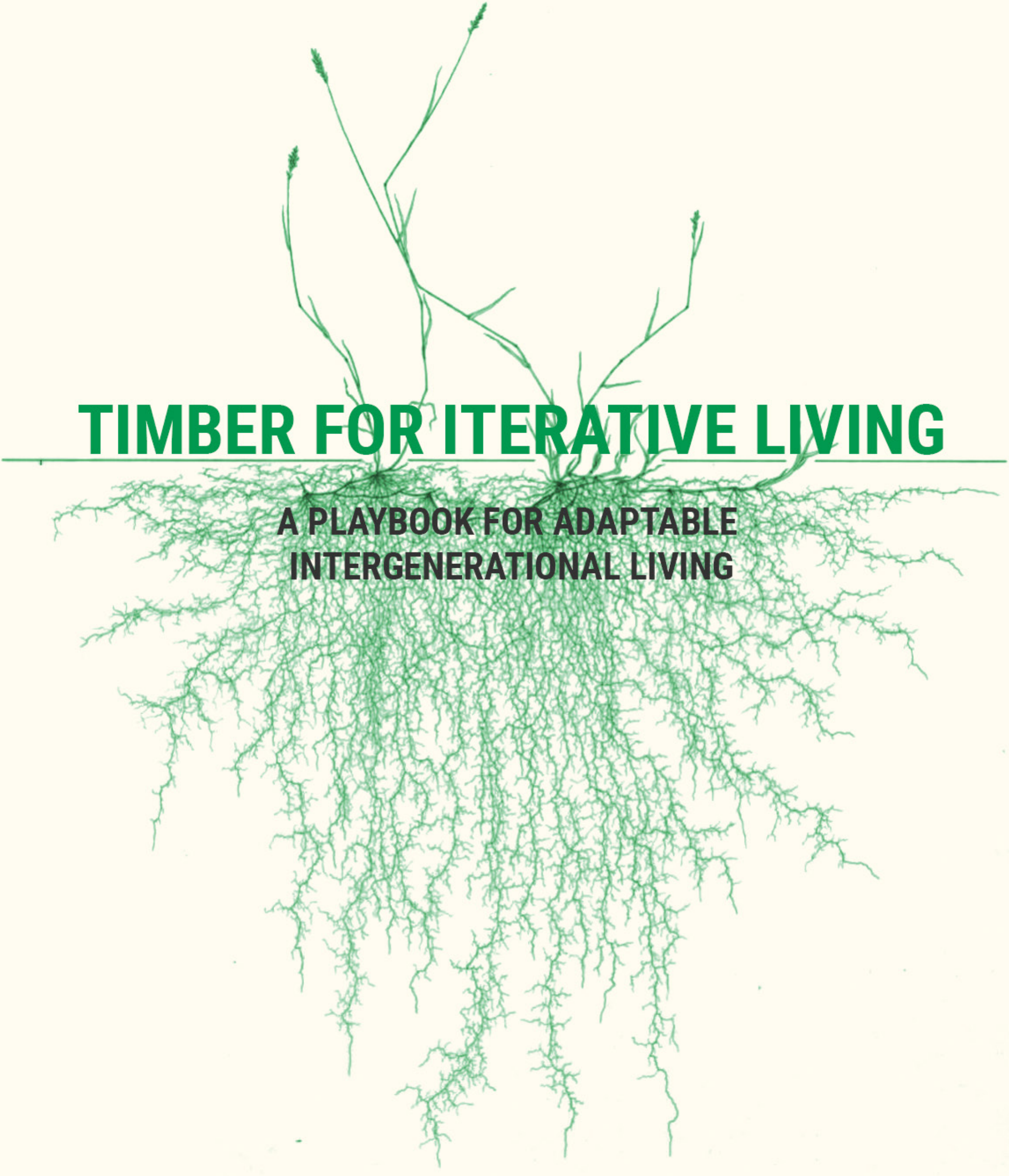
TIMBER FOR ITERATIVE LIVING



A PLAYBOOK FOR ADAPTABLE INTERGENERATIONAL LIVING

PREFACE

Timber has re-emerged as a material of significant interest in contemporary architecture as awareness grows of the contribution of the construction industry to global CO2 emissions. However, its potential extends far beyond its role as a sustainable alternative to carbon-intensive materials like steel and concrete. The challenge lies in incorporating timber into the building stock not merely as a replacement material, but as one that establishes a distinct architectural and functional impact.

To understand and utilize its potential, it is essential to examine both the intrinsic characteristics of timber and its public perception. One common misconception is that timber has a shorter lifespan compared to materials like concrete and steel which largely make up the existing urban fabric, often seen as less durable or more temporary. This view is rooted in timber's identity as a living material, something that lives and dies, whose life cycle and life span are easily conceived. Additionally, timber's historical association with crafts, workshops, and timber frame construction has reinforced its reputation as a manageable material, often viewed as accessible for self-build projects and interventions.

This perception of lightness, temporality and manageability, however, offers distinct advantages in the context of contemporary architectural needs. As societal and family dynamics evolve more rapidly than before, and as architectural practices increasingly focus on working with existing structures rather than the Tabula-rasa, materials capable of accepting adaptation are becoming essential. Timber, along with other bio-based materials, is uniquely suited to this challenge, offering the light-weight flexibility required for architectural systems to respond to shifting demands over time.

As the Netherlands is facing increasing pressure from housing shortages and densification efforts, there is an increasing interest in alternate living models that can accommodate the changing family structures and demographics of today. Among these changes, the aging population represents a significant factor. Many older adults are encouraged by legislative and social factors to age in place, remaining in their homes rather than transitioning to nursing or group homes. This approach, while practical in some cases, has often resulted in older adults living in spaces that are poorly suited to their changing mobility and care needs. Studies have also linked such arrangements to increased feelings of loneliness, particularly among elderly individuals living alone.

Timber, with its inherent association with evolving life and time, offers a material basis for designing adaptable living environments. Its aesthetic and tactile qualities, along with its capacity for modularity, make it particularly suited for structures that can evolve in response to changing family and individual needs. However, many existing homes in the Netherlands lack the necessary adaptability. For example, elderly households in multifamily apartments frequently encounter inaccessible layouts, high thresholds, or the absence of lifts, making modifications either costly or impossible. Integrating timber and bio-based materials into design systems could address these challenges, enabling homes to adapt incrementally as needs evolve, rather than requiring disruptive relocations or extensive renovations.

This research aims to develop a framework for adaptive and additive architecture by analyzing theories and practical examples of flexible and adaptable design. Case studies of intergenerational housing, encompassing both formal (professionally designed) and informal (self-directed renovations) approaches, will be examined to identify the essential elements required for adaptability.

Based on these findings, this playbook aims to guide architects and self building residents through the strategies used to design the building for future adaptation opportunities, identifying the possibilities for adaptation, and the criteria and methods to achieve them.

This playbook will include performance-based criteria and strategies for permissible development, with a focus on creating living environments that can evolve over time. By leveraging timber's unique qualities—its manageability, perceived temporality, and natural adaptability—this framework seeks to contribute to the design of housing systems that respond effectively to contemporary social and environmental challenges.

CONTENTS

WHY DO WE NEED ADAPTABLE DESIGN?

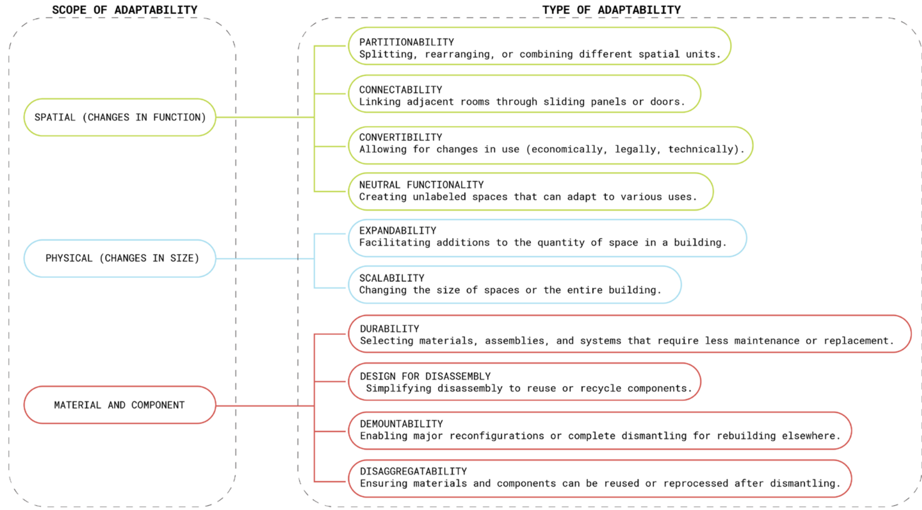
Architecture today must accommodate evolving family structures, aging populations, and fluctuating urban contexts. Adaptable systems, particularly those leveraging bio-based materials like timber, offer an approach for creating buildings that are not only sustainable but inherently flexible. However, achieving adaptability across form, function, and material requires the exploration of key concepts, definitions, and methods.

The concept of "loose-fit architecture" emerges as a central framework within this discourse. Loose-fit design prioritizes flexibility and simplicity, allowing buildings to evolve without being overly prescriptive. A loose-fit approach between the programme and the architecture works by providing spatial redundancy and low specificity, allowing the occupant to have more agency on the interpretation of a space. Having less constraints at the space plan level of the building forces the user to adapt the space to their needs. At the material level, this approach champions systems that support modification, disassembly, and reuse. The principle of loose-fit aligns closely with the characteristics of timber, a material historically associated with craftsmanship, self-build systems, and manageability. In this context, flexibility extends beyond spatial adaptability to include material adaptability—where building components are designed for low-impact assembly, dismantling, and alteration.

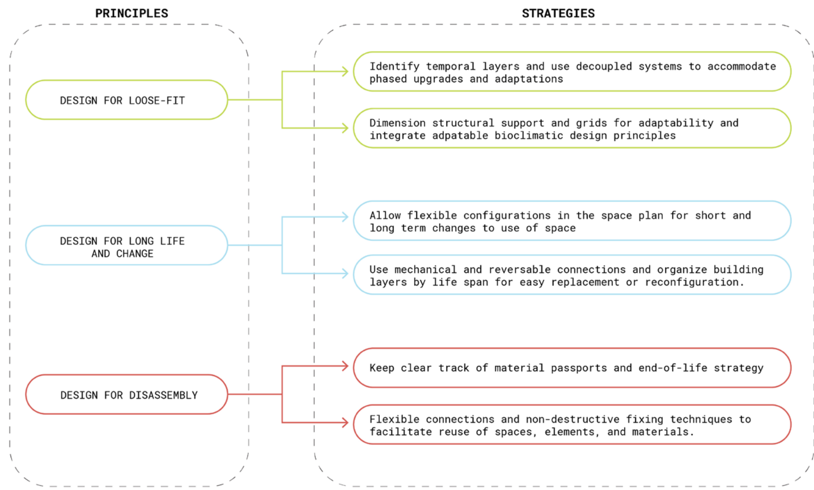
And yet, what exactly is adaptive architecture? One way to assess adaptability is to refer to the specific types of change that might occur, and how these changes are then accommodated. By categorizing adaptation into three primary scopes—spatial, physical, and material—it identifies the specific strategies for addressing changes in function, size, and components over time. These then serve as the lens through which architectural interventions can be planned, ranging from the reconfiguration of interior spaces (partitionability and connectability) to structural expansions (scalability and expandability) and material-level strategies (design for disassembly and demountability). This framework will be used to evaluate the case studies on adaptability and be used to categorize the specific actions and methods to achieve them within the context of intergenerational and co-living housing.

In addition to types of adaptive measures in architecture, The Environment Design Guide outlines a set of principles for designing adaptable architecture. These principles offer basic strategies to address evolving user needs, diverse family structures, and fluctuating urban contexts, acting as a guideline to enable buildings to remain functional and relevant over time, accommodating changes in use while minimizing environmental impact through material reuse and efficient construction practices.

By unpacking these key concepts and principles of design, this theoretical framework provides the foundation needed to explore the material strategies and performance criteria that will inform the playbook for adaptable architecture.



Taxonomy of Adaptability in Architecture



Principles and Strategies for Adaptability

WHAT IS INTERGENERATIONAL LIVING?

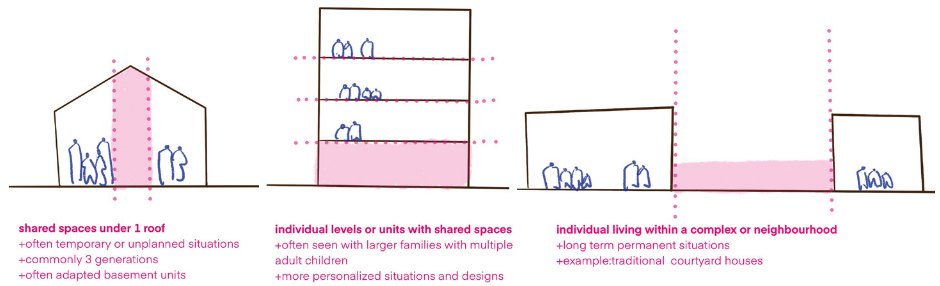
Amsterdam is experiencing several trends related to its housing shortage, including international migration patterns, an aging population, and more diverse family structures. In the coming decades, in addition to its increase in number, dwellings need to address a more diverse demographic spread, as the city currently mainly supports single-person households, and is continuing to develop this type of housing.

A significant portion of these single-person households consists of an increasing elderly population. Multiple factors, including Dutch legislation, are encouraging older adults to age in place, receiving either informal or no care, rather than moving to nursing or group homes, leading to more and more elderly remaining in houses in the suburbs and countrysides alone, which are often built for the nuclear family and too large. In addition to the aging population, statistics show that there is also a rise in divorced couples, singles, and childless couples, demonstrating the loss of significance of nuclear family dwellings, and justifying the increase in individual living. This drastic increase of individual living has been linked through studies on feelings of loneliness, which are projected to increase under current living arrangements.

In these contemporary living environments, intergenerational and co-living housing concepts have been raised as promising responses to the growing need for densification while promoting a sense of life and community within the city. Creating a strong sense of community in this type of alternative housing for the elderly could potentially free up an estimated 16% of the owner-occupied housing market in The Netherlands—properties currently owned by elderly people who might choose to move.

