken to further explore the tactile experiences associated with these materials.

SENSORY PERCEPTION

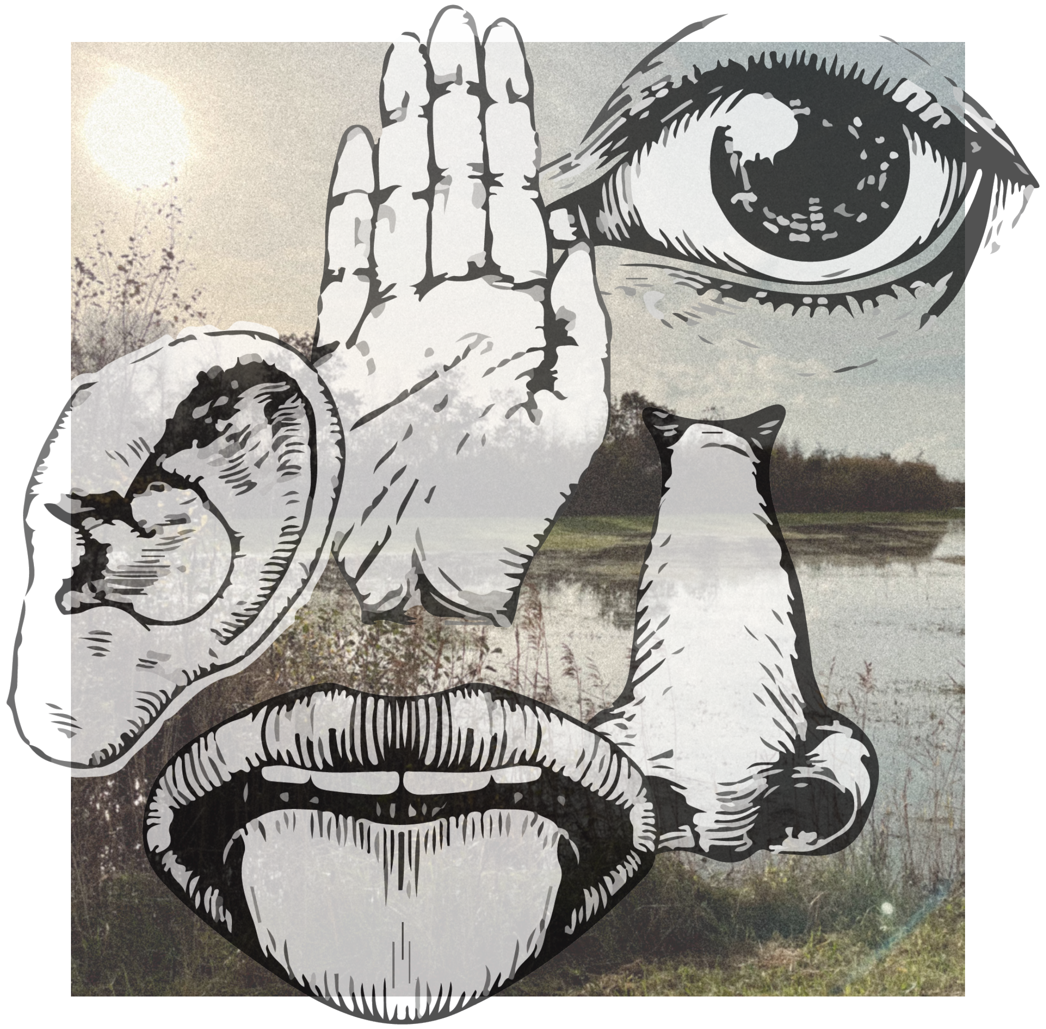
Sensory perception is the fundamental process through which organisms gather and interpret information from their environment using specialized sensory systems (Kanatlarli, 2015). These systems detect various stimuli such as light, sound, touch, taste, and smell, enabling organisms to interact with and respond to their surroundings effectively. In this research, the focus is specifically directed towards three primary senses: visual, auditory, and tactile.

Visual perception is integral to how humans and animals perceive their surroundings through the sense of sight. It involves the detection and interpretation of light and color, allowing individuals to navigate spatial environments, identify objects, and discern details (Brown & Farrelly, 2012). The eyes contain photoreceptor cells that convert light into electrical signals processed by the brain, enabling complex visual tasks such as depth perception, motion detection, and pattern recognition.

Auditory perception, or hearing, involves the detection and interpretation of sound waves in the environment. The ears capture sound vibrations, which are then transmitted as electrical signals to the brain for interpretation. This sense enables communication through speech and non-verbal cues, as well as the appreciation of music and environmental sounds. Auditory perception is essential for spatial awareness, identifying sources of sound, and responding to auditory stimuli for safety and social interaction.

Tactile perception, associated with the sense of touch, allows organisms to gather information about the physical properties of objects and surfaces. Sensory receptors in the skin detect sensations such as pressure, temperature, texture, and vibration. Tactile perception plays a crucial role in exploring and interacting with the environment, facilitating manual dexterity, object manipulation, and the recognition of shapes and textures (Sonneveld and Schifferstein, 2008). It also contributes to the emotional aspect of touch, influencing social bonding, comfort, and emotional well-being.

In architectural design, understanding these sensory modalities is paramount for creating environments that cater to human experience. By manipulating visual, auditory, and tactile stimuli, architects can shape spatial qualities to evoke specific emotional responses and enhance user comfort and engagement. This research delves into how these senses can be integrated into design practices to optimize functionality, aesthetics, and the overall sensory experience within built environments.



Fg. 3 collage of the different senses (own work)

VISUAL REALM

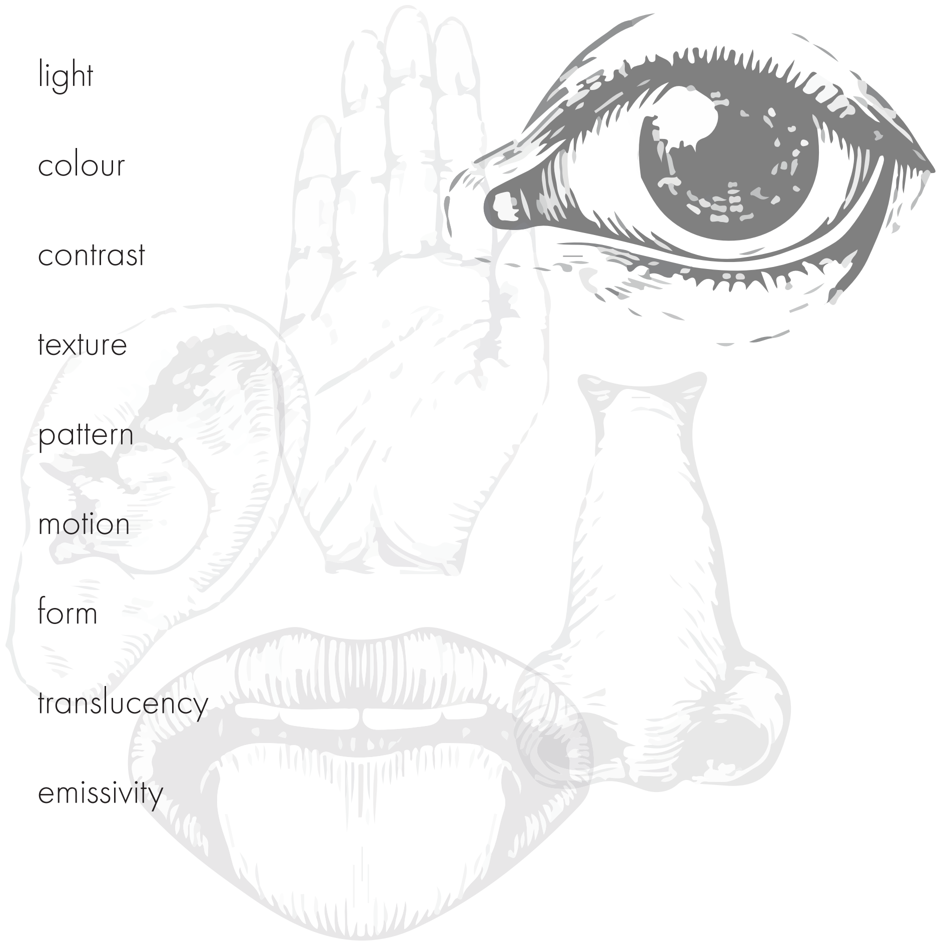
As creatures with a strong reliance on visual perception (Pallasmaa, 1996), our thought processes, reasoning, and imagination are predominantly visual. In architecture, the advancement of visual representation techniques has further emphasized the supremacy of visual experiences, overshadowing other sensory modalities. The eye takes precedence in perceiving architectural environments and is considered the primary mode of perception for humans (Kanatlarli, 2015).

When evaluating the visual impact of a material, understanding the effects of light is crucial, as highlighted by Brown & Farrelly (2012). Light enables the visual perception of color, contrast, texture, pattern, translucency, emissivity, and motion. Visual perception involves not only the recognition of shapes and colors but also the interpretation of spatial relationships.

Light exerts transformative effects on space, atmosphere and aspects such as color, temperature, form, volume, and scale. Additionally, it significantly influences emotions, well-being, and performance. It is imperative to recognize the psychological impact of visual stimuli on space occupants (Dümen et al., 2022).

Vision, as a three-dimensional sense, configures our understanding of space, depth, distance, and size, facilitating the perception of maximum information about our world and its events. Furthermore, according to Wyburn et al. (1964), the eye demonstrates heightened sensitivity to movement, ensuring the persistence of movement perception as long as any vision remains.

Attitudes toward the use of visually patterned and colored materials vary based on function, location, time, and culture.. Hence, it is essential to thoroughly examine the diverse aspects of visual perception for the development of meaningful and impactful architectural designs.



Fg. 4 collage of visual perception (own work)

HAPTIC REALM

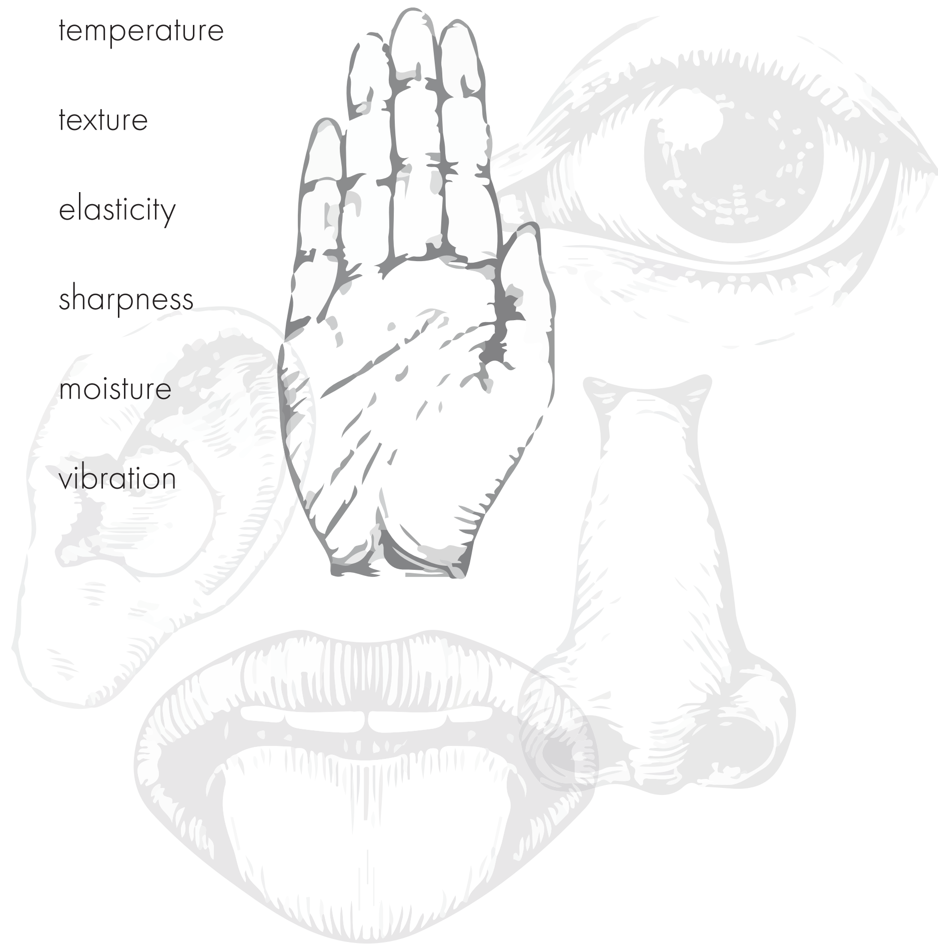
The human skin is the greatest part of our body exposed to environmental conditions (Kanatlarli, 2015). Physical interaction with the world is not limited to the hands, it involves the entire body.

The sense of touch serves as a means to record and interpret the built environment, as it creates both physical, emotional, and intellectual responses. This sensory perception is commonly refered to as the 'haptic system' (Sonneveld & Schifferstein, 2008).

Touching can occur consciously or unconsciously, serving various purposes such as expressing care, exploring, carrying, or even through accidental interactions.

Sonneveld and Schifferstein (2008) suggest that a world neglecting touch may diminish the sense of connection with the environment, potentially leading to a fading self-awareness. Touch, by Dewy (1986), is foundational for comprehending the material world, providing insights into physical aspects such as weight, temperature, wetness, texture, and elasticity. This tactile interaction becomes a crucial tool for acquiring knowledge about the world, surpassing the understanding gained through theoretical deduction (Lakoff & Johnson, 1999).

Furthermore, touch has the potential to dissolve the boundary between the self and the world. The ability to feel through objects integrates them into one's own body, as seen in a blind person sensing the world through a white stick or a carpenter feeling the wood through a saw (Bloomer & Moore, 1978). Consciously or subconsciously, our bodies engage in an ongoing dialogue with the material world, emphasizing the designer's responsibility in making deliberate decisions about the quality of this material environment.



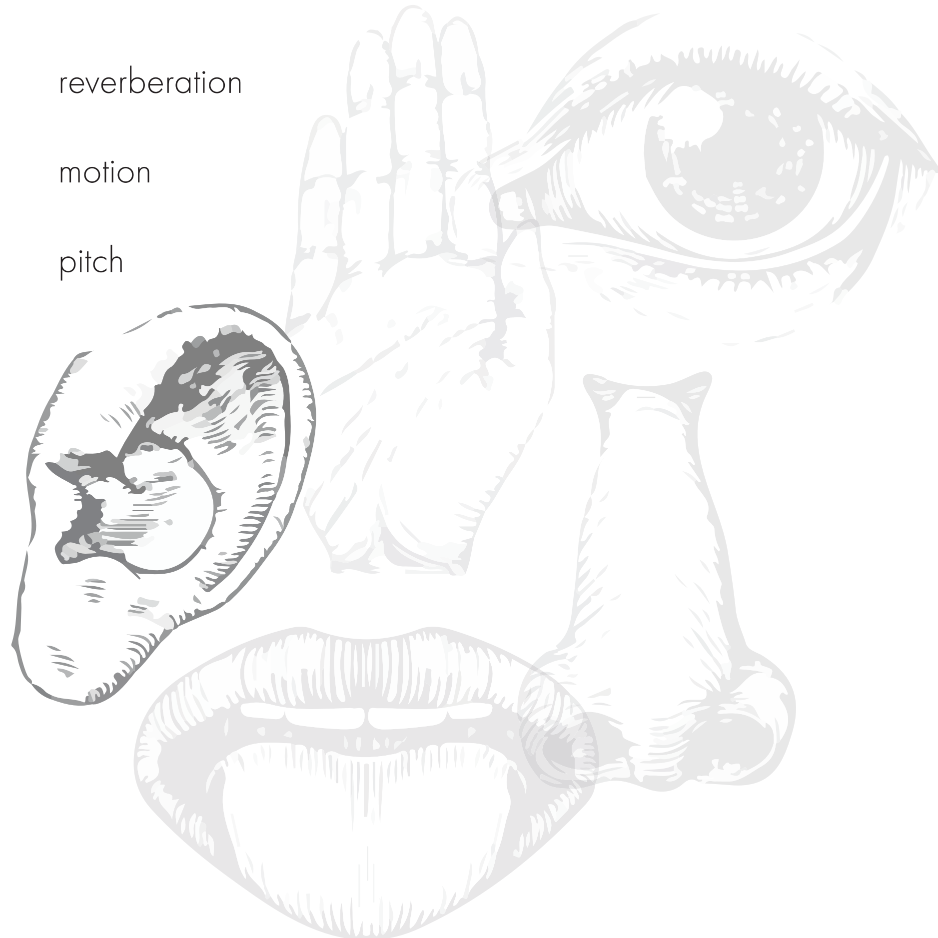
Fg. 5 collage of tactile perception (own work)

AUDITORY REALM

Acoustic perception encompasses the way individuals interpret and respond to sound within their environment. It involves the complex interaction between auditory stimuli and the human brain, influencing emotions, mood, and overall well-being. The acoustic qualities of a space, shaped by its architecture and materials, play a pivotal role in determining how sounds are transmitted, reflected, or absorbed. Effective acoustic design not only enhances the auditory experience but also contributes to the overall comfort and functionality of a given environment. Acoustic perception is particularly crucial in spaces where clarity of communication, concentration, or relaxation is paramount, highlighting the significance of considering sound as a key element in design decisions.

Interior spaces function like musical instruments, collecting, amplifying, and transmitting sound in diverse ways influenced by the space's shape and materials. The acoustic characteristics of materials can be intentionally manipulated to optimize the transmission or absorption of sound. Hard materials enable sound reflection, creating acoustically vibrant and resonant rooms, while perforated materials, fabrics, and carpets soften and absorb sound (Brown & Farrelly, 2012). Thoughtful material selection aligns with the functional requirements of a space to optimize its acoustic experience.

A conscientious approach to the sensory attributes of materials not only enhances the interior experience for all users but also contributes to the inclusivity of a space. For instance, considering the acoustic properties of materials becomes pivotal for individuals with impaired vision, hearing difficulties, or disabilities like autism. Elsamman et al.'s (2021) research advocates for creating a distinctive acoustic identity for each space by strategically employing materials with varying absorption and reflection capabilities. Additionally, incorporating acoustic landmarks in lengthy corridors can mitigate the perception of spatial loss, emphasizing the crucial role of acoustics in shaping inclusive and harmonious interior environments.



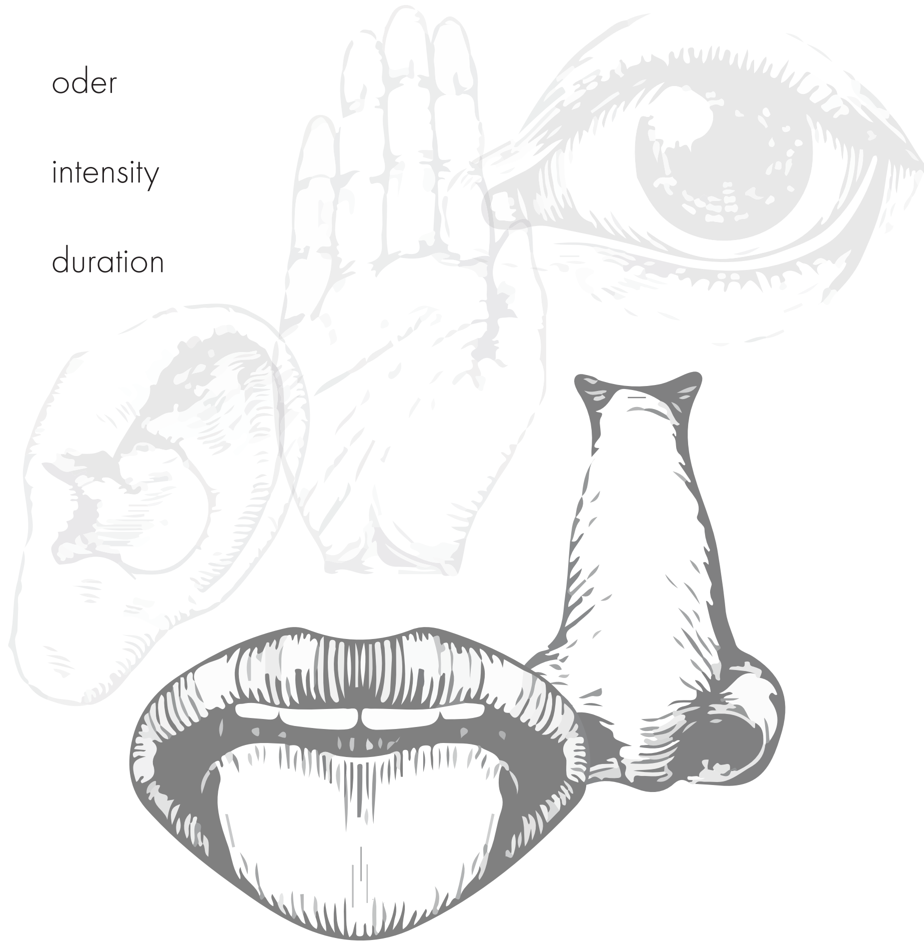
Fg. 6 collage of auditory perception (own work)

OLFACTORY & GUSTATORY REALM

In the course of this research, the olfactory and gustatory realms are intricately interconnected, often discussed in tandem due to their closely related nature. The sensory experiences of smell and taste share a symbiotic relationship, with aromas often influencing the perception of flavors. This pairing is particularly significant in understanding how individuals interpret and engage with their surroundings, creating a multisensory narrative that combines olfactory and gustatory sensations (Wyburn et al., 1964). By exploring these senses concurrently, the research aims to unravel the nuanced interactions between smell and taste, shedding light on the intertwined nature of these sensory dimensions.

Olfactory and gustatory perceptions play integral roles in shaping our sensory experiences within spaces (Elsamman et al., 2021). The sense of smell, or olfaction, can evoke powerful emotional responses and memories, influencing our overall perception of a space. As indicated in McLean's research titled *Nose-first: Practices of Smellwalking and Smellscape Mapping* (2019), factors such as the intensity of the scent, its duration, and personal preferences, including liking or disliking the scent, are discernible elements during olfactory experiences. Strategic choices in materials, finishes, and ambient scents can create specific olfactory identities for interiors, enhancing the overall atmosphere.

While architecture cannot be tasted, it undeniably plays a crucial role in shaping the overall ambiance and enhancing the pleasure derived from the act of dining and tasting. Architecture serves as a backdrop that can enhance the sensory aspects of dining, including taste. Illustrating this concept is the Fogo Island Shed, a creation of Todd Saunders. The design is centered on the idea of 'slow eating,' fostering a communal approach to dining. The layout features a long table adjacent to an open-plan kitchen, where guests and chefs share the same space. This arrangement creates an intimate dining environment, immersing individuals in the world of ingredients, techniques, aromas, and flavors (Saunders Architecture, n.d.).



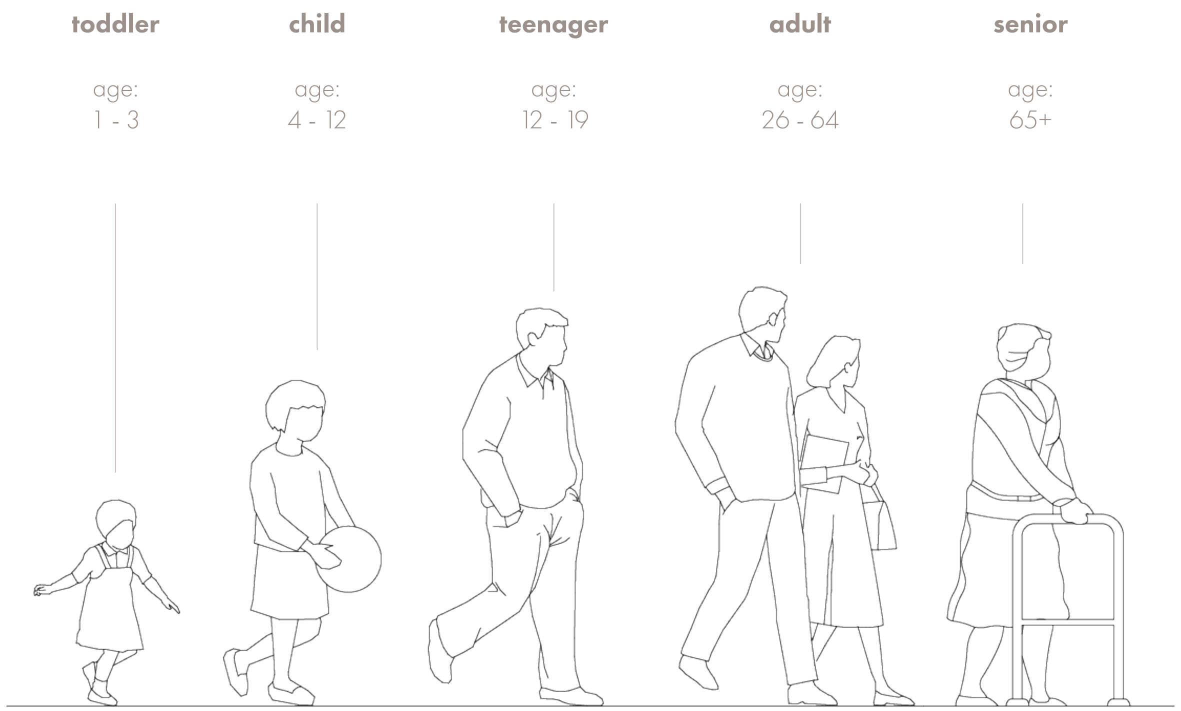
Fg. 7 collage of olfactory & gustatory perception (own work)

AGE, MEMORY & PERCEPTION

During a child's early years, tactual experiences predominantly involve being touched. As children mature and gain the ability to actively reach out and touch their surroundings, their tactual interactions become more dynamic (Dewey, 1986). While children may recognize themselves as the active agents in activities like kicking a ball or riding a bicycle, the boundary between whether they are cuddling a toy or being cuddled by it may blur, turning touching into a more interactive experience.

As we navigate through life, our experiences and memories significantly shape our perception of the world (Bloomer & Moore, 1978). This holds true across various stages of life, from childhood through adulthood. The memories we form during different life phases contribute to our understanding of sensory stimuli, influencing how we interpret and engage with our surroundings. For instance, an adult's memories may include sensations like feeling the sharp edge of a glass table or experiencing the hot temperature of a pan, contributing to their nuanced perception of materials and objects. These specific memories, associated with various tactile encounters, are often absent in toddlers and children, who, being more pure and having had fewer experiences, are yet to develop an extensive memory database for such materials and sensations.

As people age and transition into the senior stage, changes in sensory perception become more apparent. Impaired vision and hearing often become more prevalent, impacting the way seniors interact with and perceive the world around them. Additionally, memory loss may occur in some situations, further influencing how sensory information is processed and remembered. Understanding the interplay between age, memories, and sensory perception is crucial for creating environments that cater to the evolving needs and experiences of individuals across the lifespan.



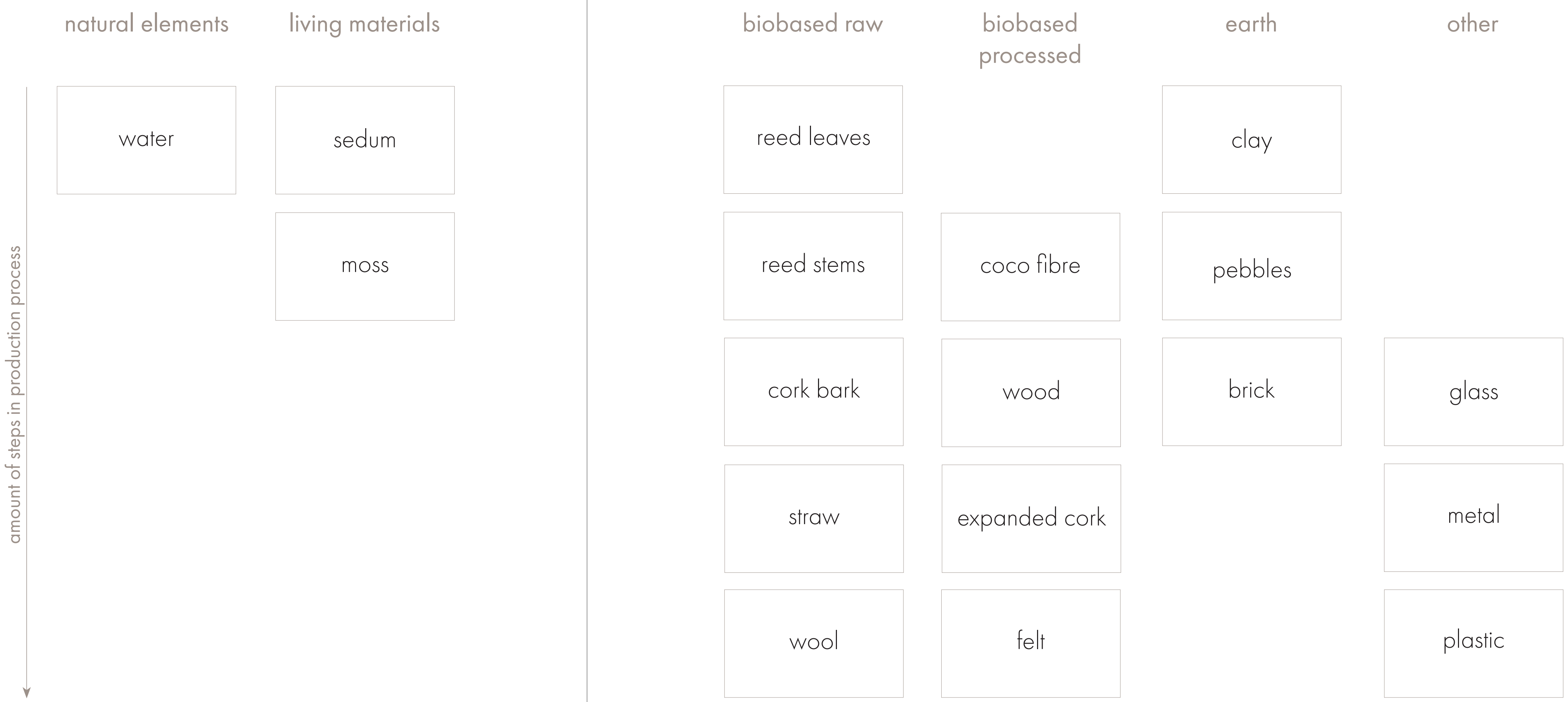
Fg. 8 sketch of people from different age groups (own work)

MATERIALS

The focus of this research is on how the use of materials can influence the sensory experience of a building.

To execute this research, a refined list of materials was curated based on various guidelines. Obtaining clear results required the inclusion of materials with diverse properties. This driagram illustrates the categorization of materials into six groups: natural elements, living materials, biobased raw (unprocessed), biobased processed, materials extracted from the earth, and others. The sorting also takes into account the number of steps required for extraction and/or production.

To ensure a focus solely on user experience rather than on easy building materials, the list included both common and uncommon building materials. This approach provided the opportunity to integrate materials from the Groninger landscape such as reed and moss.



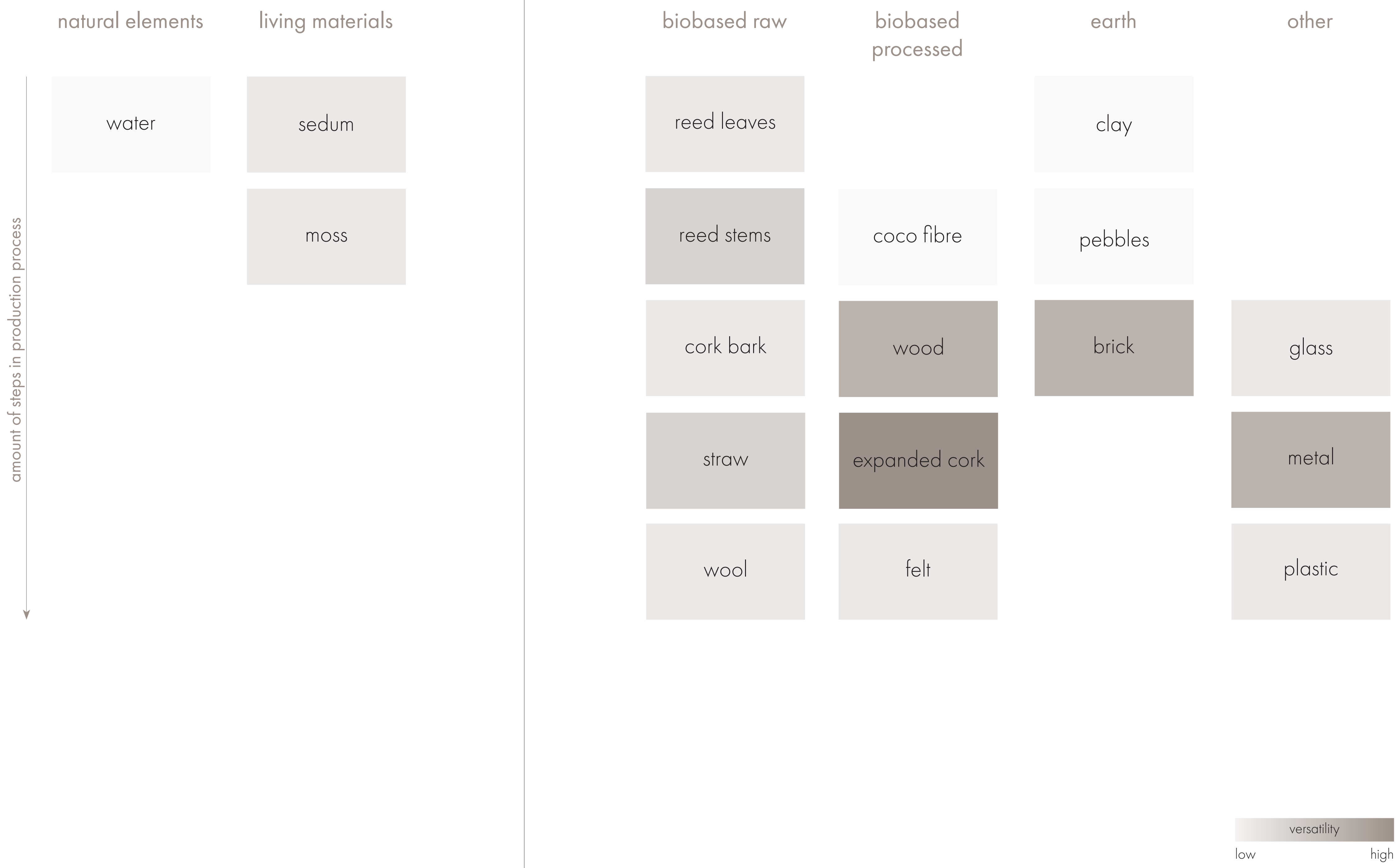
Fg. 9 diagram of chosen materials (own work)

APPLICATION

In this diagram, materials are color-coded according to their versatility, with higher rankings given to those applicable in multiple ways, such as interior finishing, exterior cladding, insulation, and/or load-bearing structure.

The top four materials in terms of applicability are expanded cork, wood, brick, and metal. These versatile elements can be employed for interior finishing, exterior cladding, and load-bearing structures. Additionally, expanded cork can serve as an insulation material.

It's worth noting that 'natural elements,' 'living materials,' and 'biobased raw' materials show lower applicability scores, as none have been utilized yet as construction materials.



Fg. 10 versatility of chosen materials (own work)

VISUAL PROPERTIES

As mentioned previously, in order to get the best results, the materials had to have varying properties. The visual properties of the materials can be seen in the figure to the right

Visual properties of a material encompass various characteristics that can be perceived by sight. Some common visual properties include colour, texture, pattern, translucency and reflectance.

Given the significant emphasis on the visual sense in architecture and design, the decision was made to center the material research around the other senses, foregoing additional testing on the visual experience of these materials. Nevertheless, it remains feasible to analyze the visual properties of the materials without conducting further tests on participants.

Fg. 11 visual properties of chosen materials (own work)

COLOUR

The figure to the right presents a simplified representation of the main colours in the materials.

It is evident that 'living materials' exhibit a predominant green hue, aligning with the natural colour of most plants.

The 'biobased processed' materials tend to feature darker tones.

A majority of the 'biobased raw' materials display a neutral-yellow undertone.

It's important to highlight that the color within the 'other' category can vary among products, as these materials are entirely manmade. Consequently, their color can be modified to suit specific preferences.

Fg. 12 simplified representation of colours in the materials (own work)

OLFACTORY & GUSTATORY PROPERTIES

In this diagram, materials are categorized by the intensity of their odor, with results derived from personal testing and general knowledge, not validated among other participants.

Observations reveal that 'living materials' exhibit the highest smell intensity after straw. Many materials, particularly those categorized as 'other,' lack a distinctive smell.

It's essential to highlight that none of the materials in the diagram are suitable for human consumption; therefore, they are not ranked based on gustatory properties.

Fg. 13 intensity of oder in the materials (own work)

ACOUSTIC PROPERTIES

In this diagram, materials are arranged based on their sound absorption coefficient, crucial for influencing the acoustic experience in a space.

The sound absorption coefficient measures the effectiveness of a material in absorbing sound waves rather than reflecting them (Joostdevree.nl, n.d.). It ranges from 0 (perfect reflection) to 1 (perfect absorption). Material texture plays a crucial role, as porous surfaces tend to have higher absorption coefficients due to increased friction and internal reflections, effectively reducing sound reflections.

Notably, 'living materials' and 'biobased' have higher absorption coefficients due to their texture.

*sound absorption coefficient is undetermined and thus estimated.

Fg. 14 acoustic absorption for chosen materials (own work)

EXPERIMENTING THE TACTILE SENSE

The human skin, being the largest part of our body exposed to diverse environmental conditions, encompasses numerous active and passive functions (Kanatlarli, 2015). Given that our hands are the primary instruments and our feet consistently engage with buildings and landscapes, designers should delve deeper into understanding these tactile experiences.

Yanagisawa and Takatsuji's research titled *Effects of Visual Expectation on Perceived Tactile Perception* (2015) highlights the influence of the visual sense on tactile perception. During testing, diverse visual stimuli influenced participants' responses to tactile samples, affecting perceived features like roughness, hardness, and stickiness. Pallasmaa (1996) suggests thinking of touch as the unconscious vision, where vision reveals what touch already knows.

Consider if a material 'looks' rough; how can the visual sense comprehend the appearance of this rough feeling? Thanks to the brain's capacity to preserve memories, it establishes a connection between visual images and past tactile experiences, highlighting the close bond between sight and touch (Bloomer & Moore, 1978).

To genuinely capture a user's tactile experience without visual bias, an experiment was conducted, echoing the material-focused research of Yanagisawa and Takatsuji (2015). Material selection significantly influences the architectural design process.

Designers wield influence over the physical and psychological experience by considering textures affecting hands and feet, as well as the temperatures of touched objects (Brown & Farrelly, 2012). The experiment's results should guide tactile-oriented design, shaping the sensory experience of a space. Consciously or subconsciously, our bodies engage in an ongoing dialogue with the material world, prompting designers to make deliberate decisions about its quality through textural juxtapositions and contrasts.

Fg. 15 collage representing tactile experience (own work)

EXPERIMENT SETUP

The experiment was structured around two setups. Initially, the research utilized the 'feeling box'. This box featured two openings allowing participants to insert their hands and touch the material inside. By blocking the participant's vision, the closed box directed attention solely to the tactile experience. Following each question session, the material was removed and substituted with the next one. However, the process of replacing materials consumed a significant amount of time and resulted in interruptions during the experiment.

After three tests, this experimental setup was replaced by the second configuration: the 'blindfolded approach', which involved blindfolding the participants. This facilitated the placement of all materials on a table, within easy reach. The materials were either directly handed to the participants, or their hands were guided toward specific materials.
This setup proved to be more efficient, allowing participants to touch multiple materials simultaneously or in quick succession, enabling effective comparisons between the different materials.

Each participant received a set of questions after touching each material. These questions were adjusted throughout the various participations to ensure optimal results.