Multigenerational housing is a concept widely seen in East Asian contexts, typically consisting of multiple generations with familial ties cohabiting within a single or connected residence. However, the rise of this trend in contemporary Western societies has adapted these arrangements to extend beyond family connections. This is demonstrated in the co-living initiatives in various European countries, showing the shift from conventional large-family arrangements to intergenerational living models that prioritize interactions between different resident groups and the sharing of knowledge and resources that extend beyond traditional familial ties.

As such, the research and subsequent design methodology builds upon these existing concepts, centering on “co-living” and “intergenerational housing”, focusing on not only living scenarios within a single household, but also on the dynamics of cross-generational interactions independent of familial ties, which is seeing a rise in the contemporary setting.



Common forms of intergenerational living

Designing for intergenerational living starts with the understanding of the varied spatial needs of different age groups. Behavioral studies reveal that these requirements extend beyond basic daily activities, such as eating and sleeping, to include learning, working, care-giving, and socializing. According to behavioural surveys and case studies presented at the 2024 International Conference on Culture-Oriented Science & Technology, several spatial conditions can be explored.

Spatially, the most important consideration is the grouping of spaces, as well as circulation paths. For instance, older adults may require en-suite bathrooms and proximity to caregivers to minimize disruptions and support their independence. Similarly, younger children benefit from spaces designed for visibility and accessibility to facilitate monitoring and care. Bedrooms and bathrooms for vulnerable groups, such as elderly individuals and young children, should be strategically placed to ensure convenience without interfering with the routines of other household members. Meanwhile, communal spaces should prioritize soundproofing and functional adaptability to support evolving household dynamics over time. These are considerations that will shape both the static and changing configurations of the design.
Family structures and their spatial needs naturally shift with life stages, requiring flexibility in housing design. Spaces must be able to adapt to new functions as family members age, children grow, and care-giving roles transition. By incorporating design strategies that anticipate these changes, intergenerational living models can offer a response to Amsterdam’s challenge of urban densification and demographic diversity, and act as an alternative to isolated single-occupancy housing. In positioning intergenerational and co-living concepts at the basis of adaptive urban housing strategies, this research aims to contribute to the discourse on sustainable densification and community-focused design.

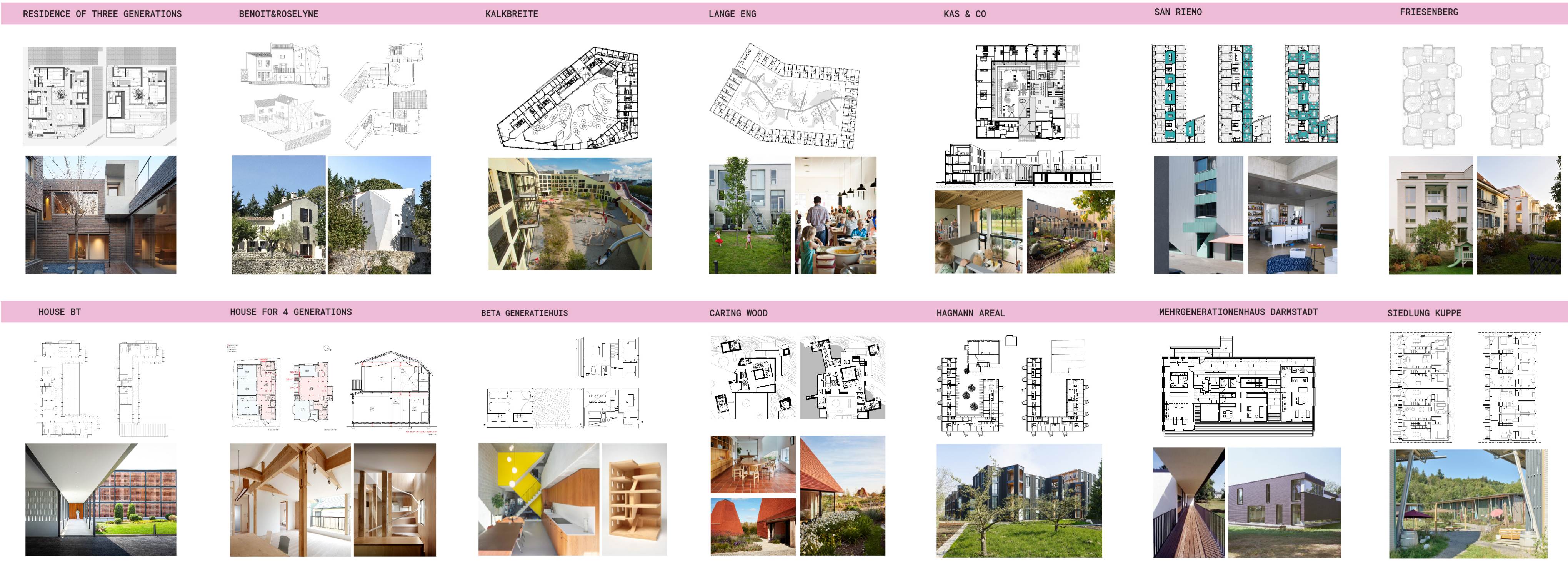
In order to identify the possible strategies for adaptive living, case studies can be analyzed to first establish the scope and typology of design, as well as the existing methods of adaptation.

As established previously, most cases of dwelling adaptation occur due to changes within the family - whether short or long-term. The idea of multi or intergenerational living is not new, especially in many Eastern cultures. However, this type of living isn't just for immigrants or large families, as studies have shown that multigenerational housing has seen a significant rise globally in recent decades. As well, the idea of intergenerational housing also applies to living situations that include people not from the same family, such as housing complexes that encourage residents of different ages and types through the inclusion of different types of units, for example, studio apartments for younger generations, as well as interconnected care homes for the elderly. It's this added complexity of interaction and symbiosis beyond merely co-existing that leads to the use of the term "intergenerational".

Due to this wide definition, there are many different types of what can be called an intergenerational dwelling. As such, a number of housing projects that might be considered under the umbrella term of multigenerational housing have been selected across Europe and Asia.

These projects are then compared with existing living typologies recognized within The Netherlands, specifically those which target older generations. This includes the common detached family homes, those specifically designed for care, such as Kangaroo Homes — 2 separate units, connected by a door, as well as more community-oriented living. In this way, there is a gradient between individual living and communal living, which can be defined by the amount of shared spaces and opportunities to interact.

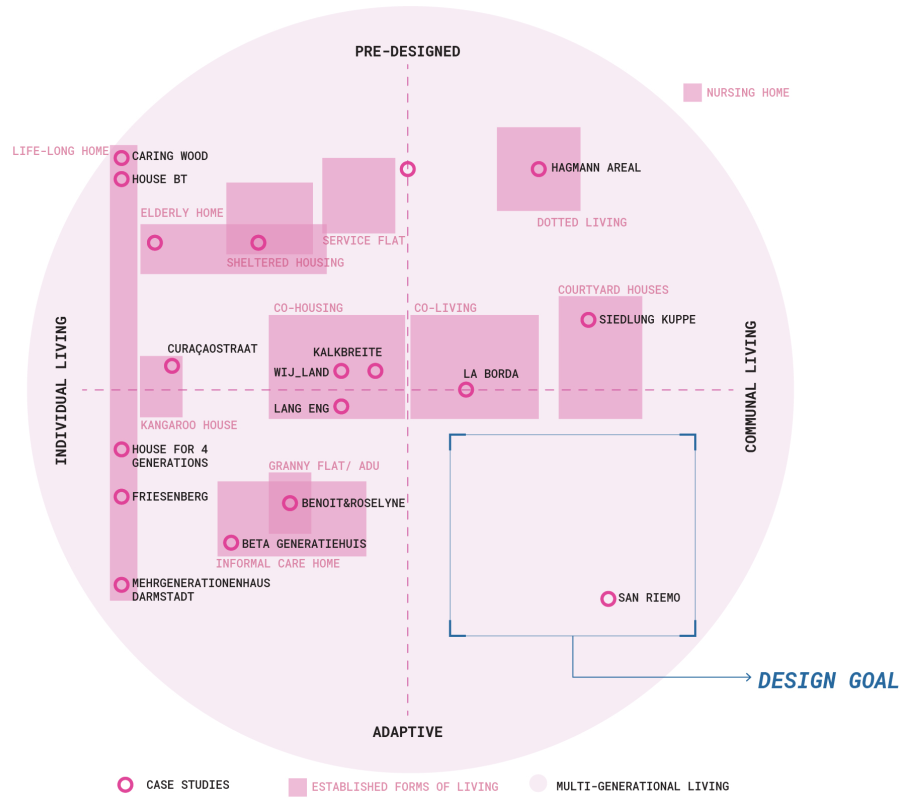
The other categorizing factor is the level of adaptability. Most of what is considered multigenerational housing is either highly customized for a specific household in a detached residence, commonly either separated by levels, by wings of the building, or are multiple collected dwellings that share a yard or



Selected case studies under the umbrella term of "intergenerational housing" outdoor space. On the other hand, there are also intergenerational housing types which actually encourage change and adaptability, whether for the family or for potential renters. Based on these 2 main categories — individual vs community and pre-designed vs adaptable, the selected projects and existing living typologies are placed on a quadrant, which can then be used to identify the necessary design considerations for intergenerational living, as well as the ways adaptation can occur.

From the quadrant, one project is selected from each category for deeper analysis. From the homes that are pre-designed for either multiple generations of a family living under one roof, or for larger intergenerational communities, a few specific considerations can be noted: the amount of shared circulation space, shared living space, accessibility, as well as the possibility of private and separate entry points. In the project "Caring Wood", there are separate wings for different members of the family which includes their sleeping quarters and bathrooms, which can be accessed through a private entrance or through the main living spaces — cooking, dining, lounging, which are shared in the central area.

This contrasts with the "Curacaostraat", where the two attached units share no common areas, but can be mutually accessed through a door in between. This aligns with the Kangaroo type, which can be used between an elderly resident and care person, or two related but separate families.



LIFE-LONG HOME
A HOME DESIGNED TO ADAPT TO CHANGING NEEDS OVER A PERSON'S LIFETIME, ENSURING ACCESSIBILITY AND COMFORT AT EVERY STAGE.

CO-HOUSING
NTENTIONAL COMMUNITIES WHERE RESIDENTS OWN PRIVATE HOMES AND SHARE COMMUNAL SPACES AND RESPONSIBILITIES IN A COLLABORATIVE LIVING ENVIRONMENT.

CO-LIVING
A MODERN SHARED LIVING ARRANGEMENT, OFTEN RENTAL-BASED, WHERE INDIVIDUALS LIVE IN PRIVATE ROOMS WITH ACCESS TO SHARED FACILITIES AND CURATED COMMUNITY ACTIVITIES.

INFORMAL CARE HOME
A LIVING SETUP WHERE FAMILY MEMBERS OR CLOSE COMMUNITY MEMBERS PROVIDE CARE AND SUPPORT TO AN INDIVIDUAL IN A NON-PROFESSIONAL CAPACITY.

KANGAROO HOUSE
A COMBINED LIVING ARRANGEMENT WHERE A LARGER FAMILY HOME INCLUDES A SEPARATE, SMALLER UNIT FOR ELDERLY RELATIVES OR CAREGIVERS.

"KNARRENHOF" COURTYARD HOUSING
A COMMUNITY-ORIENTED HOUSING MODEL WHERE RESIDENTS LIVE IN PRIVATE HOMES AROUND A SHARED COURTYARD, EMPHASIZING MUTUAL SUPPORT AND SOCIAL CONNECTION.

ELDERLY HOME
A RESIDENCE PROVIDING ACCOMMODATION AND CARE SPECIFICALLY FOR OLDER ADULTS, OFTEN WITH SHARED FACILITIES AND SOCIAL PROGRAMS.

SHELTERED HOUSING
HOUSING WITH PRIVATE UNITS FOR INDEPENDENT LIVING, SUPPLEMENTED BY COMMUNAL AREAS AND MINIMAL ON-SITE CARE OR SUPPORT SERVICES.

SERVICE FLAT
A PRIVATE APARTMENT FOR SENIORS, OFFERING ADDITIONAL SERVICES LIKE MEALS, CLEANING, AND EMERGENCY SUPPORT.

DOTTED LIVING
A DECENTRALIZED LIVING ARRANGEMENT WITH SMALLER UNITS OR CARE SERVICES SPREAD ACROSS A NEIGHBORHOOD TO INTEGRATE SUPPORT INTO COMMUNITY LIFE.

Matrix of case studies vs established housing concepts

HOW DO WE DESIGN FOR ADAPTABLE INTERGENERATIONAL LIVING?

Adaptation within living situations are more often than not rather makeshift – like adapting a single family house to accommodate the necessary changes in living situations by renovating basements, opening walls, or adding extensions. This is because many of these situations are unforeseen, or temporary, which wouldn't require a complete change of residence. This idea of temporality, or timespan is very important when discussing the adaptability of a residential building, as they would outline very different scenarios and methods of action, between moving interior partition walls on a daily basis to accommodate different functions within a home, to the "incremental housing" method (source), where entire new sections of a home can be added for expanding families. As such, three distinctive adaptive projects are chosen within the quadrant for further analysis, identifying their timescales, methods of adaptation, and the involved building components to take into account.

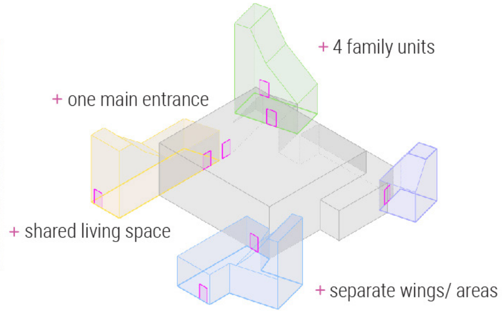
Using these examples of adaptation, a series of actions and catalogue can be established and referenced for the playbook of adaptation strategies based on scenario and therefore timescale, which includes the adding, moving, removal of interior walls, changing openings and entrances, as well as additions to the physical volume, categorized into involvement of different shearing layers.

Together, these findings will inform the strategies taken to design and plan the building for maximum future adaptation, acting as the framework for this playbook. This acts as a toolkit that allows for adaptability across multiple scales, from individual family units to entire neighborhoods, addressing diverse contexts and timeframes.

PRE-DESIGNED

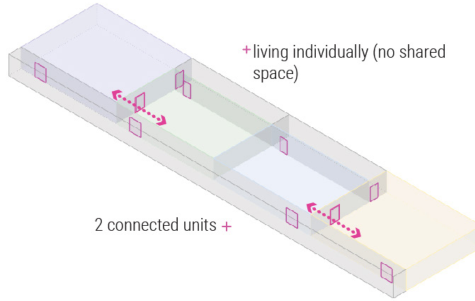
SINGLE FAMILY

CARING WOOD



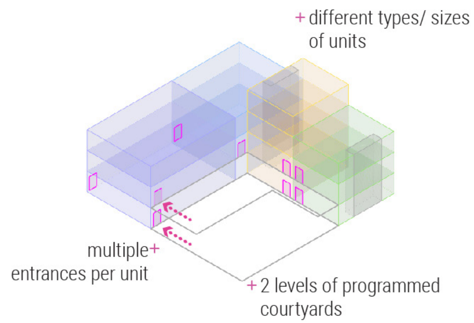
MULTI FAMILY

CURAÇAOSTRAAT GRONINGEN



COMMUNAL LIVING

KAS & CO

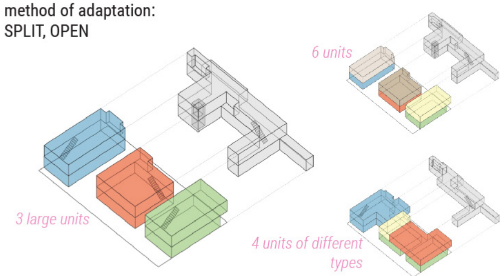


ADAPTIVE

SINGLE FAMILY

MEHRGENERATIONENHAUS DARMSTADT

method of adaptation:
SPLIT, OPEN

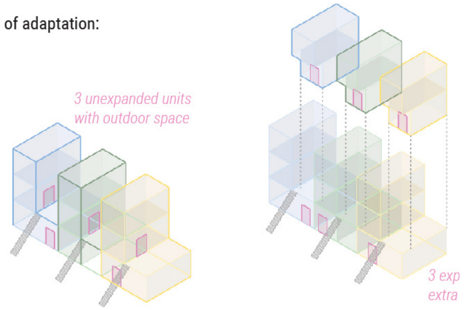


+ partitionability -- splitting/ combining spatial units
+ neutral functionality -- shared space can be converted to living units
+ access -- separate access points to each space through shared space allowing it to become independent

MULTI FAMILY

QUINTA MONROY

method of adaptation:
ADD

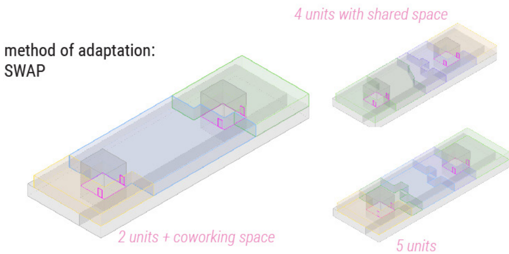


+ expandability -- porosity allows for space to grow
+ connectability -- pre-planned access routes

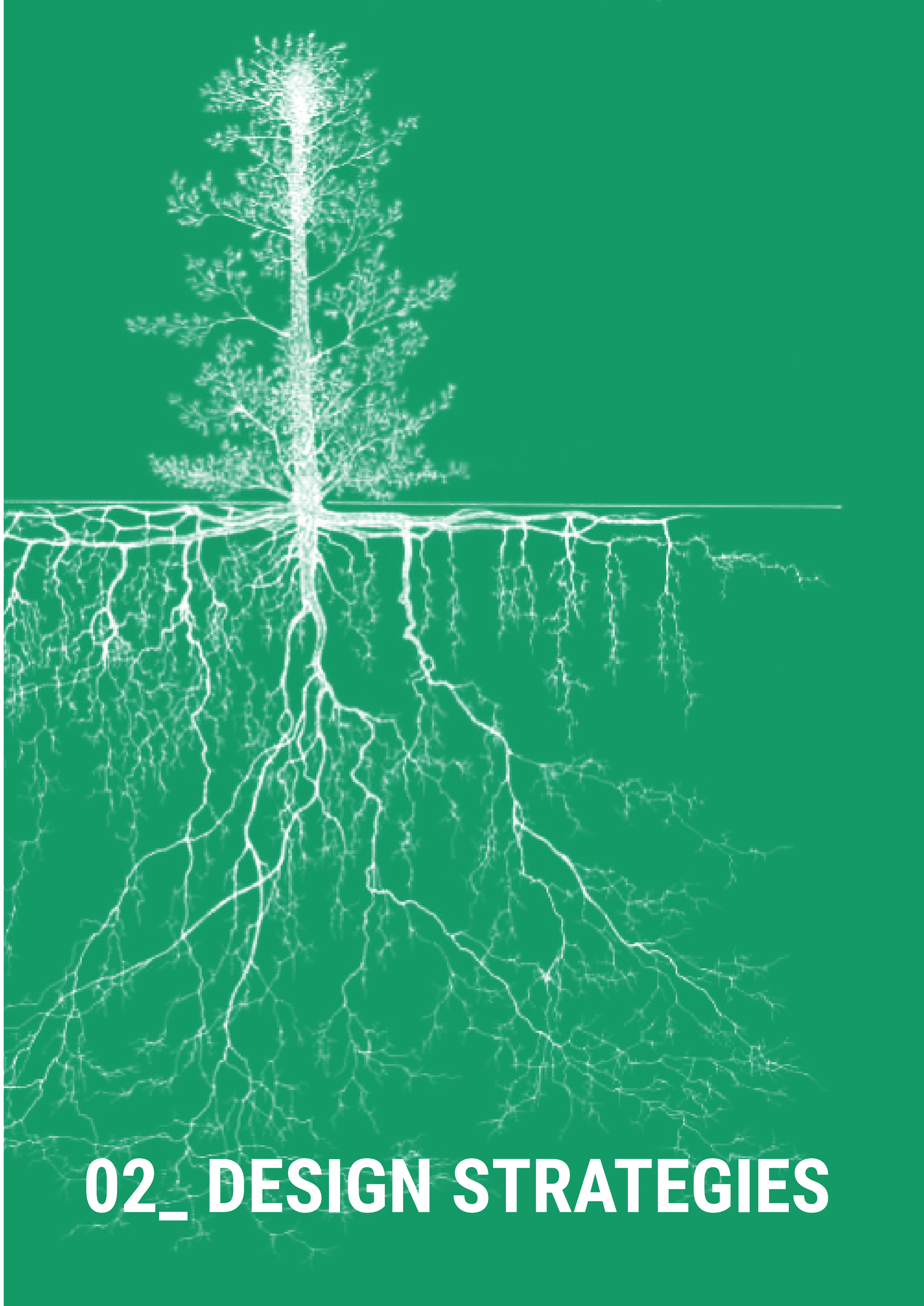
COMMUNAL LIVING

SAN RIEMO

method of adaptation:
SWAP



+ connectability -- existing openings between units allow for entire rooms to be swapped
+ neutral functionality -- large areas of shared space that can be for socializing or closed into a unit
+ access -- rearranging units depends on the circulation cores



02_ DESIGN STRATEGIES

ACTIONS FOR ADAPTABLE LIVING

Another challenge of this research looks at how adaptable architectures can be achieved across all scales, from flexibility at the spatial level as seen in the case studies, to the level of the building elements themselves. This chapter investigates strategies for material adaptation, focusing on how building components and connections can be designed to support changes in both form and function across varying timescales.

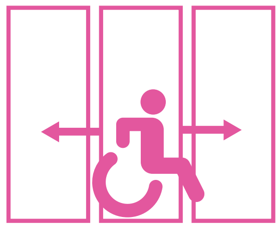
The strategies outlined in this chapter build on insights from the adaptive housing case studies, where actions for adaptation were categorized by their relevant time frame: short, medium, and long-term. Each time frame introduces distinct requirements for materials, components, and construction methods. For instance, while a long-term adaptation may allow for several months of construction, short-term adaptations require faster, more flexible solutions. To meet these varying demands, the structural system, design of connections, and material assemblies are three main categories for consideration. The aim of this research is not to identify all the possible methods, but to provide a matrix for which connection types, and material assemblies can be assessed and scored.

DESIGN STRATEGIES

In order to better understand how to address the needs of intergenerational living, a literature review was performed to generate a list of evidence-based design features that can be used when retrofitting existing apartment buildings to create more welcoming social spaces, increase social interactions, and reduce social isolation. The design features that promoted sociability found in the literature range from features relevant to new buildings to features that can be easily implemented in a retro-fit of an existing building, which lends nicely to a building that predicts incremental adaptation. From these features, 4 key themes emerged:

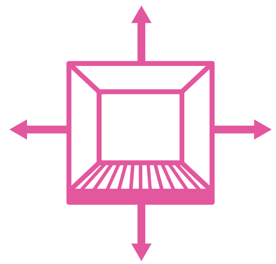
ADAPTING FOR CARE + PRIVACY

In intergenerational homes, privacy is essential for dignity and autonomy, while proximity enables caregiving when needed. Adaptable partitions, soundproof zones, and shared-but-separate suites allow households to shift between independence and intimacy—supporting different rhythms of life and care needs across generations.



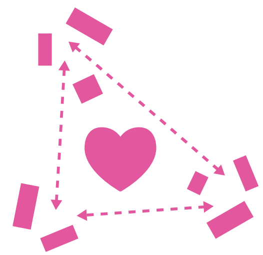
ADAPTING FOR ACCESSIBILITY

Universal design ensures every generation can navigate and enjoy the home. Step-free entrances, wide doorways, adjustable counters, and smart home technologies create a responsive environment. As mobility needs evolve, spaces must seamlessly adapt—making accessibility an integrated and unobtrusive part of everyday living.



ADAPTING FOR SPACE

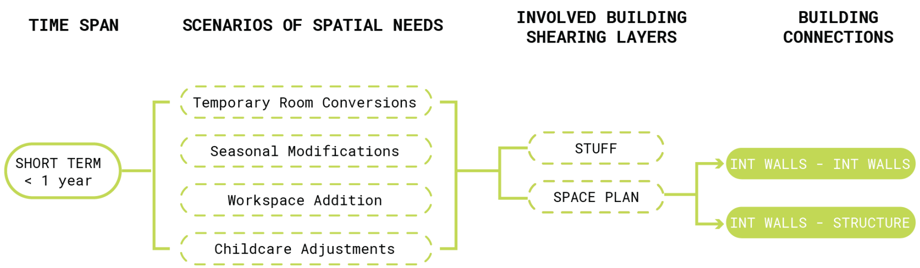
Flexible space planning supports evolving family structures and changing functions over time. Sliding walls, convertible rooms, and modular furnishings allow spaces to grow, shrink, or switch use—transforming a playroom into a guest suite or a living area into a work hub, without rebuilding.



ADAPTING FOR COMMUNITY

Shared spaces foster intergenerational bonds, collaboration, and a sense of belonging. Common kitchens, gardens, and gathering areas offer opportunities for connection, while retreat spaces respect the need for solitude. Adaptable layouts can shift between communal and private modes as household dynamics change.

LOW PERMANENCE



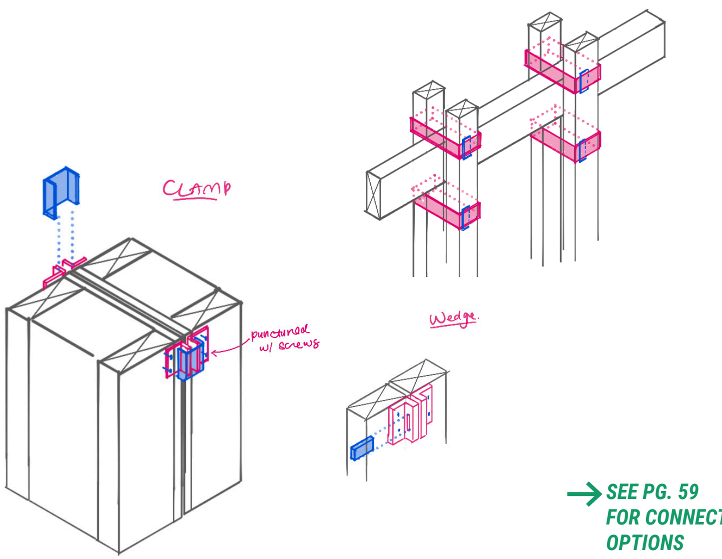
VISIBLE FASTENING SYSTEMS

SHEARING LAYER SPACE PLAN

COMPONENTS PARTITION WALLS

RISK LEVEL MODERATE

Movable wall panels and large furniture can be connected using tactile, exposed twist-lock connectors, allowing users to easily adjust or reconfigure the layout without tools.



SEE PG. 59 FOR CONNECTION OPTIONS

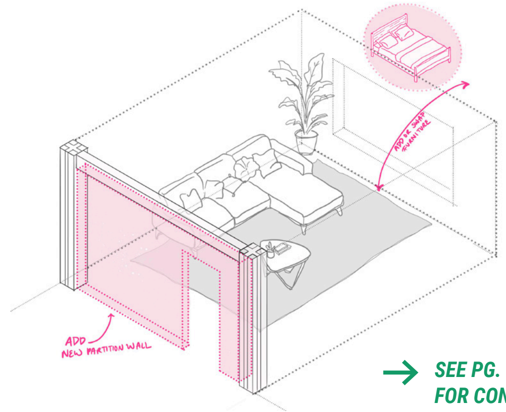
CONVERT LIVING/ DINING TO BEDROOM

SHEARING LAYER SPACE PLAN

COMPONENTS PARTITION WALLS

RISK LEVEL LOW

STRATEGY: The space plan and circulation of the units are designed for shared spaces to be easily converted to private bedrooms by adding interior walls in the suggested placements. Low impact connection methods are suggested for short term and temporary conversions.



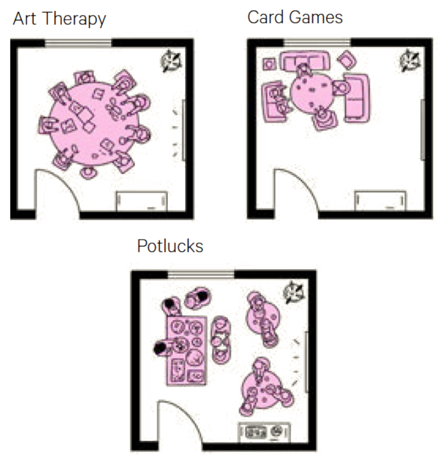
SEE PG. 70 FOR CONNECTION OPTIONS FOR WALL FRAMING

MULTI-PURPOSE SOCIAL SPACES

SHEARING LAYER STUFF

RISK LEVEL LOW

STRATEGY: The expandable pocket spaces act as informal social spaces scattered throughout the building that enable residents to randomly encounter and interact with neighbours. An open and flexible space plan allows it to be used for a variety of activities and functions without big changes.