Initially, the experiment's questions aimed to uncover basic material properties and user experiences:

- Does the material feel smooth of rough?
- Does the material feel warm or cold?
- Does the material feel fexible or stiff?
- Does the material feel dry or damp?
- Do you have any idea what the material is?
- What is your impression after feeling the material?
- Can you grade the experience of feeling this material on a scale from 1 to 10?

After three participants, a noticeable overlap in answers regarding material properties led to a modification of the questions:

- What is your impression after feeling the material?
- Do you have any idea what the material is?
- Can you grade the experience of feeling this material on a scale from 1 to 10?

Even with the altered questions, participants encountered difficulty in grading their experience of touching the materials. Consequently, for the subsequent set of participants, they were asked to *express anything that came to mind while feeling the materia*l. This approach proved to evoke the most interesting responses.

RESULTS

rough or smooth

To gain further insights into the texture of materials, participants were asked to discern whether the material feels rough, smooth, or neither.

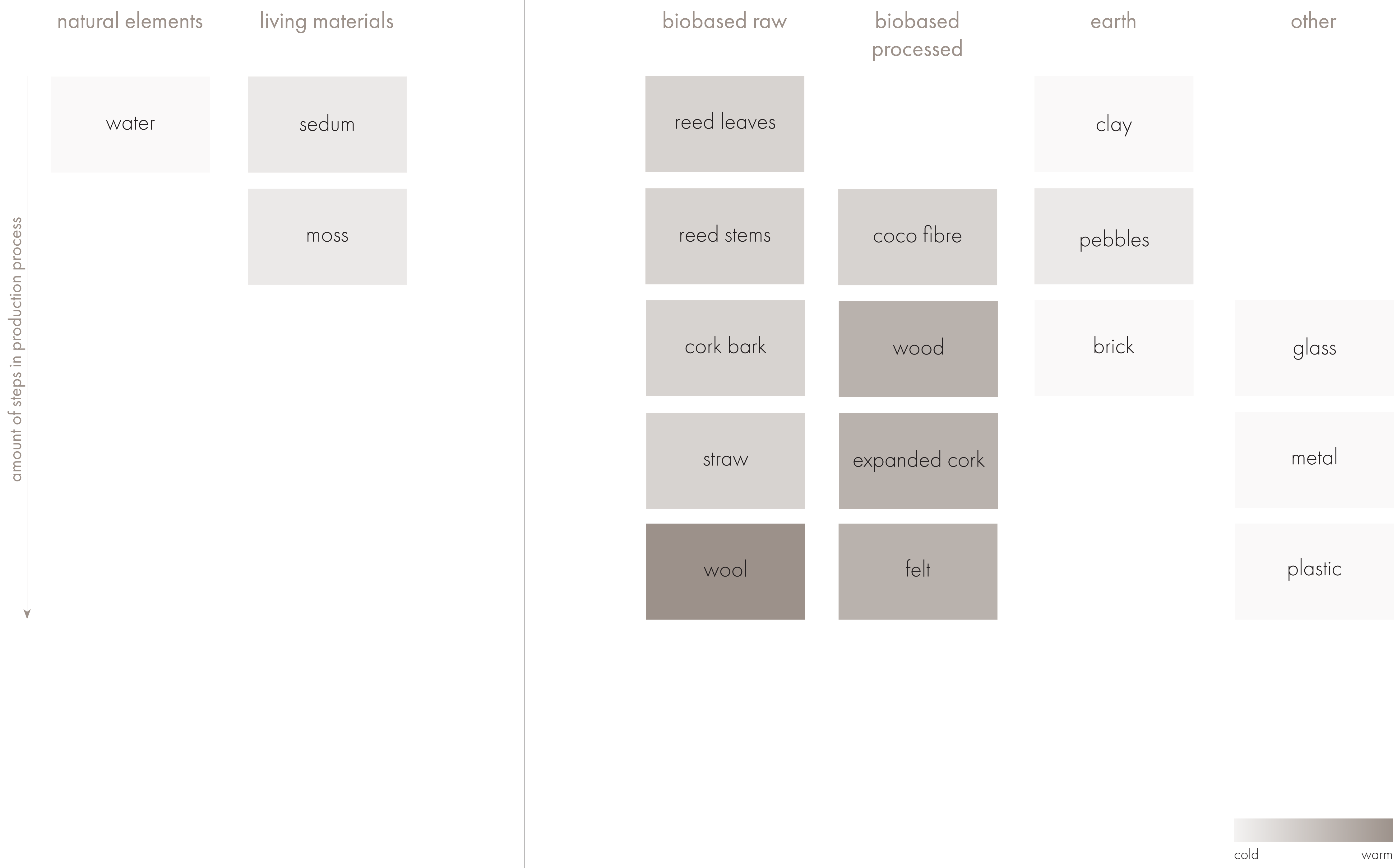
Notably, the 'living materials' and 'biobased raw' materials possess a distinctive rough texture, achieved through their natural composition, while the manmade 'other' materials exhibit an exceptionally smooth feel. This textural variation is perceived through our skin, providing a tactile experience that adds depth to our overall sensory encounter.

Fg. 16 test results of rough or smooth materials (own work)

RESULTS
warm or cold

To better understand the tactile perception of temperature, participants were queried about whether the materials felt warm or cold. During testing, some materials exhibited distinct temperatures, while others were perceived as neither warm nor cold. Notably, 'biobased' materials fell into the neutral category, whereas manmade 'other' materials were distinctly cold.

Both the thermal mass of a material, as well as its thermal conductivity coefficient play crucial roles in influencing the perception of warmth and coldness. In the context of this experiment, conducted during winter, materials with high thermal mass or high thermal conductivity coefficient were likely perceived as colder.



Fg. 17 test results of warm or cold materials (own work)

RESULTS

flexible or stiff

In this phase, participants were tasked with determining whether a material was stiff, flexible, or fell somewhere in between. The flexibility of a material not only impacts its malleability but also plays a crucial role in the extent of a participant's influence on shaping the material. Exploring whether the subjective grading of the tactile experience (positive or negative) correlates with the feeling of influence on the material's shape could be an intriguing avenue for further investigation.

It's worth noting that materials categorized under 'natural elements' and 'living materials' were consistently considered flexible, while materials in other categories yielded varying responses for each sample.

Fg. 18 test results of flexible or stiff materials (own work)

RESULTS

dry or damp

Participants were prompted to assess whether the material felt dry or damp. Interestingly, the 'biobased' materials were consistently perceived as dry, possibly attributed to their nature as grown materials that are no longer 'alive.' In this maturation process, water ceases to flow through the material's veins, leading to a drying effect.

Upon reviewing participant responses, it became evident that damp materials had a negative impact on the tactile experience, as participants felt their hands were getting dirty. This observation holds true for most materials except water, which was universally recognized as clean.

Fg. 19 test results of dry or damp materials (own work)

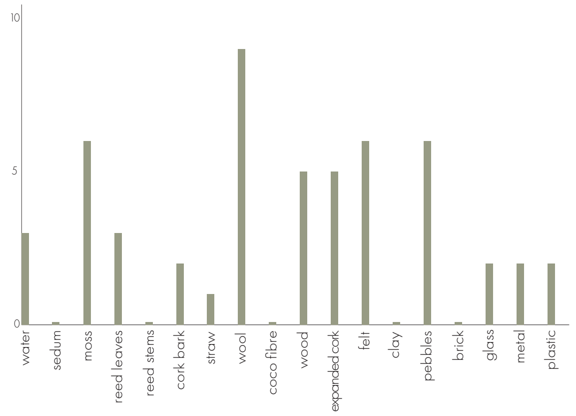
EXPERIENCE RATING

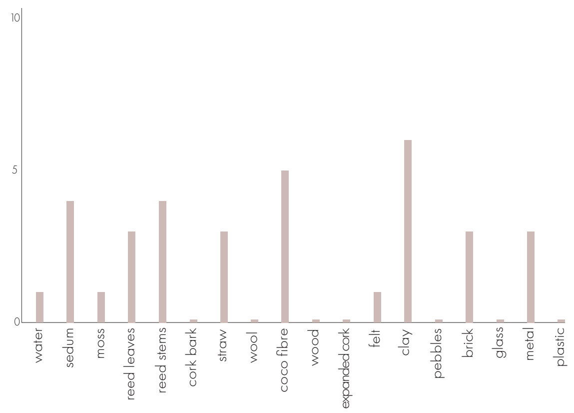
To enhance our understanding of the tactile experience with each material, participants' responses were categorized as 'positive,' 'negative,' or 'neutral.'

In the initial phase of testing, participants provided both a reaction to the material and a rating on a scale of 1 to 10. While the grades offered a general sense of the experience, participants found it challenging to assign specific scores. In the subsequent stages of the experiment, participants were instructed to express any thoughts that arose while touching the material. Although this approach did not yield an immediate 'positive' or 'neutral' response, the reactions were subsequently ranked.

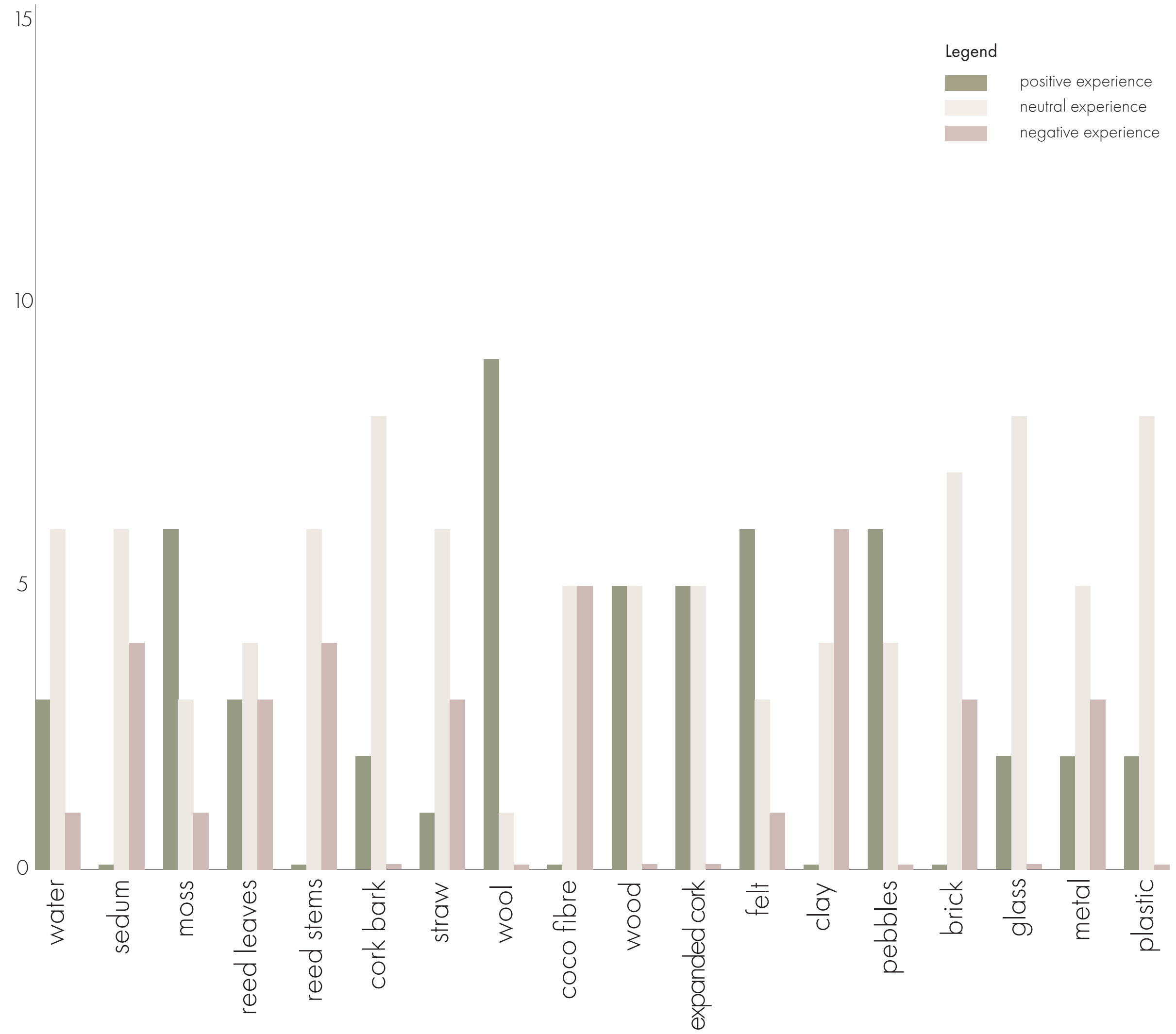
Upon analyzing the graphs, a distinct winner for the most positive and most negative tactile experience emerged. Wool was universally regarded as the best experience, while touching clay was deemed the least favorable.

All these findings will be considered in the design process for a multi-sensory experience.





Fg. 20 amount of positive tactile experiences (own work)
Fg. 21 amount of negative tactile experiences (own work)



Fg. 22 all ranked tactile experiences (own work)

EMOTIONAL RESPONSES

During the tactile experiment, participants were placed in an environment where their primary sense of sight was deliberately obscured, allowing them to focus exclusively on the tactile qualities of the materials presented.

Initially, their responses were grounded in objective assessments of the materials, noting textures, temperatures, and other physical attributes. However, as the experiment unfolded, a profound shift occurred as participants delved deeper into their tactile experiences. Beyond mere physical sensations, they began to articulate subjective responses that transcended the material realm. Memories were evoked, emotions stirred, and personal narratives emerged as participants connected deeply with the tactile stimuli.

These rich and multifaceted responses can be seen as a pivotal point in this project, guiding the exploration of how materials could be wielded not just to fulfill functional or aesthetic criteria, but to evoke profound emotional and psychological responses within architectural spaces.

This can be seen as a transition from surface-level observations to nuanced emotional expressions to create spaces with meaning and resonance.

ARCHITECTURE & EMOTION

In the evolution of this research, the focus expanded beyond the tactile exploration of materials to delve into the profound intersection of architecture and human emotions. Through a series of design experiments, the aim was to capture and amplify emotions such as desire, tranquility, and a sense of endlessness.

The collages served as a creative tool to visualize these emotions in spatial terms, featuring scale and form to evoke desired emotional states.

Desire, for instance, was represented through spaces that entice and beckon.

Tranquility, on the other hand, found expression in serene environments with rhythm and repetition.

Endlessness was explored through spatial cues and architectural elements.

This phase of research by design highlights the capacity of architectural elements not only to shape physical environments but also to profoundly influence human emotions and experiences within those spaces.

desire tranquility endlessness

Fg. 23 collages of different shapes & emotions (own work)

ARCHITECTURE & EMOTION

Building upon the foundation emotional resonance, the project ventured further into exploring the themes of shelter, adventure, and guidance within architectural spaces.

Shelter is conceptualized as more than physical protection, but as a psychological sanctuary that provides comfort and security.

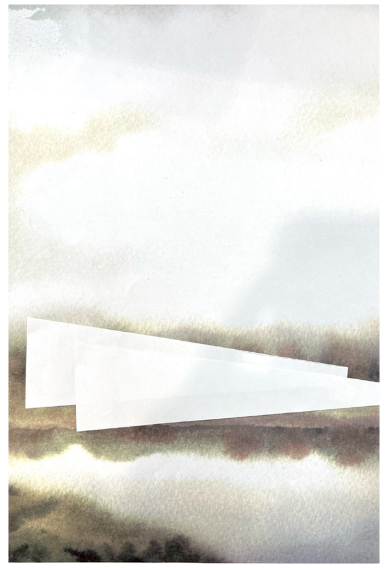
Adventure is represented by dynamic spatial sequences that invite exploration and discovery. These environments were designed to stimulate curiosity and engagement, encouraging users to embark on journeys of personal exploration within the built environment.

Guidance emerged as a theme that integrates spatial cues and architectural elements to orient and direct users through intuitive and purposeful design.

Through these explorations, the project aims to demonstrate the transformative power of architecture in shaping emotional experiences.

shelter

adventure



guidance

Fg. 24 collages of different shapes & emotions (own work)

DESIGN GUIDELINES

The design guidelines emerged from the research on sensory perception, particularly the tactile qualities of building materials. Initially, the research aimed to understand how different materials could influence sensory experiences. However, the tactile experiment revealed that the true potential of sensory design lies in crafting emotional experiences. Sensory synergy—integrating sound, visuals, and touch, and sometimes even smell and taste—became the architect's method for achieving these experiences.

The tools of an architect, including construction, orientation, materials, scale, light, and shape, can be wielded to sculpt spaces that evoke profound emotional responses.

To create the most extreme emotional experiences, the primary design guideline is contrast. This involves pairing elements to evoke varied emotional responses:

SMALL TO BIG
Transitioning from narrow, enclosed corridors to expansive, open galleries.

SMOOTH TO ROUGH
Shifting from sleek, polished surfaces to coarse, textured walls.

LIGHT TO DARK
Moving from brightly lit areas to dimly illuminated spaces.

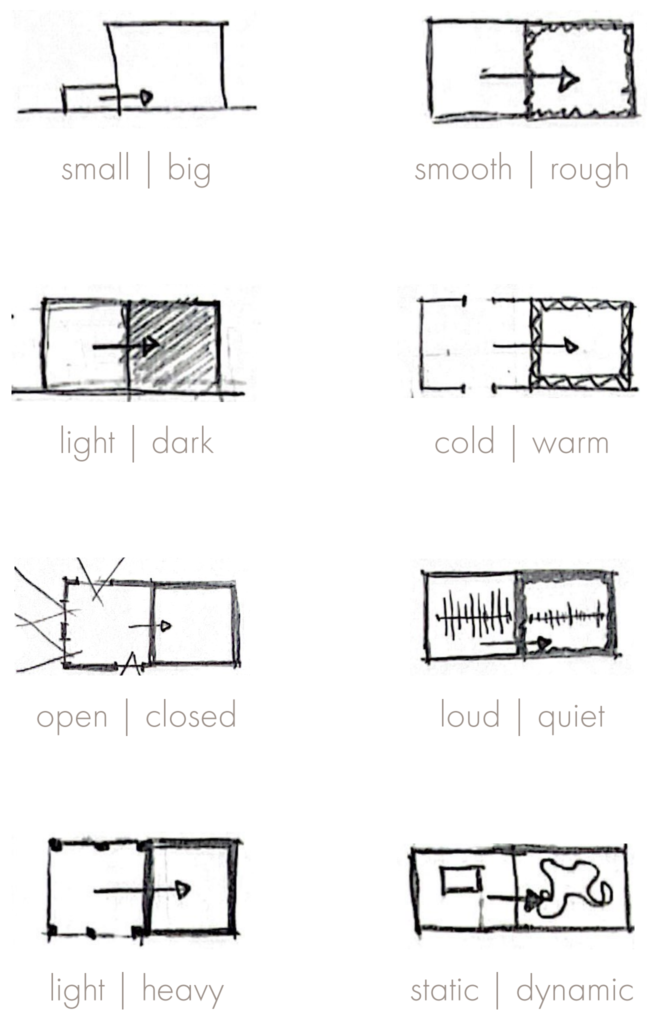
COLD TO WARM
Experiencing temperature variations through the use of different materials and lighting.

OPEN TO CLOSED
Navigating between open, airy spaces and intimate, enclosed nooks.

LOUD TO QUIET
Transitioning from noisy, bustling areas to quiet, serene zones.

LIGHT TO HEAVY
Feeling the weight and solidity of certain materials or construction contrasted with lighter, more ephemeral elements.

STATIC TO DYNAMIC
Moving through static, stable environments to more dynamic, fluid spaces.



Fg. 25 design guidelines (own work)

03.

DESIGN LOCATION

The following chapter explores a location that serves as both inspiration and a design setting. The graduation studio *Technologies and Aesthetics* focuses on the landscape of North Groningen—a region abundant with dikes, nature parks, farms, and a compelling history of water defense.

Despite my initial lack of knowledge about the location, I swiftly developed an interest in the surroundings of Lauwersoog and Lauwerslake during our excursion. The allure of the area, from the soothing sound of reeds rustling in the wind to the captivating swampy landscapes formed by floods, captured my attention.

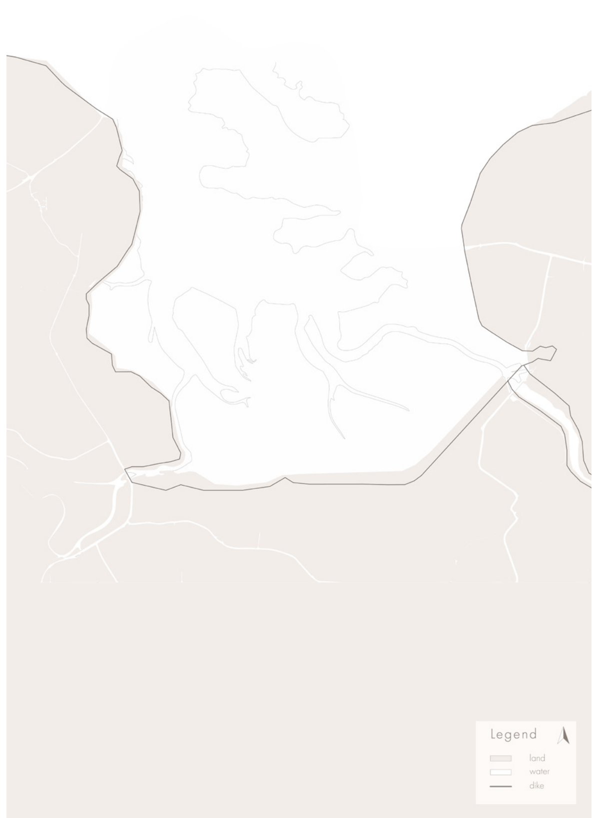
LAUWERMEER

Until 1969, the Lauwerssea was an estuary that was in open connection with the Wadden Sea, allowing free flow of ebb and flow. However, this open connection entailed risks, such as flooding and the ingress of salt water into the fresh interior (Nationaal Park Lauwersmeer, 2023). The flood disaster of 1953, which affected large parts of the Netherlands, led to renewed attention for water management and safety.

To tackle these problems, it was decided in 1969 to close the Lauwerszee and create the Lauwersmeer. The closing dike, which was originally built to close off the Wadden Sea from the Zuidersea, was extended to isolate the Lauwerssea. This project, known as the *Lauwersmeerwerken*, resulted in a new lake that houses both fresh and salt water (afdeling Lauwerszee, 1989).

In addition to creating a safer water environment, the transformation of the Lauwerszee into the Lauwersmeer also offered opportunities for nature conservation and recreation. The area surrounding the lake was declared the Lauwerslake National Park, making it an important destination for nature lovers and birdwatchers. The diversity of flora and fauna in the area benefited from the transition to a more varied and sheltered ecosystem.

Although the closure and transformation of the Lauwerssea into the Lauwerslake was not without controversy, the project has led to a balanced mix of water safety, nature conservation and recreational opportunities. Today, Lauwersmeer is known as a beautiful nature reserve that reaps the benefits of these coordinated efforts to protect and develop the environment.



Fg. 26 map showing Lauwerssea in 1969 (own work)

Fg. 27 map showing Lauwerslake in 2024 (own work)

FUTURE SCENARIO

Lauwerslake plays a crucial role in draining three-quarters of Friesland, nearly half of Groningen, and the northern part of Drenthe (Noorderzijlvest, 2021). This results in a substantial availability of fresh water. It is important for agriculture that the south of the lake remains fresh. This is under pressure due to, among other things, climate change and sea level rise.

In 2020, workgroup g*ebiedsproces KRW Lauwersmeer* formulated a integrated long-term perspective for roughly 2040 that ensures both development of robust nature and a future for arable farming (Klimaatadaptatie Groningen, 2023). Sea level rise and climate change make it necessary in the long term to partly replace the current *Cleveringenlocks* with a pumping station.

The working group proposes to design the pumping station in such a way that an extremely controlled fresh-salt transition becomes possible at the same time. A multifunctional pumping station that works in two directions: discharge of freshwater and intake of saltwater. Control is based on measurements from a fine-meshed monitoring network in Lauwersmeer, nature reserves and agricultural areas.

Not only the waterrise is a driving force for this plan, but also the plans of *Natura2000-status* and *Kaderrichtlijn Water (KRW)* to ensure nature restoration. Migratory fish such as eel, salmon and sturgeon need a natural transition from fresh to salt water to acclimatize (ARK Rewilding Nederland, n.d.). When the adult animals migrate from the sea to their spawning grounds in the large rivers, they do not swim all at once, but take a break for a while in the brackish zone in between. This gives their body the opportunity to adapt to the changing circumstances.

In addition to migratory fish, the lake is important as a 'nursery' for a large group of fish species (Klimaatadaptatie Groningen, 2023). Fish-eating birds in the Wadden Sea, in turn, depend on these young fish to raise their young. The lake thus forms an ecological link on a regional and international scale.

Fg. 28 map of future scenario Lauwerslake (own work, based on *Gebiedsproces KRW Lauwersmeer*)

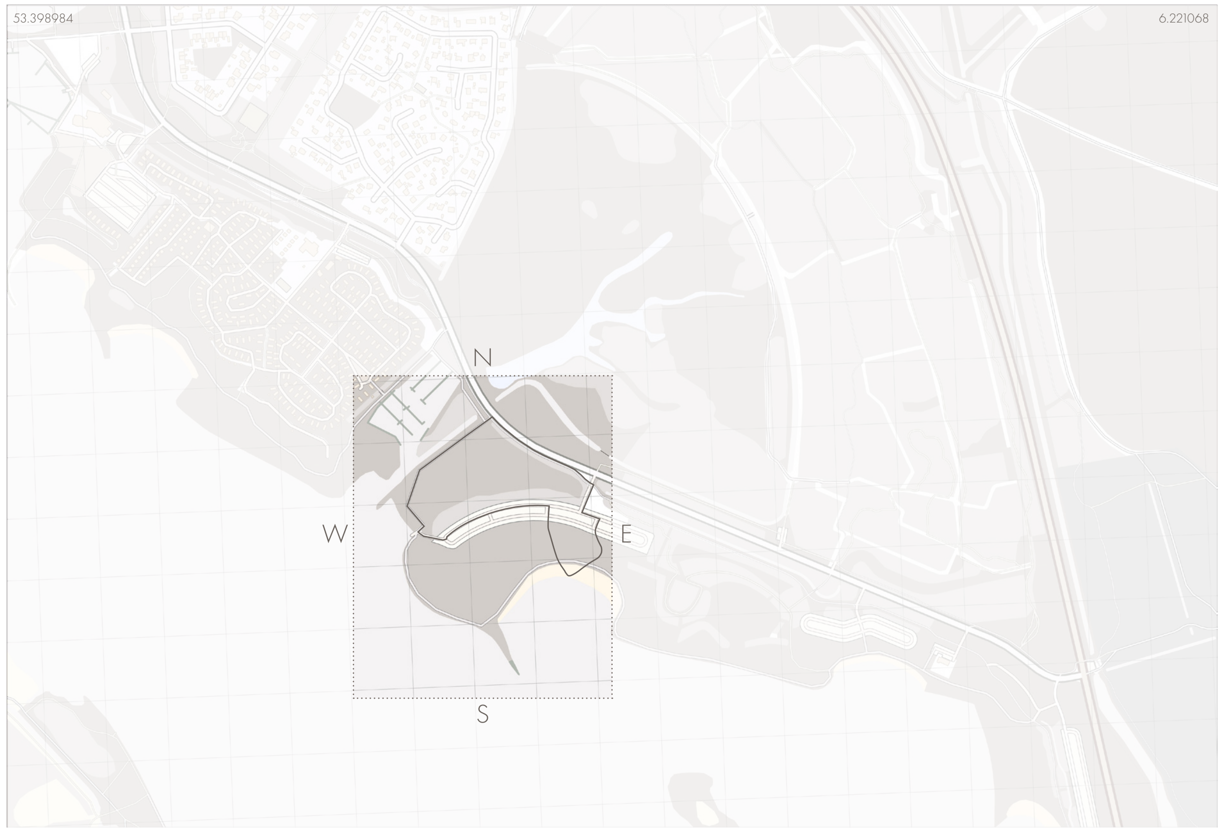
SITE ANALYSIS

'In November of 2023, our excursion took us to North Groningen, and Lauwersoog was on my must-visit list. Traveling by car through the landscape, we traversed dikes, passed farms, and approached the Lauwersoog.

Initially, the view from the car didn't strike me as particularly special. "Is this all there is?" I wondered as we drove past Lauwersoog. However, just before the Cleveringsluizen roundabout, we turned around to explore the area again. Finding a random parking lot, we decided to pause and enjoy some kibbeling. It was only when we parked in a flooded lot that we realized we were standing at the edge of the Lauwerslake. Our walking adventure began here, leading us past mushrooms, rustling reeds, and along a metal pathway through the swampy landscape, eventually merging into the flooded sections of the park. Fortunately, I had my rain boots, allowing me to venture into the submerged areas.

It was quite extraordinary—a swampy landscape where walking paths blended with the water during high tides. I captured a photo of a bench with its feet immersed in water, symbolizing the convergence of people and water.

Upon further exploration after the excursion, I delved into the place we had visited. On the map, the entire area appeared green. It goes to show, to truly understand a location, you need to be there. You must walk on the metal path with your own feet, becoming one with the water. It's about a person being shaped by the landscape, rather than the other way around.'

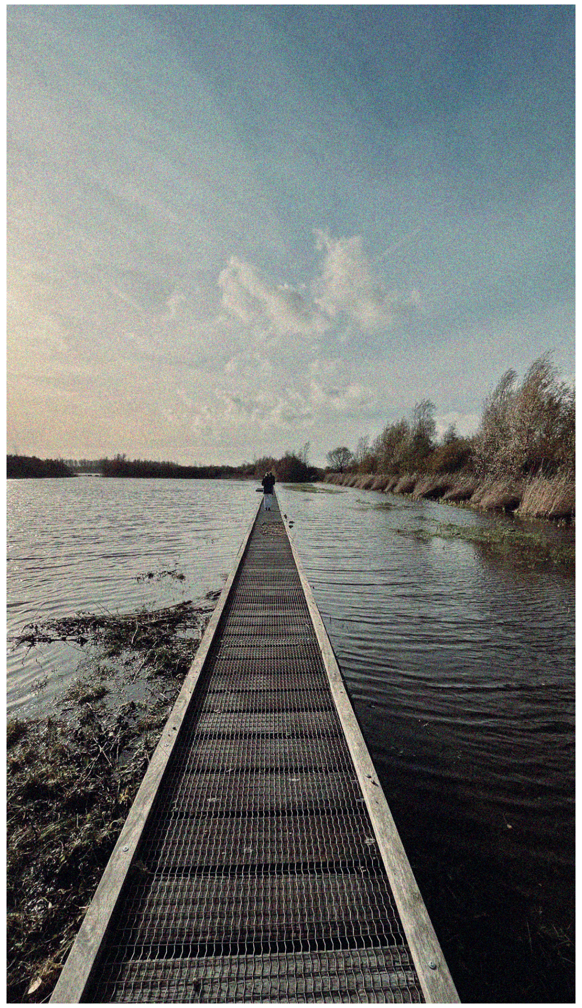


Fg. 29 site map 1:5000 (own work)

SITE VISIT

Fg. 30 picture of location (own work)

Fg. 31 picture of location (own work)



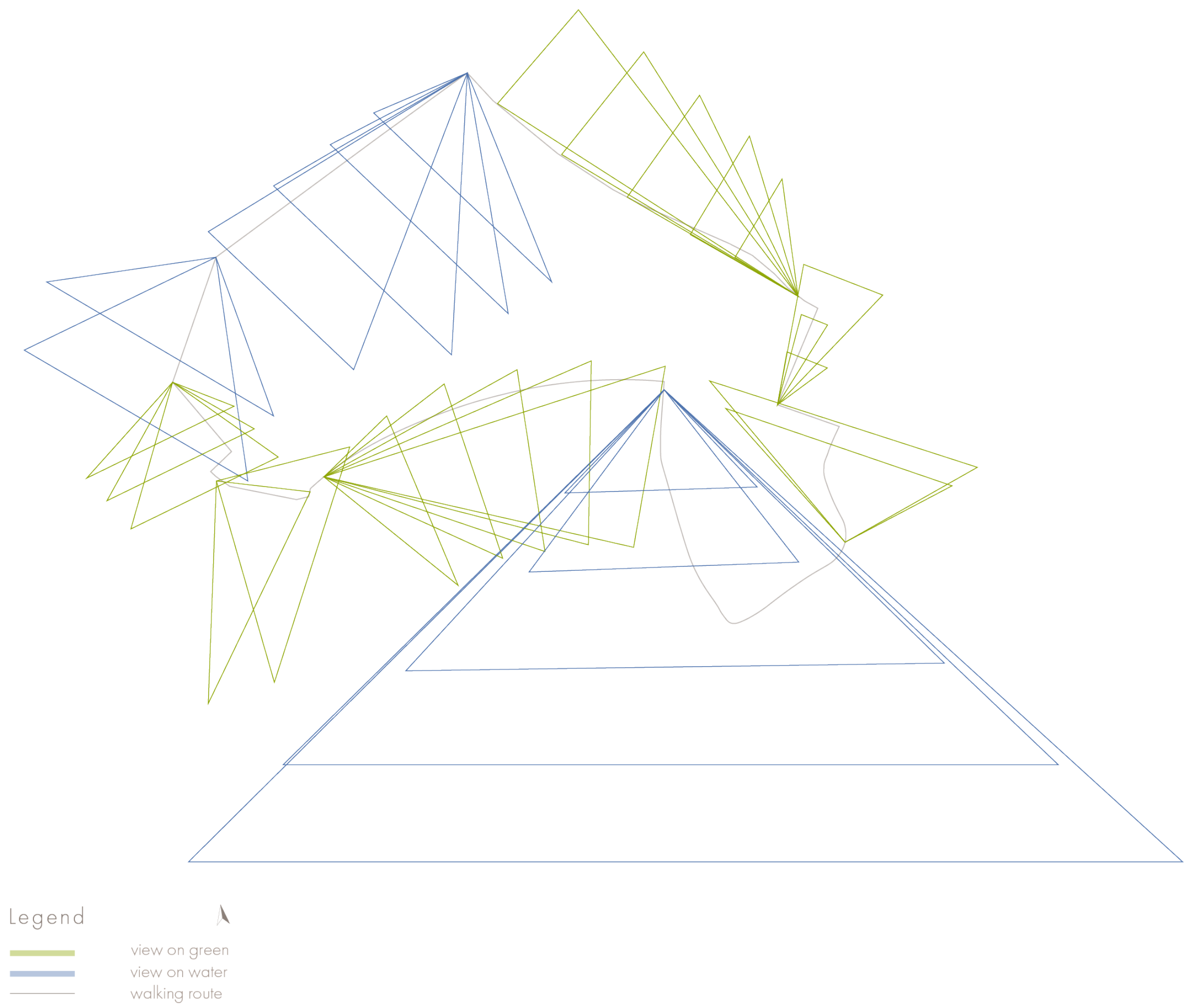
Fg. 32 picture of location (own work)

VIEW MAPPING

As highlighted earlier, understanding the sensory characteristics of a location is crucial in the design process. While the visual aspect is often the primary sense considered, view mapping extends beyond mere observation. Figure X illustrates a sensory map detailing the viewpoints along the walking route at Lauwerslake. Views can be obstructed by various elements, including natural features like tall trees or bushes, changes in the landscape such as mountains, and man-made structures like dikes or buildings. These obstructions result in a mix of broad and narrow views along the walking route, evident in Figure X through varying line densities.

The colors of the lines indicate the predominant element within a specific viewpoint, revealing that Lauwerslake's views are primarily composed of natural elements such as greenery and water. The broadest and least obstructed view in this area, highlighted in Figure X, is of the serene waters of Lauwerslake. This expansive view remains unobstructed by trees, dikes, or buildings.

For architects, designing buildings that align harmoniously with a location's natural viewpoints is vital. This approach not only shows respect for the existing landscape but also elevates the overall aesthetic and functional aspects of the structure. Integration with the surroundings transforms the building into an intrinsic part of the environment, providing inhabitants and onlookers with pleasing perspectives that enhance the inherent beauty of the location. Moreover, thoughtful design that considers attractive viewpoints fosters a symbiotic relationship between the built environment and the natural landscape, creating a sense of connection and tranquility for those who engage with the space. Architects, through aligning their designs with appealing viewpoints, play a pivotal role in cultivating a more sustainable and visually appealing urban or rural setting.



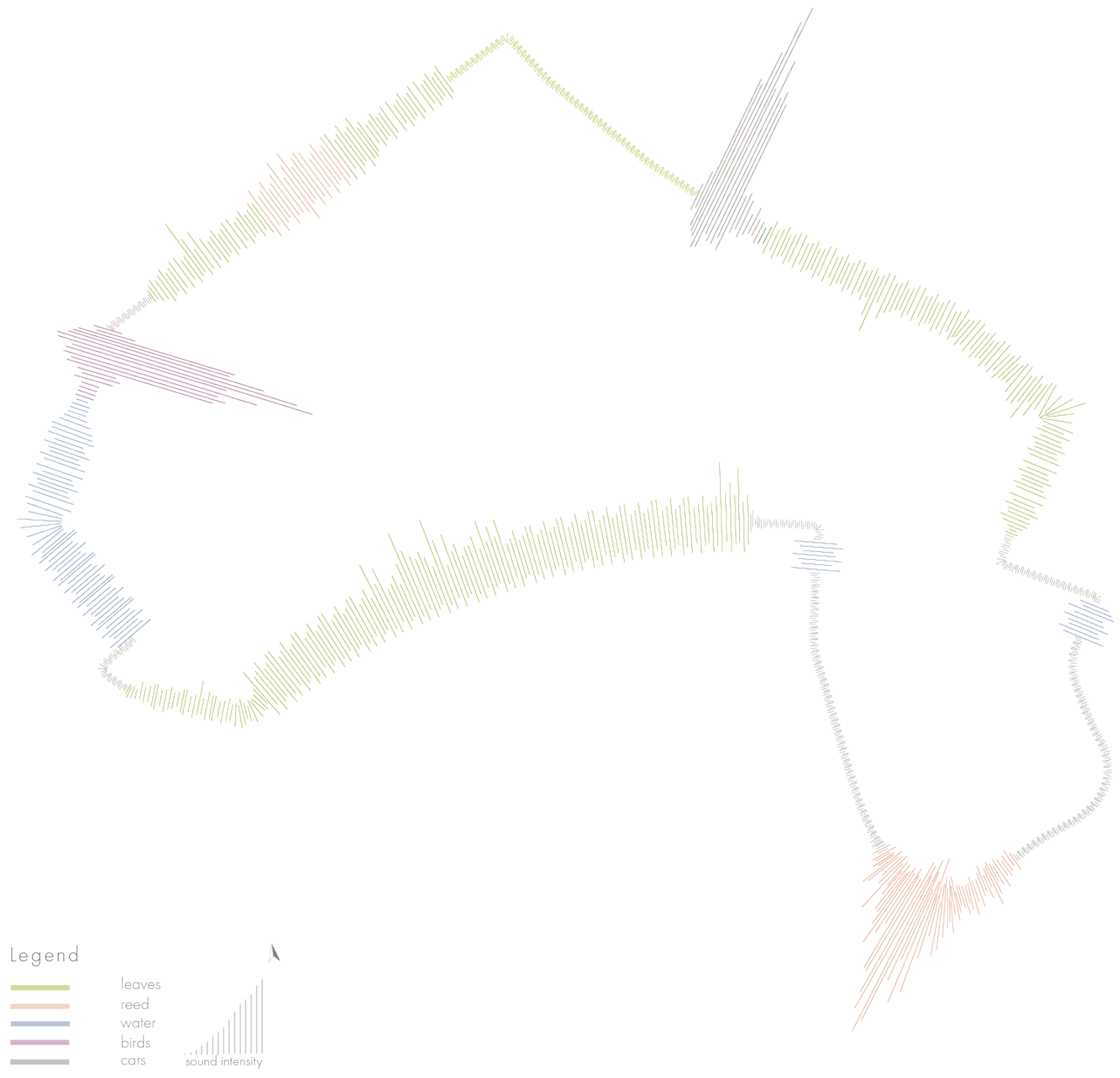
Fg. 33 sensory map of viewpoints on the design location (own work)

SOUND MAPPING

Discovering the sensory details of a place is vital for architects to craft a building that complements its environment. In the enchanting Lauwerslake area, one significant sensory aspect is the delightful soundscape that can be experienced.