LOW PERMANENCE

ADDING MOVABLE PARTITIONS

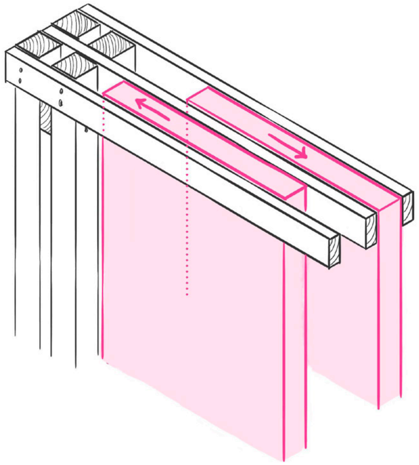
SHEARING LAYER
SPACE PLAN

COMPONENTS
PARTITION WALLS

RISK LEVEL
LOW

TOOLBOX
ROUTER
CHISELS/ CNC
DRILL
SCREWDRIVER

STRATEGY: The exposed structure and connections suggest where spaces can be additionally partitioned. The slots and gaps of mortise and tenon joints encourages movable partitions like sliding doors to be added to increase the usability of spaces.



→ SEE PG. 59
FOR TIMBER CONNECTIONS

INCREASING ACOUSTIC CONTROL

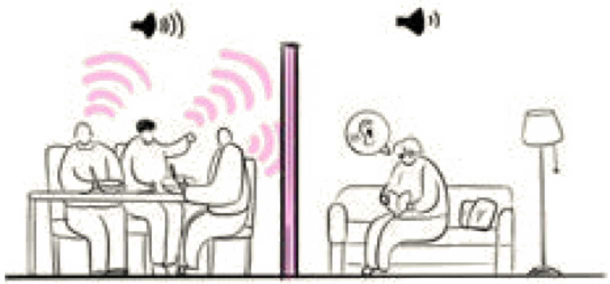
SHEARING LAYER
SPACE PLAN

COMPONENTS
PARTITION WALLS
PARTY WALLS

RISK LEVEL
LOW

TOOLBOX
UTILITY KNIFE
STAPLE GUN
SCREWDRIVER

STRATEGY: Acoustic control between units and public areas are integrated within the walls and along the edges. Additional acoustic insulation can be added to the internal walls through a paneling system.



→ SEE PG. 112
FOR INSULATION OPTIONS

FLEXIBLE + PARTITION-ABLE SPACES

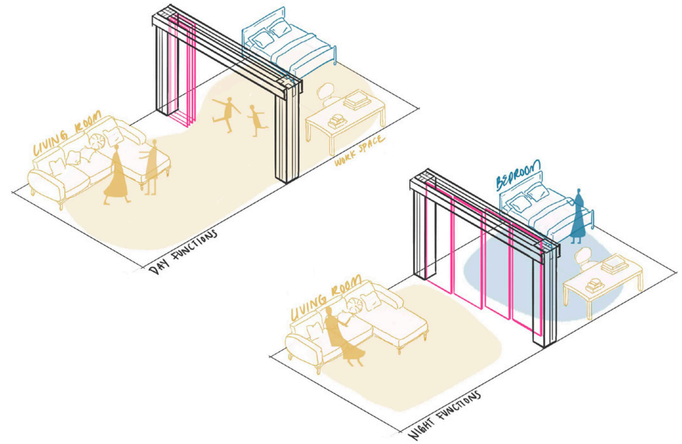
SHEARING LAYER
STUFF

COMPONENTS
PARTITION WALLS

RISK LEVEL
LOW

TOOLBOX
ROUTER
CHISELS/ CNC
DRILL
SCREWDRIVER
TABLE SAW

STRATEGY: The units are designed for movable partitions like sliding doors to be easily added. They allow a space to be flexible in its use -- closed for privacy when used as a bedroom, and open when used as a shared living space during the day.



REMOVE EXTRA BEDROOMS FOR LARGER SHARED LIVING SPACE

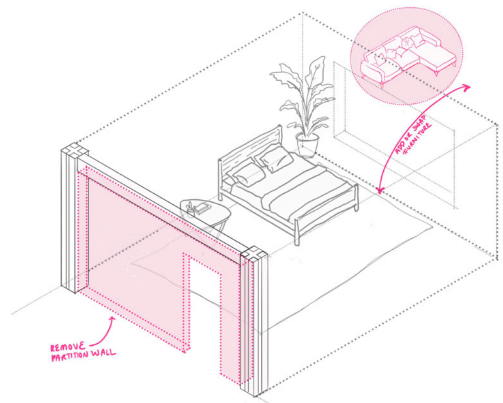
SHEARING LAYER
SPACE PLAN

COMPONENTS
PARTITION WALLS

RISK LEVEL
LOW

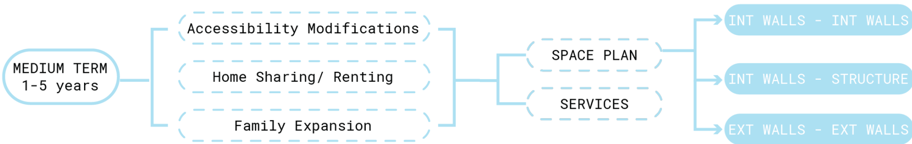
TOOLBOX
SCREWDRIVER
ALLEN KEY SET
DRILL
TAPE MEASURE
CLAMPS

STRATEGY: The space plan and circulation of the units are designed for spaces to be easily converted between closed rooms and open shared living area. Low impact connection methods are suggested for short term and temporary conversions.



→ SEE PG. 70
FOR CONNECTION OPTIONS
FOR WALL FRAMING

MODERATE PERMANENCE



CONVERT EMPTY PLOTS TO COMMUNITY SPACES

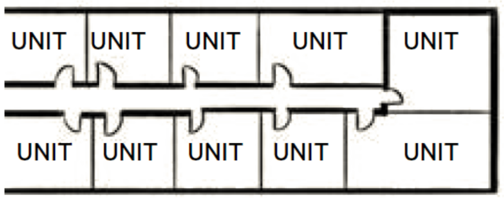
SHEARING LAYER
SKIN
SPACE PLAN

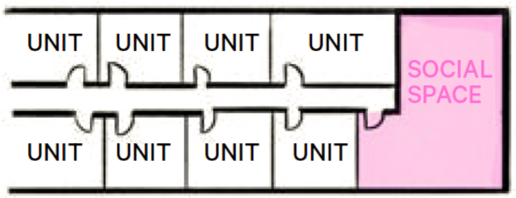
COMPONENTS
EXTERIOR WALLS

RISK LEVEL
MODERATE

TOOLBOX
SCREWDRIVER
CROW BAR
SCREWDRIVER
SEALING TAPE

STRATEGY: Place social spaces along the path of movement or near threshold spaces where residents are more likely to see them, such as near stairwells or elevators. Empty plots or unoccupied units concentrated around the elevator cores or end of the corridor can be combined or converted to flexible community spaces. In the north block of the building, this may require enclosing the space.



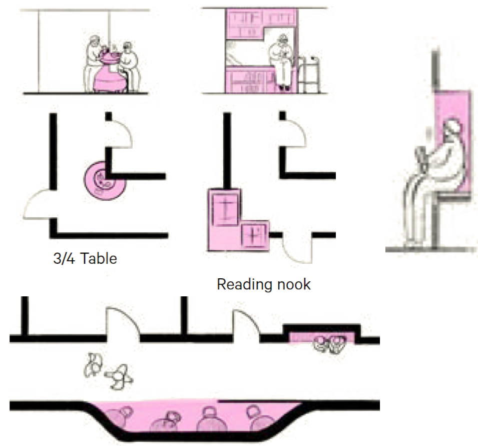


ADD SEATING/ PROGRAMMING IN HALLWAYS (SOCIAL CORRIDORS)

SHEARING LAYER
STUFF

RISK LEVEL
LOW

Providing seating in hallways can create areas where random social interactions can also occur. In addition to seating, it is suggested in the literature that having tables and art or other activities in hallways will further encourage social interaction, creating spaces known as "social corridors".



WIDEN DOORWAYS

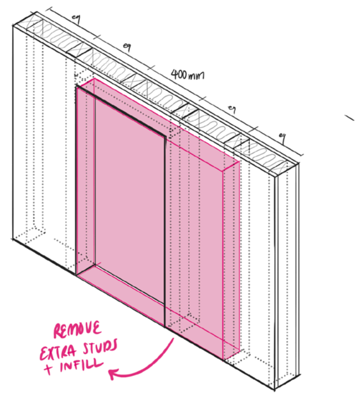
SHEARING LAYER
SPACE PLAN

COMPONENTS
PARTITION WALLS

RISK LEVEL
LOW

TOOLBOX
SCREWDRIVER
CROW BAR
SCREWDRIVER
MEASURING TAPE

STRATEGY: The majority of walls are constructed with a timber framing system with the same spacing (400mm oc), whether pre-fabricated or self-built, interior or exterior. This allows easy removal of material to widen doors from 800mm to 1200mm for improved accessibility.



MODERATE PERMANENCE

ADDING EXTERIOR DOOR IN INNER COURTYARD

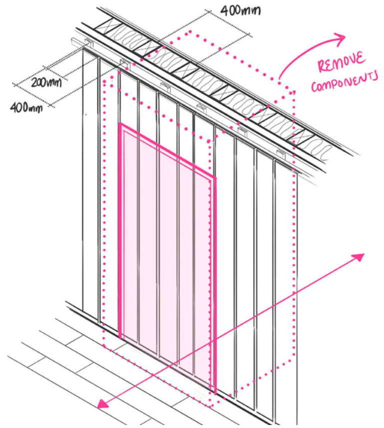
SHEARING LAYER: SKIN

COMPONENTS: EXTERIOR WALLS

RISK LEVEL: MODERATE

TOOLBOX:
SCREWDRIVER
CROW BAR
CIRCULAR SAW
SEALING TAPE

STRATEGY: Phase 1 construction uses modular sized building components that are sized to accommodate additional fenestration. Vertical cladding is used in the inner courtyard and aligns with the wall framing to minimize cuts required for the intervention.



SPLIT OPEN PATIO FOR PRIVATE BALCONY

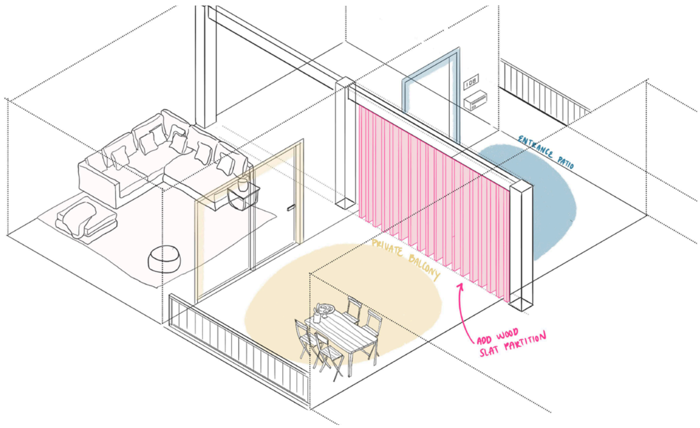
SHEARING LAYER: SPACE PLAN

COMPONENTS: PARTITION WALLS

RISK LEVEL: LOW

TOOLBOX:
SCREWDRIVER
MACHINE SAW

STRATEGY: The open space dedicated to each unit for possible future expansion doubles as the entry patio to the unit in the meantime, accessed from the shared corridor. A separation wall can also be added to split the 8m deep patio to add a private balcony accessed from inside the unit.



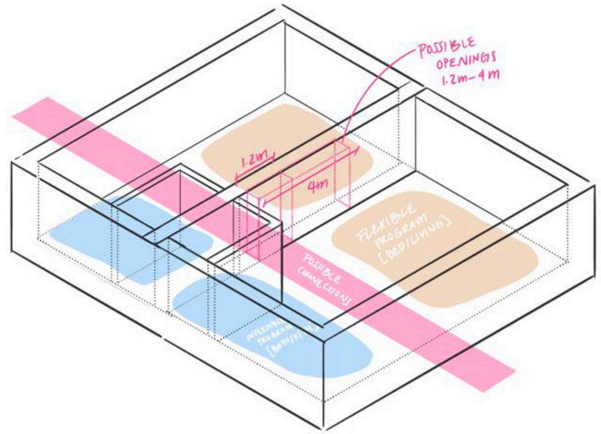
CONNECT UNITS FOR KANGAROO CARE HOMES

SHEARING LAYER: SPACE PLAN

COMPONENTS: PARTY WALLS

RISK LEVEL: MODERATE

STRATEGY: The space plan of the units are designed with areas where the partition walls between 2 adjacent units can be removed to connect the units, either through a simple door or a larger opening for a joint living space. Note: these then become one fire compartment.



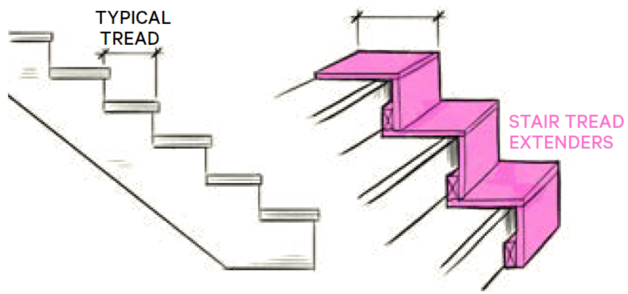
EXTEND STAIR TREADS

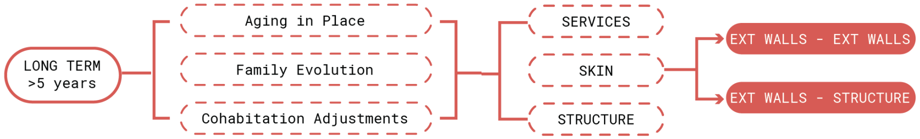
SHEARING LAYER: SPACE PLAN

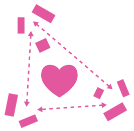
COMPONENTS: IN-UNIT STAIRS

RISK LEVEL: MODERATE

As individuals age, a major concern is the risk of falling as this can have many major health implications for seniors. One of the reasons that seniors often slip and fall on stairs is because of the tread length; however, this can be abated simply by increasing the tread length of stairs.







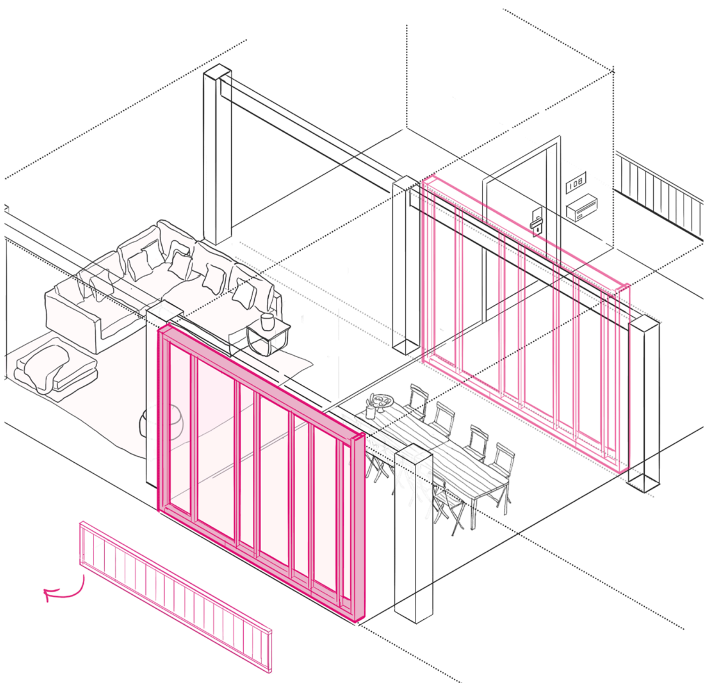
SHEARING LAYER
STUFF

RISK LEVEL
LOW

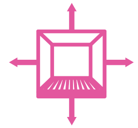
TOOLBOX
SCREWDRIVER
MEASURING TAPE
JIGSAW/
MACHINE SAW

CONVERT PATIO SPACE TO SHARED DINING BETWEEN UNITS

STRATEGY: The units are designed for movable partitions like sliding doors to be easily added. They allow a space to be flexible in its use -- closed for privacy when used as a bedroom, and open when used as a shared living space during the day.



HIGH PERMANENCE



SHEARING LAYER
STRUCTURE

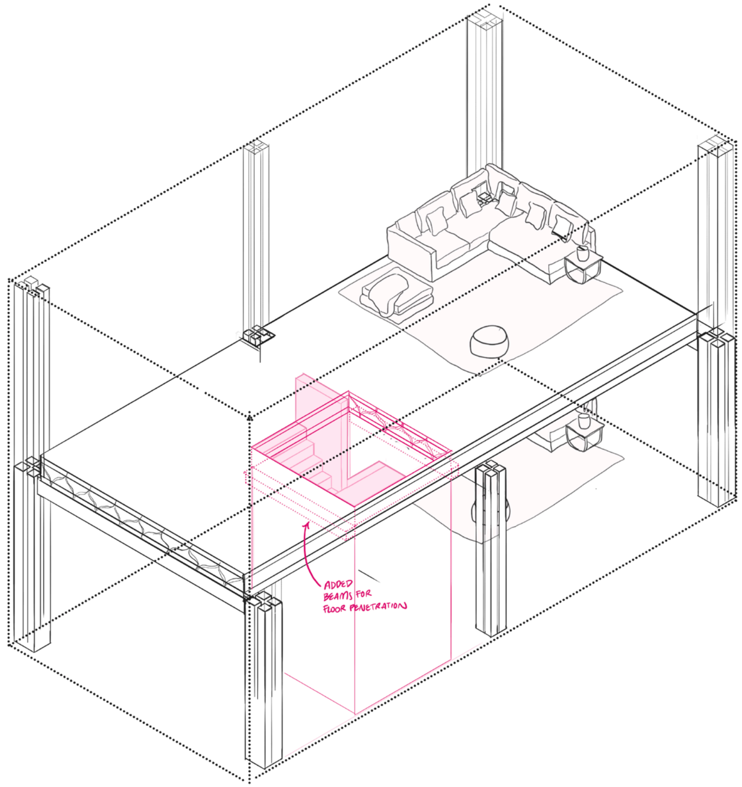
COMPONENTS
PARTITION
FLOORS

RISK LEVEL
MODERATE

TOOLBOX
CIRCULAR SAW
RECIPROCATING SAW
DRILL
PRY BAR
TEMPORARY SAFETY RAILINGS

CONNECT UNITS VERTICALLY

STRATEGY: Stacked unit layouts align service zones and floor openings, enabling future installation of stairs or lift shafts between levels. Fire-rated floor assemblies and modular ceiling panels allow for clean vertical cuts and safe integration between connected units.



HIGH PERMANENCE

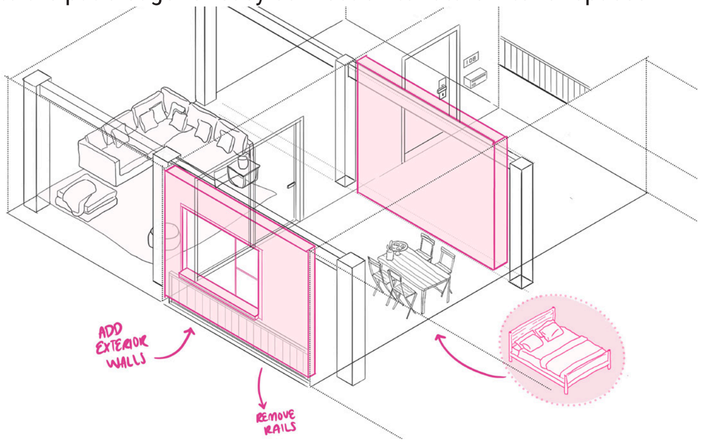
CONVERT PATIO TO EXTRA ROOMS

SHEARING LAYER SKIN

COMPONENTS EXTERIOR WALLS

RISK LEVEL HIGH

STRATEGY: The structural grid and foundation are pre-dimensioned to support enclosure of patio spaces, allowing infill walls and roof extension without altering the primary structure. Services such as ventilation and electrical conduits are pre-routed to the patio edge for easy connection to future interior spaces.



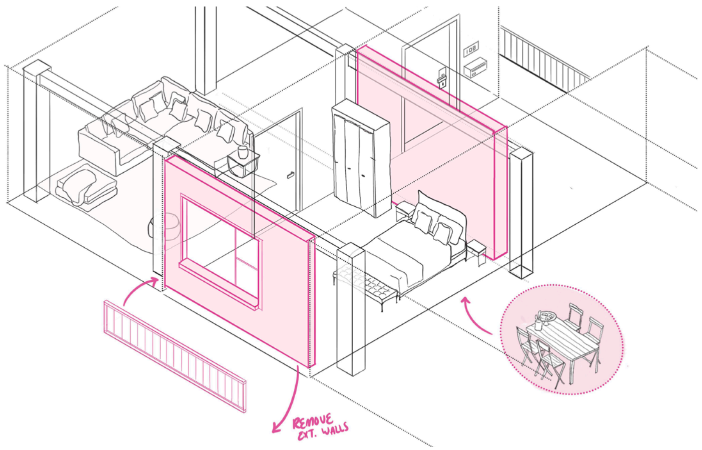
REMOVE EXTRA BEDROOMS FOR MORE PATIO SPACE

SHEARING LAYER SKIN

COMPONENTS EXTERIOR WALLS

RISK LEVEL HIGH

STRATEGY: Non-load-bearing partition walls allow for easy removal to open the floor plate toward the exterior. Modular facade elements can be disassembled and relocated to redefine the building envelope, transforming interior space into an open or semi-open patio.



→ SEE PG. 80 FOR EXTERIOR WALL DETAILS

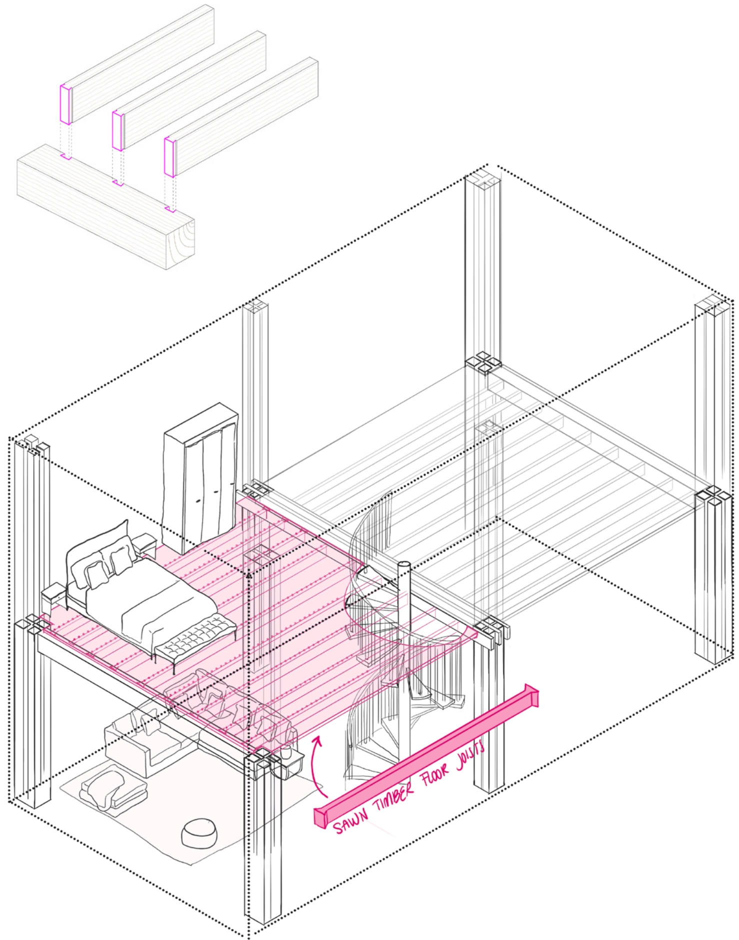
TURN LOFT INTO DUPLEX FOR ADDITIONAL FLOOR SPACE

SHEARING LAYER STRUCTURE

COMPONENTS PARTITION FLOORS

RISK LEVEL MODERATE

STRATEGY: The ceiling height and structural spans are designed to allow insertion of a mezzanine or partial second floor with minimal reinforcement. Floor openings for stair access are pre-designated within the structural grid to enable vertical circulation without major demolition.



→ SEE PG. 94 FOR FLOOR ASSEMBLIES

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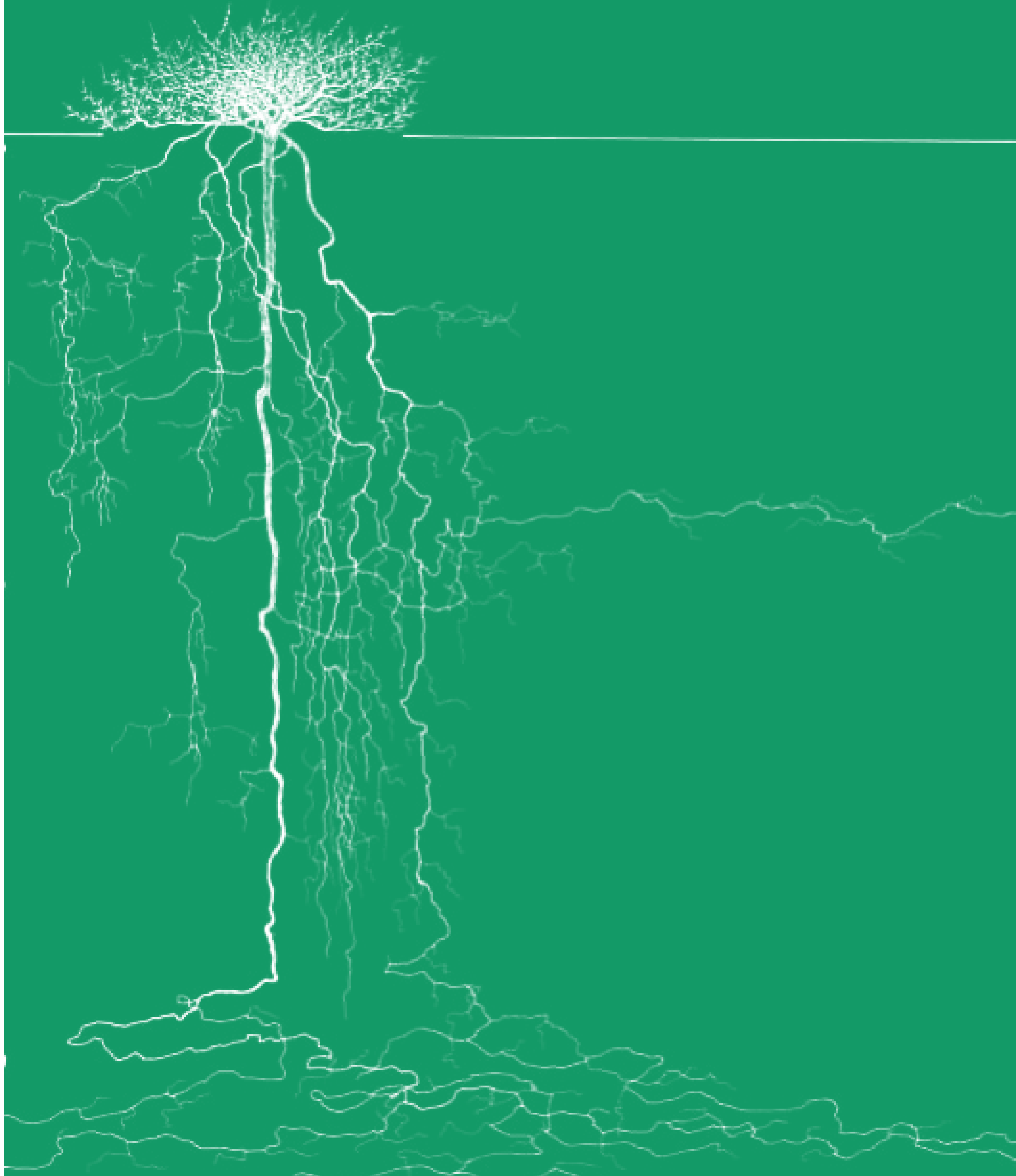


03_ BUILDING OVERVIEW

BUILDING OVERVIEW_ SUPPORT STRUCTURE

This chapter outlines the structural and spatial strategy for the transformation of an existing concrete parking garage into a flexible, timber-based residential structure. The approach begins with the principle of "removing to add"—a strategy that incrementally reduces the weight and load demands of the existing structure to enable upward expansion. Heavier concrete floor slabs, originally designed to support the live loads of parking, are gradually removed and replaced with lighter mass timber floors, making room for new residential density while remaining within the capacity of the original pile foundation.