To further explore the auditory landscape, an acoustic sensory map (figure X) was created to capture the intricate sounds along the walking route. The colours on the map signify the source of the sounds, with the length of the lines providing insights into the volume and intensity of each sound. These lines are strategically positioned along the walking route, offering a visual representation of the auditory experience in relation to the journey.

In Lauwersmeer, the primary auditory experiences unfold with the gentle rustling of leaves and reeds in the wind, accompanied by the melodic symphony of birds chirping and taking flight. The flooded regions add an extra dimension to the sound encounter, forming a rhythmic pattern as you move through these areas, creating a unique interplay between human footsteps and the harmonious sounds of nature.
This auditory composition not only defines the acoustic character of the Lauwerslake area but also provides architects with an opportunity to orchestrate the built environment to dance in harmony with the natural cadence of the surroundings.



Fg. 34 sensory map of acoustics on the design location (own work)

VISUALS
in the landscape of Groningen

LINES

The straight line of the walking dock sharply contrasts with the organic shapes of the surrounding nature. The dock's geometric precision creates a visual tension that emphasizes the interplay between human design and the untamed beauty of the landscape.

Fg. 35 walkway through the landscape (own work)

SHAPES

Mushrooms take on various shapes, contributing unique silhouettes to the natural scenery. From classic umbrella caps to delicate frills, each variety forms a captivating mosaic

Fg. 36 mushrooms at Lauwerslake (own work)

COLOUR

The Sea Buckthorn seeds, with their distinct orange shade, intricately color the landscape, resembling small pixels scattered amidst the lush green plants

Fg. 37Sea Buckthorn seeds at Lauwerslake (own work)

SOUNDS

in the landscape of Groningen

REED

Psithurism: a rustling or whispering sound, such as leaves in the wind, envelops Lauwerslake, a symphony amplified by the flourishing expanse of reeds.

Fg. 38 reed at Lauwerslake (own work)

BIRDS

Lauwerslake is a sanctuary for a diverse array of bird species, each contributing its unique song. By cherishing these habitats, their melodies will resonate eternally in the landscape.

Fg. 39 ducks flying away (own work)

WATER

The coast echoes with the movement of water. However, when human feet travel through the water, a grander symphony unfolds.

Fg. 40 walking through water (own work)

TOUCH
in the landscape of Groningen

WATER

A metal footpath seamlessly fades into the water, tempting the near-inevitability of touching its surface with your feet.

Fg. 41 Marc trying to not touch the water (own work)

REED

Lauwerslake is abundant with reed, yet harvesting it can prove more challenging than anticipated. As the reed sways with the wind, eluding my grasp, I extend myself in an effort to reach the stems.

Fg. 42 trying very hard to pick the reed (own work)

FLOWER

Engaging in the common activity of picking flowers provides an opportunity to seize a fragment of nature's beauty, creating cherished keepsakes.

Fg. 43 picking a fluffy flower (own work)

04.

THE CONCEPT

In this chapter, the concept and design principles of the project are explored in detail, offering insights into the programmatic elements, intended audience, spatial configuration, and material selections. Each space within the museum of emotions is meticulously defined, reflecting a distinct emotional narrative crafted through thoughtful use of materials such as cork, wood, and stone.

PROGRAM

The program of the design is a Museum of Emotions, a space that transcends conventional boundaries and immerses visitors in sensory and emotional experiences. The architectural program is designed to evoke different feelings and emotions, with each space offering a unique identity.

Upon entering, visitors are welcomed into the foyer, featuring a reception and cloakroom. This initial space sets the tone for the journey ahead, inviting guests to prepare for an exploration of their emotions.

The heart of the museum is the gallery, a sanctuary where art takes center stage. Here, visitors are encouraged to engage with the exhibits in silence, allowing the curated environment to evoke feelings of shelter, safety, and introspection.

Adjacent to the gallery is the café, a vibrant and robust space designed to foster a sense of activity and community, where visitors can gather, converse, and create noise, echoing the ambiance of a bustling and lively hub.

Supporting the primary spaces are the facility hubs, which include a kitchen, toilets, storage, meeting room, and back office.

The museum is situated in a park next to Lauwerslake, which will function as a haven for the artist-in-residence program, with the museum serving as the central point. Four small studios invite artists to reside for approximately three months, providing a tranquil environment for creative work. Once their artworks are completed, they will be displayed in the museum for visitors to enjoy.

While the artist-in-residence program creates a supportive ecosystem for artistic creation, the focus of this design project is on the museum itself. The museum aspires to be a place where both nature and humanity thrive together. By integrating artistic and sensory exploration, it aims to deepen the connection between visitors and the natural world.

Museum of Emotions	1226 m²
foyer	748 m²
reception & cloakroom	25 m²
gallery	149 m²
café	113 m²
facility hubs	108 m²
kitchen	22 m²
toilets	23 m²
storage	38 m²
meeting room	15 m²
back office	9 m²
basement with technical room & storage	926 m²

Fg. 44 collage of artist in residence studios (own work)

TARGET AUDIENCE

Nestled in the picturesque landscape of Lauwersoog, the Museum of Emotions and Artist in Residence project extends an invitation to a diverse audience spanning all age groups. Conceived as a harmonious blend of artistic expression and the untamed beauty of nature, this endeavor seeks to engage visitors in a sensory journey, stimulating not just their eyes but every facet of perception.

As a haven of immersive experiences, the museum caters to individuals of all ages, recognizing that each visitor will interpret and engage with the spaces in a unique way. Children may discover vibrant hues and playful sounds in the café, while adults may find solace in the subtle textures and tranquility of the gallery. Each space within the museum is curated to evoke a specific emotional response, creating an inclusive environment that transcends generational boundaries.

Artists are embraced as integral contributors to this vibrant program. The Artist in Residence program invites creators to draw inspiration from the natural wonders of Lauwersoog, capturing the essence of the landscape in their works. These artists will reside in small studios within the park, working for three months and contributing their completed pieces to the museum, enriching the sensory experiences offered to visitors.

Beyond human interactions, the project aspires to be a bridge connecting the human world with the wildlife that calls Lauwersoog home. The museum is designed to harmoniously coexist with the ecosystem, featuring reed-populated wetlands to promote biodiversity and sheltered nesting places for birds beneath the building's overhang. This thoughtful integration fosters a sense of interconnectedness between the built environment and the natural world.

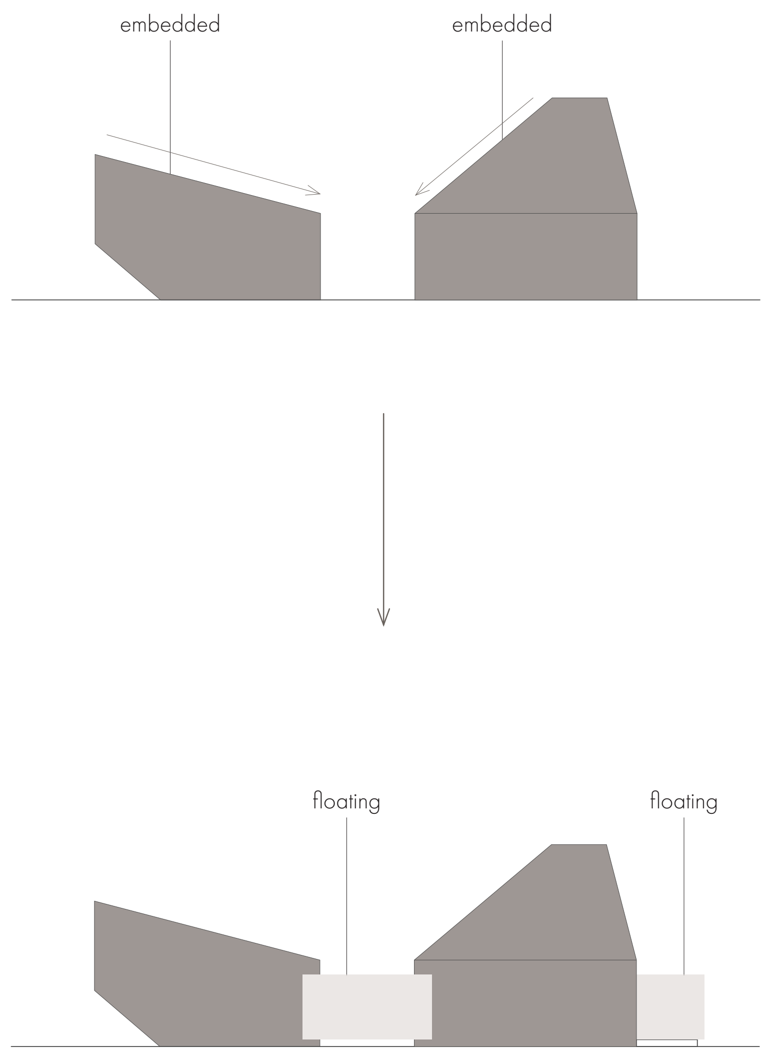
In essence, the Museum of Emotions and Artist in Residence project is a celebration of diversity – of age, artistic expression, and the vibrant ecosystem that surrounds us. It beckons visitors to step into a realm where the senses come alive, where art meets nature, and where the bridge between humans and wildlife is traversed with respect and awe.

Fg. 45 collage representing target group (own work)

THE CONCEPT

The Museum of Emotions embodies a striking architectural composition that harmonizes with its natural setting. At its core, two structures are meticulously embedded within the landscape, exuding an impression of timeless emergence and presence. Their gentle slopes converge towards each other, imparting a sense of solidity while suggesting fluid movement.

Surrounding these cores is a lightweight structure, seemingly suspended above the ground. This ethereal enclosure embraces the cores with its graceful lines, creating a visual and spatial dialogue between built form and nature. Together, these architectural elements form a cohesive design that invites exploration and contemplation within a serene and integrated environment.



Fg. 46 concept diagram (own work)

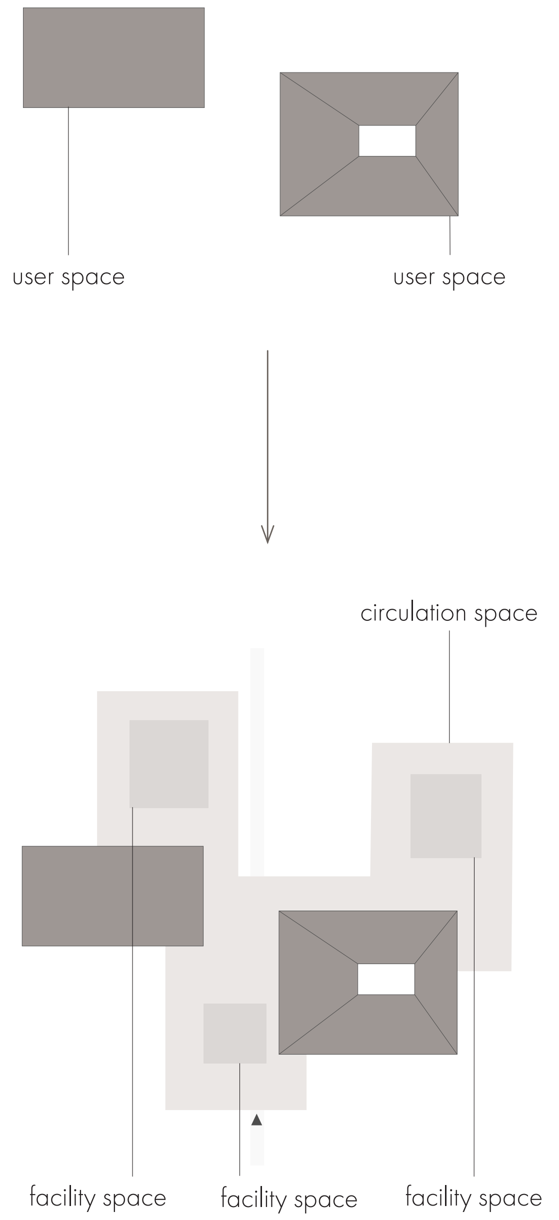
THE CONCEPT

Within the Museum of Emotions, each architectural element serves a distinct purpose in enriching the visitor experience. The two cores, nestled within the landscape, serve as the focal points of activity. The café core invites social interaction and culinary delights, while the gallery core immerses visitors in artistic contemplation.

Connecting these cores is the floating structure, which functions as a circulation space where visitors can freely roam. It houses the entrance and foyer, welcoming guests into the museum experience.

Within this floating space, strategically located facility hubs provide essential amenities such as toilets, offices, and a kitchen, ensuring the seamless operation of the museum while maintaining the tranquil atmosphere of the cores.

Together, these spatial configurations and functions create a dynamic yet harmonious environment that invites exploration and contemplation.



Fg. 47 concept diagram (own work)

DEFINING THE SPACES

For the design of this museum, three distinct spaces have been created, each evoking a different emotion or feeling through their unique architectural features and material choices.

CAFE

The first core of the museum is the café, characterized by a rock-like and robust atmosphere. This space is designed with large split-face travertine stones for both the interior and exterior, giving it a rugged, cavernous appearance.

The café embodies a sense of hustle and bustle, where noise and social interaction are encouraged. The form of the space is reminiscent of a cave emerging from the landscape, with thickened walls that enhance the feeling of solidity and shelter. This design choice creates a haven of activity: an inviting environment for visitors to gather, converse, and feel the energetic pulse of the museum.

GALLERY

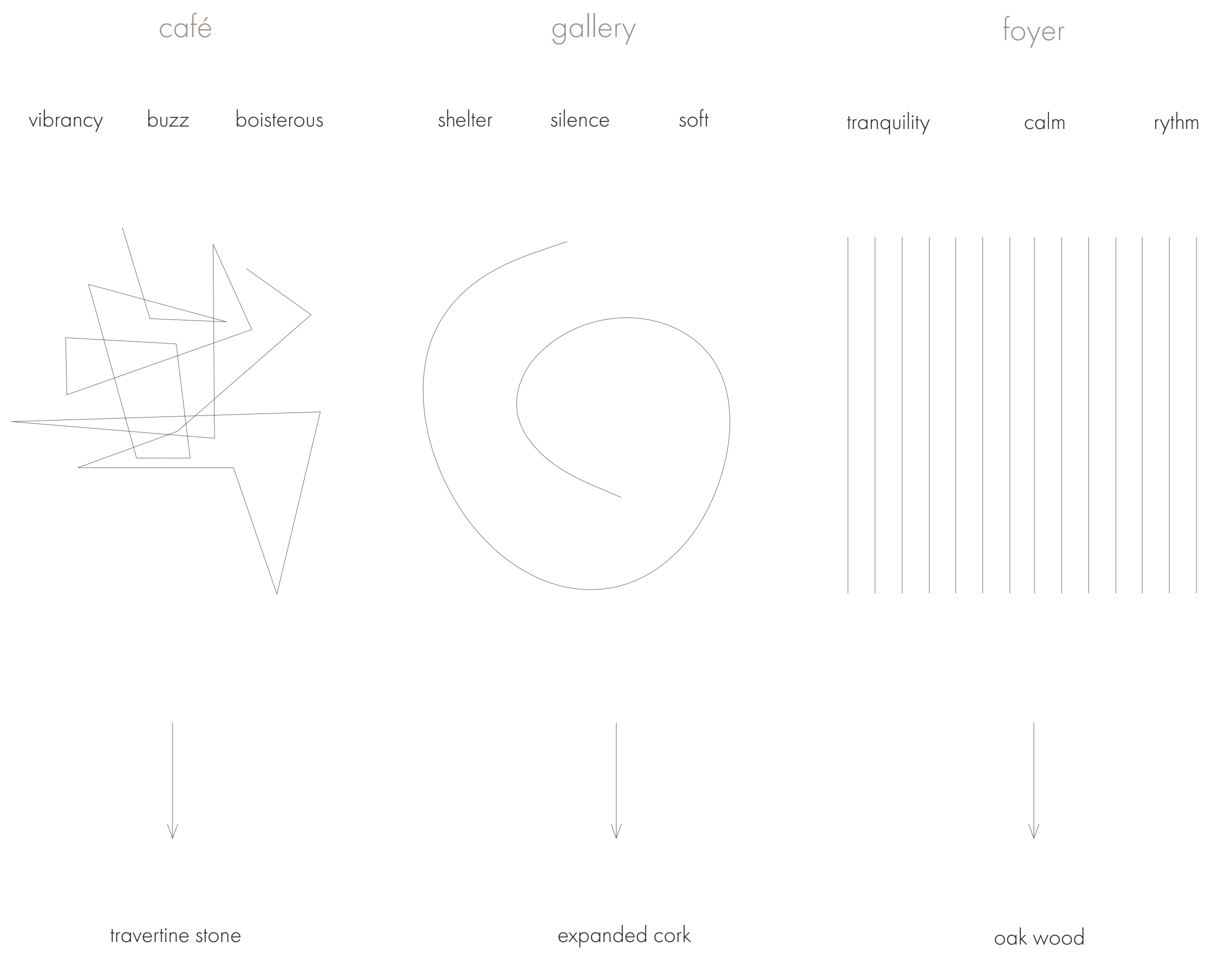
The second core is the gallery, where the focus shifts to art and the emotions it evokes. This space is constructed with expanded cork, chosen for its acoustic properties and its ability to create a sense of enclosure and safety. The gallery tapers to a point, reinforcing the feeling of protection and intimacy. A skylight at the pinnacle allows natural light to illuminate the art, without providing views to the outside, directing all attention to the artworks.

The gallery demands silence, fostering a serene and contemplative atmosphere. The thick walls of cork not only enhance acoustic comfort but also emphasize the sense of seclusion and concentration on the art within.

FOYER

Connecting these two cores is a volume crafted from oak wood, symbolizing a tranquil forest. The verticality of the oak façade represents trees, with a central feeling of peace and calm. This space serves as a neutral zone where visitors can walk quietly, engage in soft conversation, and where artists can find a serene place to work. This volume also acts as a transitional space between the interior and exterior, featuring numerous operable windows that create a strong connection with the outdoor environment. The entrance and foyer are part of this volume, inviting natural light and air to flow through, enhancing the sense of openness and relaxation.

Finally, the facility spaces will be clad in a neutral-toned felt, ensuring they seamlessly blend into the museum's overall design.

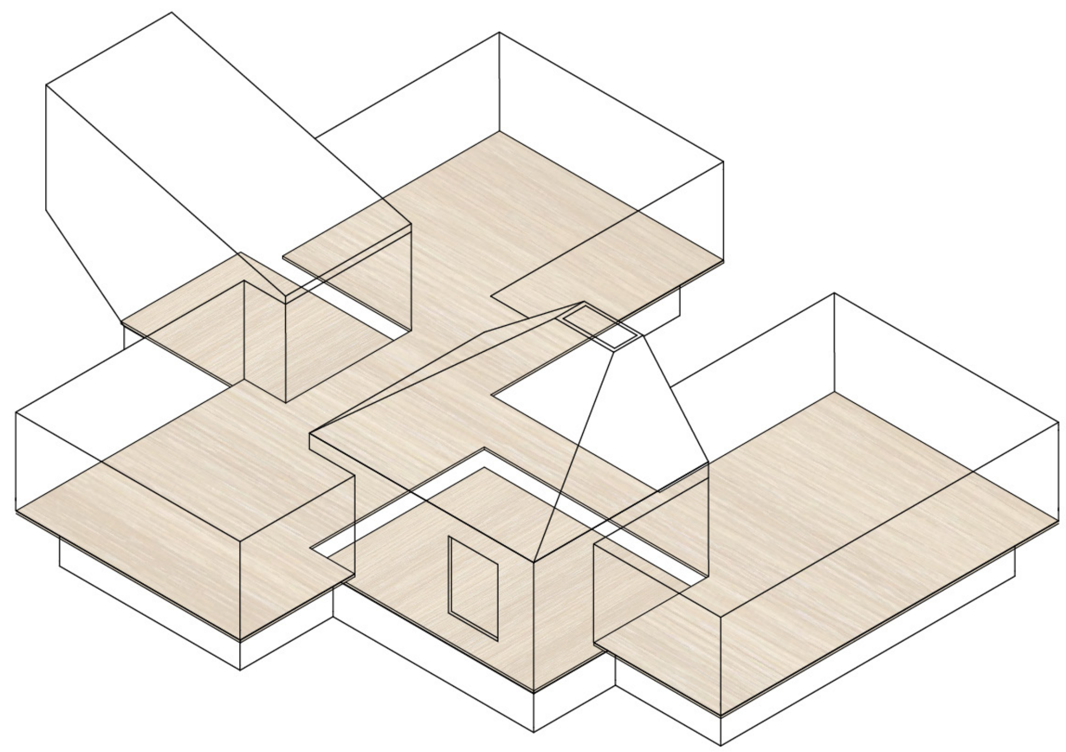


FLOORING

The floor is a fundamental part of the building that humans almost always touch. While the choice of interior, exterior, and furniture can vary, touching the floor is inevitable.

Despite the varied emotional experiences and material applications in each space, the entire museum is unified by a continuous oak wood floor, varying in grain direction. The choice of oak for the flooring is deliberate, as it is a calm and neutral material that visitors constantly interact with. This consistency in flooring ensures a cohesive experience as visitors slowly walk through the museum.

In summary, the Museum of Emotions uses distinct materials and architectural forms to sculpt unique sensory and emotional experiences within its core spaces, each meticulously designed to evoke specific feelings in visitors. The continuous oak wood floor plays a crucial role in creating a unified and neutral experience, seamlessly tying together the various emotional narratives within the museum.



Fg. 48 diagram showing flooring (own work)

TRAVERTINE STONE

Travertine is a natural stone from the limestone family, formed by the precipitation of calcium carbonate in mineral springs, particularly hot springs (The Editors of Encyclopaedia Britannica, 1998b). It is renowned for its marble-like texture and is available in various colors, with beige being among the most popular. Split-face travertine refers to travertine that has been split along its natural grain, creating a rough, textured surface that enhances its natural beauty.

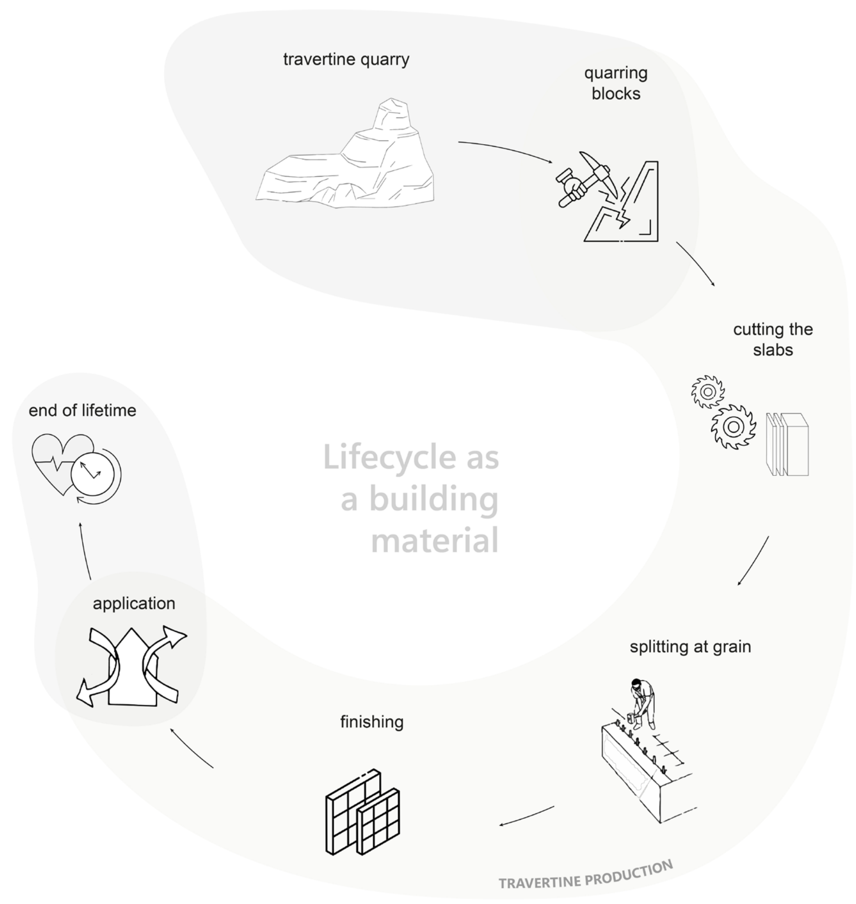
Beige travertine boasts a warm, neutral tone that complements many design styles. Its surface often features natural holes and troughs, giving it a rustic and timeless appeal. Travertine is durable and suitable for both interior and exterior applications, including countertops, flooring, and cladding.

The production process of split-face travertine stones begins with quarrying, where travertine is extracted from quarries often located near abundant natural springs (Toplu, n.d.). Large blocks of travertine are cut from the earth using diamond wire saws or chainsaws. These blocks are then transported to a processing facility, where they are cut into slabs using gang saws, which employ multiple blades to achieve the desired thickness.

To achieve the split-face texture, the travertine slabs are split along their natural grain, either manually or with a mechanical splitter. This process involves applying force to the stone until it splits, revealing a rough, uneven surface. The split slabs are then trimmed to the desired dimensions using a stone saw, ensuring uniform size and shape.

The split-face slabs may undergo additional finishing processes, such as washing and brushing, to remove any loose particles and enhance the natural texture of the stone. While not always necessary, sealing the travertine can help protect it from stains and moisture, particularly in high-traffic areas or places prone to spills. A penetrating sealer is typically applied to the stone's surface.

In summary, travertine, especially beige split-face travertine, is a versatile and durable material that brings a rustic, timeless appeal to various architectural and design applications. Its production involves careful extraction, cutting, splitting, trimming, finishing, and sometimes sealing, to ensure its natural beauty and longevity.



Fg. 49 production process of travertine (own work)

EXPANDED CORK

Cork is the bark of the cork oak (Quercus suber), a tree native to the Mediterranean and Iberian regions, including Portugal, Spain, southern France, Italy, and the Maghreb. This tree, which can grow crookedly to heights of 10 to 20 meters and live up to 200 years, has a light, open crown consisting of branches with long, oval-shaped, grey-green leaves. It thrives on granitic soils without limestone.

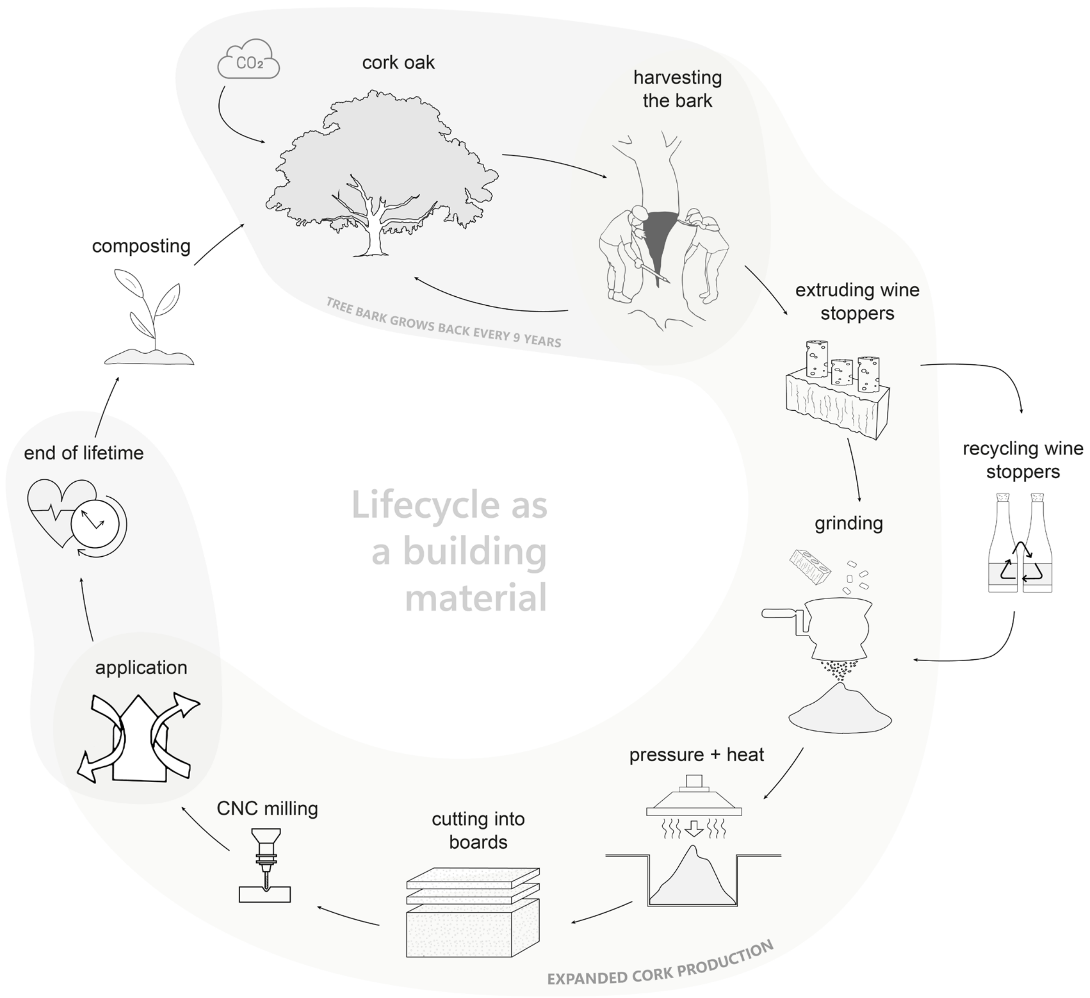
The cork bark is formed by the phelogen in the tree's outer layer and can be easily stripped without harming the tree. This process stimulates the tree to regenerate new phelogen, increasing its carbon consumption by three to five times. The continuous cell formation provides an insulating layer against high summer heat, protecting the tree from drying out and shielding it from external influences, including fires. The bark's resilience allows the tree to recover and regenerate its branches and leaves even after severe damage.

Cork harvesting is sustainable, as it involves removing the thick outer bark without killing the tree. Each cork oak can be harvested every nine to twelve years, up to 15 times over its lifespan. This environmentally friendly practice boosts the tree's carbon consumption significantly.

The harvested bark undergoes boiling, drying, and flattening before producing the first cork products, such as wine stoppers. Residual bark and recycled wine stoppers are ground into granules, with granule size adjusted for various applications. The granules undergo agglomeration using overheated water steam at temperatures between 300ºC and 370ºC, where over 90% of the energy consumed is biomass. The cork's natural resins, specifically suberin, bind the granules, resulting in 100% natural expanded cork, also known as black cork.

After molding, the cork products cure for a specific period, allowing the adhesive to set and the cork to harden, ensuring structural integrity. The final products are trimmed or cut to precise dimensions and finished for the desired texture or appearance.

In addition to expanded cork, agglomerated or pressed cork is commonly used in household products. This process is similar but uses a synthetic bonding agent (polyurethane) instead of heat, making it not 100% natural. Pressed cork combines natural cork with synthetic agents to bind the granules without utilizing the material's natural resin.



Fg. 50 lifecycle and production process of expanded cork (own work)

OAK WOOD

Oak wood is derived from oak trees, particularly species such as Quercus robur and Quercus petraea, which are native to Europe, North America, and parts of Asia (The Editors of Encyclopaedia Britannica, 1998a). These trees are known for their slow growth and dense grain, which contribute to the wood's strength and resilience.

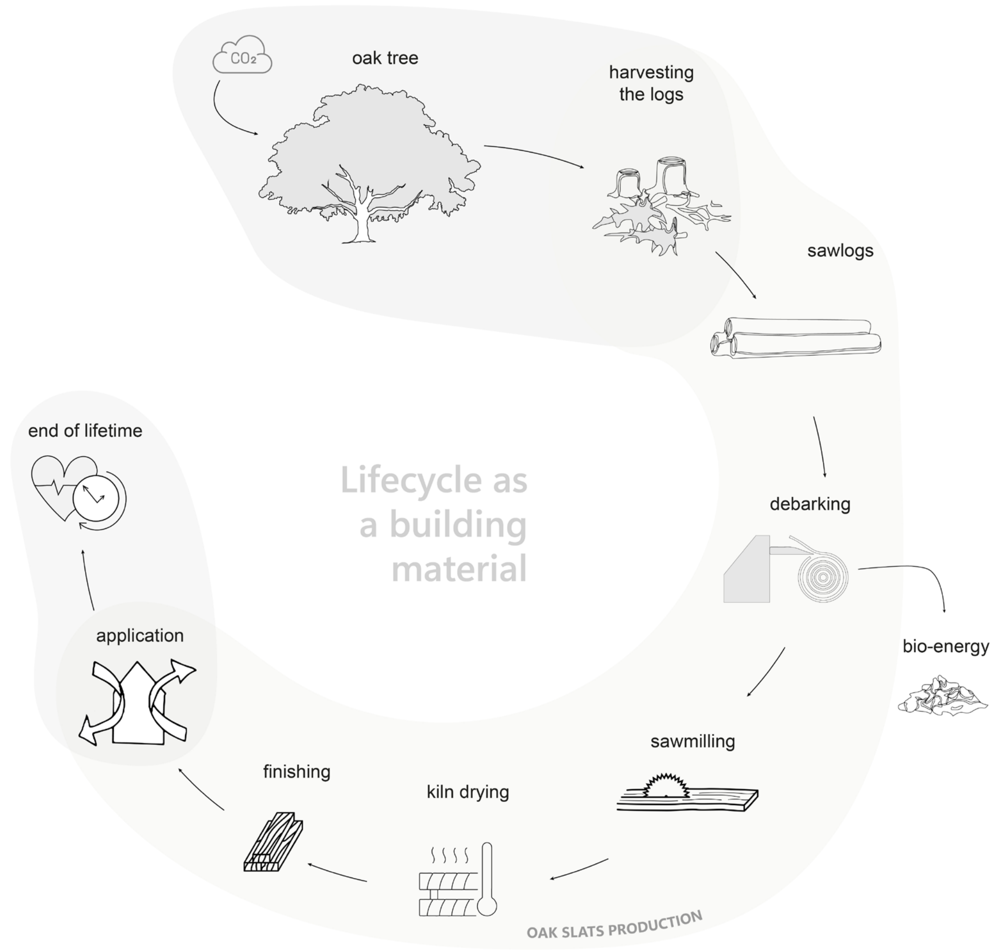
The production process of oak wooden facade slats begins with the careful selection of mature oak logs (Duffield Timber, 2024). These logs are harvested from managed forests to ensure minimal environmental impact. Once harvested, the logs are transported to sawmills where they undergo a series of processing steps.

First, the logs are debarked and sawn into rough planks or boards. These rough-sawn boards are then kiln-dried to reduce their moisture content, which stabilizes the wood and prevents warping or cracking. After drying, the boards are planed to achieve smooth and uniform surfaces.

Next, the oak boards are cut into slats of specific dimensions suitable for facade cladding. This cutting process can vary depending on the desired profile and dimensions of the slats. Some slats may be left with a natural edge or shaped to achieve a specific aesthetic effect.

Following cutting, the oak slats may undergo additional treatments depending on the desired finish and durability. This can include surface treatments such as brushing, sanding, or applying protective coatings like oils or stains to enhance the wood's natural color and grain while providing resistance to weathering and UV radiation.

Once prepared, the oak wooden facade slats are ready for installation. They are typically fixed horizontally or vertically onto the building's facade framework using appropriate fasteners.



Fg. 51 production process of travertine (own work)

05.

THE DESIGN

In this chapter, we delve into the intricate design details and architectural configurations that define the Museum of Emotions. Here, you will find a comprehensive exploration of the floor plans, elevations, facades, and intricate details that collectively shape the spatial experience within and around the museum.

Each drawing and diagram presented offers a window into the thoughtful considerations and creative decisions that have sculpted the museum's form and function. From spatial organization to material selection, this chapter unveils the synthesis of aesthetics, functionality, and sensory engagement that characterize the museum's design.

DESIGN LOCATION

The Museum of Emotions is situated within a serene parkland adjacent to the Lauwersmeer, a wetland area renowned for its biodiversity and natural beauty. This park is envisioned to be transformed into a bioswale park, designed to manage and retain excess water, thereby enhancing the ecological balance of the wetland surroundings. Strategically positioned on a small mound or "terp," the museum building is elevated to protect against potential flooding.

In planning the museum's location, careful consideration was given to the orientation with respect to the sun path and prevailing wind directions.

The architectural composition of the museum begins with a pathway that extends from the Strandweg, connecting to the adjacent parking area. This pathway symbolizes the sense of endlessness evoked by the vast landscape of Lauwersmeer. As visitors enter this pathway, they are gradually immersed in the natural surroundings, preparing them for the sensory and emotional experiences offered within the museum's interior. This intentional design approach not only invites exploration but also establishes a serene transition from the external environment into the curated spaces of the museum, fostering a profound connection with nature from the moment one arrives.

Fg. 52 site map 1:2500 (own work)

BIOSWALE PARK

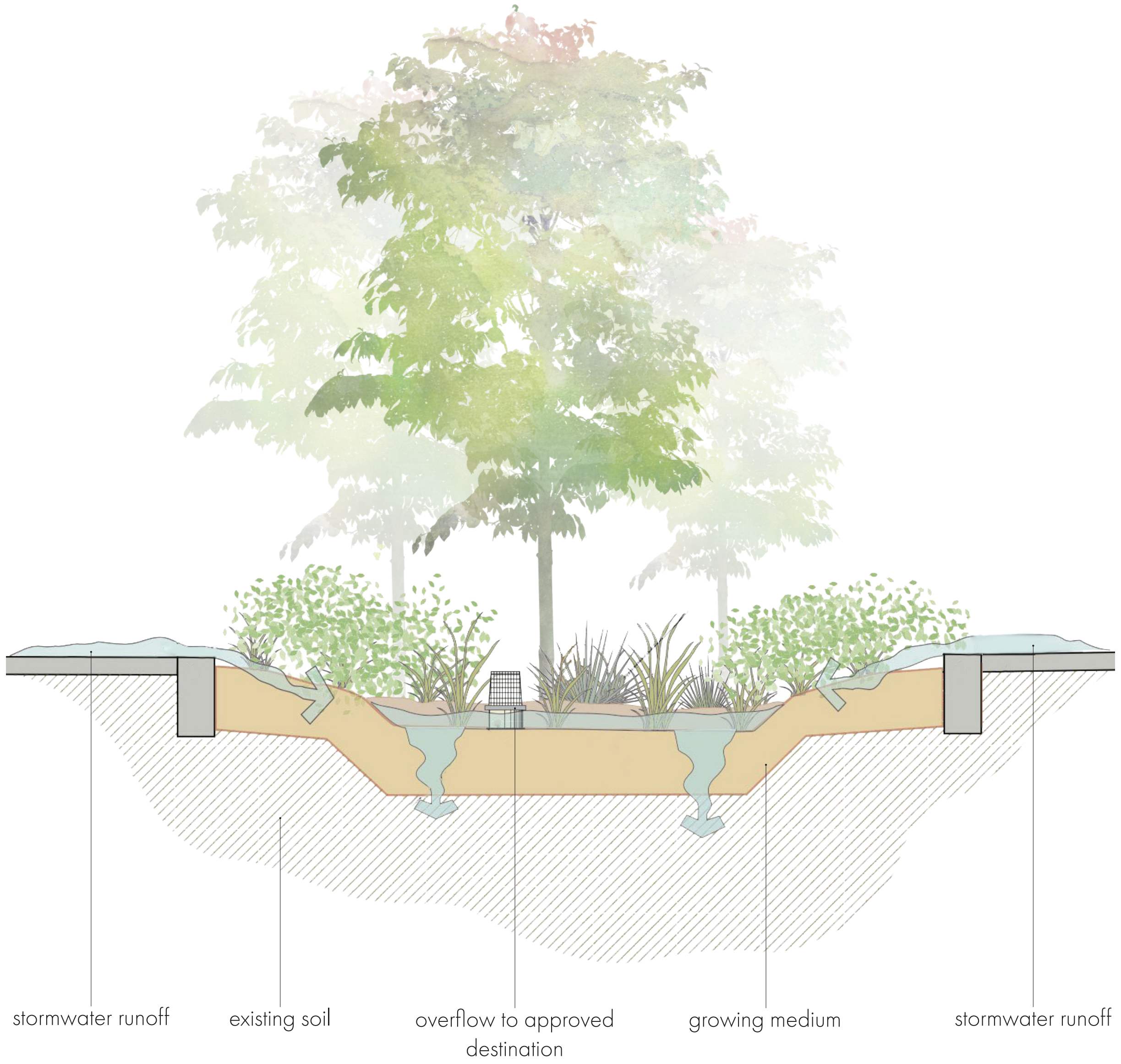
A bioswale park will be integrated into the wetland area around Lauwersmeer, where a museum will be placed on a mount (terp) in the middle of the park. The bioswale will temporarily store and manage excess surface water runoff, preventing flooding and erosion while maintaining the area's natural balance. By capturing water during heavy rainfalls and releasing it slowly, the bioswale will protect the surrounding environment and promote a healthier ecosystem.

The bioswale park is particularly suited to the Lauwersmeer area, which is a Natura-2000 protected site. By employing a bioswale, the park will help to safeguard the unique wetland habitats and the diverse species that reside there. This method aligns with the conservation objectives of Natura-2000, ensuring that the ecological integrity of the Lauwersmeer is preserved.

In addition to water management, the design aims to enhance biodiversity by increasing the reed population and providing sheltered nesting places for birds under the overhang of the building. These features will support local wildlife, including bird species that prefer ground-level, sheltered nesting sites. The increased reed population will offer habitats for various wetland species, contributing to the overall health of the ecosystem.

The bioswale park will also create a unique visitor experience, where the interplay of natural and built environments can be appreciated. The museum, situated on the terp, will offer panoramic views of the surrounding wetland and serve as a reminder of the importance of sustainable design practices.

Overall, the bioswale park will contribute to sustainable water management and environmental conservation, creating a harmonious relationship between the museum and its natural surroundings. The combination of flood control, biodiversity promotion, and aesthetic value makes this an exemplary model of how architecture and landscape design can work together to support and enhance natural ecosystems.



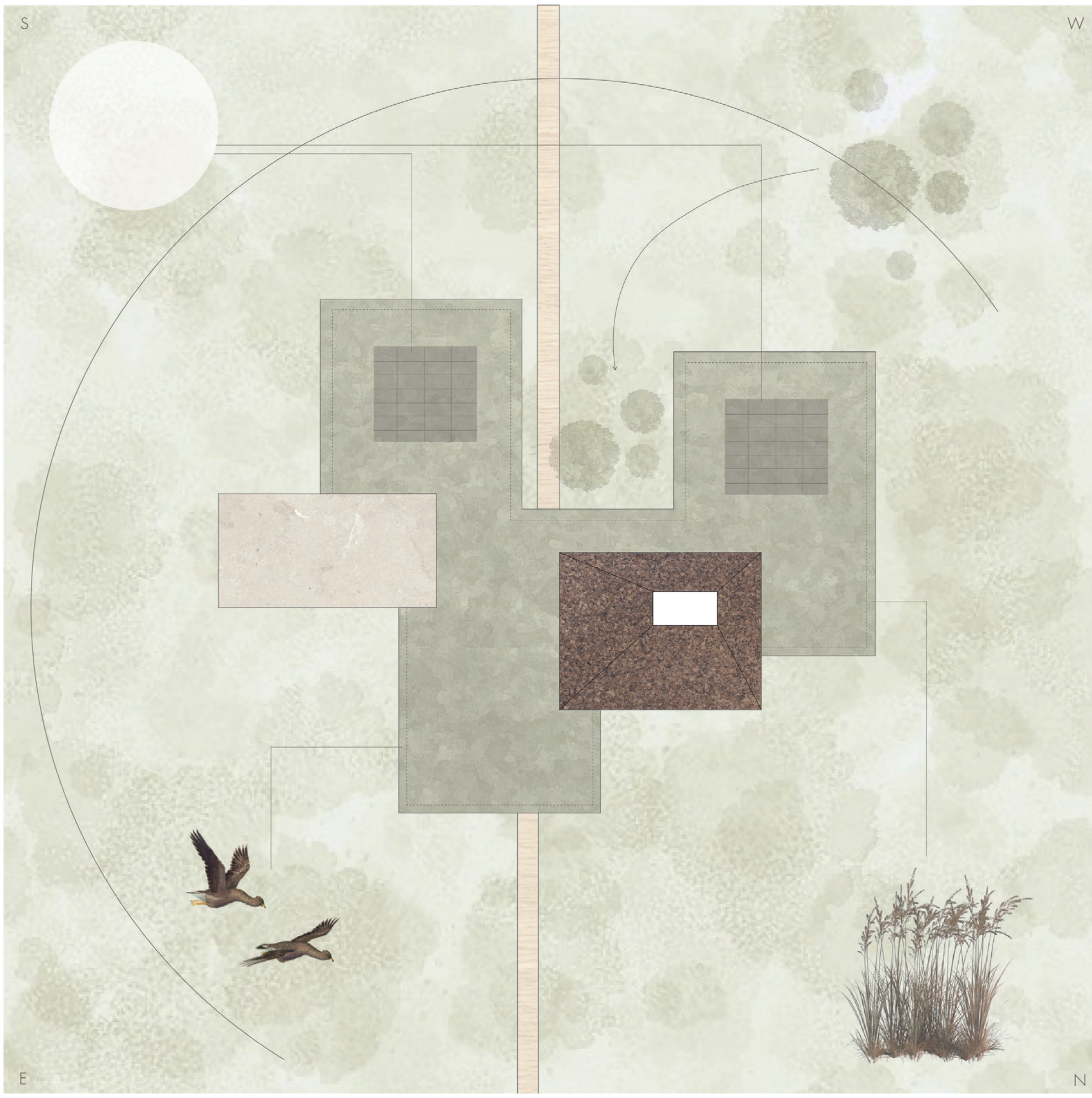
Fg. 53 schematic section of bioswale (own work)

INTEGRATING THE LANDSCAPE

The Museum of Emotions is not just a structure set in a park near Lauwersmeer; it is a seamless extension of its natural surroundings. Forming harmony with nature, the museum's design deliberately integrates the landscape into its form. The building's shape gracefully pulls in the contours of the park, creating a garden-like environment that extends beneath the overhang of the foyer. This sheltered space provides a haven for birds seeking nesting opportunities within the reeds, fostering biodiversity within the urban setting.

Central to the museum's ecological footprint is its sedum roof, a green expanse that crowns the foyer. This living roof serves a practical purpose by promoting biodiversity, improving thermal insulation and ensuring temporary water storage. Moreover, integrated solar panels on the roof deliver renewable energy from the sun, powering the museum with sustainable electricity and further reducing its environmental impact.

The museum's commitment to sustainability is evident in its design, from the integration of natural elements to the incorporation of renewable energy sources.



Fg. 54 roof view in landscape (own work)

Fg. 55 north-east facade 1:100 (scaled)

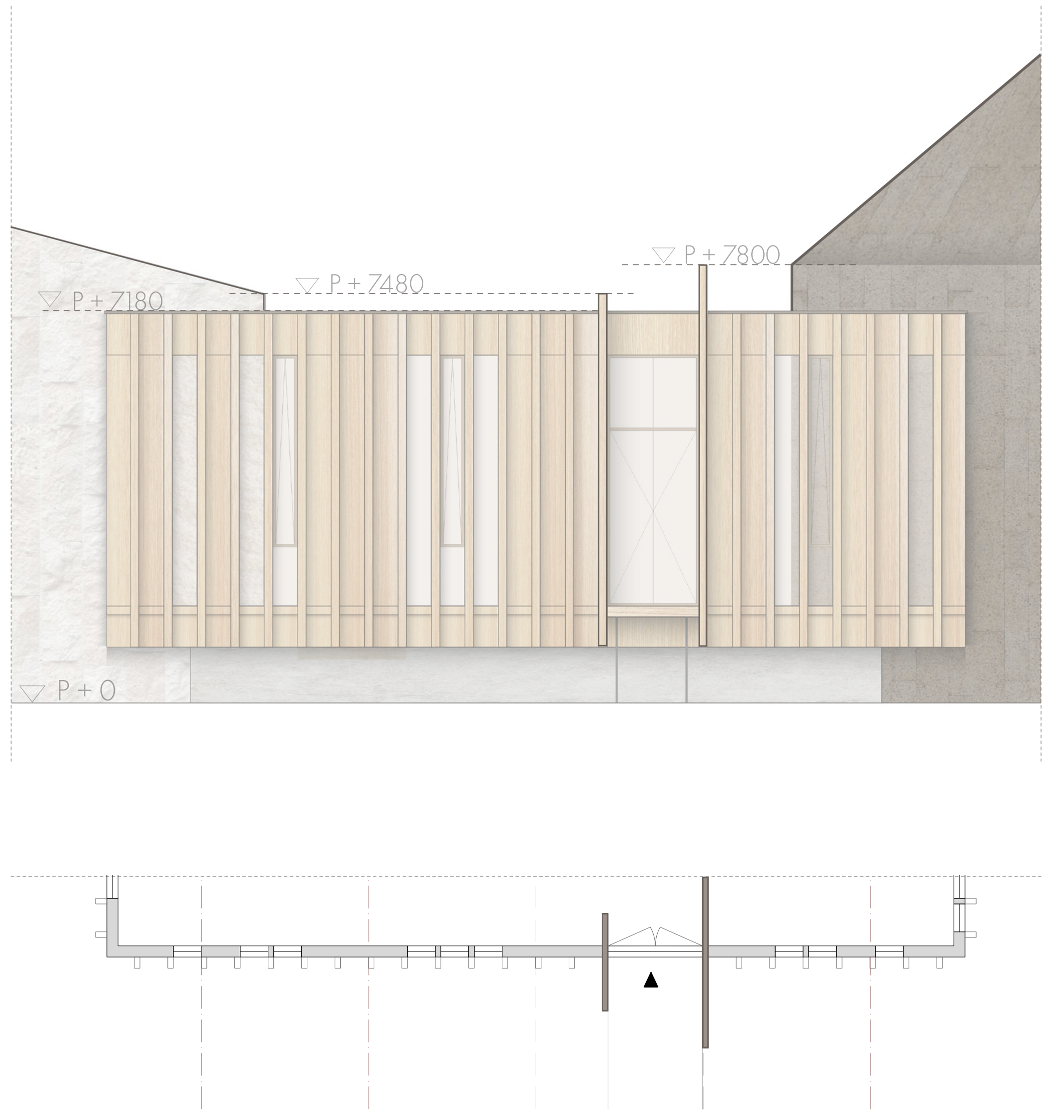
Fg. 56 south-west facade 1:100 (scaled)

SYNERGY IN COMPOSITION

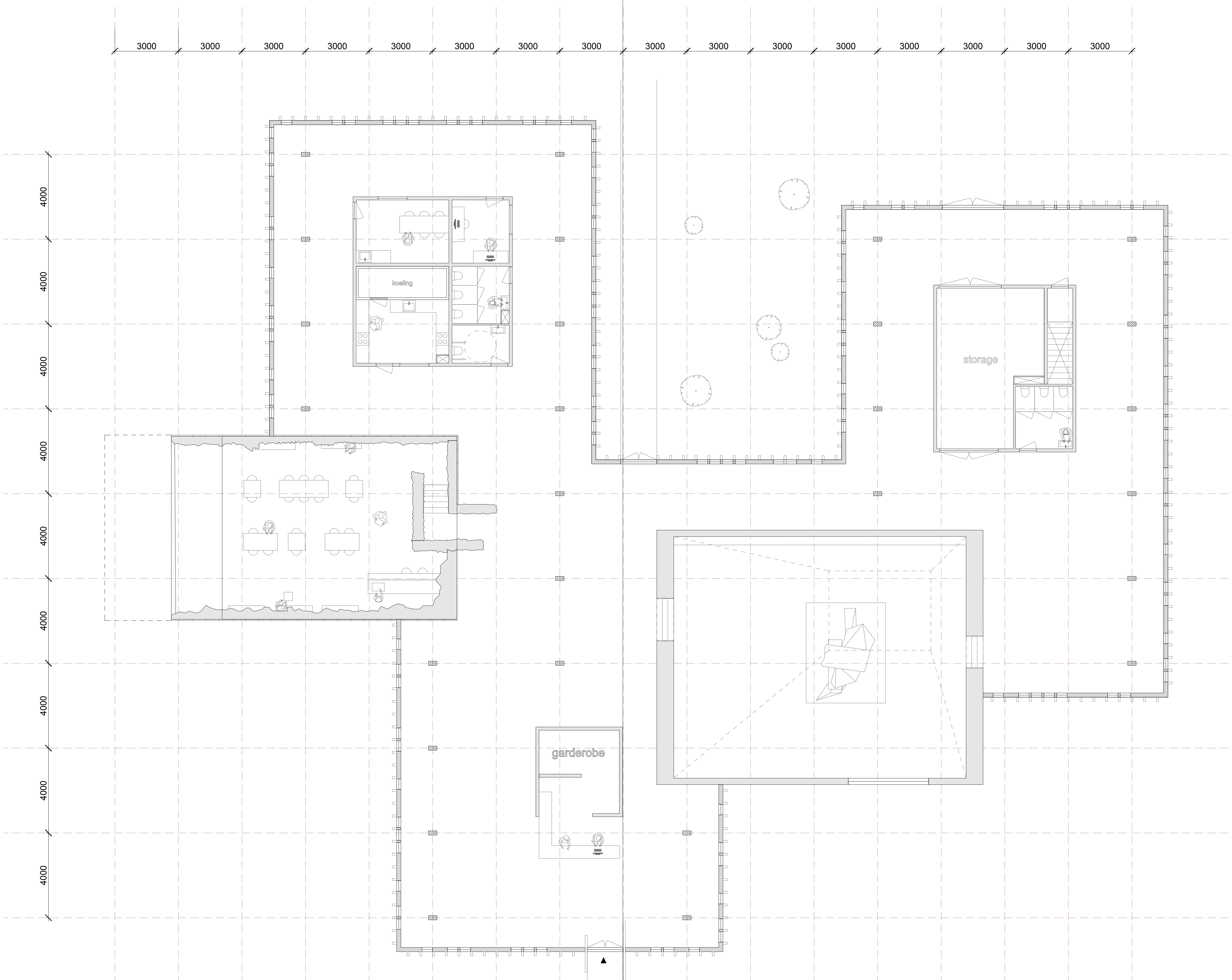
Creating synergy within the Museum of Emotions goes beyond sensory integration; it embraces the idea that a building should function like a well-tuned machine. Every element, from structure to materials, must work in harmony to create a unified experience. In designing a museum with distinct spaces and materials, achieving this synergy becomes essential. This can be realized through careful consideration of scale, proportions, structure, and overall composition.

The entrance serves as a key focal point for achieving compositional synergy. It is not just a door but a highlighted feature that draws visitors in. The entrance distinguishes itself from the main wooden structure through the use of elongated wooden slats. These slats rise above the roofline, creating a visual connection to the lowest points of the two cores, subtly varying in height to add dynamism and interest.

To foster a sense of guidance, a concept explored in the research, these wooden slats extend into the landscape, forming walls that lead visitors towards the museum. This continuity of design elements ensures that the entrance is not just an opening but a welcoming gesture that integrates seamlessly with both the exterior and interior environments. As visitors move inward, the slats continue their path, guiding them towards the reception area and reinforcing a cohesive and navigable journey throughout the museum.



Fg. 57 elevation fragment of front entrance



Fg. 58 floor plan 1:100 (scaled)

LAYER OF CURTAINS

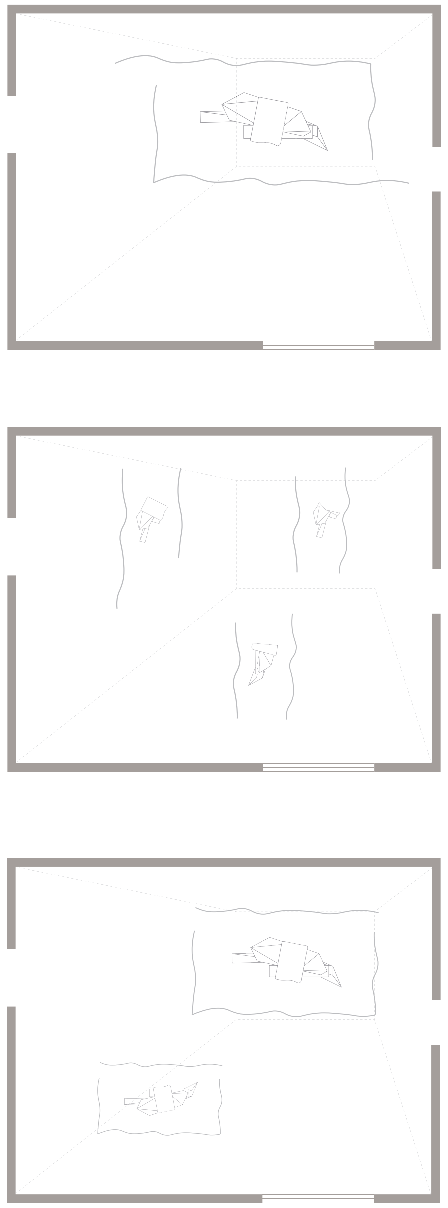
In the gallery, the curtains serve as the final layer in the narrative of materiality and composition, embodying a profound sense of intimacy. Made from a soft, white fabric, the curtains were carefully chosen based on tactile experiments conducted during the research phase, where they proved to be the most inviting to touch. These curtains invite users to engage with the space actively, offering a tactile and interactive experience.

The curtains allow users to participate in shaping their environment. They can be opened or closed as desired, letting individuals tailor their experience within the gallery. This interaction marks a point where the architect steps back, giving users the freedom to collaborate with the artist in creating unique sensations and spatial experiences.

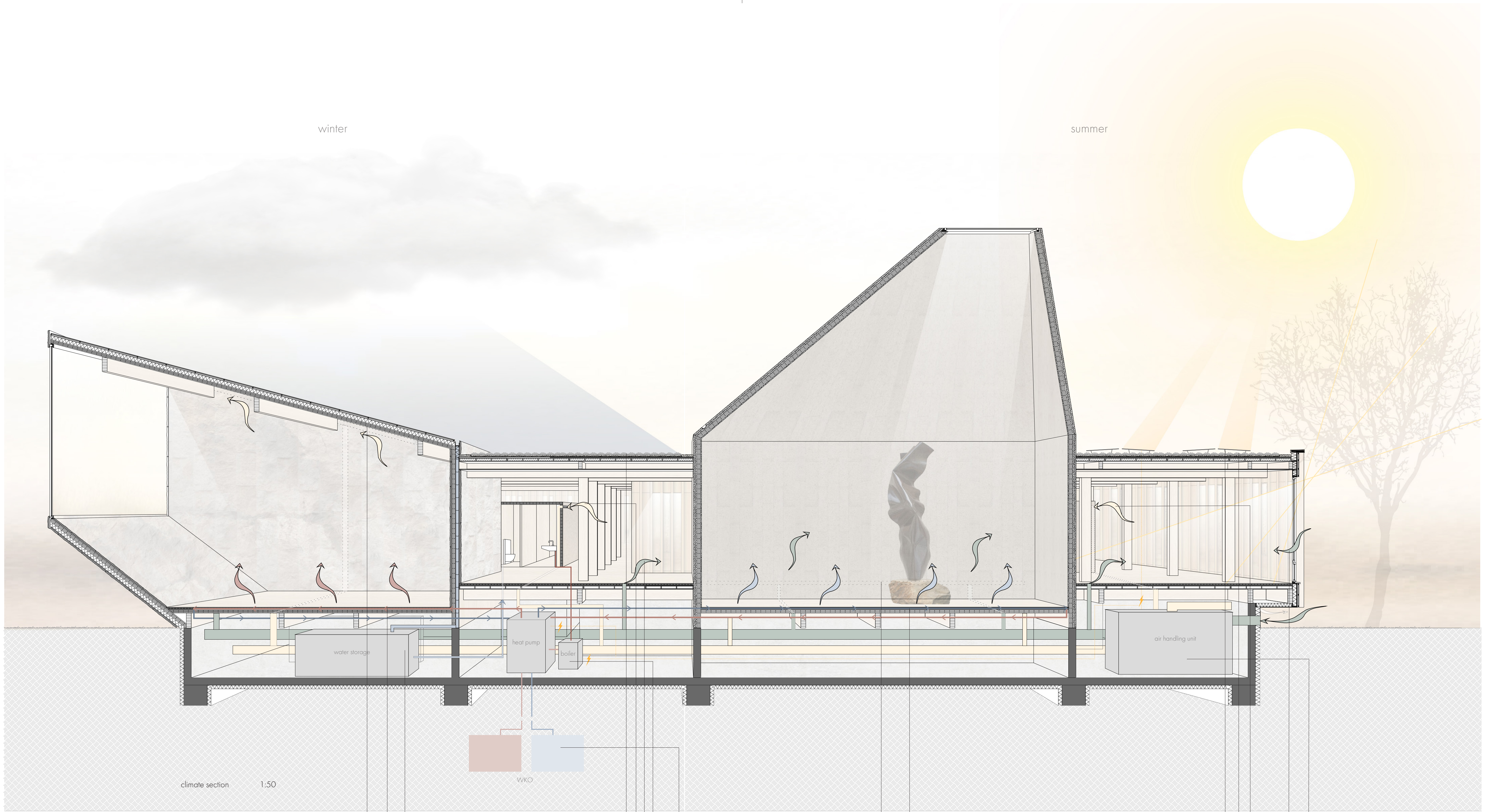
The curator of the art installation is afforded creative freedom with these curtains. They can be used to form smaller, intimate spaces within the gallery, adapting to the specific needs of the art on display. The versatility of the curtains allows for dynamic configurations, providing a responsive and evolving environment that complements the artwork.

The curtains are attached to a railing system integrated into the floor and suspended from anchor points in the ceiling. This setup enables the curtains to be hung at varying heights, following the contours of the gallery space. By adjusting the curtains, the incoming light can be modulated to suit different situations, enhancing the sensory and emotional experience of the gallery.

Through their tactile quality and adaptability, the curtains enrich the gallery environment, fostering a sense of intimacy and engagement that resonates with the overarching theme of sensory synergy in the museum.



Fg. 59 diagram of curtain options



air exhaust through core walls

underfloor heating powered by the heat pump

rainwater storage for toilet flushing

sedum roof for rainwater drainage delay

air exhaust through facility hub

air supply through floor

boiler to further heat tap water

air supply through core walls

underfloor cooling powered by the heat pump

thermal energy storage system (WKO) with a ground source heat pump

roof solar panels to power technical installations

sedum roof for solar panel cooling

air exhaust through facility hub

openable windows for natural ventilation

air handling unit for mechanical ventilation

Fg. 60 climate section 1:50 (scaled)

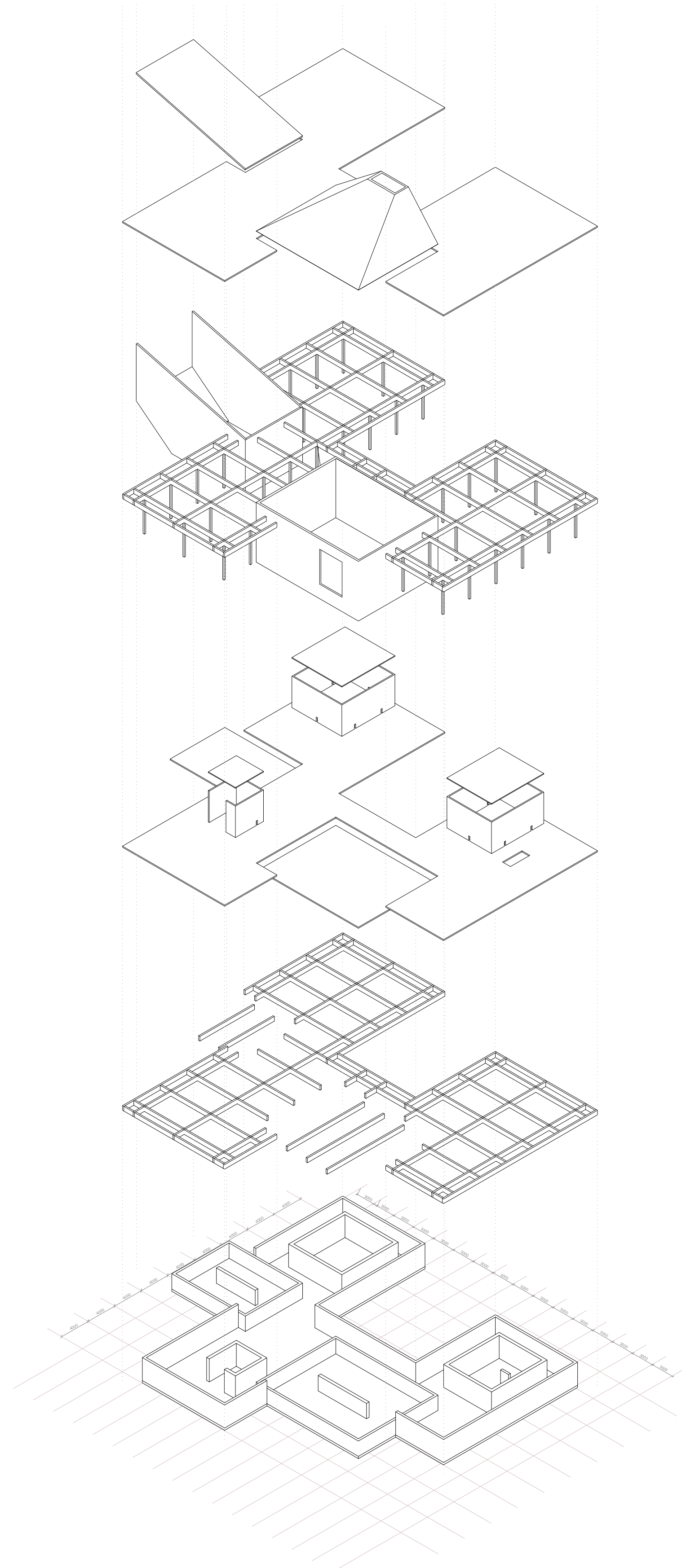
STRUCTURAL DESIGN

The structural framework of the building consists of a concrete foundation and basement. On top of these rest two cores made of CLT (Cross-Laminated Timber) and a framework of oak wooden columns and glulam beams.

The structural design is also a key element in achieving synergy within the building. Although the cores are structured differently from the neutral space, using CLT walls versus a timber framework, the entire structure finds harmony in the consistent use of timber. This cohesive approach ensures that the building works as a machine, with all elements integrated to maintain stability.

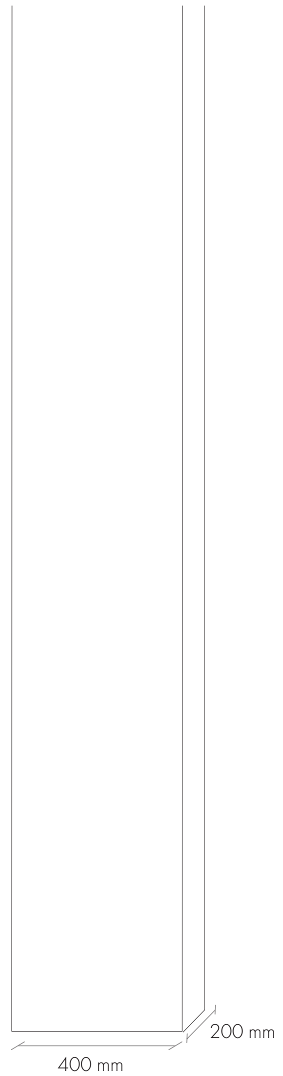
By integrating and securing the timber frame structure with the CLT cores, a stable construction is achieved. Within the timber frame are the facility hubs, each with its own structural support.

The floors and roofs consist of Kerto Ripa boxes or CLT, allowing the structure to operate as a unified timber assembly, combining different wooden elements for strength and stability. This synergy in structural design ensures that the various components work together seamlessly, enhancing the overall integrity and functionality of the building.

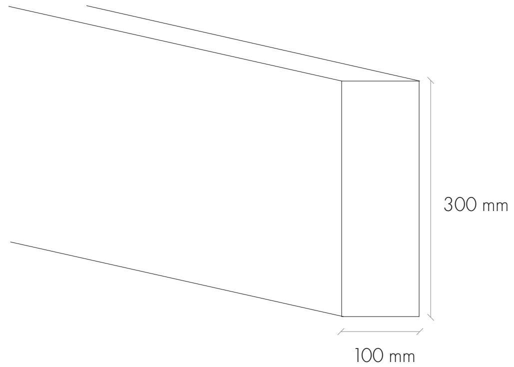


Fg. 61 exploded axonometric view of load-bearing structure

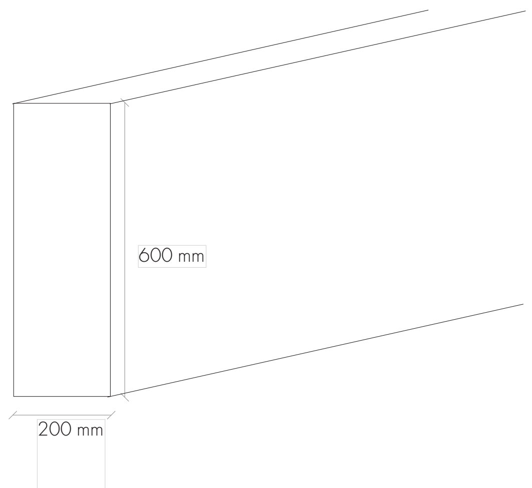
STRUCTURAL OVERVIEW



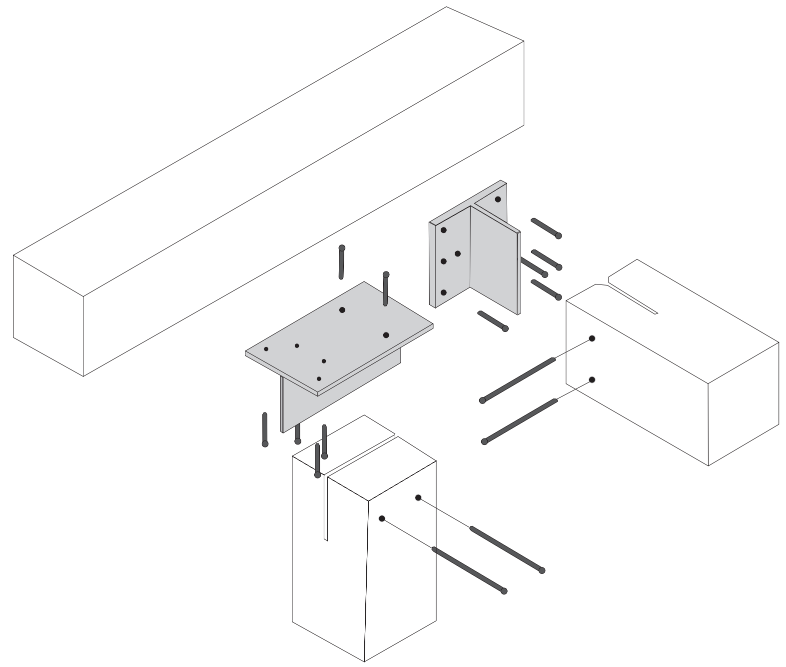
oak column dimensions

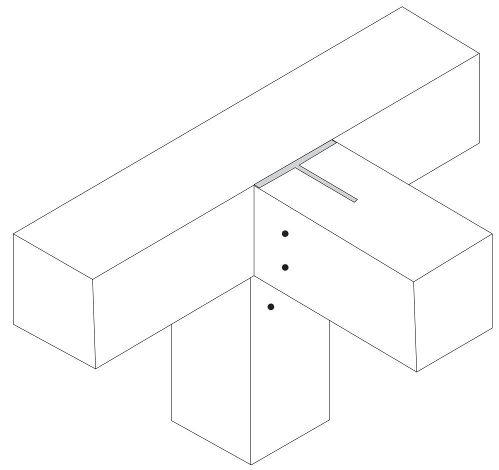


secondary gluelam beam dimensions

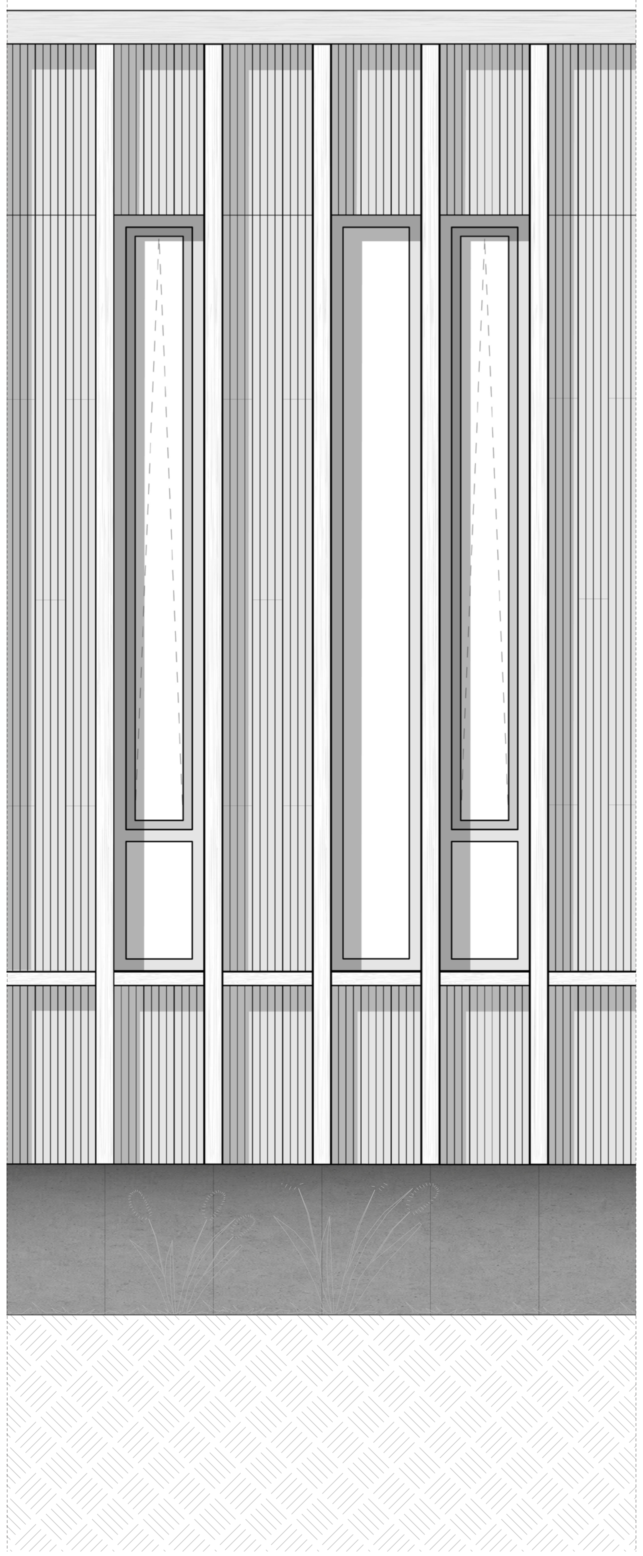


primary glulam beam dimensions

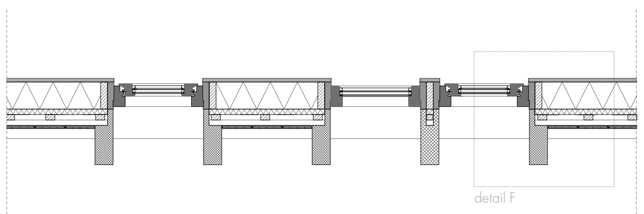




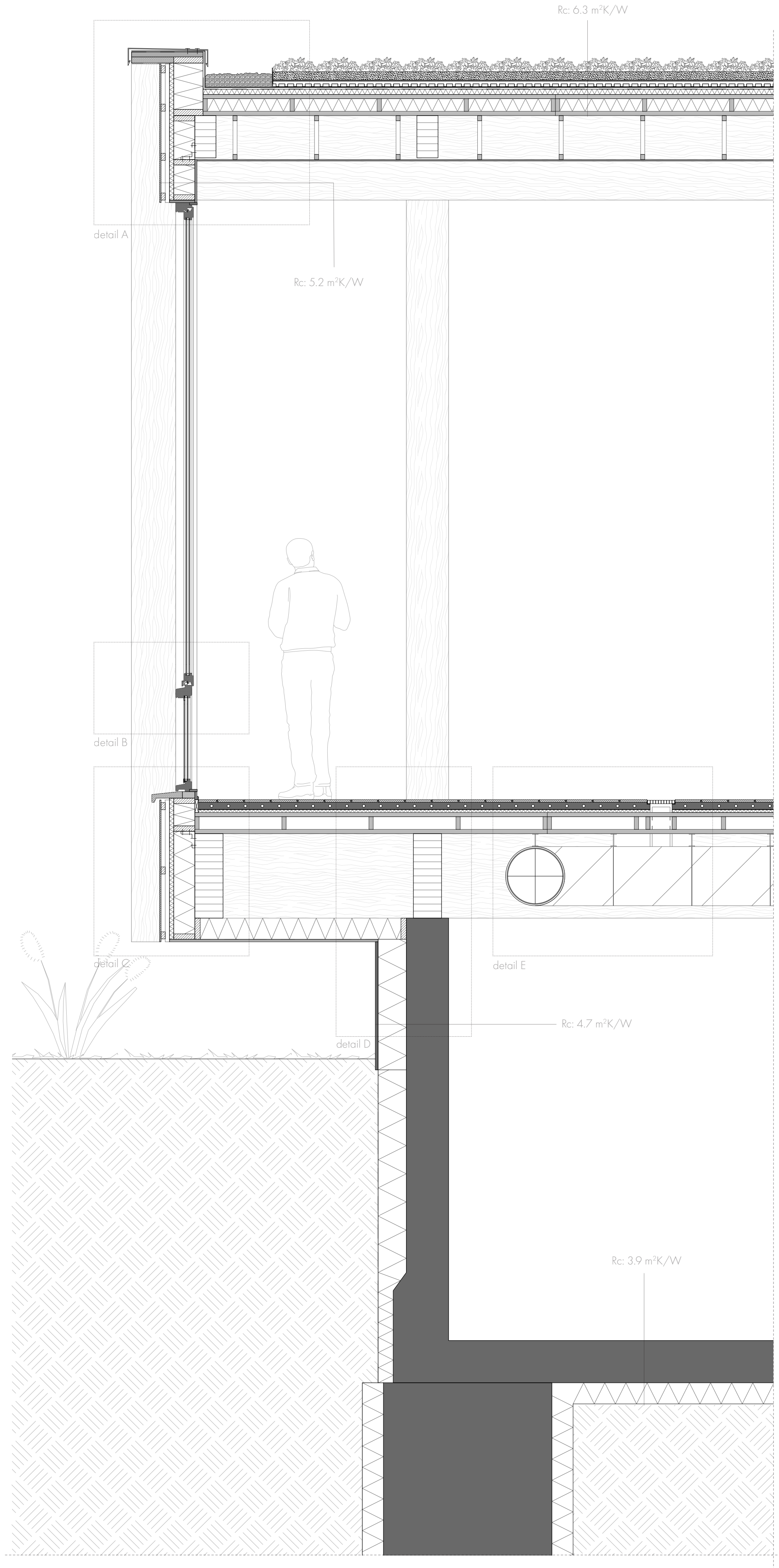
connection detail



facade fragment 1:20

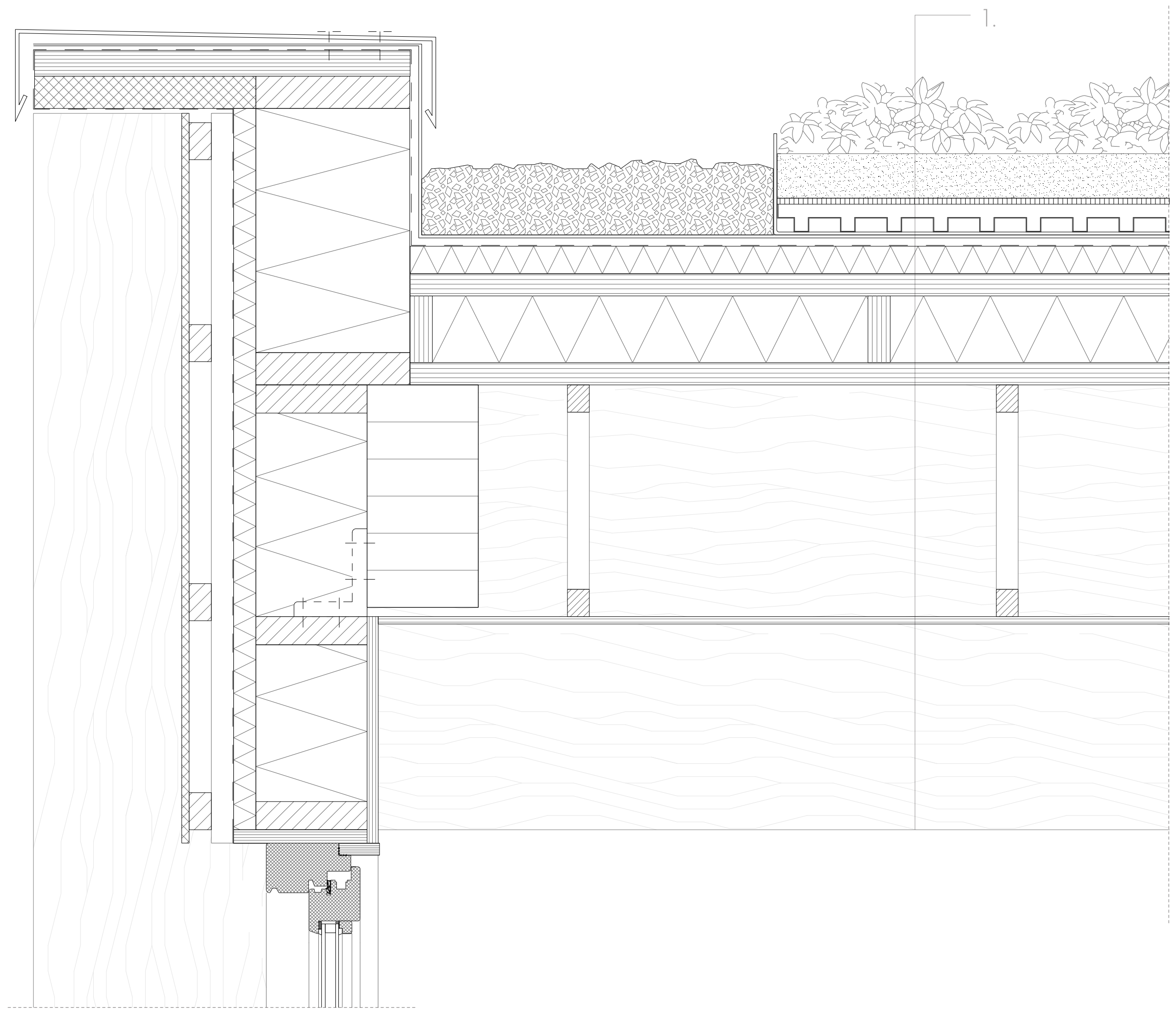


horizontal section 1:20



vertical section 1:20

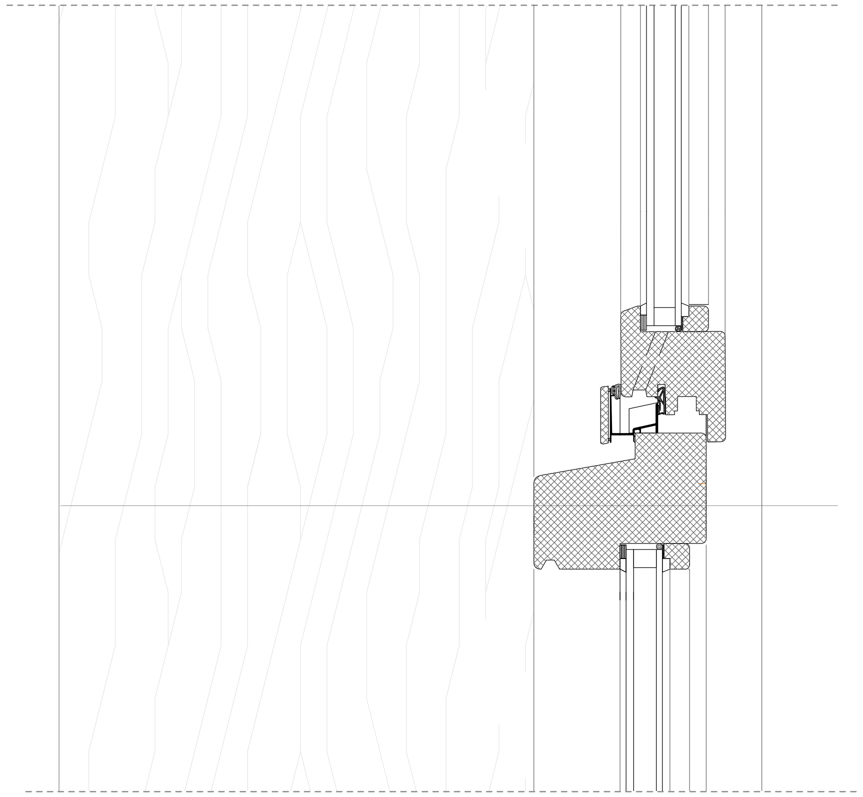
ROOF DETAIL



detail A 1:5 (scaled to 1:10)