The structural strategy builds on the garage's inherent logic of repetition and robustness, using a table construction method to introduce new timber post-and-beam volumes above. These land on an intermediate level of mass timber wall panels, strategically placed to act as Vierendeel trusses. This enables loads from the new timber structure to span between the three primary lines of the existing load-bearing walls and transfer forces directly to the original foundation points—avoiding the need for reinforcement or excavation.

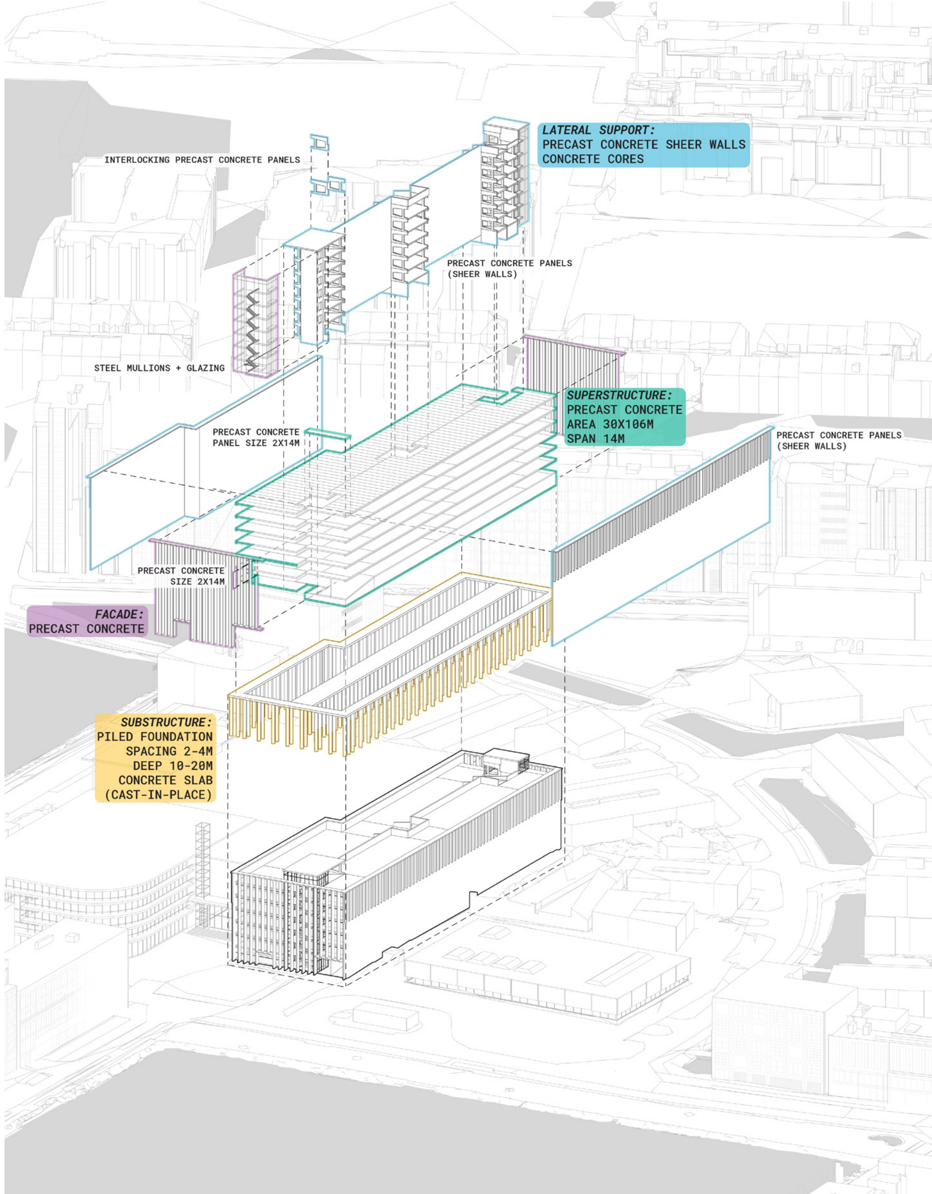
Over time, as transportation infrastructure improves and car dependency declines, this strategy supports a phased densification: more residential units can be added as demand grows, and structural capacity becomes available through the removal of outdated parking decks. This makes the building a living framework—capable of evolving without disruption to its foundation or long-term usability.

Beyond structure, this chapter also describes the spatial organization of the building, including the integration of a material archive and reuse system that enables circular construction and local material storage. The plan organizes programs by intensity and adaptability: shared and support functions at the base, flexible housing units above, and spaces for collective or community use interwoven throughout.

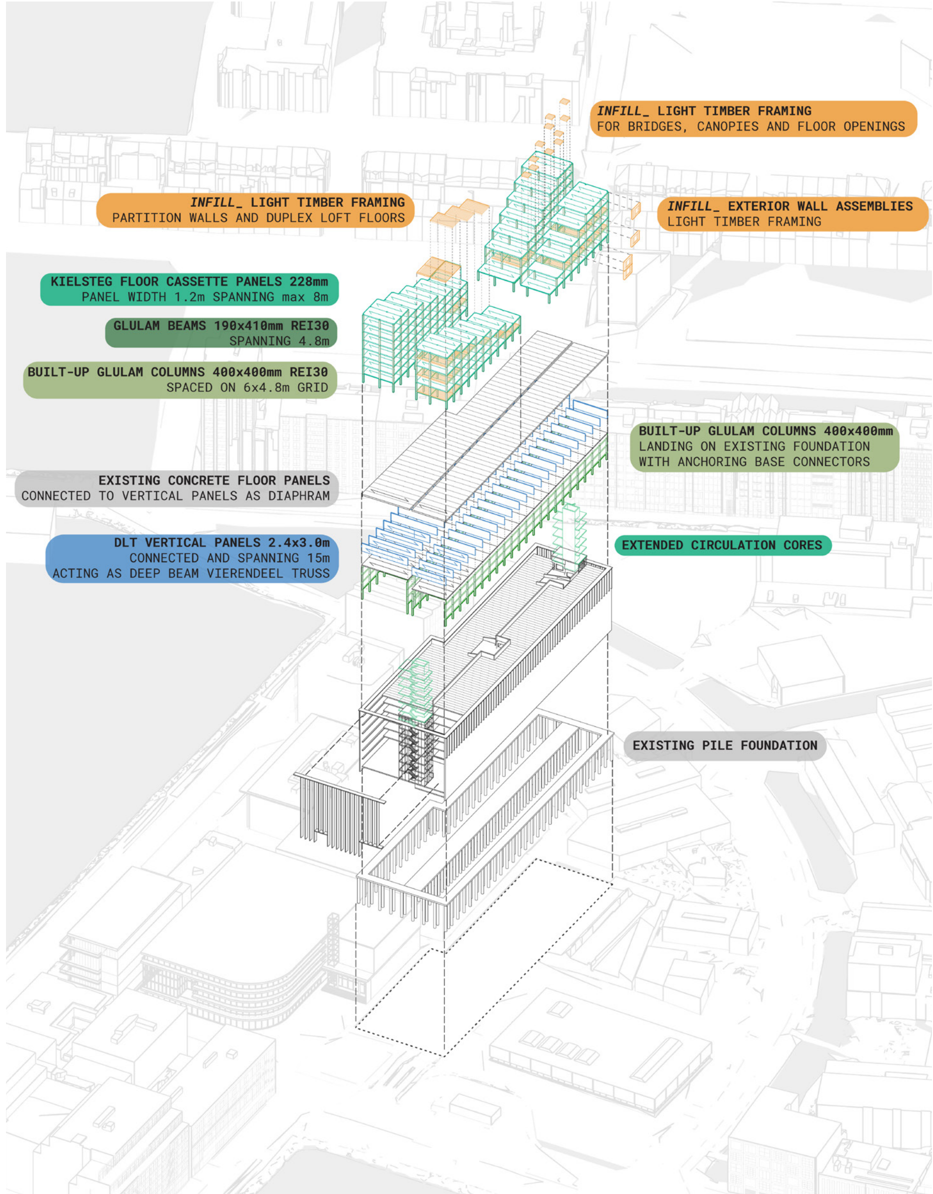
Finally, the section will define the design of the base unit typology, which serves as the core for residential expansion and transformation. These units are conceived for adaptability over time—capable of subdivision, extension, or reconfiguration in response to changing household needs.

The chapter concludes with an overview of the climate strategy, focusing on passive design principles, thermal zoning, and envelope strategies tailored to timber construction. Together, these elements form a resilient and responsive system for sustainable urban living.

STRUCTURAL CONCEPT



EXISTING BUILDING STRUCTURAL ANALYSIS



NEW CONSTRUCTION ASSEMBLY OVERVIEW

ASSEMBLY CONCEPT

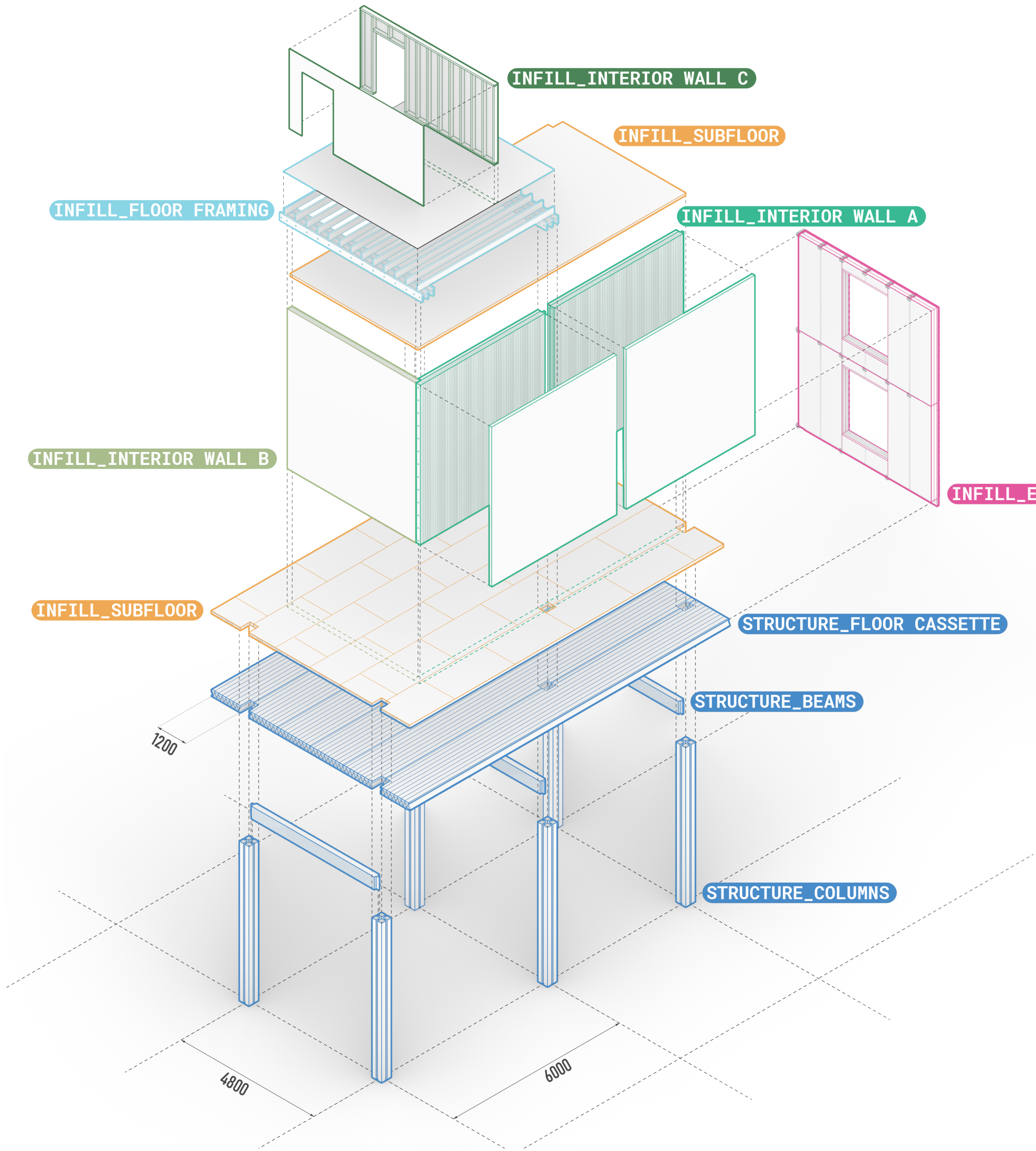
The assembly strategy is based on the principles of the Open Building concept, with the more permanent support structure and short-term, user-adaptable components -- the infill. The strategy follows a layered subsystem approach, where building systems are treated as independent, mono-functional layers. This enables components—such as load-bearing elements, installation zones, and spatial enclosures—to operate separately, allowing for individual adaptability, maintenance, and replacement over time.

The supporting structure acts as the permanent framework for the building. Structural floors are constructed with Kielsteg floor cassettes, which have a high strength-to-weight ratio. These span between beams that connect to stacked columns across each floor for efficient load transfer and structural continuity.