1.	sedum vegetation	50 - 150 mm
	substrate layer	60 mm
	drainage layer	80 mm
	root barrier	> 20 mm
	impermeable layer	> 2 mm
	sloped thermal insulation	+/- 35 mm
	kerto ripa roof box with isulation	150 mm
	glulam beam	600 mm
	ceiling anchor	300 mm
	wooden ceiling board	10 mm

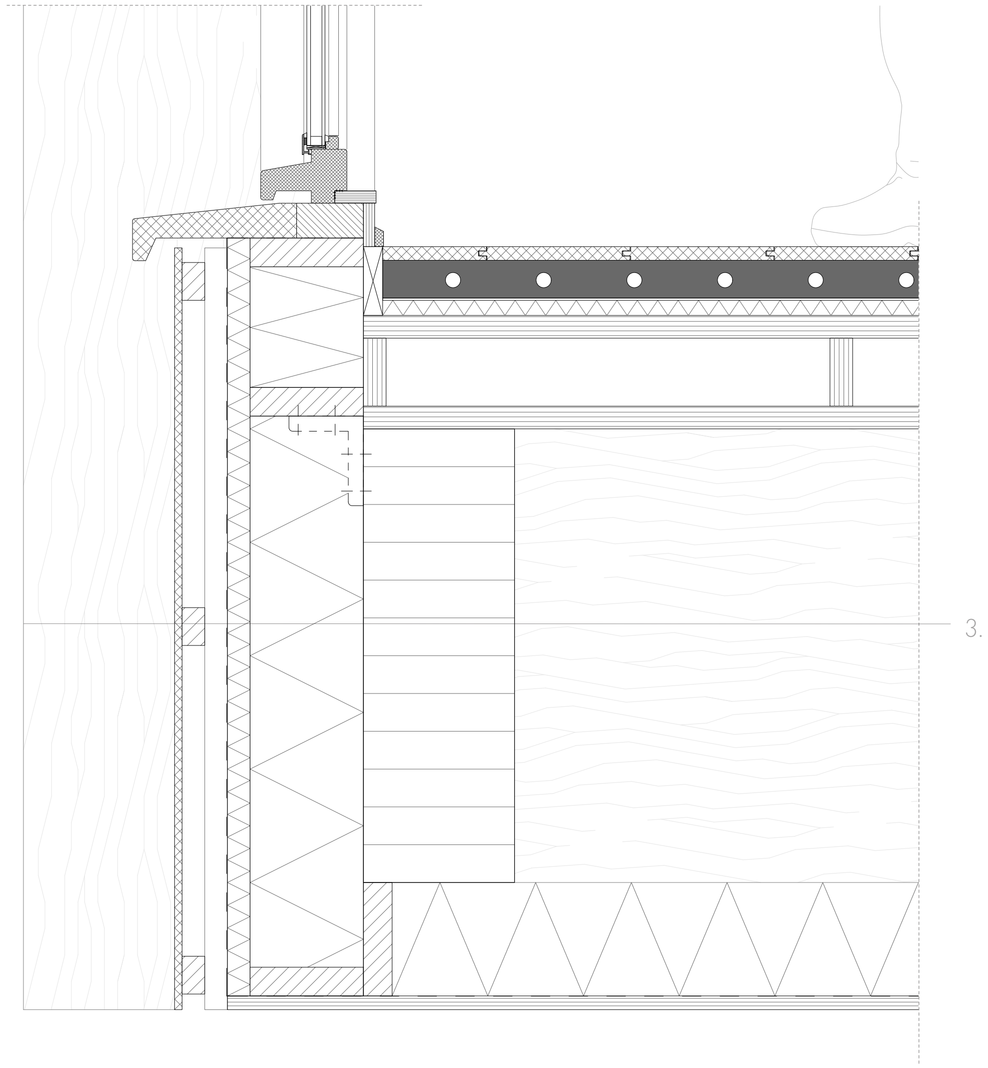
WINDOW FRAME DETAIL



detail B 1:5

2.	oak wooden slats	200 mm
	oak wooden window frame	114 mm
	HR++ glazing	24 mm

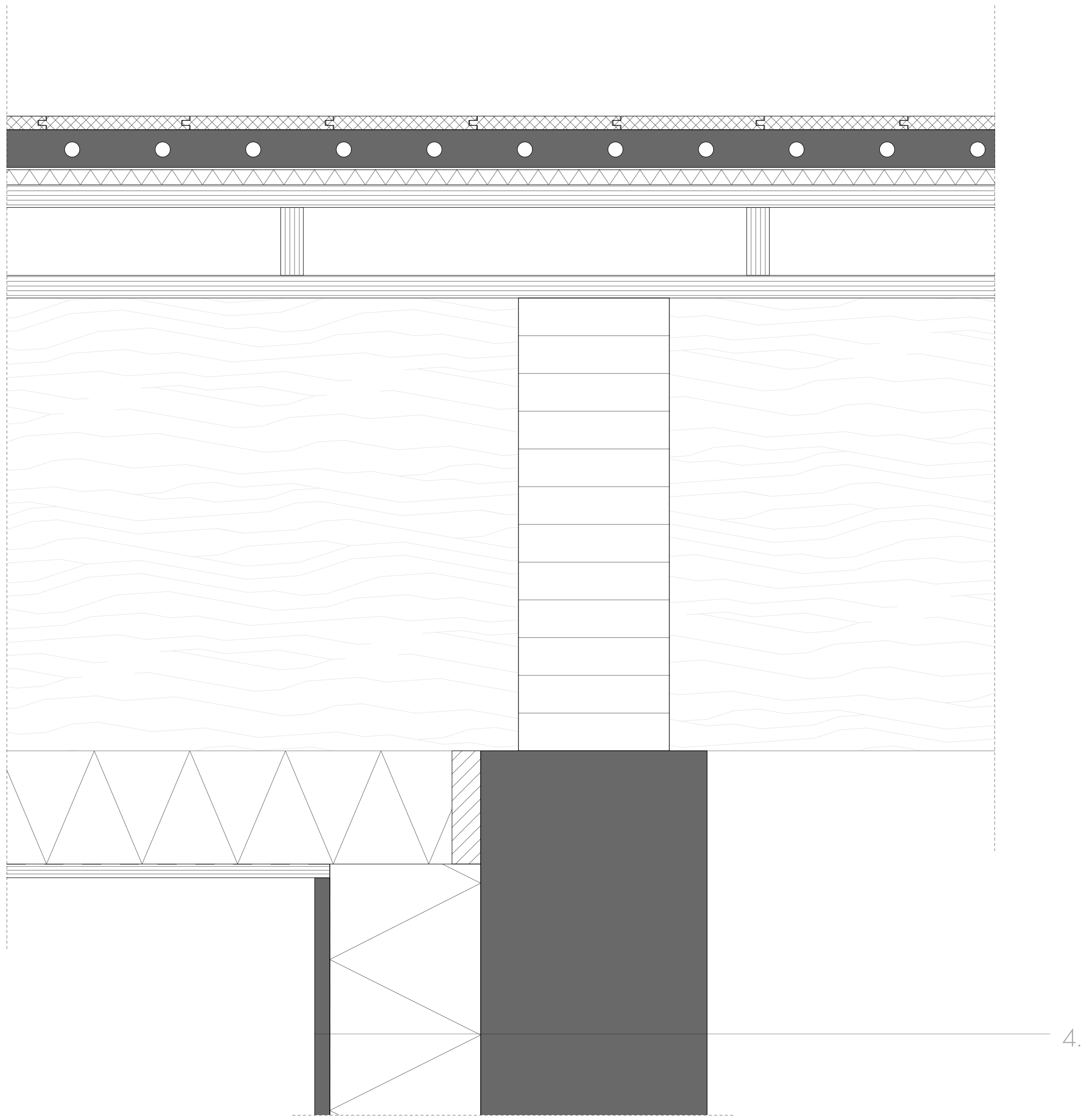
WINDOW SILL DETAIL



detail C 1:5 (scaled to 1:10)

3.	oak slats	200 mm
	planed oak exterior cladding	20 mm
	horizontal battening	30 mm
	vertical battening	30 mm
	waterproof layer	> 2 mm
	thermal insulation	30 mm
	HSB with insulation	150 mm
	vapor barrier layer	> 2 mm
	glulam secondary beam	300 mm

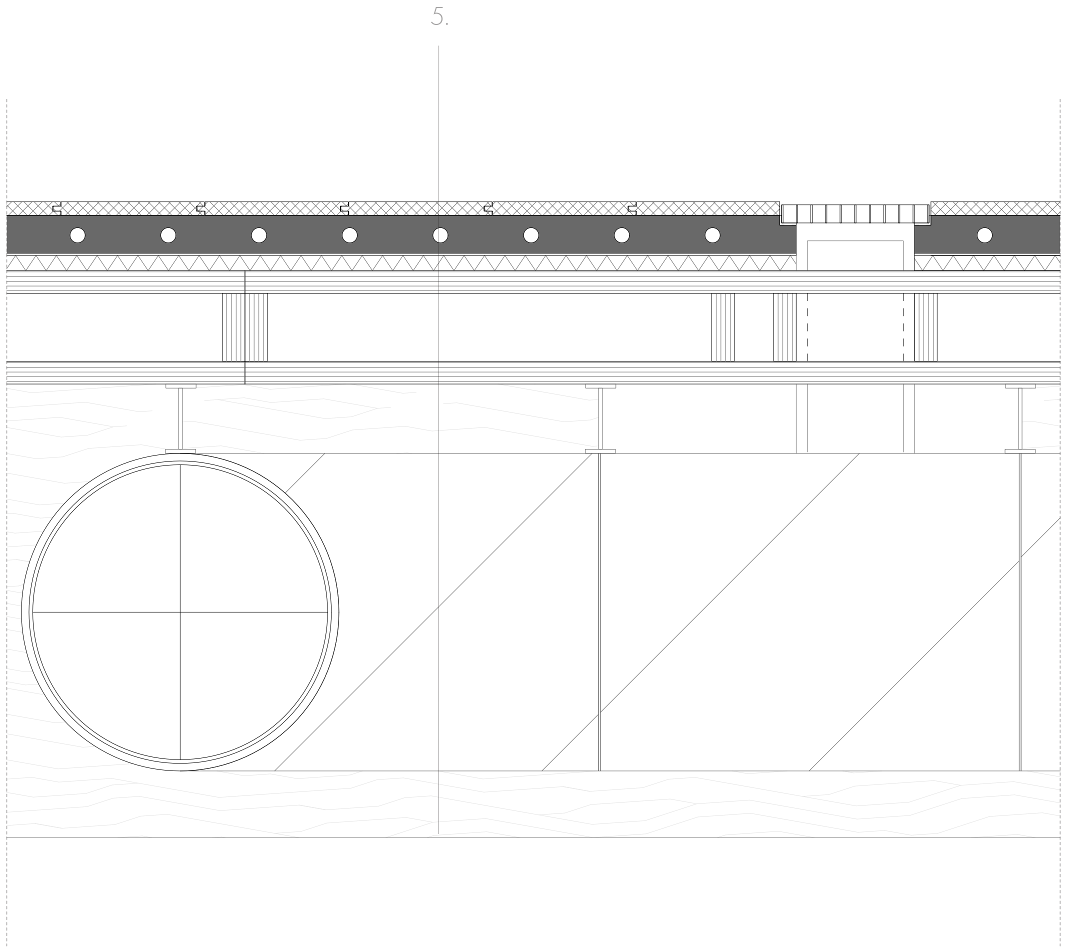
CORNER DETAIL



detail D 1:5 (scaled to 1:10)

4.	side board with insulation	220 mm
	concrete basement wall	300 mm

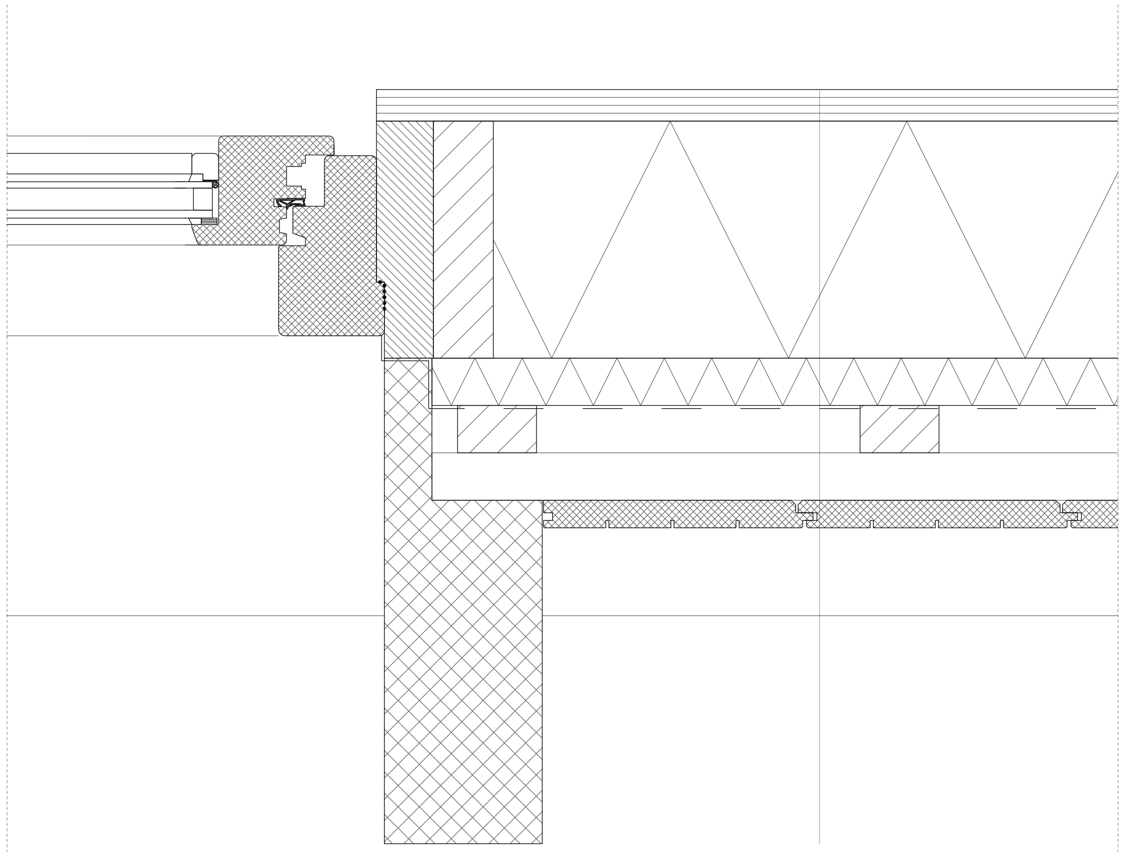
FLOOR DETAIL



detail E 1:5 (scaled to 1:10)

5.	oak wood floor boards	18 mm
	in-screed underfloor heating system	50 mm
	insulation	20 mm
	kerto ripa floor box	250 mm
	gluman beam	600 mm
		420 mm
	air supply ventilation duct	

HORIZONTAL DETAIL



detail F 1:5

6.	oak slats	200 mm
	planed oak exterior cladding	20 mm
	horizontal battening	30 mm
	vertical battening	30 mm
	waterproof layer	> 2 mm
	thermal insulation	30 mm
	HSB with insulation	150 mm
	vapor barrier layer	> 2 mm
	interior finishing	30 mm

A JOURNEY THROUGH THE SPACES

06.

EPILOGUE

In this concluding chapter, the research findings on sensory perception and emotional experiences in architecture are presented. It serves not only as a summary but also as a platform for in-depth discussions and critical reflections.

Through an analytical lens, the chapter explores the implications of the research outcomes, shedding light on the nuances discovered during the exploration of sensory engagement and emotional responses in architectural design.

Furthermore, it initiates a discourse on potential avenues for future research, identifying areas that require further investigation and exploration. By engaging in this reflective and forward-thinking discussion, the chapter underscores the dynamic nature of the subject matter and the continual evolution of our understanding of how sensory synergy and emotional narratives can be crafted by architects to create impactful architectural environments.

CONCLUSION

In conclusion, this project has significantly contributed to our understanding of the influential role architects play in crafting rich sensory and emotional experiences through their strategic choices. Initially focused on unraveling the sensorial properties of specific materials, the research expanded to explore the sensory and emotional qualities embedded within the unique landscape of Lauwersoog in Groningen. This comprehensive approach has provided a deeper insight into how the built environment can elevate and enrich user experiences.

The review of pertinent literature and theoretical frameworks surrounding sensory perception provided valuable insights into the potential of the built environment to enhance user experiences. This foundational knowledge served as a springboard for a more in-depth examination of the tactile qualities of the materials studied. Through a carefully conducted experiment, participants' tactile preferences were elucidated, revealing key tactile properties such as roughness, temperature, and flexibility inherent in the materials.

A meticulous analysis of the Lauwerslake area's landscape further enriched our comprehension of its sensory dimensions, encompassing sounds, views, and even tastes. Sensory mapping as a methodological tool proved instrumental in providing a comprehensive overview of these diverse sensory experiences within the area. These insights facilitated the formulation of a tailored program, laying the groundwork for the development of design strategies.

However, a pivotal shift occurred during the research, emphasizing the importance of emotional experiences alongside sensory perception. It became evident that sensory synergy could be used as a method for crafting emotional narratives in architectural spaces. This understanding was implemented into the design, with a focus on creating spaces that evoke specific emotions through the integration of sound, visuals, and tactile experiences.

The final design of the Museum of Emotions reflects these insights. The program includes distinct cores, each evoking different feelings and emotions through careful material and spatial choices. The café, constructed with large split-face travertine stones, is designed to feel robust and bustling, like a rocky outcrop rising from the landscape. The gallery, made from expanded cork, creates a sense of shelter and safety, with its pointed shape and acoustic properties enhancing the quiet, contemplative atmosphere for viewing art. The neutral space connecting these cores, crafted from oak wood, provides a tranquil, forest-like environment for visitors to transition between the different emotional experiences. And even the interior elements, like curtains soft to the touch.

By seamlessly integrating the findings from material-focused experiments, landscape analyses, and the exploration of emotional responses, the research addresses existing gaps in our understanding of sensory perception and emotional engagement in architecture. The dynamic interplay between theoretical insights, empirical investigations, and practical applications underscores the multifaceted nature of architectural considerations. This project paves the way for the continued evolution of designing spaces that resonate with human senses and emotions, opening doors to future explorations and innovations within the field.

REFLECTION

For the architectural graduation project '*Sculpting Sensations*', I embarked on a journey exploring sensory perception, tactile experiences, and the intricate relationship between materials, space, and emotions in architectural design. This journey unfolded in two main phases: research and design, each presenting its own set of challenges and discoveries. Initially, the research delved into the study of how we perceive our surroundings and experience sounds, smells, tastes and touch, paving the way for a deeper understanding of the sensory realm.

Subsequently, I transitioned into the design phase, where I strived to translate these insights into the creation of a museum with distinct spatial identities. My aim was to transcend conventional architectural norms and create spaces that evoke profound emotional responses. As I reflect on the culmination of this project, I am prompted to explore the guiding questions that shaped my approach and shed light on the insights gained throughout this transformative process. Through a series of reflective inquiries, I attempt to unravel the layers of my work, examining its significance, implications, and potential avenues for future exploration.

The relation between the graduation project topic, the master track Architecture, and the master programme MSc Architecture, Urbanism and Building Sciences

Throughout the journey of my research and design for my graduation project in Architecture, I embarked on an exploration initially centered around the sensory experience of new biobased materials, with a particular emphasis on tactility. However, as my project evolved, I uncovered a deeper understanding that surpassed mere tactile sensations. It became increasingly evident that my investigation was not solely about the physical qualities of materials, but rather about the profound impact of architecture on user experience.

This realization led me to question whether aesthetics, especially in the context of our studio, Technologies & Aesthetics, could be confined solely to the visual realm or whether it should also encompass other sensory and emotional experiences. Delving into this inquiry, I discovered the intricate interplay between materials, spatial configurations, light, and scale that possess the remarkable ability to intensify sensory experiences and evoke a wide variety of emotions and feelings within individuals. This expanded perspective highlights the relevance of designing for these emotions and experiences in architecture.

While many newer biobased materials are technically understood, their emotional and sensory properties remain less researched, indicating an exciting avenue for exploration and innovation in the field. By bridging the gap between technical advancements and considerations of human experience, my project underscores the importance of a comprehensive design approach that integrates both the pragmatic and the experiential facets of architecture. This holistic approach not only enriches our understanding of architectural aesthetics but also paves the way for the creation of spaces that are not only visually appealing but also deeply resonate with users on an emotional and sensory level, ultimately enhancing the quality of human experience within built environments.

The influence of the research on the design

The journey from research to design in my project was marked by a dynamic interplay between investigation and creation, with each influencing and enriching the other. Initially, my research delved into the sensory experience, focusing primarily on the tactile qualities of specific materials. As I delved deeper into the literature and conducted experimental research, it became evident that while tactile preferences were noteworthy, the essence of the participants' experiences, feelings, emotions, and associations held greater significance.

This realization prompted a shift in perspective, leading me to explore the creation of stronger emotional experiences within architectural spaces. Thus, as I transitioned into the design phase, I found that the initial guidelines derived from my research were insufficient to start the design process. Instead, I sought to integrate materials, light, shape, and size to evoke varied emotional responses within the built environment. By creating contrasting spaces, from open and light-filled areas to sheltered and enclosed spaces, the design aimed to amplify these experiences. This exploration led to the establishment of new design guidelines aimed at intensifying emotional experiences and defining distinct spatial zones within the design.

Moreover, the programmatic decisions were informed by these guidelines, with the museum emerging as the ideal setting to materialize varied emotional experiences. The multifunctional nature of the museum allowed for the creation of diverse spaces catering to different activities, each paired with its own emotional experience. Additionally, earlier research into cork resurfaced during the design process, with its visual, acoustic, and emotional qualities informing material selection and application.

Thus, the continuous nature of research and design not only shaped the trajectory of my project but also enriched its conceptual depth and experiential richness, ultimately resulting in a design that transcends mere functionality to evoke profound emotional connections within its users.

The value of the way of working approach, methods, methodology

Reflecting on my way of working throughout the research and design phases of my project, I have come to appreciate the inherent value of a hands-on approach. This method, especially crucial given the tactile nature of my research, has consistently yielded tangible insights and a deeper understanding of the subject matter. During the research phase, this hands-on approach translated into direct experimentation, enabling me to intimately explore the sensory qualities of materials. This not only provided valuable data but also ignited a curiosity that propelled the research forward.
Similarly, in the design process, I found that engaging in model making was indispensable for grasping material assembly, spatial configurations, and the interplay of light within architectural spaces. Through tactile exploration with physical models, I visualized and refined design concepts more effectively, leading to informed decisions. This hands-on approach not only fostered creativity and innovation but also deepened my connection with the design process itself, enriching both the journey and the outcome.
In assessing the value of my methodology, I recognize its role in not only enhancing the quality of my work but also in fostering a deeper connection with the design process itself, ultimately enriching both the process and the outcome.

The academic and societal value, scope and implication of the graduation project, including ethical aspects

Assessing the academic and societal value, scope, and implications of my graduation project, I find it to be multifaceted and far-reaching. Academically, my project contributes to the expanding discourse within architecture by bridging the gap between technical innovation and human experience. By delving into the sensory dimension of architectural design and advocating for a more inclusive understanding of aesthetics, my research challenges traditional notions and offers novel insights into the potential of (biobased) materials. This not only enriches the academic landscape but also lays the groundwork for future explorations in the field.
Societally, my project holds significant implications for the built environment and the communities it serves. By prioritizing the creation of spaces that evoke emotional and sensory experiences, my design strives to foster a more empathetic and human-centered approach to architecture. This has the potential to enhance the quality of life for individuals interacting with the built environment, promoting well-being and connection within communities. Moreover, the ethical aspect of my project lies in its emphasis on sustainability and mindful material usage. By advocating for the adoption of biobased materials and designing for emotional durability, my project aligns with ethical imperatives to lessen environmental impact and promote responsible architectural practices.
Overall, the academic and societal value of my graduation project lies in its potential to reshape architectural discourse, enrich human experiences, and promote ethical design practices that prioritize both people and planet.

The value of the transferability of the project results

In assessing the transferability of my project results, it becomes clear that its implications extend far beyond the confines of the initial research scope. While the focus was primarily on exploring the sensory properties of a select list of biobased, living, earth, and manmade materials, the methodologies developed offer versatile applications. The hands-on experimentation conducted can be effectively adapted to explore a broader range of materials, thus broadening the research's relevance and reach. Furthermore, the sensory mapping conducted at the design location of Lauwersmeer highlights the methodology's adaptability to diverse geographical contexts. Although the mapping provided site-specific insights, its approach can be replicated in various locations worldwide, facilitating a nuanced understanding of the sensory landscape and guiding contextually sensitive design interventions. Thus, while my project was rooted in a specific context, its transferability lies in its potential to inform and inspire future research and design across different materials and locations, ultimately contributing to the advancement of sensory-driven architectural practices globally.

Evolvement of perspective on architecture, design, and the role of the architect

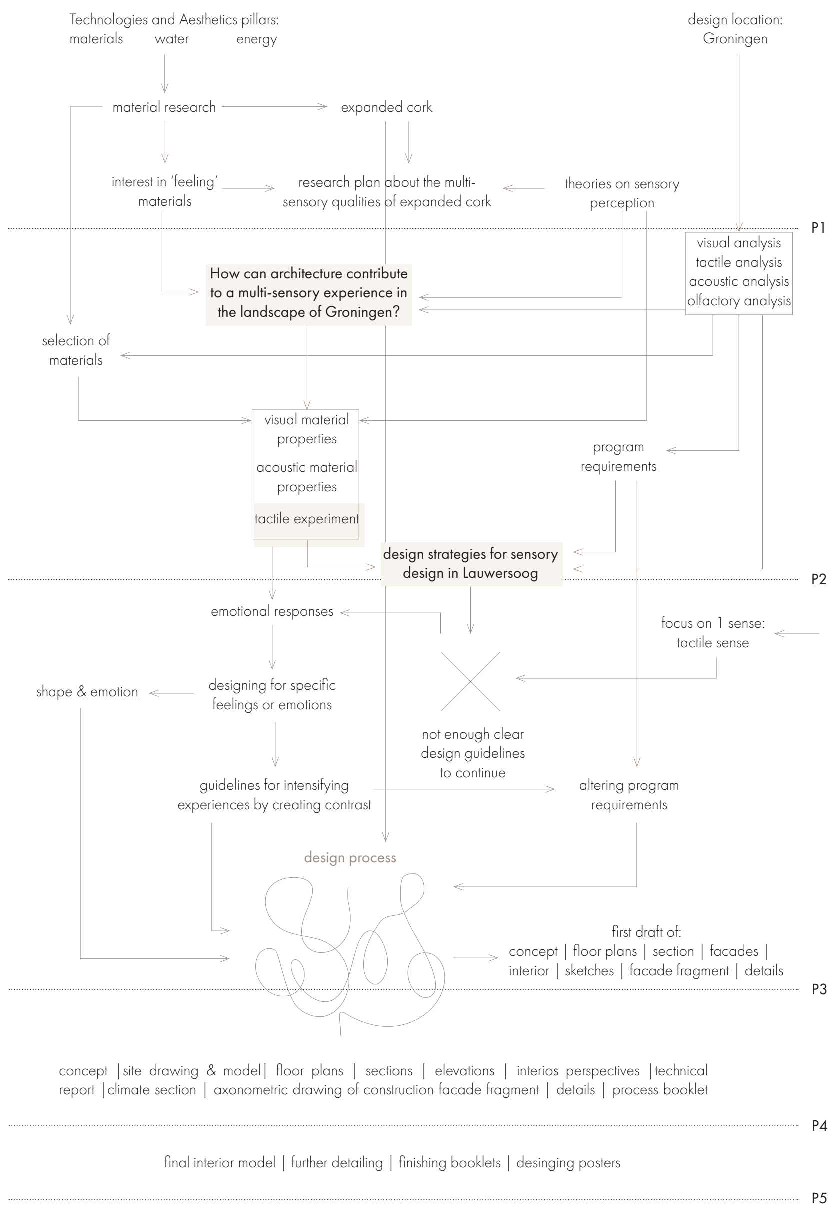
Throughout the course of my graduation project, my perspectives on architecture, design, and the role of the architect underwent a profound evolution. Initially, I approached architecture primarily as a discipline concerned with creating functional and aesthetically pleasing spaces. However, as my project unfolded and I delved deeper into the exploration of sensory perception and emotional resonance, I came to realize the transformative potential of architecture beyond its physical qualities. I began to view architecture as a powerful medium for shaping human experiences and fostering emotional connections. This shift in perspective challenged me to reconsider the traditional role of the architect as a mere designer of buildings and instead embrace a more holistic approach that prioritizes empathy, sustainability, and human-centered design principles. As I navigated the complexities of my project, I discovered the profound responsibility that architects hold in shaping the built environment and the lives of those who inhabit it. This newfound perspective has fundamentally altered my approach to design, instilling in me a deep sense of purpose and a commitment to creating spaces that not only function beautifully but also enrich the human experience in meaningful and profound ways.

Aspects that could have benefitted from further exploration

Looking back on my project, I believe that further exploration and refinement into emotional experiences could have been beneficial, particularly in the research phase. While the original intent was to investigate sensory perception through all senses, the focus eventually narrowed to the tactile sense. However, as the design process unfolded, it became evident that the emotional experience of users was perhaps more compelling than solely sensory experiences. In this project, the emotional value emerged unexpectedly as a result of the tactile experiments, eventually assuming a significant role, despite not being the primary focus initially. In hindsight, it would have been valuable to shift the research focus towards exploring the emotions, feelings, and associations evoked by architectural materials and spaces. Understanding how materials can serve as tools to evoke specific emotional responses could have provided deeper insights into the design process. This shift in focus may have facilitated earlier and more informed design choices, ultimately enhancing the overall quality and resonance of the project.

Looking ahead..

As I look ahead to the final P5 presentation, I am filled with anticipation for the next phase of my project's development. With a month remaining, I am eager to delve deeper into refining the interior experience, particularly through the creation of a detailed model that will bring my design vision to life in a tangible and immersive way. Additionally, I am committed to further advancing the technical elaboration of key elements, such as the natural stone and cork cores, by focusing on details that will enhance both their functionality and aesthetic appeal. As I continue to navigate the final stages of my project, I am excited to see how these refinements will contribute to the overall narrative and impact of my design, ultimately resulting in a compelling and comprehensive presentation that reflects the depth and thoughtfulness of my exploration into sensory- and emotion driven architecture.



bibliog.

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This section presents the bibliography, encompassing all the references and sources consulted throughout the research and design process. The listed materials include books, articles, and studies that provided valuable insights into sensory perception, emotional experiences in architecture, and the specific qualities of the materials and shapes explored in this project. These references form the foundation of the research, supporting the theoretical framework and guiding the practical application of sensory and emotional design principles.

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appendix.

ADDITIONAL INFORMATION

This appendix presents a thorough documentation of the tactile experiment conducted as part of the research. The detailed data contained here offers a comprehensive view of participants' responses, providing insights into their experiences with various materials.

Additionally, demographic information about the participants is included, offering insights into their diverse backgrounds. Factors such as age, a crucial determinant of sensory perception, are explored to enhance the contextual understanding of the experiment's outcomes.

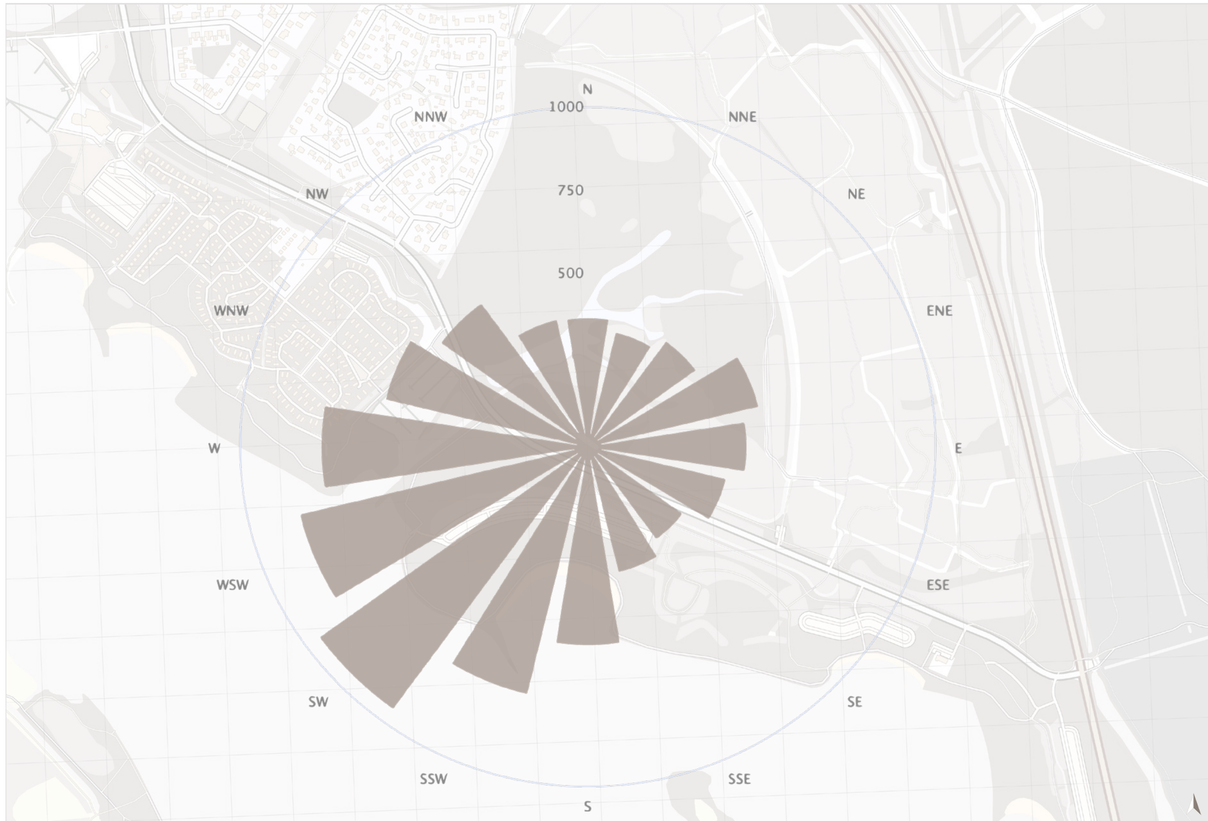
TECHNICAL REPORT

This technical report details the calculations and engineering principles behind the design choices for the Museum of Emotions. Each decision, from ventilation and temperature regulation to load-bearing structures, is thoroughly examined to ensure optimal functionality, sustainability, and user comfort.

The design aims to create emotional experiences through the built environment, requiring a blend of aesthetic vision and technical precision.

SUNPATH

WIND ORIENTATION



WKO & HEAT PUMP

The building features an advanced thermal energy storage system (WKO) with a ground source heat pump. This technology harnesses natural sources in the ground for both heating and cooling, minimizing the ecological footprint.

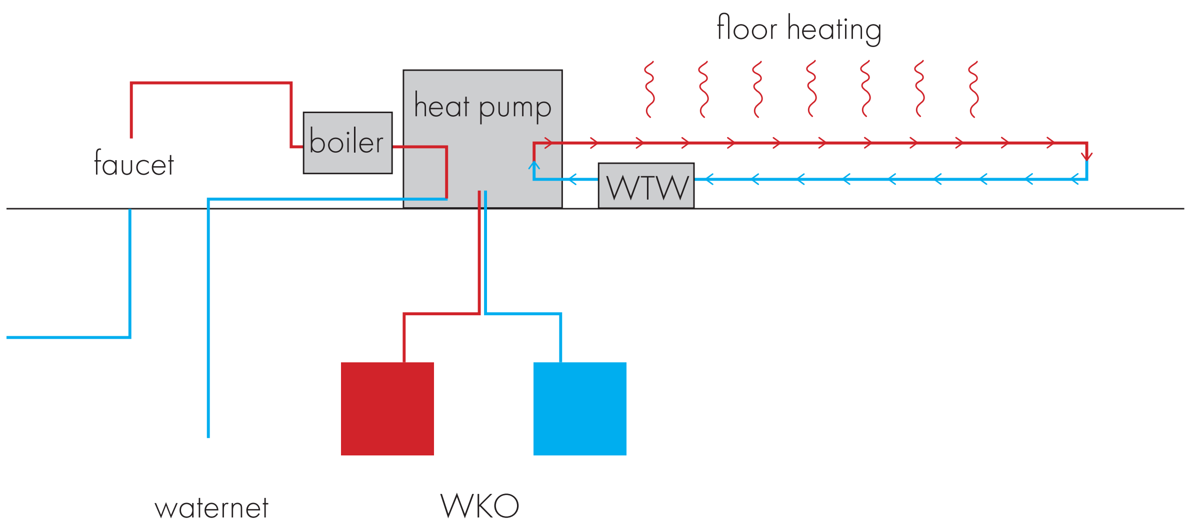
To distribute heat evenly, underfloor heating powered by the heat pump is employed. This provides comfort and saves energy by utilizing heat sources more efficiently.

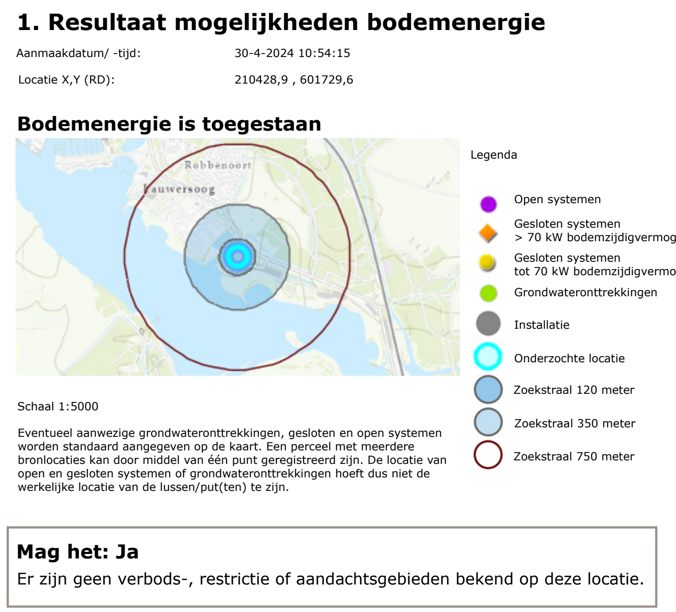
The cooled water from the underfloor heating passes through a heat recovery unit (WTW) before returning to the heat pump, recycling heat and minimizing waste.

For hot water, the ground source heat pump is also utilized. Cold water is heated to the desired temperature for use in faucets and showers. Additionally, hot water is stored in a boiler for immediate availability. By installing solar panels on the roof of the building, the generated solar energy can be used to power the boiler. This is a sustainable and environmentally friendly way to produce hot water, as it utilizes renewable energy sources instead of fossil fuels.

Research is being conducted into options for reusing used tap water, such as recycling greywater, to manage the water supply more efficiently and reduce environmental impact.

This integrated climate concept aims to create a comfortable, healthy living environment and contribute to a cleaner and greener future for all.





1. Resultaat mogelijkheden bodemenergie

Aanmaakdatum/ -tijd: 30-4-2024 10:54:15

Locatie X,Y (RD): 210428,9 , 601729,6

Bodemenergie is toegestaan

Legenda

- Open systemen
- Gesloten systemen > 70 kW bodemzijdigvermogen
- Gesloten systemen tot 70 kW bodemzijdigvermogen
- Grondwateronttrekkingen
- Installatie
- Onderzochte locatie
- Zoekstraal 120 meter
- Zoekstraal 350 meter
- Zoekstraal 750 meter

Schaal 1:5000

Eventueel aanwezige grondwateronttrekkingen, gesloten en open systemen worden standaard aangegeven op de kaart. Een perceel met meerdere bronlocaties kan door middel van één punt geregistreerd zijn. De locatie van open en gesloten systemen of grondwateronttrekkingen hoeft dus niet de werkelijke locatie van de lussen/put(ten) te zijn.

Mag het: Ja

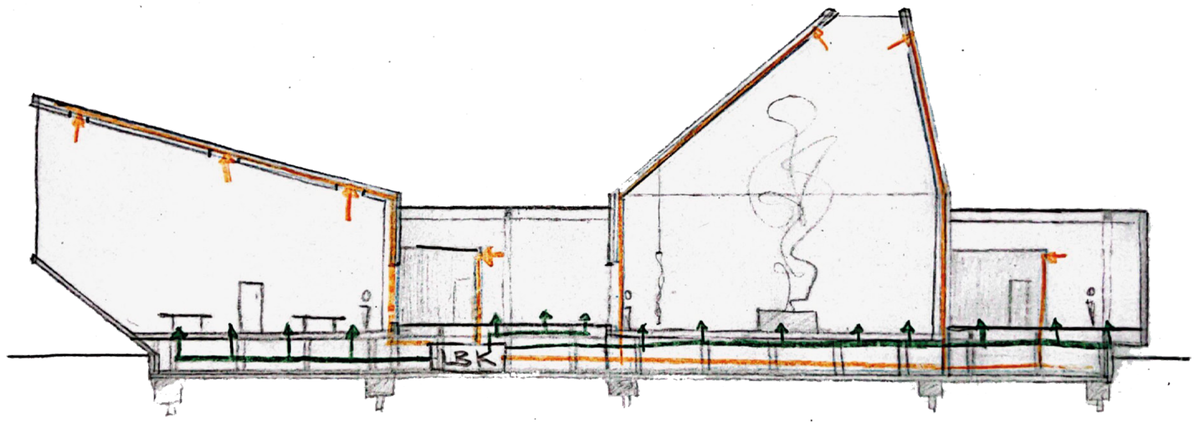
Er zijn geen verbods-, restrictie of aandachtsgebieden bekend op deze locatie.

THERMAL ENERGY STORAGE SYSTEM (WKO)

According to the WKO tool (SOURCE XX), it is permitted to apply geothermal energy at the design location.

There are no prohibition, restriction, or attention areas known at the location.

VENTILATION CHOICE



Concept 1 **type D**

The air handling unit will be placed in the basement.

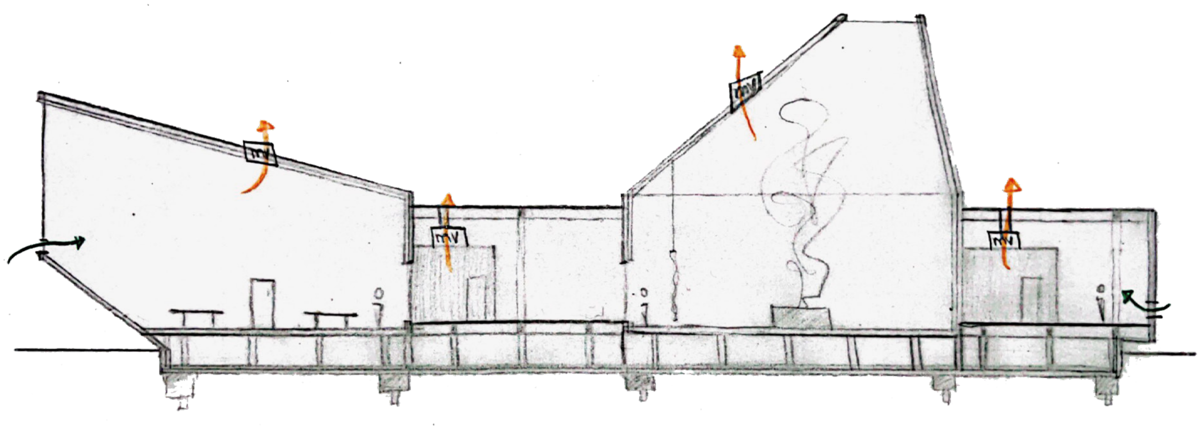
The air supply will take place through the floors.

The air exhaust will take place through the walls in the cores, or through the service hubs in the entrance hall.

PROS
In a ventilation system D, the incoming outside air is first filtered. This means that there are no pollen, dust, or pollen in the air entering the house, unlike system C.

Another major factor is the temperature. System D extracts heat from the exhausted indoor air and also uses it to heat the drawn outside air. This results in minimal heat loss and significantly increases comfort.

Lastly, the air handling unit will ensure better ventilation in case of a peak in visitors during special events.



Concept 2 **type C**

In total, five mechanical ventilation units will be installed. One on each of the three service hubs and one in each core.

They will be placed on the roof, where the air exhaust takes place.

The air supply is via ventilation grilles and possibly through operable windows.

CONS
In system C, there is no filter, so the incoming air can be full of pollen, dust, or pollen.

With system C, the outside air enters the house directly. In winter, this is (too) cold air, and in summer, (too) warm air.

CONCLUSION
Ventilation type D with an air handling unit is the best option for this building.

VENTILATION CALCULATION

	ventilation	oppervlakte	volume	personen	ventilatiebehoefte	ventilatievoud
entrance	type D	856 m²	2996 m3	50	2996 m3	
gallery	type D	149 m²	1639 m3	20	1639 m3	
lunchroom	type D	113 m²	904 m3	30	904 m3	
facility space 1	type D	60 m²	210 m3	12	210 m3	
facility space 2	type D	48 m²	168 m3	3	168 m3	

De ventilatiekanalen zijn gedimensioneerd middels de formule:

$$A = \frac{\dot{V}}{3600 \cdot v}$$

Hierin is:
A= de doorsnede van het kanaal in m²
V= het ventilatiedebiet in m³/h
v= de luchtsnelheid in m/s

luchtverversing

horeca	kantoor		school
	licht inspannend	zwaar inspannend	
14 m³/uur pp	30 m³/uur pp	50 m³/uur pp	40-50 m³/uur pp

V= aantal personen x luchtverversing (m3/uur pp)

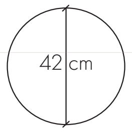
Voor de entree:
V= 50 x 30 = 1500 m³/h

v = 3 m/s (ivm geluid)

A= 1500/(3600 x 3) = 0,14 m²

Van oppervlakte van een cirkel naar diameter:

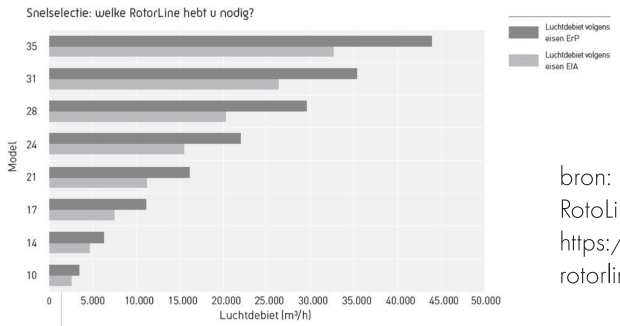
$A = \pi \times r^2$
$r^2 = A / \pi$
$r = \sqrt{(A / \pi)}$



$r = \sqrt{(0{,}14 / \pi)} = 0{,}21$ m
dus diameter = 0,21 x 2 = 0,42 m

ventilatievoud = ventilatiedebiet/behoefte / volume

1500 / 2996 = 0,50



bron:
RotoLine
https://viewer.ipaper.io/ned-air-bv/brochure-rotorline/?Page=31&page=32

Afmetingen en gewichten per RotorLine-model

Gegeven	Eenheid	Model 10	14	17	21	24	28	31	35
L: Lengte*	(mm)	2.100	2.450	2.450	2.800	3.150	3.150	3.150	3.500
B: Breedte*	(mm)	1.050	1.400	1.750	2.100	2.450	2.800	3.150	3.500
H: Hoogte**	(mm)	1.050	1.400	1.750	2.100	2.450	2.800	3.150	3.500
Gewicht	(kg)	600	900	1.200	1.700	2.200	2.600	3.000	3.700

* Lengte en breedte zijn exclusief de afmetingen van de druppelvangers. De druppelvangers zijn voor alle modellen 210 mm diep.
** Afmetingen zijn exclusief framehoogte. De modellen 10 t/m 24 hebben een framehoogte van 80 mm. Het model 28 heeft een framehoogte van 100 mm. De modellen 31 en 35 hebben een framehoogte van 120 mm.

Is een LBK nodig? Of is mechanische ventilatie genoeg?
Bij speciale evenementen in de entree van het museum zullen er meer mensen aanwezig zijn dus lbk beter

BENG CALCULATION

FUNCTION

The museum is a medium-sized utility building with various volumes and functions, including two cores that house the gallery and lunchroom, and the entrance extending into the foyer and circulation space. Several service cores are located within this space.

Since the foyer constitutes the largest part of the museum and is more challenging to condition, it has been chosen to include only the foyer for the following calculations. Approximately 90% of this space serves as gathering function, and around 10% serves as office function.

VALUES

The facades thermal resistance (Rc-value) must comply with the current requirements of Bouwbesluit. Therefore, all facades of the foyer must have a minimum Rc-value of 4.5 m²K/W.

The facade includes windows equipped with HR++ glass. HR++ glass has a solar heat gain coefficient (g-value) of 0.6 without shading. The wooden louvers on the exterior facade provide sun shading for part of the day. Hence, the g-value of the glass with shading is set to 0.4. HR++ glass has an average U-value of 1.2.

For the roof, an Rc-value of 6.0 m²K/W (the minimum value from Bouwbesluit) is maintained, and for the floor, a value of 4.0 m²K/W applies.

INSTALLATIONS

For heating and cooling, a ground source heat pump is utilized. This is connected to a thermal energy storage (WKO) system, and the spaces are cooled and heated through underfloor heating (water-based).

Hot water supply is managed by electric boilers. This can be centrally controlled since only a small amount of hot water is needed in the building. Additionally, water pipes are small and occupy little space.

The efficiency of shower water heat recovery (WTW) is considered negligible (0%) due to the low hot water consumption in the building.

Natural ventilation is set at 20%, based on the number of windows that can be opened in these spaces.

In most of the building, ventilation type D with heat recovery of 80% is employed.

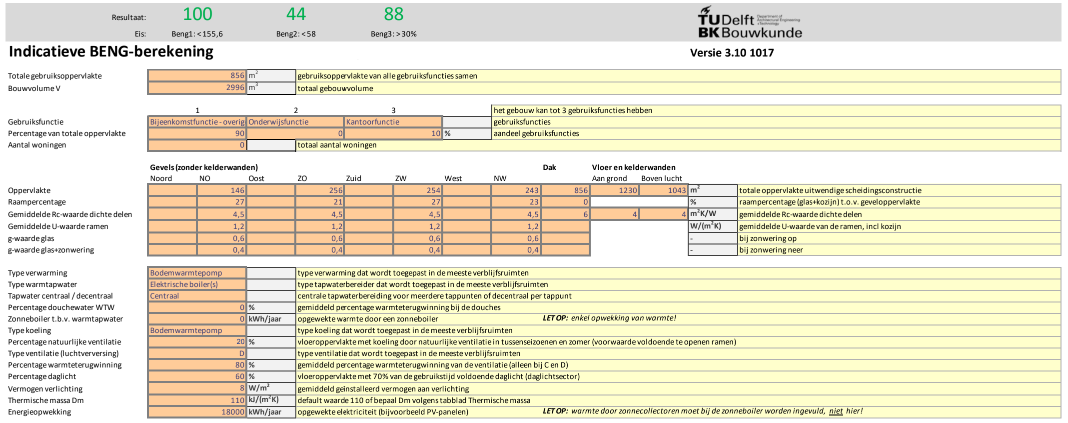
The daylight percentage is derived from areas with windows and the amount of daylight penetration, resulting in an estimated daylight percentage of 60%.

The standard value for the power of energy-efficient lighting is 8 W/m².

VALUES

window percentage =
(m² window / m² facade) x 100

Northeast	(40 m² / 146 m²) x 100 = 27%
Southeast	(54 m² / 256 m²) x 100 = 21%
Southwest	(68 m² / 254 m²) x 100 = 27%
Northwest	(56 m² / 243 m²) x 100 = 23%



Resultaat: 100 44 88

Eis: Beng1: < 155,6 Beng2: < 58 Beng3: > 30%

TU Delft BK Bouwkunde

Indicatieve BENG-berekening

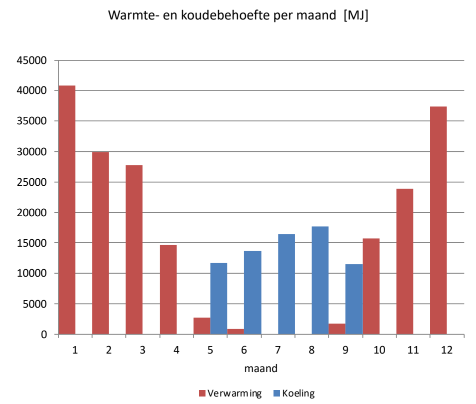
Versie 3.10 1017

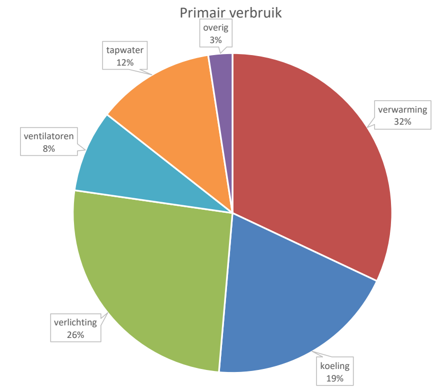
Totale gebruiksoppervlakte	856	m²	gebruiksoppervlakte van alle gebruiksfuncties samen
Bouwvolume V	2996	m³	totaal gebouwvolume

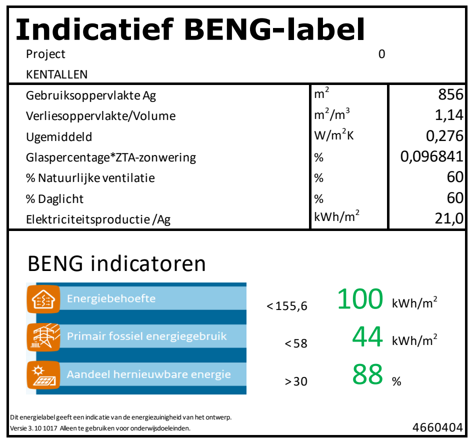
	1	2	3		het gebouw kan tot 3 gebruiksfuncties hebben
Gebruiksfunctie	Bijeenkomstfunctie - overig	Onderwijsfunctie	Kantoorfunctie		gebruiksfuncties
Percentage van totale oppervlakte	90	0	10	%	aandeel gebruiksfuncties
Aantal woningen	0				totaal aantal woningen

	Gevels (zonder kelderwanden) Noord	NO	Oost	ZO	Zuid	ZW	West	NW	Dak	Vloer en kelderwanden Aan grond	Boven lucht		
Oppervlakte		146		256		254		243	856	1230	1043	m²	totale oppervlakte uitwendige scheidingsconstructie
Raampercentage		27		21		27		23	0			%	raampercentage (glas+kozijn) t.o.v. geveloppervlakte
Gemiddelde Rc-waarde dichte delen		4,5		4,5		4,5		4,5	6	4	4	m²K/W	gemiddelde Rc-waarde dichte delen
Gemiddelde U-waarde ramen		1,2		1,2		1,2		1,2				W/(m²K)	gemiddelde U-waarde van de ramen, incl kozijn
g-waarde glas		0,6		0,6		0,6		0,6				-	bij zonwering op
g-waarde glas+zonwering		0,4		0,4		0,4		0,4				-	bij zonwering neer

Type verwarming	Bodemwarmtepomp		type verwarming dat wordt toegepast in de meeste verblijfsruimten
Type warmtapwater	Elektrische boiler(s)		type tapwaterbereider dat wordt toegepast in de meeste verblijfsruimten
Tapwater centraal / decentraal	Centraal		centrale tapwaterbereiding voor meerdere tappunten of decentraal per tappunt
Percentage douchewater WTW	0	%	gemiddeld percentage warmteterugwinning bij de douches
Zonneboiler t.b.v. warmtapwater	0	kWh/jaar	opgewekte warmte door een zonneboiler *LET OP: enkel opwekking van warmte!*
Type koeling	Bodemwarmtepomp		type koeling dat wordt toegepast in de meeste verblijfsruimten
Percentage natuurlijke ventilatie	20	%	vloeroppervlakte met koeling door natuurlijke ventilatie in tussenseizoenen en zomer (voorwaarde voldoende te openen ramen)
Type ventilatie (luchtverversing)	D		type ventilatie dat wordt toegepast in de meeste verblijfsruimten
Percentage warmteterugwinning	80	%	gemiddeld percentage warmteterugwinning van de ventilatie (alleen bij C en D)
Percentage daglicht	60	%	vloeroppervlakte met 70% van de gebruikstijd voldoende daglicht (daglichtsector)
Vermogen verlichting	8	W/m²	gemiddeld geïnstalleerd vermogen aan verlichting
Thermische massa Dm	110	kJ/(m²K)	default waarde 110 of bepaal Dm volgens tabblad Thermische massa
Energieopwekking	18000	kWh/jaar	opgewekte elektriciteit (bijvoorbeeld PV-panelen) *LET OP: warmte door zonnecollectoren moet bij de zonneboiler worden ingevuld, niet hier!*







Indicatief BENG-label

Project 0

KENTALLEN

Gebruiksoppervlakte Ag	m²	856
Verliesoppervlakte/Volume	m²/m³	1,14
Ugemiddeld	W/m²K	0,276
Glaspercentage*ZTA-zonwering	%	0,096841
% Natuurlijke ventilatie	%	60
% Daglicht	%	60
Elektriciteitsproductie /Ag	kWh/m²	21,0

BENG indicatoren

Energiebehoefte	< 155,6	100	kWh/m²
Primair fossiel energiegebruik	< 58	44	kWh/m²
Aandeel hernieuwbare energie	> 30	88	%

4660404

CONCLUSION

The BENG calculation reveals that the primary consumption of the foyer consists of heating (32%) and lighting (26%).

SOLAR PANELS

To make the building energy-neutral, an energy generation of approximately 18 000 kWh per year is required. This generation will be achieved through the use of PV panels installed on the roof of the foyer.

Revenue per m² of solar panel = 150 kWh/year

120 m² x 150 = 18 000 kWh/year

HEAT BALANCE CALCULATION

VALUES

For the foyer, the heat and cool demand are calculated. According to BRON XX, the temperature in a museum should be 21 °C +/- 3 °C.

The thermal resistance values (Rc-values) of the building must comply with the requirements set forth in Bouwbesluit:
Facade: 4.5 m²K/W
Roof: 6.0 m²K/W
Floor (above ground): 3.7 m²K/W

The ventilation requirement per person is 30 m³/h, and there are an average of 50 people in the foyer.

The total ventilation requirement for the foyer is:
V = 50 x 30 = 1500 m³/h

ventilation rate = ventilation requirement / volume

1500 / 2996 = 0.50

window percentage =
(m² window / m² facade) x 100

Northeast	(40 m² / 146 m²) x 100 = 27%
Southeast	(54 m² / 256 m²) x 100 = 21%
Southwest	(68 m² / 254 m²) x 100 = 27%
Northwest	(56 m² / 243 m²) x 100 = 23%

CALCULATION

Formula for heating / cooling need:

$$T_i = T_e + \frac{Q_{zon} + Q_{intern} + Q_{verwarming} - Q_{koeling}}{H_{transmissie} + H_{ventilatie} + H_{infiltratie}}$$

SUMMER SITUATION

T indoor: 24 °C
T outdoor: 30 °C

24 = 30 + (26 851.2 + 12 848 - Qkoeling)/1359.93

Qkoeling = 47 859 W

INTERMEDIATE SITUATION

T indoor: 21 °C
T outdoor: 10 °C

21 = 10 + (27 736 + 12 848 - Qkoeling)/1359.93

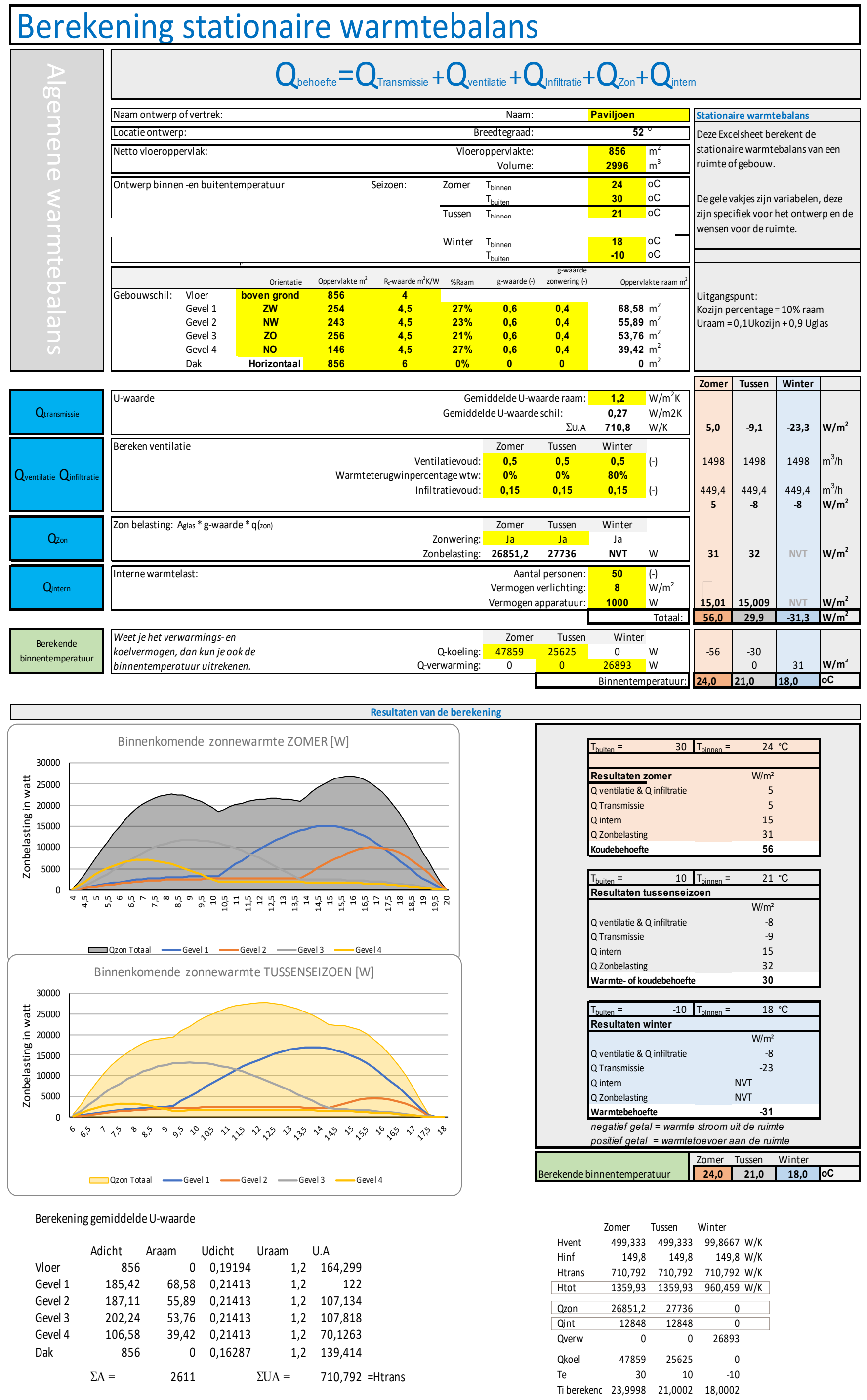
Qkoeling = 25 625 W

WINTER SITUATION

T indoor: 18 °C
T outdoor: -10 °C

18 = -10 + (0 + 0 + Qverwarming)/960.46

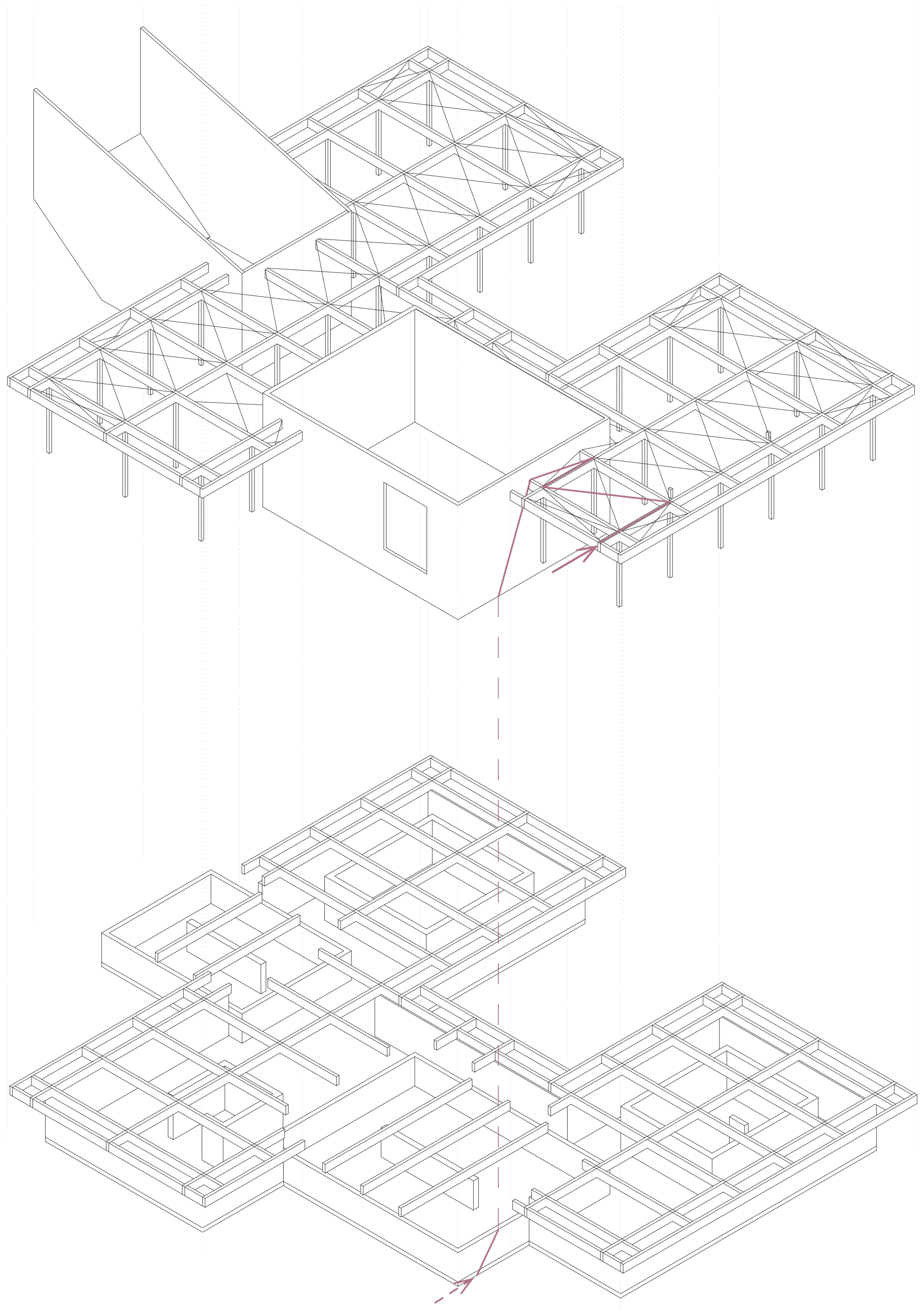
Qverwarming = 26 893 W

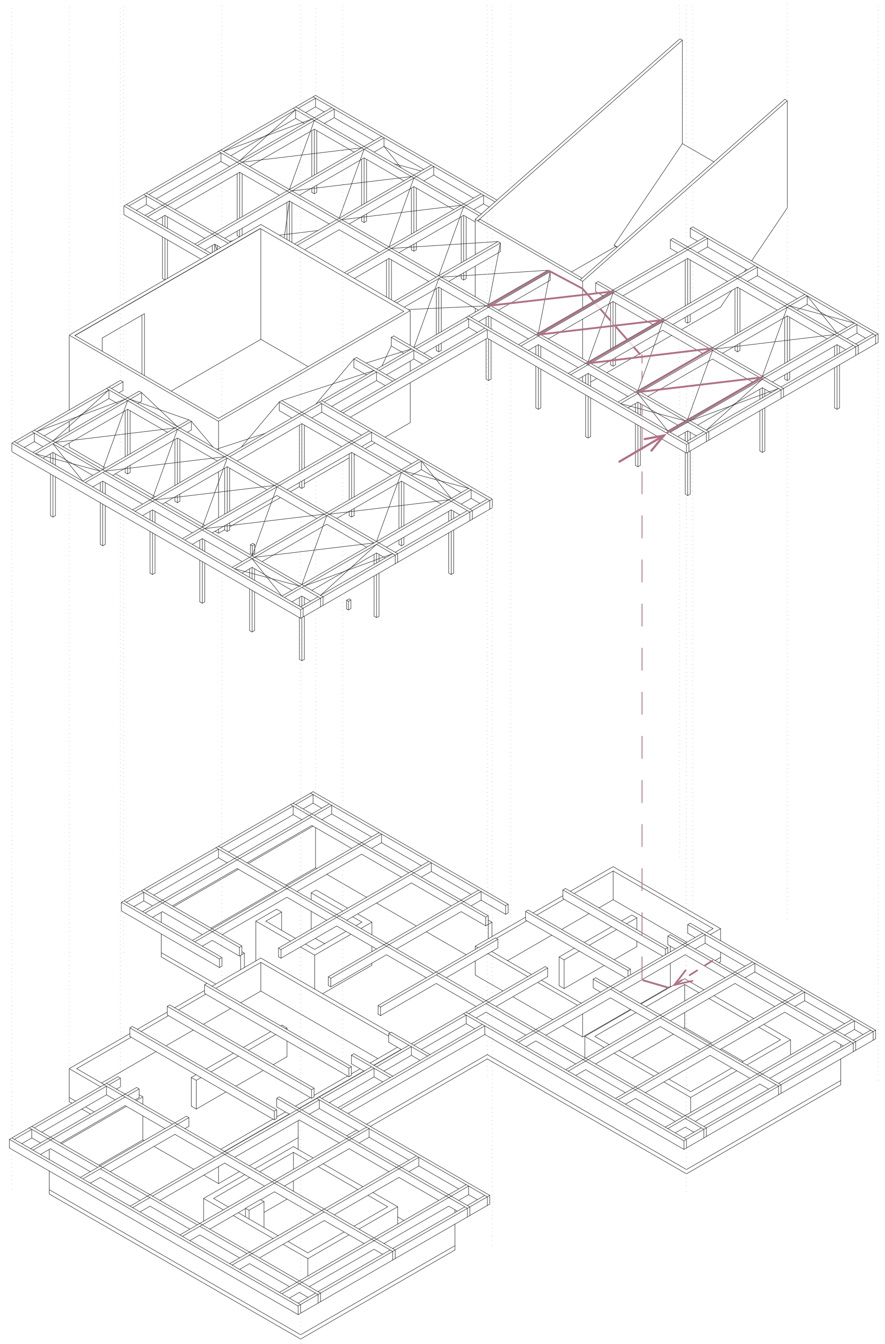


TRANSFER OF FORCE

The wind force is transferred to the foundation through beams (compressive force -) and wind braces (tensile force +) in the roof, CLT walls (compressive force -), and the basement walls (compressive force -).

NOTE: transfer of force can be done by applying a rigid roof. Wind braces are therefore not needed anymore.





FLOOR BEAM DIMENSIONS

RULE OF THUMB

Beam XX has been selected as the critical beam. This beam supports the roof of the museum. The span of the beam is 6000 mm.

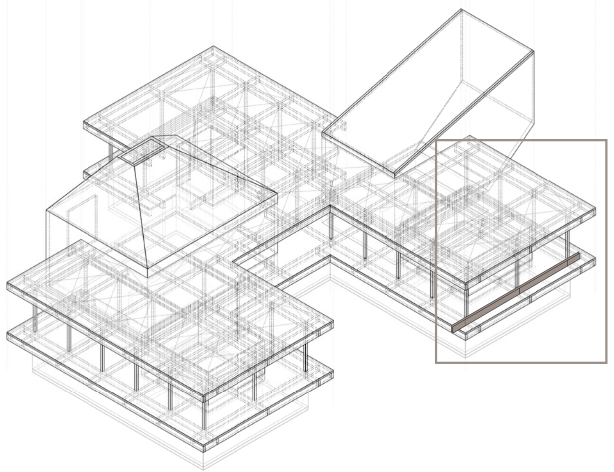
Using the rule of thumb for glulam beams dimensions, the height of the beam is estimated.

h = 1/20 l

So, the beam height is 6000/20 = 300 mm.

width = 1/6 to 1/8 x height

so the width of the beam is 300/6 = 50 mm



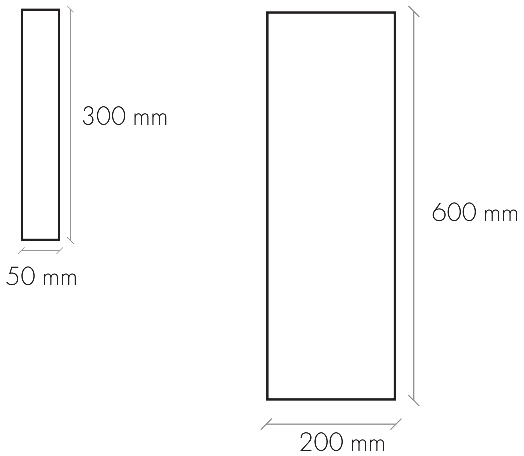
	hout		staal	beton	
	gezaagd	gelamineerd	IPE / HE	t.pl. gestort	prefab
$h_{dakliggers}$	$\frac{1}{20}\ell$	$\frac{1}{20}\ell$	$\frac{1}{30}\ell$	$\frac{1}{20}\ell$	$\frac{1}{20}\ell$
$h_{vloerliggers}$	$\frac{1}{20}\ell$	$\frac{1}{12}\ell$	$\frac{1}{20}\ell$	$\frac{1}{10}\ell$	$\frac{1}{20}\ell$

COLUMN DIMENSION CALCULATION

Sheet XX has been used to determine a rough sizing of a glulam floor beam.