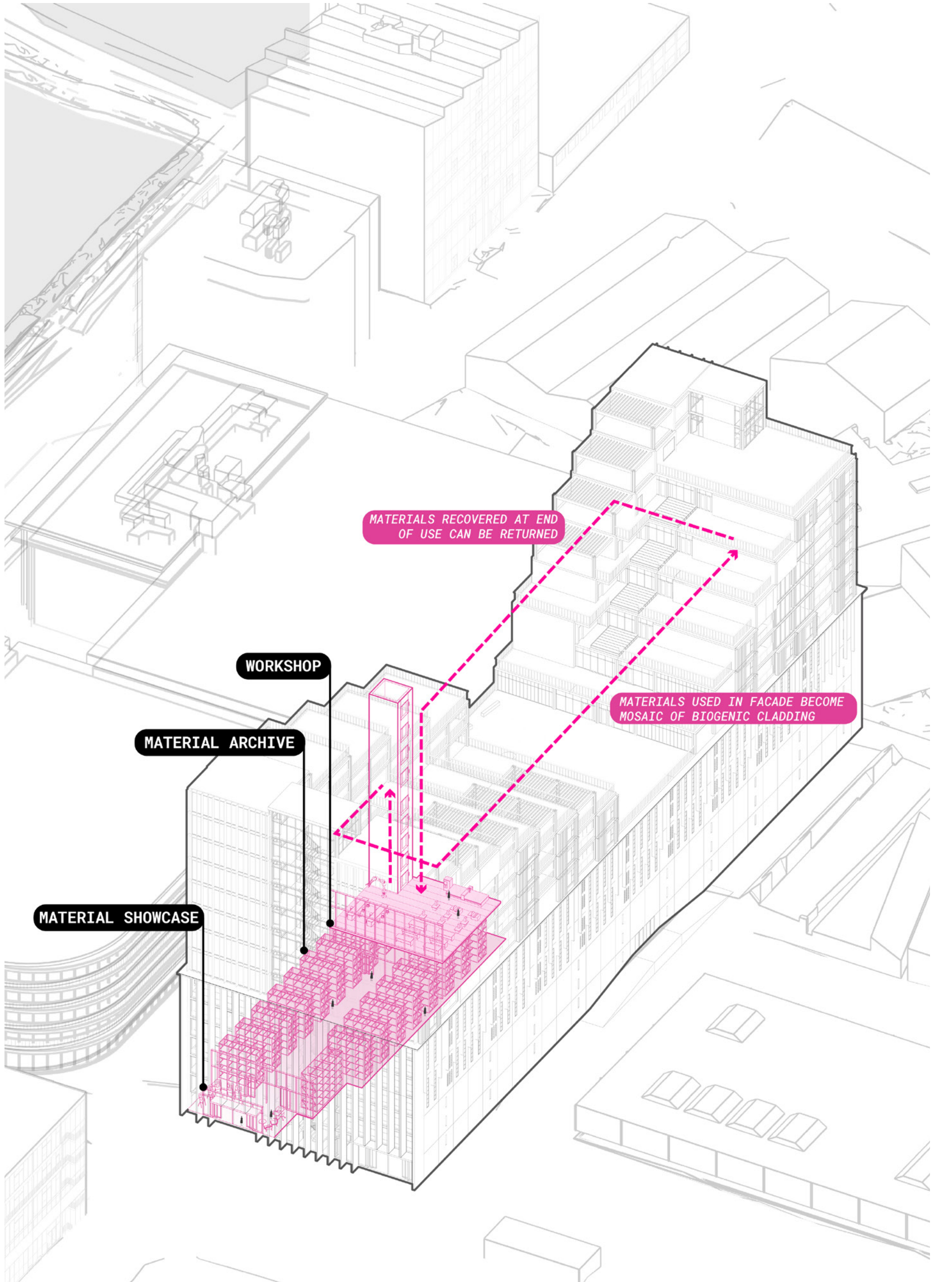
The design prioritizes fire safety through the integration of solid DLT partition walls with decoupled, double-leaf constructions. Fire compartments are defined by offset joints or interlocking panels at wall junctions.

Interior partition walls are flexible in layout but generally correspond to the structural grid, allowing for a degree of layout variability without compromising structural logic. The infill components—such as partition walls, facades, and installation layers—are conceived as replaceable and non-destructively demountable units.

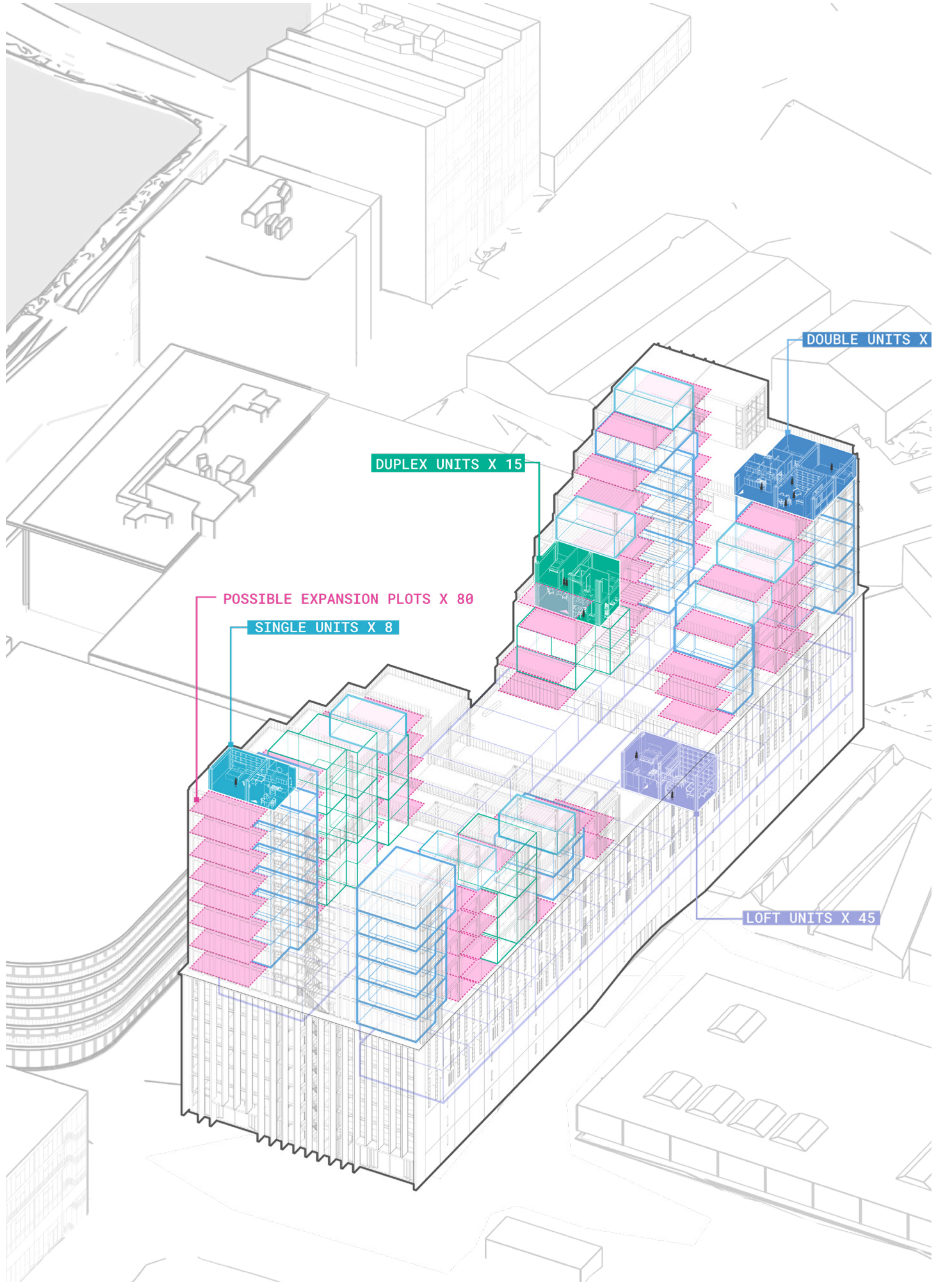
By minimizing fixed connections between layers, this strategy ensures a high degree of flexibility and adaptability throughout the building's lifecycle. It supports phased transformation and user-driven adaptations.