The beam has a span of 6 meters and a center-to-center distance of 4 meters. The estimated value of the total floor load is 10 kN/m², as it is floor that holds a gathering function.

Additionally, technical properties such as the strength class and modulus of elasticity (E-modulus) of glulam beams have been researched.



CONCLUSION

According to the sheet, a glulam beam of 50 x 300 mm **does not** meet the UC standard.

Therefore, it has been decided to go for a glulam beam of 200 x 600 mm that does meet the UC standard.

Bepaling dimensies houten ligger volgens globale belasting

gelamineerd	ℓ_{hoh} =	4	[m]	b =	100	[mm]
	$q_{tot\ rekenw}$ =	10	[kN/m²]	h =	600	[mm]
	q_{UGT} =	40	[kN/m]	W =	6000000	[mm³]
	$q_{Q;kar.w}$ =	5	[kN/m²]	I =	1800000000	[mm⁴]
	$q_{BGT\ vb}$ =	20	[kN/m]	f_{cd} =	30	[N/mm²]
	ℓ_{oversp} =	6	[m]	E =	13600	[N/mm²]
sterkte						
veld mom =	180000000	[Nmm]		σ_m =	30,0	[N/mm²]
	UC =	1,00	VOLDOET	$W_{benodigd}$ =	6000000	[mm³]
stijfheid						
	$q_{BGT\ kruip}$ =	16	[kN/m]	$U_{bij\ norm}$ vloer =	18,00	[mm]
	U_{bij} =	24,82	[mm]	$U_{bij\ norm}$ vl-wand =	12,00	[mm]
	UC vloer =	1,38	VOLDOET NIET	$I_{benodigd}$ =	2481617647	[mm⁴]
	(UC vl.wand =	2,07		$I_{benodigd}$ =	3722426471	[mm⁴])

Bepaling dimensies houten ligger volgens globale belasting

gelamineerd	ℓ_{hoh} =	4	[m]	b =	200	[mm]
	$q_{tot\ rekenw}$ =	10	[kN/m²]	h =	600	[mm]
	q_{UGT} =	40	[kN/m]	W =	12000000	[mm³]
	$q_{Q;kar.w}$ =	5	[kN/m²]	I =	3600000000	[mm⁴]
	$q_{BGT\ vb}$ =	20	[kN/m]	f_{cd} =	30	[N/mm²]
	ℓ_{oversp} =	6	[m]	E =	13600	[N/mm²]
sterkte						
veld mom =	180000000	[Nmm]		σ_m =	15,0	[N/mm²]
	UC =	0,50	VOLDOET	$W_{benodigd}$ =	6000000	[mm³]
stijfheid						
	$q_{BGT\ kruip}$ =	16	[kN/m]	$U_{bij\ norm}$ vloer =	18,00	[mm]
	U_{bij} =	12,41	[mm]	$U_{bij\ norm}$ vl-wand =	12,00	[mm]
	UC vloer =	0,69	VOLDOET	$I_{benodigd}$ =	2481617647	[mm⁴]
	(UC vl.wand =	1,03		$I_{benodigd}$ =	3722426471	[mm⁴])

Karakteristieke eigenschappen en sterkteklassen van homogeen gelamineerd naaldhout

Eigenschap	GL20h	GL22h	GL24h	GL26h	GL28h	GL30h	GL32h	Eenheid
$f_{m,g,k}$	20	22	24	26	28	30	32	N/mm²
$E_{0,g,mean}$	8,4	10,5	11,5	12,1	12,6	13,6	14,2	kN/mm²

bron: https://www.houtdatabase.nl/infobladen/Infoblad_Houteigenschappen-Sterktegegevens.pdf

ROOF BEAM DIMENSIONS

RULE OF THUMB

Beam XX has been selected as the critical beam. This beam supports the roof of the museum. The span of the beam is 12000 mm.

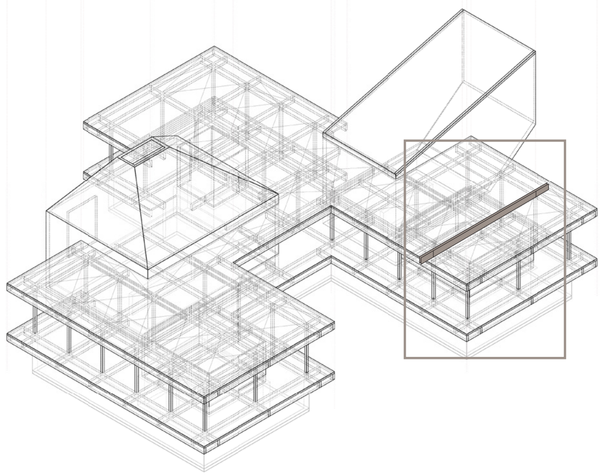
Using the rule of thumb for glulam beams dimensions, the height of the beam is estimated.

h = 1/20 l

So, the beam height is 12000/20 = 600 mm.

width = 1/6 to 1/8 x height

so the width of the beam is 600/6 = 100 mm



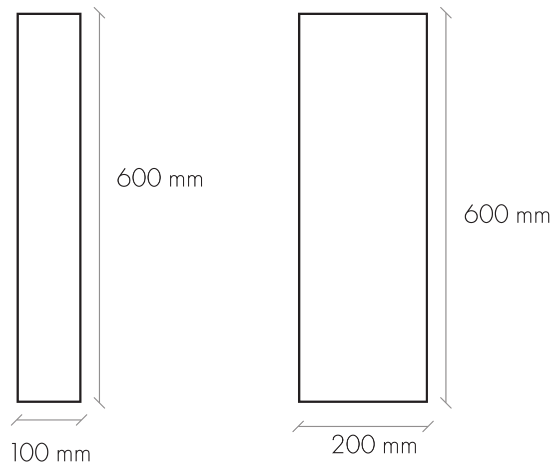
	hout		staal	beton	
	gezaagd	gelamineerd	IPE / HE	t.pl. gestort	prefab
$h_{dakliggers}$	$\frac{1}{20}\ell$	$\frac{1}{20}\ell$	$\frac{1}{30}\ell$	$\frac{1}{20}\ell$	$\frac{1}{20}\ell$
$h_{vloerliggers}$	$\frac{1}{20}\ell$	$\frac{1}{12}\ell$	$\frac{1}{20}\ell$	$\frac{1}{10}\ell$	$\frac{1}{20}\ell$

COLUMN DIMENSION CALCULATION

Sheet XX has been used to determine a rough sizing of a glulam roof beam.

The beam has a span of 12 meters and a center-to-center distance of 4 meters. The estimated value of the total floor load is 2 kN/m², as it is a wooden roof without a terrace.

Additionally, technical properties such as the strength class and modulus of elasticity (E-modulus) of glulam beams have been researched.



CONCLUSION

According to the sheet, a glulam beam of 100 x 600 mm **does not** meet the UC standard.

Therefore, it has been decided to go for a glulam beam of 200 x 600 mm that does meet the UC standard.

Bepaling dimensies houten dakligger volgens globale belasting

gelamineerd	ℓ_{hoh} =	4	[m]	b =	100	[mm]
	$q_{tot\ rekenw}$ =	2	[kN/m²]	h =	600	[mm]
	q_{UGT} =	8	[kN/m]	W =	6000000	[mm³]
	$q_{Q;kar.w}$ =	1	[kN/m²]	I =	1800000000	[mm⁴]
	$q_{BGT\ vb}$ =	4	[kN/m]	f_{cd} =	30	[N/mm²]
	ℓ_{oversp} =	12	[m]	E =	13600	[N/mm²]
sterkte						
veld mom =	144000000	[Nmm]		σ_m =	24,0	[N/mm²]
	UC =	0,80	VOLDOET	$W_{benodigd}$ =	4800000	[mm³]
stijfheid						
	$q_{BGT\ kruip}$ =	3	[kN/m]	$U_{bij\ norm\ dak}$ =	48,00	[mm]
	U_{bij} =	79,41	[mm]			
	UC dak =	1,65	VOLDOET NIET	$I_{benodigd}$ =	2977941176	[mm⁴]

Bepaling dimensies houten dakligger volgens globale belasting

gelamineerd	ℓ_{hoh} =	4	[m]	b =	200	[mm]
	$q_{tot\ rekenw}$ =	2	[kN/m²]	h =	600	[mm]
	q_{UGT} =	8	[kN/m]	W =	12000000	[mm³]
	$q_{Q;kar.w}$ =	1	[kN/m²]	I =	3600000000	[mm⁴]
	$q_{BGT\ vb}$ =	4	[kN/m]	f_{cd} =	30	[N/mm²]
	ℓ_{oversp} =	12	[m]	E =	13600	[N/mm²]
sterkte						
veld mom =	144000000	[Nmm]		σ_m =	12,0	[N/mm²]
	UC =	0,40	VOLDOET	$W_{benodigd}$ =	4800000	[mm³]
stijfheid						
	$q_{BGT\ kruip}$ =	3	[kN/m]	$U_{bij\ norm\ dak}$ =	48,00	[mm]
	U_{bij} =	39,71	[mm]			
	UC dak =	0,83	VOLDOET	$I_{benodigd}$ =	2977941176	[mm⁴]

Karakteristieke eigenschappen en sterkteklassen van homogeen gelamineerd naaldhout

Eigenschap	GL20h	GL22h	GL24h	GL26h	GL28h	GL30h	GL32h	Eenheid
$f_{m,g,k}$	20	22	24	26	28	30	32	N/mm²
$E_{0,g,mean}$	8,4	10,5	11,5	12,1	12,6	13,6	14,2	kN/mm²

bron: https://www.houtdatabase.nl/infobladen/Infoblad_Houteigenschappen-Sterktegegevens.pdf

COLUMN DIMENSIONS

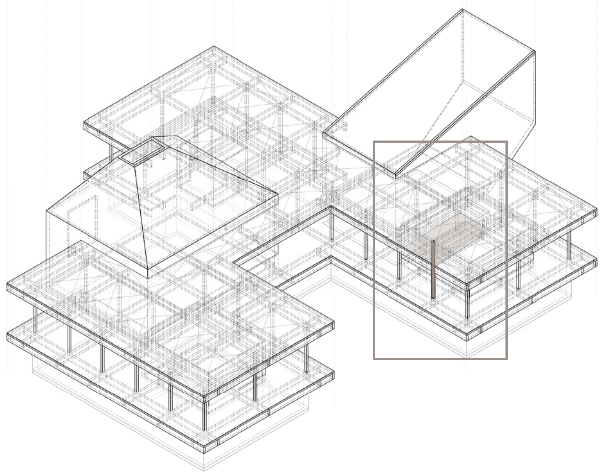
RULE OF THUMB

Column XX has been selected as the critical column. This column supports the roof of the museum. The height of the column is 4500 mm. The building has a concrete basement with one floor above.

Using the rule of thumb for column dimensions, the thickness of the column is estimated.

h = 1/20 l

So, the column thickness is 4500/20 = 225 mm. A column of planed oak wood is chosen.



COLUMN DIMENSION CALCULATION

Sheet XX has been used to determine a rough sizing of a wooden column.

The column is 4500 mm tall and supports a roof area of 4 by 7.5 meters. The estimated value of the total floor load is 2 kN/m², as it is a wooden roof without a terrace.

Additionally, technical properties such as the strength class and modulus of elasticity (E-modulus) of oak wood have been researched.

CONCLUSION

According to the sheet, a wooden column of 225 x 225 mm meets the UC standard. However, it has been decided to slightly over-dimension to 250 x 250 mm.

BUCKLING CALCULATION

Next, the column is checked for buckling using the following formula:

$$F_{cr} = \frac{\pi^2 \cdot E \cdot I}{l_{cr}^2}$$

$F_{cr} = \pi^2 \times ((11000 \times 2{,}14 \times 10^8)/4500^2 = 1\ 147 \times 10^3$ N

$$n = \frac{F_{cr}}{F_{c;d}} \geq 5$$

n =1 147 x 10^3 / 60 x 10^3 = 19

19 > 5, so it meets the criteria. There is no risk of buckling.

Bepaling dimensies houten of betonnen kolom volgens globale belasting

	lengte			breedte			rekenwaarde			
opp.vl dak =	4	[m]	x	7,5	[m]	x	2	[kN/m^2]	=	60 [kN]

$F_{c;d}$ = 60 [kN]

$A = F_{c;d}/f_{c;d}$ = 2000 [mm^2] --> d = 44,72136 [mm] -->

$f_{c;d}$ = 30 [N/mm^2]

ℓ_{cr} = 4,5 [m]

$E_{d\ (UGT)}$ = 11000 [N/mm^2]

F_{cr} = 1,15E+06 [N]

UC = 0,26 VOLDOET

$I_{z\ ben}$ = 5,60E+07 [mm^4]

b = 225 mm

h = 225 mm

I_z = 2,14E+08 [mm^4]

--> 250 x 250

Sterkteklassen van loofhout					
Sterkte		Sortering	Handelsnaam	Wetenschappelijke benaming	Herkomst
C	22	DIN 4074 LS10 & better	Populier	Populus nigra	Duitsland
D	24	UNI 11035 S	Tamme Kastanje	Castenea sativa	Italië
D	30	DIN 4074 LS10	Europees Eiken	Quercus petraea / robur	Duitsland
D	30	DIN 4074 LS10 & better	Esdoorn	Acer pseudoplatanus	Duitsland
D	35	DIN 4074 LS10 & better	Beuken	Fagus sylvatica	Duitsland
D	35	BS 5756 TH1	Wit Essen	Fraxinus americana	USA
D	35	NF B 52-001 HS ST1	Jaboty	Erisma uncinatum	Frans Guyana
D	40	BS 5756 TH1	Amerikaans Rood Eiken	Quercus rubra	USA
D	40	DIN 4074 LS13	Beuken	Fagus sylvatica	Duitsland
D	40	NEN 5493 C3 STH	Tali / Missanda	Erythrophlum ivorense / suaveolens	Kameroen
D	40	NEN 5493 C3 STH	Okan / Denya	Cylocodiscus gabunensis	Kongo Braz. en Kameroen

Karakteristieke eigenschappen en sterkteklassen van gezaagd loofhout									
	D18	D24	D30	D35	D40	D50	D60	D70	
$f_{m,k}$	18	24	30	35	40	50	60	70	N/mm²
$E_{0,mean}$	9,5	10	11	12	13	14	17	20	kN/mm²
ρ_{mean}	570	580	640	650	660	750	840	1080	kg/m³
ρ_k	475	485	530	540	550	620	700	900	kg/m³
$f_{t;0;k}$	11	14	18	21	24	30	36	42	N/mm²
$f_{t;90;k}$	0,6	0,6	0,6	0,6	0,6	0,6	0,6	0,6	N/mm²
$f_{c;0;k}$	18	21	23	25	26	29	32	34	N/mm²
$f_{c;90;k}$	7,5	7,8	8,0	8,1	8,3	9,3	10,5	13,5	N/mm²
$f_{v;k}$	3,4	4,0	4,0	4,0	4,0	4,0	4,5	5,0	N/mm²
$E_{0,05}$	8,0	8,5	9,2	10,1	10,9	11,8	14,3	16,8	kN/mm²
$E_{90,mean}$	0,63	0,67	0,73	0,80	0,86	0,93	1,13	1,33	kN/mm²
G_{mean}	0,59	0,62	0,69	0,75	0,81	0,88	1,06	1,25	kN/mm²
$G_{0,05}$	0,50	0,53	0,58	0,63	0,68	0,74	0,89	1,05	kN/mm²

Tabel 2. Karakteristieke eigenschappen en sterkteklassen van gezaagd loofhout

bron: https://www.houtdatabase.nl/infobladen/Infoblad_Houteigenschappen-Sterktegegevens.pdf

RESEARCH PLAN

The research plan developed for P1 laid the foundation for an in-depth exploration into the multisensory qualities of expanded cork. This plan outlined a systematic approach to investigating how this versatile material interacts with the senses of touch, sight, and sound. The primary aim was to understand how expanded cork can be utilized to enhance sensory experiences in architectural spaces. By focusing on its tactile properties, acoustic performance, and visual appeal, the research aimed to uncover new ways to integrate expanded cork into design practices, ultimately contributing to the creation of more immersive and emotionally resonant environments.

RESEARCH PLAN

In 1891, the accidental discovery of expanded cork transpired within the premises of John T. Smith's buoy and lifejacket factory. Cork, derived from the outer bark of the cork oak tree (Quercus suber), had traditionally been associated with its conventional application as stoppers for wine bottles, a practice with a rich history dating back to ancient Greece. Expanded cork however, paved the way for innovation due to its insulating properties, stemming from the formation of air bubbles within cork granules during the process of heating and compression (Wilton & Howland, 2020).

This revelation of the remarkable insulating properties prompted the widespread adoption of expanded cork boards as an insulation material, notably improving the thermal performance of thousands of residences. Nevertheless, it was not until the twenty-first century that architects began to utilize expanded cork boards as an external façade cladding. Architects Álvaro Siza Vieira and Eduardo Souto de Moura initially introduced cork façade cladding in their Pavilion of Portugal for the Exposition in Hannover in 2000, paying tribute to Portugal as the primary manufacturer of this cork. Later, in 2015, ATKA Arquitectos utilized expanded cork's acoustic properties to suppress noise from a school playground nearby Casa Bonjardim. More recently, Associate Professor in Architecture Matthew Barnet Howland, together with Dido Milne and Oliver Wilton, introduced an entirely new approach to expanded cork as a building material in their design for Cork House. Its monolithic walls and corbelled roofs are predominantly crafted from expanded load-bearing cork blocks, offering a highly innovative self-build system that is designed as a kit-of-parts. The components are prefabricated off-site and then meticulously assembled on-site without the need for mortar or adhesive.

While extensive research has been conducted on the technical and sustainability aspects of expanded cork as a building material, there exists a notable gap in the academic field. The realm of multi-sensory engagement with expanded cork cladding, with its potential to evoke tactile, visual, and olfactory sensations, remains relatively unexplored. This research seeks to bridge this gap, delving into the understudied dimension of expanded cork's multi-sensory qualities, thereby highlighting its potential in the field of architectural design and user experience.

THEORETICAL FRAMEWORK

The theoretical framework forms the primary review of existing theories, serving as a guideline for developing arguments within the research. To establish a strong foundation, key concepts will be defined.

Expanded Cork

Expanded cork is, according to Wilton and Howland (2020), 100% cork with no added ingredients, formed by heating cork granules causing them to expand, blacken and meld together. During this process, cork's natural binder, suberin, is extracted by super-heated steam.

Multi-sensory

The term multi-sensory is, according to Vermeersch's PhD dissertation Less Vision, More Senses. Towards a More Multisensory Design Approach (2013), expanded from adding various senses together to the interplay of those senses.

These senses can be understood as the five traditional main senses: "the sense of sight, the sense of hearing, the sense of touch, the sense of taste, and the sense of smell." (Maclachlan 1989, p. 3) Though other senses have been added, such as the sense of temperature, the sense of pain, the kinaesthetic sense, which involves various parts of our bodies.

Multi-sensory design

Multi-sensory design is defined by Schifferstein's plublication Multi sensory design (2011) and claims that designers are more likely to achieve success in creating deliberate experiences for individuals, such as feelings of delight, trust, or care, when they possess an awareness of the messages communicated through various senses and understand how these messages contribute to the overall experience.

Sensory quality

Quality refers to the extent to which an object or entity meets a defined set of characteristics or standards. According to the research of Dümen et al. Unfolding the material: A proposal of a multi-sensory experience oriented material exhibition medium (2022), sensory evaluation methods can be used to determine if a materials meets these sensory qualities.

Many philosophers, however, doubt that one can provide any successful explanation of sensory qualities - of how things look, feel, or seem to a perceiving subject.

User perception

According to J.J. Gibson's ecological perception theory (1981), individuals perceive their environment solely based on the information it offers and make precise judgments according to the sensory information they receive. It suggests that perception is an active process influenced by the properties of the environment (Ben-Ze'ev, 1981).

In the context of the research, this theory could emphasize the importance of sensory qualities to the user's perception.

User experience

User experience can be defined as a user's perceptions and response, resulting from the user or anticipated use of a product, service, system, or space. User experience includes user's emotions,

beliefs, responses, preferences, responses, and accomplishments before, during and after use (Vermeersch, 2013).
Experience with a product or a space occurs via various interfaces and one significant interface is the material (Dümen et al., 2022). Material experience can be defined into experiential levels: sensorial (sensory properties of materials), interpretive (associated values), affective (evoked emotions) and performative (referring to the human interaction)

This research, while shedding light on the multi-sensory experience of expanded cork in architectural design, does not investigate the diverse experiences of users who may not engage all their senses. For instance, it does not address the specific needs and sensory encounters of visually impaired individuals. Their unique perspective and interaction with architectural environments and materials are an essential aspect that warrants consideration in future research.

RESEARCH AIM

The aim of this research is to uncover the multi-sensory qualities inherent in expanded cork, and, in doing so, explore its potential role and contribution within the field of architecture. By delving into the tactile, visual, olfactory, and potentially auditory experiences offered by expanded cork, this research seeks to gain a comprehensive understanding of its sensory impact. This exploration extends beyond the investigation of the material's technical properties. By unveiling the potential of expanded cork as a sensorial building material, this research aspires to shed light on its potential to enhance the quality of architectural spaces and elevate the overall user experience.

RELEVANCE

Historically, architectural practice primarily centered around visual perception, yet recent decades have witnessed a notable shift as architects and designers increasingly acknowledge the significance of engaging other senses, including touch, sound, and scent (Spence, 2020). Nevertheless, the research into sensory interplay remains under-developed in the architecture field. This research not only offers valuable insights into the important role of the human senses in architectural design but also undertakes a material-focused investigation, centered around expanded cork. Looking ahead, the aspiration is for the architectural design practice to incorporate this increasing awareness of sensory interplay and its profound influence. By adopting a multi-sensory design approach, a future where buildings and urban spaces are thoughtfully crafted to enhance our social, cognitive, and emotional well-being can be realized.

METHODOLOGY

This research will be carried out using multiple research methods. As mentioned in the theoretical framework, existing theories will serve as a guideline for developing arguments and defining key concepts within the research. Literature review will be conducted to gain insights into these existing theories and to gather information regarding expanded cork. Given the sensorial nature of the subject matter, the majority of the research will be executed through a series of carefully designed experiments.

Literature review

The literature review to be undertaken in this research serves a threefold purpose, focusing on three distinct areas of knowledge: expanded cork, multi-sensory user perception, and multi-sensory design. The examination of expanded cork will draw extensively from Wilton and Howland's Cork Construction Kit (2020), which promises to offer valuable insights into the material and its architectural applications. Furthermore, the defining of guidelines for multi-sensory user experience will rely on established theories, such as J.J. Gibson's influential work on ecological perception theory (1981). Finally, Schifferstein's publication Multi-Sensory Design (2011) will be examined to facilitate the translation of these theoretical foundations into practical design strategies. This comprehensive literature review will provide a knowledge base for the forthcoming research, bridging the domains of material science, sensory perception, and architectural design.

Experimenting

An experiment will be conducted to gain deeper insights into the user's perception of expanded cork. A total of 50 participants will be presented with a 200 mm x 200 mm expanded cork board. The participants will be organized into five smaller groups, with four groups

focusing on individual senses, and one group engaging all senses simultaneously. The experiment will be carried out in distinct phases to systematically explore the sensory dimensions.
To evaluate the visual qualities of expanded cork, participants will be instructed to observe the expanded cork board without physical contact. As defined in the research of Dümen et al. (2022) Unfolding the material: A proposal of a multi-sensory experience oriented material exhibition medium, visual perception can be determined by the texture, colour, thickness and transparency.
In addition, the research of Dümen et al. (2022) offers a method for evaluating haptic or tactile material qualities. Participants can touch, lift or apply pressure to the expanded cork board, therefore experiencing its texture, temperature, hardness, stiffness, elasticity and weight.
To assess the olfactory qualities of expanded cork, participants will be instructed to exclusively focus

on the sense of smell while eliminating the other senses, such as by wearing a blindfold. Following the olfactory experience, they will be asked to assess the aroma based on various criteria. These criteria, as defined in McLean's study titled Nose-first: Practices of Smellwalking and Smellscape Mapping (2019), include aspects like the strength of the scent, its duration, personal preferences (liking or disliking the scent) and any associations the scent may evoke in the user.
Finally, the acoustic qualities of expanded cork will be analyzed by the participants, who will engage their auditory sense in the assessment. The focal point of this evaluation will be the material's sound absorption, shedding light on its potential contributions to acoustic comfort and quality within architectural environments.

This experiment, however, only assesses the user's perception of the material on a limited scale of 200 mm x 200 mm. In the field of architecture, expanded cork is typically applied over larger surfaces, often in combination with other materials, like glass. This might cause apparent variations in the results of the user's perception of this controlled experiment setting, versus the user's perception of the material in the applied environment.
In addition, the surrounding context can potentially influence the multi-sensory experience. Sounds, smells and even lights of the city or landscape can overtake the user's sensory impressions. On the contrary, the experience can be intensified by the context. For example, the aucoustic qualities of expanded cork are mostly noticeable when surrounding noise is present.

Case study
Consequently, a case study will be conducted to examine how the surrounding context and architectural scale impact the multi-sensory experience of users. The chosen site for this investigation is the Float in Leiden, a houseboat designed by studio RAP in 2022. This case study will also consider the interplay with other materials. Notably, the large, translucent glass doors and windows are in contrast with the expanded cork facade cladding, adding an extra layer to the sensory experience.

After conducting extensive research, a conclusion will be reached, ultimately forming design strategies for using expanded cork in the architectural field. However, the extent to which cork facades contribute to multi-sensory architecture will depend on how architects and designers integrate these qualities into their projects. For some projects, the focus on sensory experiences may be more pronounced, while in others, it may play a supporting role.

Figure 1: Conceptual diagram of research (own work)

EXPANDED CORK

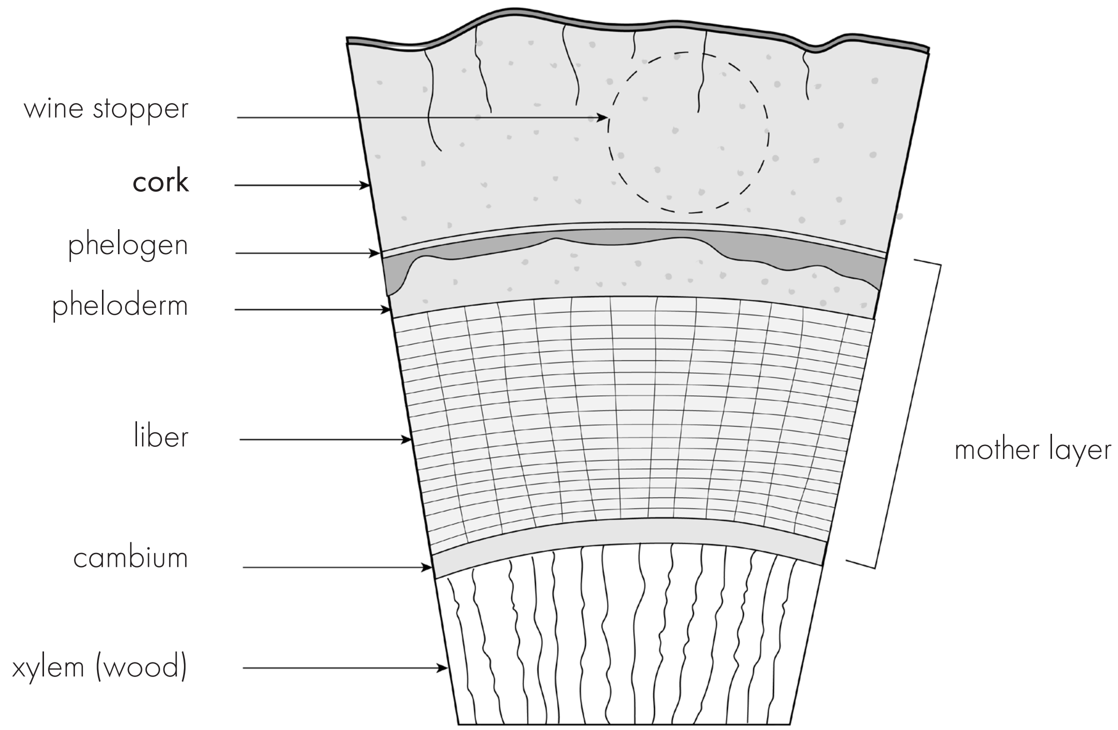
In the early stages of the project, extensive research was dedicated to exploring the properties and applications of expanded cork as a building material. This additional information provides insights into the manufacturing process, environmental benefits, and practical uses of expanded cork within architectural contexts.

EXPANDED CORK

Cork is the bark of thee cork oak (Querqus Suber), which grows in the Mediterranean and Iberian region. It is a whimsical tree that tends to grow crooked, 10 to 20 meters high and can live 150 up to 200 years. The tree crown is very light and open and consists of branches with long, oval-shaped, grey-green leaves. It grows best on granitic soils without limestone, such as those found in Portugal, Spain, southern France, Italy and the Maghreb.

Cork is formed by the phelogen located in the outer bark of the cork oak. It can be easily stripped off without damaging the tree. In turn, the tree responds by regenerating new phelogen, causing an increase of carbon consumption by three to five times.

The continuous cell formation provides an insulating layer against the high summer heat. Without this protection, the tree would dry out. In addition, the bark also protects the tree from other external influences. Even in the event of a fire, the bark protects the trunk, so that at a later stage the tree can still form branches and leaves again.



Fg. 1 section of cork (own work)

LIFECYCLE & PRODUCTION PROCESS

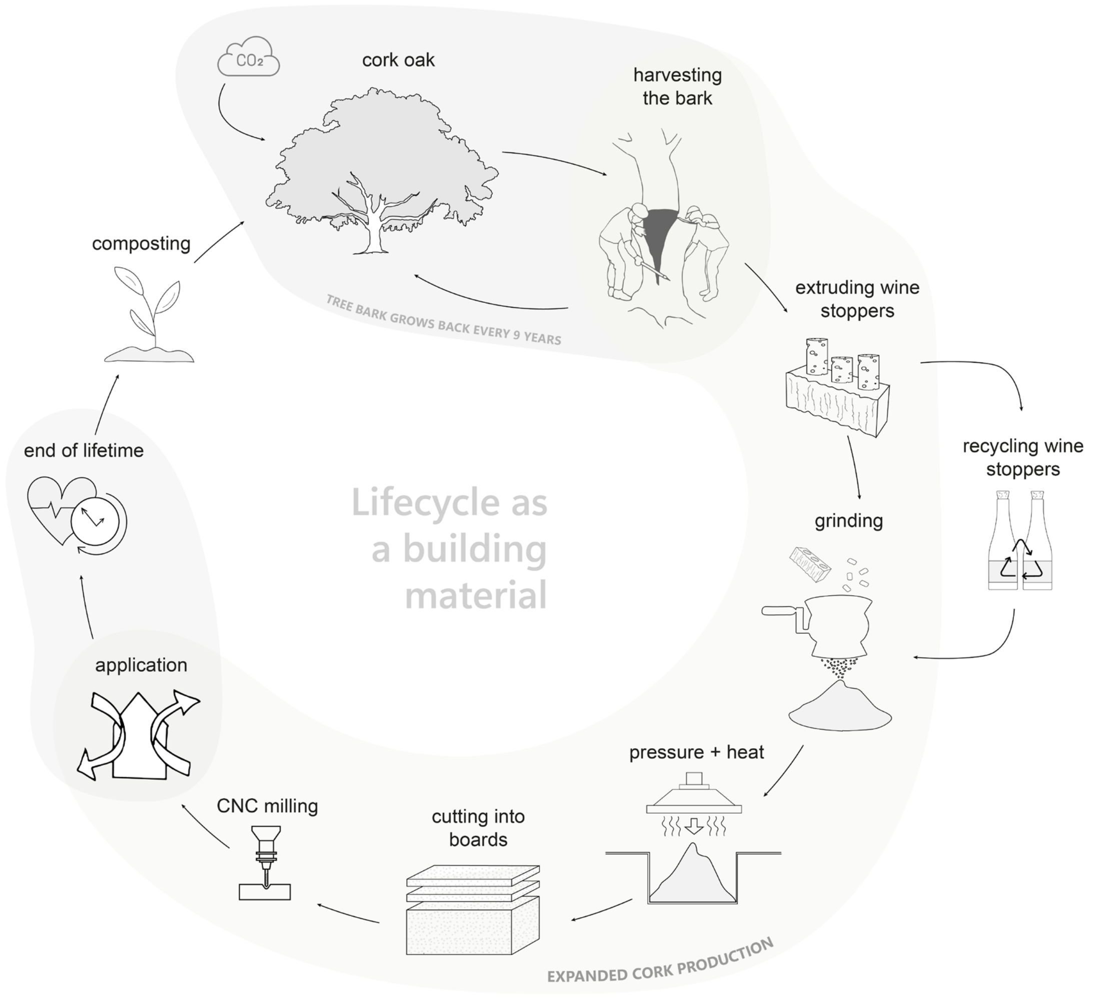
Cork comes from the bark of the cork oak tree (Quercus suber). Cork bark is unique in that it has a thick outer layer that can be removed without killing the tree. This means that cork is harvested without ever cutting down a tree or killing it. It takes between nine and twelve years for the cork tree to regrow its thick bark, at which time it can be harvested again. Since cork trees can live for more than 200 years, each tree can be harvested as many as 15 times. Remarkably, harvesting the cork oak's bark boosts the tree's carbon consumption by three to five times.

After boiling, drying and flattening the bark, the first cork product can be procuded by extruding wine stoppers. The residual bark, together with recycled wine stoppers, is ground into small granules. The size of the granules can be adjusted to suit the intended application.

After the granulation processes, the agglomeration of the cork is done using overheated water steam, at a temperature between 300ºC - 370ºC using a steam boiler, in which +90% of energy consumption is biomass (Amorim Cork Insulation, n.d.). The agglomeration of the granules is achieved through the resins of the cork itself, more specifically the suberin, making expanded cork (also known as black cork) 100% natural.

After being molded, the cork products are left to cure for a specific period of time. During this phase, the adhesive sets and the cork hardens, ensuring the product maintains its shape and structural integrity. Once the curing process is complete, the expanded cork products are often trimmed or cut to precise dimensions and finished to achieve the desired surface texture or appearance.

In addition to the 100% natural expanded cork boards mentioned before, agglomerated or pressed cork is also commenly used in household products. The production process is simular, but varies in the method of binding the cork granules. Pressed cork is moulded without the use of heat, therefore not utilizing the material's natural rasin. Instead, agglomerated cork is a mixture of natural cork and a synthetic bonding agent (polyurethane), and it therefore ceases to be a 100% natural product.



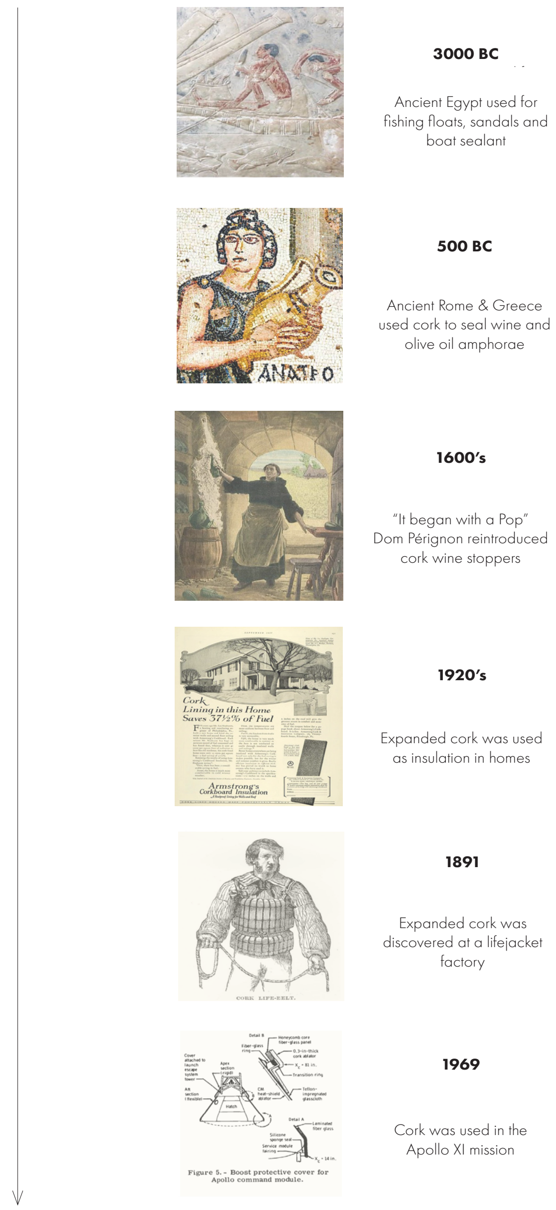
Fg. 1 lifecycle and production process of expanded cork (own work)

HISTORICAL APPLICATIONS

Cork has a history that spans thousands of years. Its usage can be traced back to ancient civilizations, with early evidence of cork found in Ancient Egyptian tombs. The Ancient Greeks and Romans utilized cork for a range of purposes, from sealing amphorae (storage jars) to crafting sandals. However, cork's prominence grew significantly during the 17th century when Dom Pierre Perignon, a French monk, popularized its use in sealing wine bottles. Cork's unique qualities, such as its buoyancy, flexibility, and insulation properties, made it a coveted material in a wide array of applications.

Expanded cork, a material made by using cork's suberin to bind granules, was only discovered in1891at John T.smith's buoy and life jacket factory. At that time, the filling of life jackets was done using a metal cylinder that allowed the life jacket to be kept open while workers filled the same cylinder with granulated cork. One of the cylinders clogged and was set aside but inadvertently rolled into a brazier and went unnoticed until the next morning. The next day, while cleaning the ashes from the brazier, they noticed that the cork inside the cylinder had not been burnt and that the heat had been enough to bind the whole mass into a single chocolate-brown shape. The expansion of the cork granules had formed air pockets within the block, enhancing its insulation properties.

These qualities were utilized in the 1920's when expanded cork boards were installed to insulate American homes. Even NASA recongized cork's amazing properties and has integrated the material into multiple spacecrafts and rockets, starting with the Apollo XI mission, that put the first men on the moon.



Fg. 1 timeline of cork application (own work)

TECHNICAL COMPARISON

The compressive strength of expanded cork notably differs from that of concrete, being significantly lower (CORKLINK & Westfield Technologies Lda, n.d.). However, it's important to highlight that, despite this lower strength, expanded cork is comparatively stronger due to its lower density. Moreover, the production of expanded cork requires significantly lower temperatures than concrete. Another noteworthy aspect is cork's impressively low embodied carbon footprint of 0 kg CO2/m³, signifying an environmentally friendly manufacturing process with minimal to no carbon emissions. This makes it a sustainable choice for construction, in contrast to concrete, which has a considerably higher embodied carbon footprint of approximately 105 kg CO2 per cubic meter (m³).

Beyond its structural characteristics, expanded cork exhibits commendable insulating properties, which are on par with traditional insulation materials such as rock wool. In addition to its insulating qualities, expanded cork delivers excellent acoustic performance.

Furthermore, expanded cork is suitable for use as an exterior facade cladding, as it is both water- and fireproof.

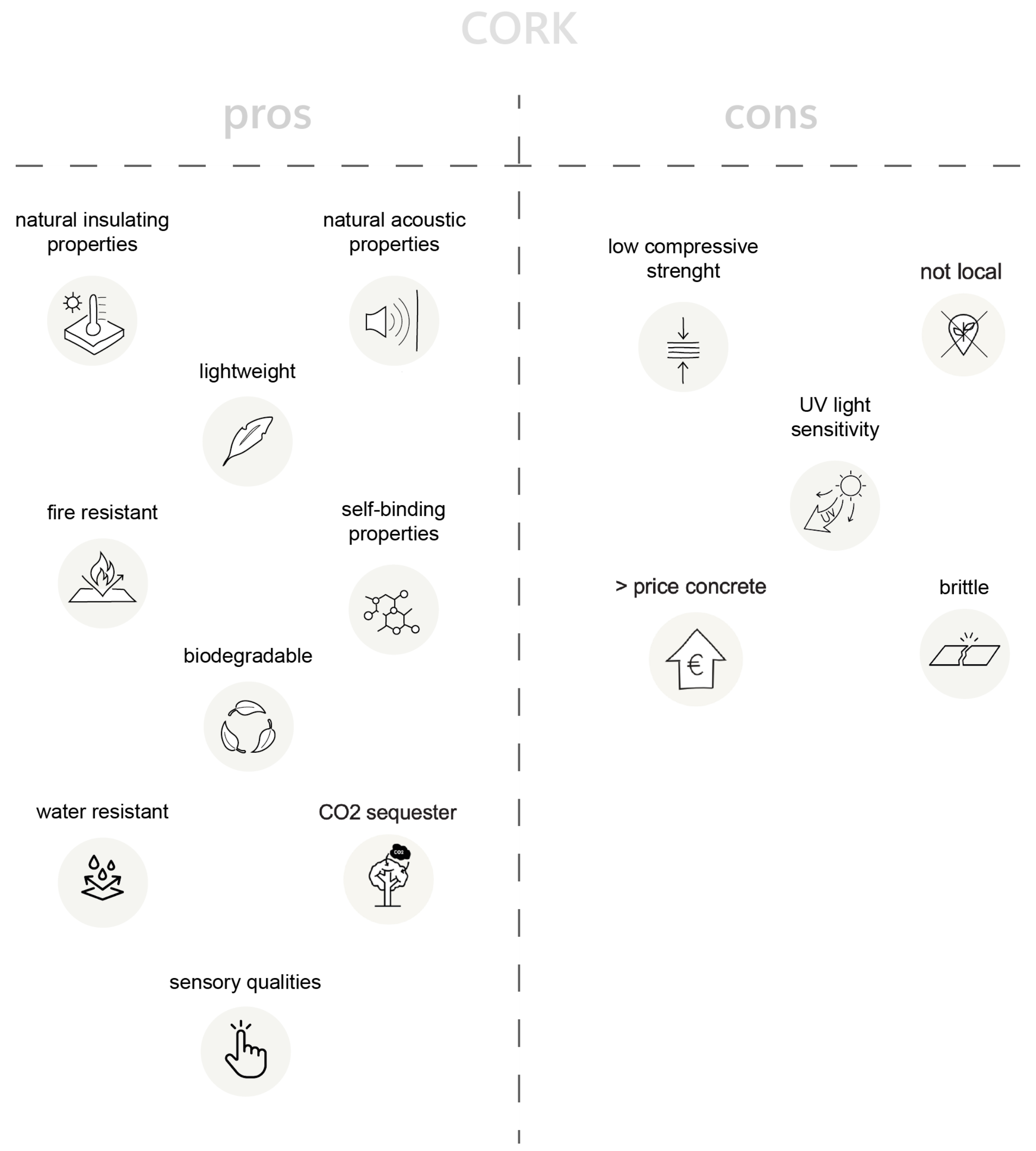
	Expanded Cork	Concrete
Ultimate compression	3 MPa	24 MPa
Density	125 kg/m3	2.400 kg/m3
Temperature to Produce	370 °C	1400 °C
Embodied Carbon footprint	0 KgCO2/m³	105 KgCO2/m³

	Expanded Cork	Rock wool
Thermal conductivity	0.040 W/(mK)	0.044 W/(m*K)

Fg. 1 technical comparison of expanded cork & concrete (own work)

PROS & CONS

Cork as a building material has multiple advantages as well as disadvantages. The following diagram gives an overview of the pros and cons of expanded cork as a building material.



Fg. 1 overview of pros & cons of expanded cork (own work)

EXPERIMENT RESULTS

This section presents the comprehensive results of the tactile experiment, which aimed to explore the emotional and sensory responses elicited by different materials. Participants, with varying backgrounds, were asked to touch and feel a selection of materials without visual input and express their immediate thoughts and feelings.

Their responses were carefully recorded and analyzed, revealing a spectrum of emotional reactions. These reactions were then categorized and ranked as positive, neutral, or negative. The findings provide valuable insights into how tactile qualities of materials can influence emotional experiences, informing future design choices that prioritize sensory and emotional engagement.

Participant 1

Name: Jeanne
Age: 82
Gender: female

Experiment date: 25/12/2023

Participant 1 was given all materials through the ‘feeling box’ method. She was asked the following questions for each material:

Does the material feel smooth of rough?
Does the material feel warm or cold?
Does the material feel fexible or stiff?
Does the material feel dry or damp?

Do you have any idea what the material is?
What is your impression after feeling the material?

Can you grade the experience of feeling this material on a scale from 1 to 10?

amount of steps in production process

natural elements	living materials	biobased raw	biobased processed	earth	other
water smooth cold very flexible not prickly very damp feels like water ‘erg nat’ 6	sedum smooth cold flexible not prickly damp feels like rubber ‘vies’ 4	reed leaves rough - flexible prickly dry feels like staw - -		clay smooth very cold stiff not prickly damp feels like clay ‘niet fijn’ 4	
	moss - cold very flexible not prickly bit damp feels like sponge ‘wel fijn’ 7	reed stems very rough cold stiff very prickly dry - ‘niet fijn’ 3	coco fibre very rough cold flexible very prickly dry feels like carpeting ‘niet fijn’ 4	pebbles rough cold stiff not prickly damp feels like pebbles ‘niet bijzonder fijn’ 6	
		cork bark rough - stiff not prickly dry feels like bark ‘prima’ 7	wood smooth - stiff not prickly dry feels like plastic - 7	brick rough cold stiff prickly damp feels like brick ‘niet zo fijn’ 5	glass smooth cold stiff not prickly dry feels like glass ‘niet bijzonder’ 6
		straw rough - flexible prickly dry feels like straw - 3	expanded cork rough warm stiff not prickly dry feels like cork - 7		metal smooth very cold stiff not prickly dry feels like metal ‘niet heel fijn’ 5
		wool rough warm stiff not prickly dry feels like rockwool ‘prettig’ 8	felt smooth warm flexible not prickly dry feels like insulation ‘fijn’ 7		plastic smooth cold stiff not prickly damp feels like a tile - 6

Participant 1

Name: Jeanne
Age: 82
Gender: female

Experiment date: 25/12/2023

Participant 1 was given all materials through the ‘feeling box’ method. She was asked the following questions for each material:

Does the material feel smooth of rough?
Does the material feel warm or cold?
Does the material feel fexible or stiff?
Does the material feel dry or damp?

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What is your impression after feeling the material?

Can you grade the experience of feeling this material on a scale from 1 to 10?

amount of steps in production process

natural elements	living materials	biobased raw	biobased processed	earth	other
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	moss - cold very flexible not prickly bit damp feels like sponge ‘wel fijn’ 7	reed stems very rough cold stiff very prickly dry - ‘niet fijn’ 3	coco fibre very rough cold flexible very prickly dry feels like carpeting ‘niet fijn’ 4	pebbles rough cold stiff not prickly damp feels like pebbles ‘niet bijzonder fijn’ 6	
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		straw rough - flexible prickly dry feels like straw - 3	expanded cork rough warm stiff not prickly dry feels like cork - 7		metal smooth very cold stiff not prickly dry feels like metal ‘niet heel fijn’ 5
		wool rough warm stiff not prickly dry feels like rockwool ‘prettig’ 8	felt smooth warm flexible not prickly dry feels like insulation ‘fijn’ 7		plastic smooth cold stiff not prickly damp feels like a tile - 6

Participant 2

Name: Koos
Age: 80
Gender: male

Experiment date: 25/12/2023

Participant 2 was given all materials through the 'feeling box' method. He was asked the following questions for each material:

Does the material feel smooth of rough?
Does the material feel warm or cold?
Does the material feel fexible or stiff?
Does the material feel dry or damp?

Do you have any idea what the material is?

What is your impression after feeling the material?

Can you grade the experience of feeling this material on a scale from 1 to 10?

amount of steps in production process ↓

natural elements	living materials	biobased raw	biobased processed	earth	other
water smooth cold flexible prickly very damp feels like water - 7	sedum smooth - flexible not prickly very damp feels like plant 'modderig' 6	reed leaves rough warm flexible not prickly dry feels like straw - 8		clay smooth very cold flexible not prickly damp feels like clay 'plakkerig' 6	
	moss rough - flexible not prickly bit damp feels like moss 'erg fijn' 8	reed stems very rough - stiff very prickly dry - - 3	coco fibre rough - flexible very prickly dry feels like a brush 'niet heel fijn' 6	pebbles rough - flexible not prickly damp feels like fine gravel 'hoekig' 7	
		cork bark rough - flexible a bit prickly dry feels like reed 'stro rechtop' -	wood smooth warm stiff not prickly dry feels like tile - 7	brick rough cold stiff not prickly dry feels like brick 'niet bijzonder' 6	glass smooth cold stiff not prickly dry feels like glass 'glad en scherp' 7
		straw rough - flexible prickly dry feels like woodwool 7	expanded cork smooth but rough warm stiff not prickly dry feels like cork 'kan het indeuken' 7		metal smooth very cold stiff not prickly dry feels like metal can 'heel koud' 5
		wool rough warm very flexible not prickly dry feels like pillow fill 'zacht' 8	felt rough warm flexible not prickly dry feels like felt 'prima' 7		plastic very smooth cold stiff not prickly damp feels like stone, tile or marble 6

Participant 2

Name: Koos
Age: 80
Gender: male

Experiment date: 25/12/2023

Participant 2 was given all materials through the 'feeling box' method. He was asked the following questions for each material:

Does the material feel smooth of rough?
Does the material feel warm or cold?
Does the material feel fexible or stiff?
Does the material feel dry or damp?

Do you have any idea what the material is?

What is your impression after feeling the material?

Can you grade the experience of feeling this material on a scale from 1 to 10?

amount of steps in production process ↓

natural elements	living materials	biobased raw	biobased processed	earth	other
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	moss rough - flexible not prickly bit damp feels like moss 'erg fijn' 8	reed stems very rough - stiff very prickly dry - - 3	coco fibre rough - flexible very prickly dry feels like a brush 'niet heel fijn' 6	pebbles rough - flexible not prickly damp feels like fine gravel 'hoekig' 7	
		cork bark rough - flexible a bit prickly dry feels like reed 'stro rechtop' -	wood smooth warm stiff not prickly dry feels like tile - 7	brick rough cold stiff not prickly dry feels like brick 'niet bijzonder' 6	glass smooth cold stiff not prickly dry feels like glass 'glad en scherp' 7
		straw rough - flexible prickly dry feels like woodwool 7	expanded cork smooth but rough warm stiff not prickly dry feels like cork 'kan het indeuken' 7		metal smooth very cold stiff not prickly dry feels like metal can 'heel koud' 5
		wool rough warm very flexible not prickly dry feels like pillow fill 'zacht' 8	felt rough warm flexible not prickly dry feels like felt 'prima' 7		plastic very smooth cold stiff not prickly damp feels like stone, tile or marble 6

Participant 3

Name: José
Age: 82
Gender: female

Experiment date: 25/12/2023

Participant 3 was given all materials through the 'feeling box' method. She was asked the following questions for each material:

Does the material feel smooth of rough?
Does the material feel warm or cold?
Does the material feel fexible or stiff?
Does the material feel dry or damp?

Do you have any idea what the material is?

What is your impression after feeling the material?

Can you grade the experience of feeling this material on a scale from 1 to 10?

amount of steps in production process ↓

natural elements	living materials	biobased raw	biobased processed	earth	other
water smooth cold flexible not prickly very damp feels like water - 5	sedum rough cold flexible not prickly very damp feels like plants 'niet fijn' 4	reed leaves rough - flexible prickly dry feels like staw - 5		clay smooth cold flexible not prickly damp feels like clay 'vies' 4	
	moss smooth - flexible not prickly damp feels like grass - 6	reed stems rough - stiff very prickly very dry feels like bark 'niet fijn' 4	coco fibre very rough - not flexible very prickly dry feels like a broom 'te ruw' 3	pebbles - cold medium flexible not prickly - feels like pebbles 'niet bijzonder' 6	
		cork bark rough warm stiff prickly dry feels like wood - 6	wood smooth warm stiff not prickly dry feels like wood - 6	brick rough cold stiff not prickly dry feels like brick - 4	glass smooth cold stiff not prickly dry feels like glass 'scherpe randjes' 5
		straw rough - flexible prickly dry feels like straw - 4	expanded cork rough but smooth - stiff not prickly dry feels like cork - 6		metal smooth cold stiff not prickly dry feels like metal - 6
		wool rough warm flexible not prickly dry feels like wool 'lekker zacht' 7	felt smooth warm flexible not prickly dry feels like cotton swaps 7		plastic smooth - stiff not prickly dry feels like a bathroom tile 6

Participant 3

Name: José
Age: 82
Gender: female

Experiment date: 25/12/2023

Participant 3 was given all materials through the 'feeling box' method. She was asked the following questions for each material:

Does the material feel smooth of rough?
Does the material feel warm or cold?
Does the material feel fexible or stiff?
Does the material feel dry or damp?

Do you have any idea what the material is?

What is your impression after feeling the material?

Can you grade the experience of feeling this material on a scale from 1 to 10?

amount of steps in production process ↓

natural elements	living materials	biobased raw	biobased processed	earth	other
water smooth cold flexible not prickly very damp feels like water - 5	sedum rough cold flexible not prickly very damp feels like plants 'niet fijn' 4	reed leaves rough - flexible prickly dry feels like staw - 5		clay smooth cold flexible not prickly damp feels like clay 'vies' 4	
	moss smooth - flexible not prickly damp feels like grass - 6	reed stems rough - stiff very prickly very dry feels like bark 'niet fijn' 4	coco fibre very rough - not flexible very prickly dry feels like a broom 'te ruw' 3	pebbles - cold medium flexible not prickly - feels like pebbles 'niet bijzonder' 6	
		cork bark rough warm stiff prickly dry feels like wood - 6	wood smooth warm stiff not prickly dry feels like wood - 6	brick rough cold stiff not prickly dry feels like brick - 4	glass smooth cold stiff not prickly dry feels like glass 'scherpe randjes' 5
		straw rough - flexible prickly dry feels like straw - 4	expanded cork rough but smooth - stiff not prickly dry feels like cork - 6		metal smooth cold stiff not prickly dry feels like metal - 6
		wool rough warm flexible not prickly dry feels like wool 'lekker zacht' 7	felt smooth warm flexible not prickly dry feels like cotton swaps 7		plastic smooth - stiff not prickly dry feels like a bathroom tile 6

Participant 4

Name: Karlijn
Age: 20
Gender: female

Experiment date: 25/12/2023

Participant 4 was given all materials through the 'blindfolded' method. She was asked the following questions for each material:

What is your impression after feeling the material?

Do you have any idea what the material is?

Can you grade the experience of feeling this material on a scale from 1 to 10?

amount of steps in production process

natural elements	living materials	biobased raw	biobased processed	earth	other
water 'heel nat haha' feels like water 7	sedum 'prima, maar nat' feels like a plant 6	reed leaves 'iets fijner dan stro' feels like straw but different -		clay 'ew plakkerig' feels like butter or clay erasers 5	
	moss 'lekker zacht' feels like moss 7	reed stems 'prikt heel erg' feels like bark 4	coco fibre 'niet zo prettig' feels like doormat 5	pebbles 'koud & ruw' feels like pebbles 7	
		cork bark 'heel ruw' - -	wood 'prima' feels like real wood -	brick 'ruw & korrelig' feels like brick -	glass 'koud' feels like glass -
		straw 'niet echt fijn' feels like straw -	expanded cork 'wel lekker zacht maar ook hard' feels like cork 6		metal 'glad' feels like a metal can -
		wool 'zacht maar ook ruw' feels like wool 8	felt 'zacht en flexibel' feels like felt -		plastic 'hard' feels like wood 7

Participant 4

Name: Karlijn
Age: 20
Gender: female

Experiment date: 25/12/2023

Participant 4 was given all materials through the 'blindfolded' method. She was asked the following questions for each material:

What is your impression after feeling the material?

Do you have any idea what the material is?

Can you grade the experience of feeling this material on a scale from 1 to 10?

amount of steps in production process

natural elements	living materials	biobased raw	biobased processed	earth	other
water 'heel nat haha' feels like water 7	sedum 'prima, maar nat' feels like a plant 6	reed leaves 'iets fijner dan stro' feels like straw but different -		clay 'ew plakkerig' feels like butter or clay erasers 5	
	moss 'lekker zacht' feels like moss 7	reed stems 'prikt heel erg' feels like bark 4	coco fibre 'niet zo prettig' feels like doormat 5	pebbles 'koud & ruw' feels like pebbles 7	
		cork bark 'heel ruw' - -	wood 'prima' feels like real wood -	brick 'ruw & korrelig' feels like brick -	glass 'koud' feels like glass -
		straw 'niet echt fijn' feels like straw -	expanded cork 'wel lekker zacht maar ook hard' feels like cork 6		metal 'glad' feels like a metal can -
		wool 'zacht maar ook ruw' feels like wool 8	felt 'zacht en flexibel' feels like felt -		plastic 'hard' feels like wood 7

Participant 5

Name: Marieke
Age: 52
Gender: female

Experiment date: 25/12/2023

Participant 5 was given all materials through the 'blindfolded' method. She was asked to say anything that came to mind while feeling the material.

The answer were given in Dutch.

amount of steps in production process

natural elements

water
'water'
'koud'

living materials

sedum
'grote krullen'
'nat'
'plantjes, vetplantjes voor op een dak'

moss
'fijner dan sedum, maar ook gek'
'plakkerig, nat'
'krullen'

biobased raw

reed leaves
'rieten dak'
'prikt'
'stro?'

reed stems
'huh, heh?'
'ribbeltjes, ribkarton?'
'boomschors?'
'wat is dit?'

cork bark
'schors'
'hetzelfde als kurk maar harder'

straw
'fijner dan die bladeren'

wool
'kussenvulling'
'lekker, fijn, zacht'
'warm worden'

biobased processed

coco fibre
'vloerbedekking van vroeger'
'niet zo fijn'
'kokos'

wood
'hout'
'warmer'
'fijn, beter'

expanded cork
'dofheid'
'warmte, rust, zacht, veert'
'kurk'
'traumasensitief'

felt
'vilt'
'fijn'

earth

clay
'wat is dit?'
'bah!'
'koud'
'klei?'
'blijft aan handen plakken'

pebbles
'koud, nat?'
'het gewicht voelt wel fijn'
'kiezeltjes'
'niet zo fijn in je schoenen'

brick
'baksteen'

other

glass
'scherp'
'glas'

metal
'blik'
'aluminium'
tikt erop
'je hoort het'

plastic
'minder scherp dan glas'
'wel hard & koud'

Participant 5

Name: Marieke
Age: 52
Gender: female

Experiment date: 25/12/2023

Participant 5 was given all materials through the 'blindfolded' method. She was asked to say anything that came to mind while feeling the material.

The answer were given in Dutch.

amount of steps in production process

natural elements

water
'water'
'koud'

living materials

sedum
'grote krullen'
'nat'
'plantjes, vetplantjes voor op een dak'

moss
'fijner dan sedum, maar ook gek'
'plakkerig, nat'
'krullen'

biobased raw

reed leaves
'rieten dak'
'prikt'
'stro?'

reed stems
'huh, heh?'
'ribbeltjes, ribkarton?'
'boomschors?'
'wat is dit?'

cork bark
'schors'
'hetzelfde als kurk maar harder'

straw
'fijner dan die bladeren'

wool
'kussenvulling'
'lekker, fijn, zacht'
'warm worden'

biobased processed

coco fibre
'vloerbedekking van vroeger'
'niet zo fijn'
'kokos'

wood
'hout'
'warmer'
'fijn, beter'

expanded cork
'dofheid'
'warmte, rust, zacht, veert'
'kurk'
'traumasensitief'

felt
'vilt'
'fijn'

earth

clay
'wat is dit?'
'bah!'
'koud'
'klei?'
'blijft aan handen plakken'

pebbles
'koud, nat?'
'het gewicht voelt wel fijn'
'kiezeltjes'
'niet zo fijn in je schoenen'

brick
'baksteen'

other

glass
'scherp'
'glas'

metal
'blik'
'aluminium'
tikt erop
'je hoort het'

plastic
'minder scherp dan glas'
'wel hard & koud'

Participant 6

Name: Roel
Age: 17
Gender: male

Experiment date: 25/12/2023

Participant 6 was given all materials through the 'blindfolded' method. He was asked to say anything that came to mind while feeling the material.

The answer were given in Dutch.

amount of steps in production process

natural elements	living materials	biobased raw	biobased processed	earth	other
water 'water' 'spetteren'	sedum 'huh wat is dit?' 'leeft dit?'	reed leaves 'leuk' 'friemelen'		clay 'klei' 'niet fijn' 'nat'	
	moss 'gras maar net niet' 'nep gras?' 'gek, raar, zacht' 'ook een beetje ruw'	reed stems 'gaas + papier'	coco fibre 'kunstgras' 'lekker voor buiten maar niet voor binnen'	pebbles 'zwaar' 'steentjes' 'wel fijn' 'koud, maar fijn koud'	
		cork bark 'tak' 'karton' 'ruw' 'hout?'	wood 'hout' 'licht' 'schutting'	brick 'baksteen'	glass 'glas' 'glad' 'breekbaar' 'wel fijn'
		straw 'hooi' 'konijnenhok'	expanded cork 'piepschuim?' 'voelt bekend' 'kurk'		metal 'metaal' 'licht' 'handig'
		wool 'wollig' 'vulling van een knuffel' 'lekker'	felt 'matje voor prikken op basisschool' 'zacht' 'veiligheid'		plastic 'glad, fijn' 'dempend' 'stuk bowlingbaan' 'gymzaalvloer maar harder' 'plastic omheen'

Participant 6

Name: Roel
Age: 17
Gender: male

Experiment date: 25/12/2023

Participant 6 was given all materials through the 'blindfolded' method. Heewas asked to say anything that came to mind while feeling the material.

The answer were given in Dutch.

amount of steps in production process

natural elements	living materials	biobased raw	biobased processed	earth	other
water 'water' 'spetteren'	sedum 'huh wat is dit?' 'leeft dit?'	reed leaves 'leuk' 'friemelen'		clay 'klei' 'niet fijn' 'nat'	
	moss 'gras maar net niet' 'nep gras?' 'gek, raar, zacht' 'ook een beetje ruw'	reed stems 'gaas + papier'	coco fibre 'kunstgras' 'lekker voor buiten maar niet voor binnen'	pebbles 'zwaar' 'steentjes' 'wel fijn' 'koud, maar fijn koud'	
		cork bark 'tak' 'karton' 'ruw' 'hout?'	wood 'hout' 'licht' 'schutting'	brick 'baksteen'	glass 'glas' 'glad' 'breekbaar' 'wel fijn'
		straw 'hooi' 'konijnenhok'	expanded cork 'piepschuim?' 'voelt bekend' 'kurk'		metal 'metaal' 'licht' 'handig'
		wool 'wollig' 'vulling van een knuffel' 'lekker'	felt 'matje voor prikken op basisschool' 'zacht' 'veiligheid'		plastic 'glad, fijn' 'dempend' 'stuk bowlingbaan' 'gymzaalvloer maar harder' 'plastic omheen'

Participant 7

Name: Lucas
Age: 52
Gender: male

Experiment date: 25/12/2023

Participant 7 was given all materials through the ‘blindfolded’ method. He was asked to say anything that came to mind while feeling the material.

The answer were given in Dutch.

amount of steps in production process

natural elements	living materials	biobased raw	biobased processed	earth	other
water ‘water’	sedum ‘water plantjes’	reed leaves ‘bladeren’		clay ‘klei’	
	moss ‘mos’	reed stems ‘riet’ ‘graanstengels’	coco fibre ‘deurmat’	pebbles ‘steentjes’	
		cork bark ‘boomschors’	wood ‘houten plank’	brick ‘baksteen’	glass ‘glas’
		straw ‘hooi’	expanded cork ‘kapot breken’ ‘piepschuim’ ‘kurk’		metal ‘metaal’
		wool ‘prikt een beetje’ ‘uit elkaar trekken’	felt ‘vilt’		plastic ‘randjes’ ‘laagjes’ ‘gelamineerd hout’ ‘glad’

Participant 7

Name: Lucas
Age: 52
Gender: male

Experiment date: 25/12/2023

Participant 7 was given all materials through the ‘blindfolded’ method. He was asked to say anything that came to mind while feeling the material.

The answer were given in Dutch.

amount of steps in production process

natural elements	living materials	biobased raw	biobased processed	earth	other
water ‘water’	sedum ‘water plantjes’	reed leaves ‘bladeren’		clay ‘klei’	
	moss ‘mos’	reed stems ‘riet’ ‘graanstengels’	coco fibre ‘deurmat’	pebbles ‘steentjes’	
		cork bark ‘boomschors’	wood ‘houten plank’	brick ‘baksteen’	glass ‘glas’
		straw ‘hooi’	expanded cork ‘kapot breken’ ‘piepschuim’ ‘kurk’		metal ‘metaal’
		wool ‘prikt een beetje’ ‘uit elkaar trekken’	felt ‘vilt’		plastic ‘randjes’ ‘laagjes’ ‘gelamineerd hout’ ‘glad’

Participant 8

Name: Mitchell
Age: 30
Gender: male

Experiment date: 26/12/2023

Participant 8 was given all materials through the 'blindfolded' method. He was asked to say anything that came to mind while feeling the material.

The answer were given in Dutch.

amount of steps in production process

natural elements	living materials	biobased raw	biobased processed	earth	other
water 'water' 'natte vingers' 'spetteren'	sedum 'nat' 'plantjes'	reed leaves 'hoola rokjes' 'riet achtig?' 'feestje!' geluid speelt mee!		clay 'creativiteit' 'gum van vroeger' 'scheuren & kneden' 'koud'	
	moss 'natuur' 'mossig' 'snorkelen' 'onderwaterplant' 'gek maar fijn'	reed stems 'gestructe muur' 'niet aanzitten' 'gebergte met hoogtes' 'reliëf'	coco fibre 'sensatie' 'contrast voor- & achterkant' 'deurmat' 'niet pijnlijk'	pebbles 'zwaar' 'spelen' 'zen tuintje' 'egaal maken' 'prettig gevoel'	
		cork bark 'handen afdoen want voelt vies' 'boomschors' 'wil wel verder ontdekken'	wood 'fotolijstje' 'bewerkt hout'	brick 'baksteen' 'korrelig, maar ook massief'	glass 'glas' 'glad' 'breekbaar'
		straw 'konijnenhok'	expanded cork 'brokkelig' 'stevig piepschuim' 'kwetsbaar' 'prettig, luchtig' 'bros'		metal 'koud' 'steriel' 'industrieel'
		wool 'oeh, lekker' 'pluizig & warm' 'snel kapot' 'niet te hard trekken'	felt 'stevig maar flexibel' 'vilt-achtig' 'meer isolerend' 'niet vrolijk, saai' 'kantoorvloer'		plastic 'strak' 'hard' 'plastic' 'stevig, niet snel kapot' 'niet bijzonder'

Participant 8

Name: Mitchell
Age: 30
Gender: male

Experiment date: 26/12/2023

Participant 8 was given all materials through the 'blindfolded' method. He was asked to say anything that came to mind while feeling the material.

The answer were given in Dutch.

amount of steps in production process

natural elements	living materials	biobased raw	biobased processed	earth	other
water 'water' 'natte vingers' 'spetteren'	sedum 'nat' 'plantjes'	reed leaves 'hoola rokjes' 'riet achtig?' 'feestje!' geluid speelt mee!		clay 'creativiteit' 'gum van vroeger' 'scheuren & kneden' 'koud'	
	moss 'natuur' 'mossig' 'snorkelen' 'onderwaterplant' 'gek maar fijn'	reed stems 'gestructe muur' 'niet aanzitten' 'gebergte met hoogtes' 'reliëf'	coco fibre 'sensatie' 'contrast voor- & achterkant' 'deurmat' 'niet pijnlijk'	pebbles 'zwaar' 'spelen' 'zen tuintje' 'egaal maken' 'prettig gevoel'	
		cork bark 'handen afdoen want voelt vies' 'boomschors' 'wil wel verder ontdekken'	wood 'fotolijstje' 'bewerkt hout'	brick 'baksteen' 'korrelig, maar ook massief'	glass 'glas' 'glad' 'breekbaar'
		straw 'konijnenhok'	expanded cork 'brokkelig' 'stevig piepschuim' 'kwetsbaar' 'prettig, luchtig' 'bros'		metal 'koud' 'steriel' 'industrieel'
		wool 'oeh, lekker' 'pluizig & warm' 'snel kapot' 'niet te hard trekken'	felt 'stevig maar flexibel' 'vilt-achtig' 'meer isolerend' 'niet vrolijk, saai' 'kantoorvloer'		plastic 'strak' 'hard' 'plastic' 'stevig, niet snel kapot' 'niet bijzonder'

Participant 9

Name: Britt
Age: 24
Gender: female

Experiment date: 26/12/2023

Participant 9 was given all materials through the 'blindfolded' method. She was asked to say anything that came to mind while feeling the material.

The answer were given in Dutch.

amount of steps in production process

natural elements	living materials	biobased raw	biobased processed	earth	other
water 'ew' 'water'	sedum 'natte plantjes' 'beetje vies'	reed leaves 'hard & raar' 'riet' 'vingers verdwijnen erin'		clay 'ew, klei' 'zwaar & koud' 'niet fijn' 'duikt in'	
	moss 'zacht & donsig' 'mos' 'zitten er beestjes in?'	reed stems 'boom?' 'of toch niet?'	coco fibre 'hard & grof' 'borstelbezem' 'deurmat'	pebbles 'steentjes' 'ASMR' (fijn geluid) 'lekker maar onhandig'	
		cork bark 'voelt een beetje hetzelfde (als reed stems)' 'hoppelig' 'hard' 'ruw'	wood 'vloer' 'glad hout' 'lekker'	brick 'baksteen' 'zwaar & hard'	glass 'glad maar scherp' 'glas'
		straw 'stro' 'konijn' 'prikkelig'	expanded cork 'piepschuim?' 'harder dan piepschuim' 'deukjes' 'ongelijk'		metal 'koud' 'plaat'
		wool 'zacht' 'beter dan mos' 'krakelig' 'watjes' 'niet lekker genoeg'	felt 'trap vloerbedekking' 'stof' 'net niet zacht, maar ook niet stevig'		plastic 'glad' 'blokje hout' 'scherp' 'muurtegels'

Participant 9

Name: Britt
Age: 24
Gender: female

Experiment date: 26/12/2023

Participant 9 was given all materials through the 'blindfolded' method. She was asked to say anything that came to mind while feeling the material.

The answer were given in Dutch.

amount of steps in production process

natural elements	living materials	biobased raw	biobased processed	earth	other
water 'ew' 'water'	sedum 'natte plantjes' 'beetje vies'	reed leaves 'hard & raar' 'riet' 'vingers verdwijnen erin'		clay 'ew, klei' 'zwaar & koud' 'niet fijn' 'duikt in'	
	moss 'zacht & donsig' 'mos' 'zitten er beestjes in?'	reed stems 'boom?' 'of toch niet?'	coco fibre 'hard & grof' 'borstelbezem' 'deurmat'	pebbles 'steentjes' 'ASMR' (fijn geluid) 'lekker maar onhandig'	
		cork bark 'voelt een beetje hetzelfde (als reed stems)' 'hoppelig' 'hard' 'ruw'	wood 'vloer' 'glad hout' 'lekker'	brick 'baksteen' 'zwaar & hard'	glass 'glad maar scherp' 'glas'
		straw 'stro' 'konijn' 'prikkelig'	expanded cork 'piepschuim?' 'harder dan piepschuim' 'deukjes' 'ongelijk'		metal 'koud' 'plaat'
		wool 'zacht' 'beter dan mos' 'krakelig' 'watjes' 'niet lekker genoeg'	felt 'trap vloerbedekking' 'stof' 'net niet zacht, maar ook niet stevig'		plastic 'glad' 'blokje hout' 'scherp' 'muurtegels'

Participant 10

Name: Lisa
Age: 29
Gender: female

Experiment date: 26/12/2023

Participant 10 was given all materials through the ‘blindfolded’ method. She was asked to say anything that came to mind while feeling the material.

The answer were given in Dutch.

amount of steps in production process ↓

natural elements	living materials	biobased raw	biobased processed	earth	other
water ‘water’	sedum ‘nat’ ‘plantjes ofzo?’	reed leaves ‘riet’ ‘scherp’ ‘kiezels voelden lekkerder’		clay ‘klei’ ‘ruikt ook!’	
	moss ‘wat is dit?’ ‘mos?’ ‘minder fijn dan grind’ ‘ew’	reed stems ‘wat is dit?’ ‘hout?’	coco fibre ‘borstel’ ‘prikt een beetje’	pebbles ‘grint in vissenkom’ ‘ja lekker’ ‘strandstoel’	
		cork bark ‘boomschors’	wood ‘laminaat’ ‘groefjes’ ‘hout’	brick ‘koud’ ‘baksteen’	glass ‘spiegel’
		straw ‘stro’	expanded cork ‘piepschuim, maar zachter’ ‘ribbelig’ ‘zwaarder dan piepschuim’ ‘kinderpuzzel’		metal ‘metaal’ ‘lekker’
		wool ‘beter’ ‘lekker’ ‘wol’	felt ‘vilt matje voor naalden’		plastic ‘wat is dit?’ ‘plasitc’ ‘afgeslepen’

Participant 10

Name: Lisa
Age: 29
Gender: female

Experiment date: 26/12/2023

Participant 10 was given all materials through the ‘blindfolded’ method. She was asked to say anything that came to mind while feeling the material.

The answer were given in Dutch.

amount of steps in production process ↓

natural elements	living materials	biobased raw	biobased processed	earth	other
water ‘water’	sedum ‘nat’ ‘plantjes ofzo?’	reed leaves ‘riet’ ‘scherp’ ‘kiezels voelden lekkerder’		clay ‘klei’ ‘ruikt ook!’	
	moss ‘wat is dit?’ ‘mos?’ ‘minder fijn dan grind’ ‘ew’	reed stems ‘wat is dit?’ ‘hout?’	coco fibre ‘borstel’ ‘prikt een beetje’	pebbles ‘grint in vissenkom’ ‘ja lekker’ ‘strandstoel’	
		cork bark ‘boomschors’	wood ‘laminaat’ ‘groefjes’ ‘hout’	brick ‘koud’ ‘baksteen’	glass ‘spiegel’
		straw ‘stro’	expanded cork ‘piepschuim, maar zachter’ ‘ribbelig’ ‘zwaarder dan piepschuim’ ‘kinderpuzzel’		metal ‘metaal’ ‘lekker’
		wool ‘beter’ ‘lekker’ ‘wol’	felt ‘vilt matje voor naalden’		plastic ‘wat is dit?’ ‘plasitc’ ‘afgeslepen’

Participant 11

Name: Tjitske
Age: 11
Gender: female

Experiment date: 16/01/2024

Participant 11 was given all materials through the 'blindfolded' method. She was asked to say anything that came to mind while feeling the material.

The answer were given in Dutch.

amount of steps in production process ↓

natural elements	living materials	biobased raw	biobased processed	earth	other
water 'dit is water' 'natte vingers' 'wel leuk'	sedum 'ew' 'natte plantjes'	reed leaves 'glad maar de onderkant is prikkelig' 'ijslolliestokjes'		clay 'ew' 'is dit kaas?'	
	moss 'mos' 'zacht' 'indrukbaar' 'ja lekker maar ook een beetje vies'	reed stems 'bijenhotel' 'niet zo fijn'	coco fibre 'ew' 'spons' 'prikt een beetje'	pebbles 'vogelzaadjes' 'handen zijn stoffig' 'niet perse lekker maar wil wel graaien'	
		cork bark 'boomstam' 'hobbelig en scherp' 'niet zo fijn'	wood 'glad hout' 'beetje scherp'	brick 'baksteen' 'zwaar'	glass 'glad en scherp' *tikt erop*
		straw 'hooi' 'konijnenhok of cavia's'	expanded cork 'foam maar harder' 'wijnfles openen'		metal 'glad maar ook scherp' 'metaal' *tikt erop*
		wool 'teddybeer vulling' 'fijn' 'herkenbaar' 'kneden'	felt 'prikmatje op school in groep 6' 'ja lekker zacht als een kat'		plastic 'marmer' 'keukenaanrecht' 'glad maar scherpe randjes'

Participant 11

Name: Tjitske
Age: 11
Gender: female

Experiment date: 16/01/2024

Participant 11 was given all materials through the 'blindfolded' method. She was asked to say anything that came to mind while feeling the material.

The answer were given in Dutch.

amount of steps in production process ↓

natural elements	living materials	biobased raw	biobased processed	earth	other
water 'dit is water' 'natte vingers' 'wel leuk'	sedum 'ew' 'natte plantjes'	reed leaves 'glad maar de onderkant is prikkelig' 'ijslolliestokjes'		clay 'ew' 'is dit kaas?'	
	moss 'mos' 'zacht' 'indrukbaar' 'ja lekker maar ook een beetje vies'	reed stems 'bijenhotel' 'niet zo fijn'	coco fibre 'ew' 'spons' 'prikt een beetje'	pebbles 'vogelzaadjes' 'handen zijn stoffig' 'niet perse lekker maar wil wel graaien'	
		cork bark 'boomstam' 'hobbelig en scherp' 'niet zo fijn'	wood 'glad hout' 'beetje scherp'	brick 'baksteen' 'zwaar'	glass 'glad en scherp' *tikt erop*
		straw 'hooi' 'konijnenhok of cavia's'	expanded cork 'foam maar harder' 'wijnfles openen'		metal 'glad maar ook scherp' 'metaal' *tikt erop*
		wool 'teddybeer vulling' 'fijn' 'herkenbaar' 'kneden'	felt 'prikmatje op school in groep 6' 'ja lekker zacht als een kat'		plastic 'marmer' 'keukenaanrecht' 'glad maar scherpe randjes'

MODEL PHOTOS

The following model photos represent the culmination of hands-on work that significantly enriched my learning experience. Engaging directly with materials and construction techniques provided invaluable insights that theoretical studies alone could not offer.

Through building these models, I gained a deeper understanding of spatial relationships, structural integrity, and the practical application of my design concepts. This process of hands-on experimentation and iteration was crucial in refining my ideas and enhancing the overall design of the Museum of Emotions.


SCULPTING SENSATIONS *Crafting Emotional Narratives through Sensory Synergy in Architectural Spaces*

In *Sculpting Sensations*, I embark on an exploration of how architecture can transcend the purely visual to engage the full spectrum of human senses. This project delves into the psychological and emotional impact of sensory-rich environments, uncovering how the interplay of materials, light, sound, and texture can shape our experiences and evoke deep emotional responses.

Through research and design, I demonstrate how sensory synergy can be used as a method to create spaces that resonate on a personal and emotional level. The journey begins with an investigation into sensory perception, exploring how we interact with and are influenced by our surroundings. This research phase lays the foundation for a series of design interventions that culminate in a unique museum concept, where each space is sculpted to evoke specific emotions and sensations.

The report has been created with the help of my tutors, Geert Coumans, Peter Koorstra, and Claudia van Leest. Their guidance was instrumental in helping me navigate the challenges and discoveries throughout the project.

Sculpting Sensations is not just a reflection of an academic journey; it is a manifesto for a more empathetic and human-centered approach to architecture. By bridging technical innovation with sensory and emotional considerations, this work paves the way for creating built environments that are not only functional and aesthetically pleasing but also profoundly enriching to the human experience.

Join me on this inspiring journey and discover how architecture can touch the heart, engage the senses, and sculpt the sensations that shape our lives.

Kim van den Bosch
21 June 2024