SPATIAL ORGANIZATION



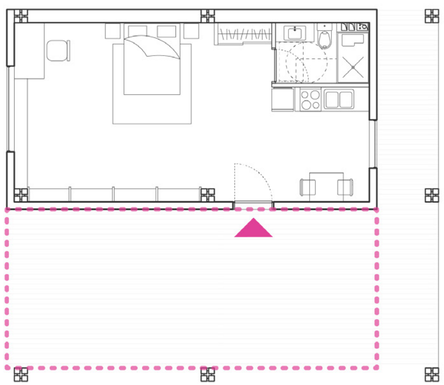
CIRCULAR MATERIAL-USE + STORAGE CONCEPT



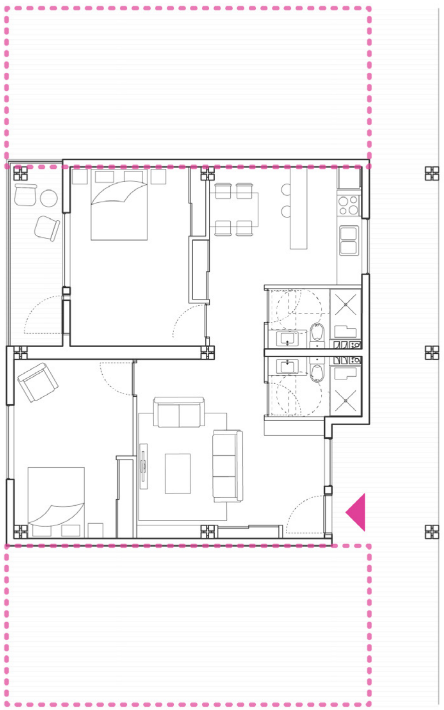
RESIDENTIAL + EXPANSION DISTRIBUTION

BASE UNIT TYPES

RESIDENTIAL UNITS

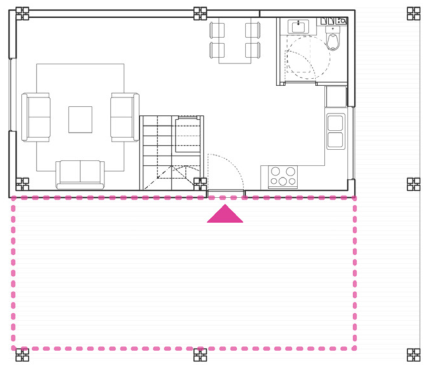


FLAT 1 BED 1BATH + 1X

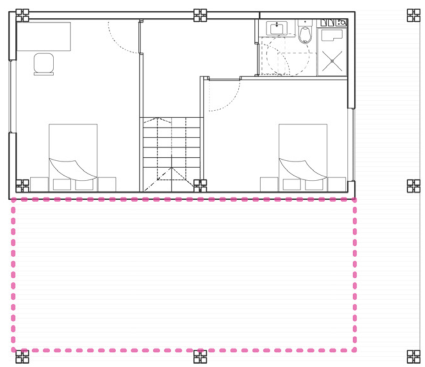


FLAT 2 BED 2BATH + 2X

LOWER LEVEL

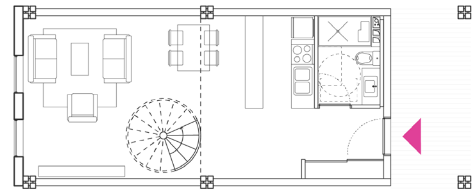


UPPER LEVEL

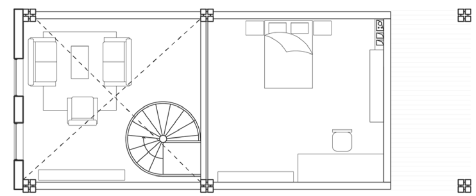


DUPLEX 2BED 2BATH + 2X

LOWER LEVEL

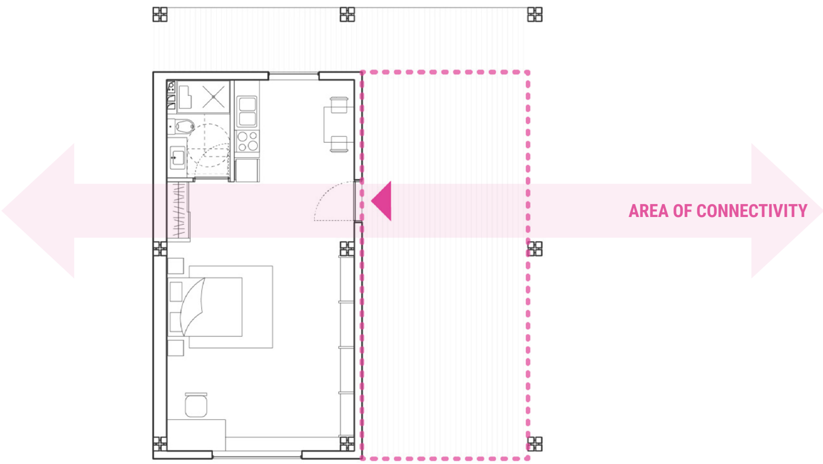


UPPER LEVEL

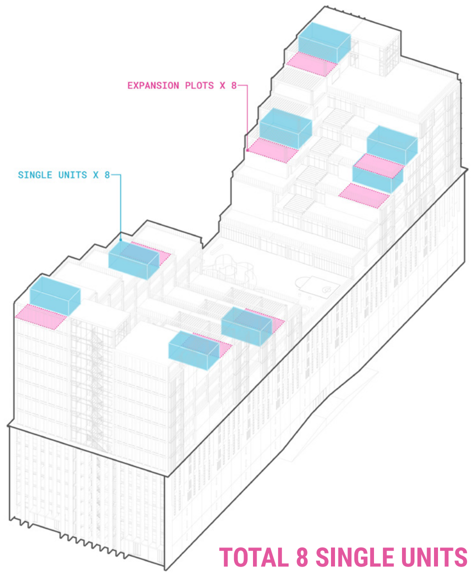


LOFT 1BED 1BATH + 2X

RESIDENTIAL UNITS



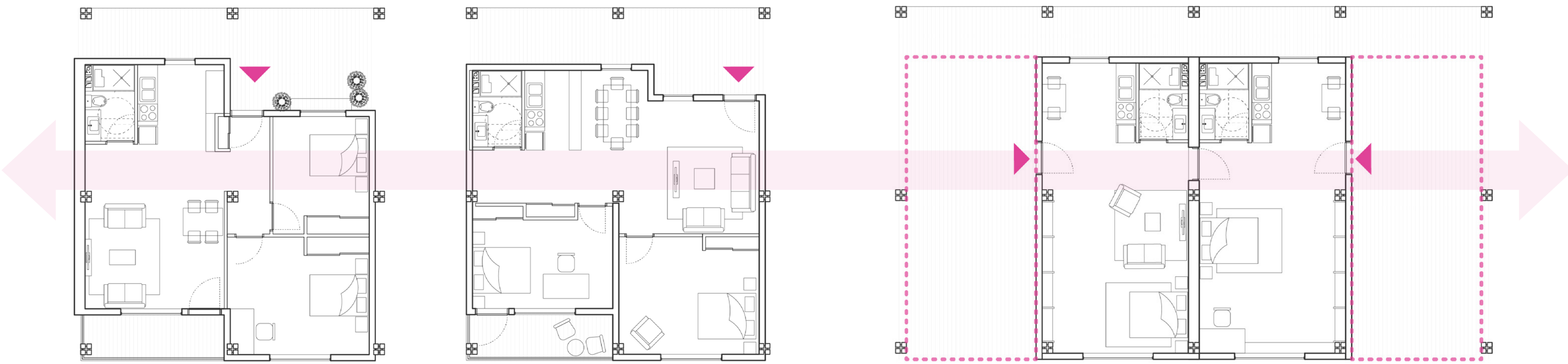
FLAT 1 BED 1BATH + 1X



TOTAL 8 SINGLE UNITS IN BUILDING

EXPANDED UNIT VARIATIONS

COMBINED UNITS

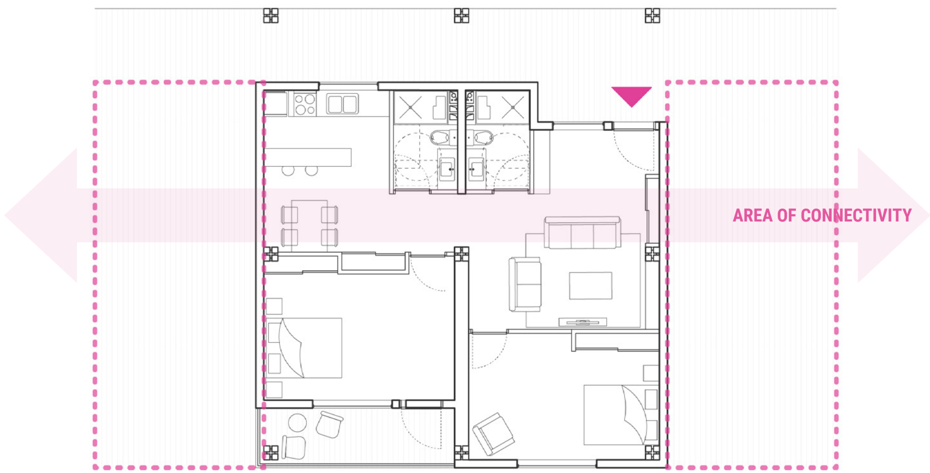


FLAT 2 BED 1BATH

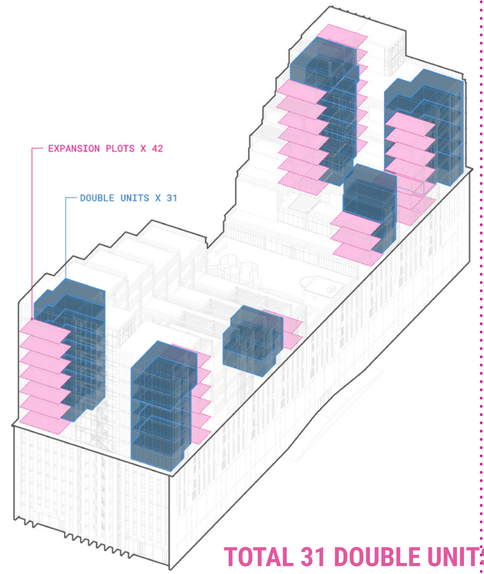
FLAT 2 BED 1BATH

FLAT 1BED 1BATH + 1BED 1 BATH

RESIDENTIAL UNITS

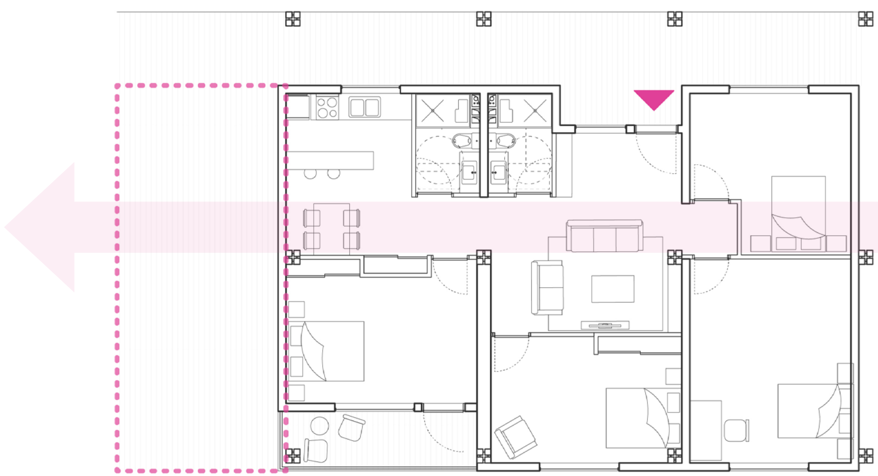


FLAT 2 BED 2BATH + 2X



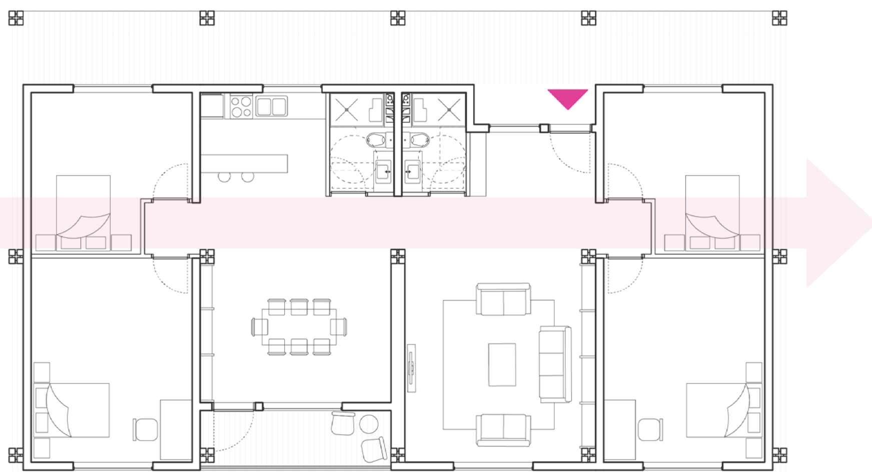
TOTAL 31 DOUBLE UNITS IN BUILDING

PARTIALLY EXPANDED



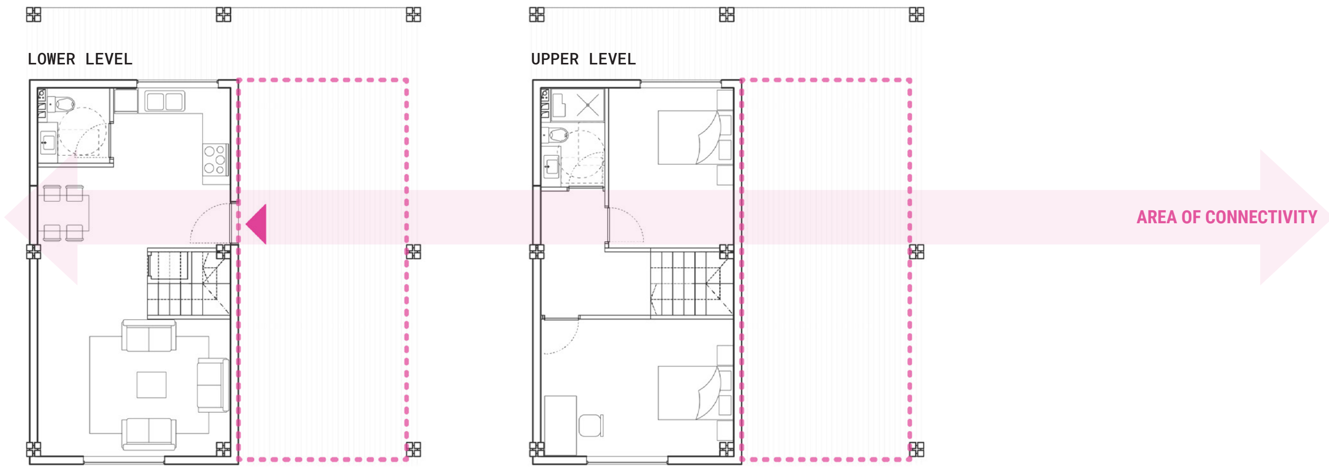
FLAT 3BED 2BATH

FULLY EXPANDED

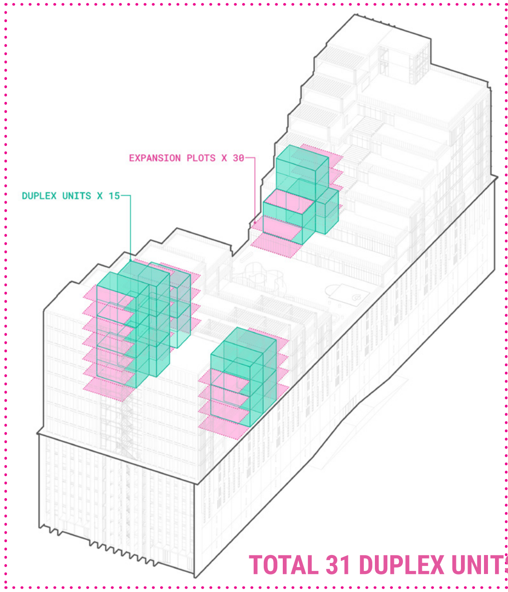


FLAT 5BED 2BATH

RESIDENTIAL UNITS



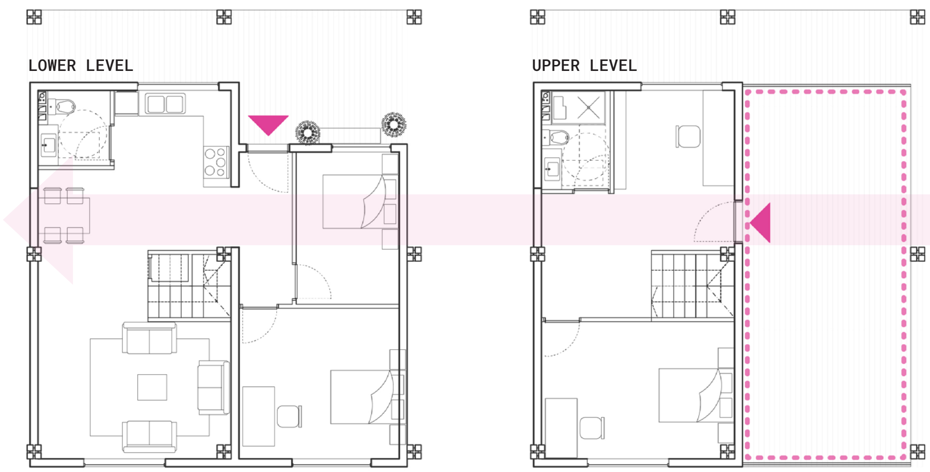
DUPLEX 2BED 2BATH + 2X



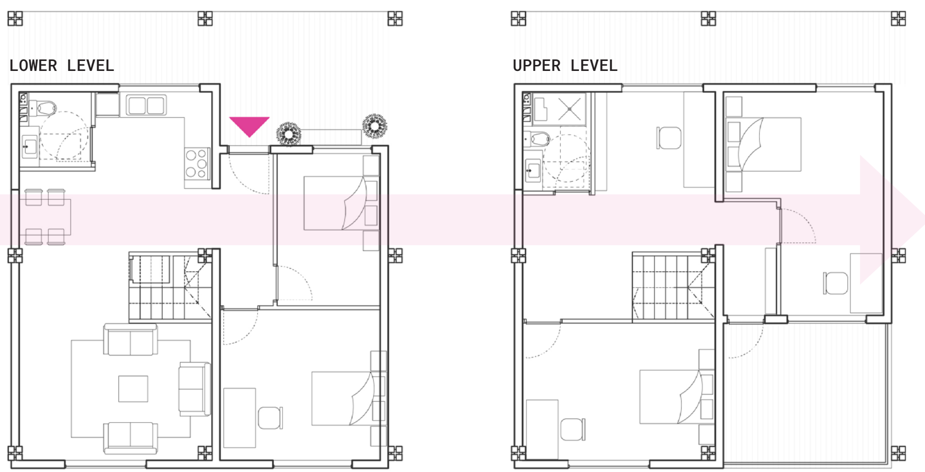
TOTAL 31 DUPLEX UNITS IN BUILDING

LOWER LEVEL EXPANSION

UPPER LEVEL EXPANSION

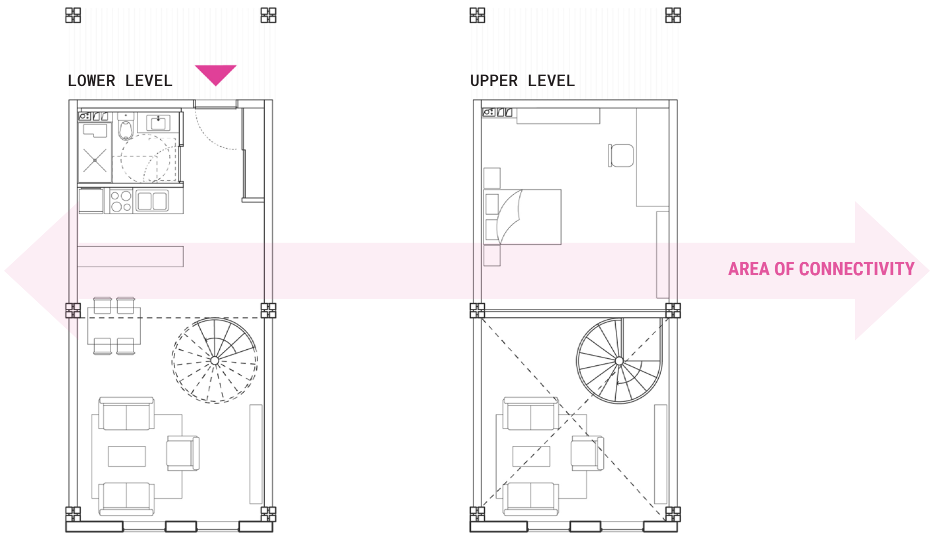


DUPLEX 3BED 2BATH

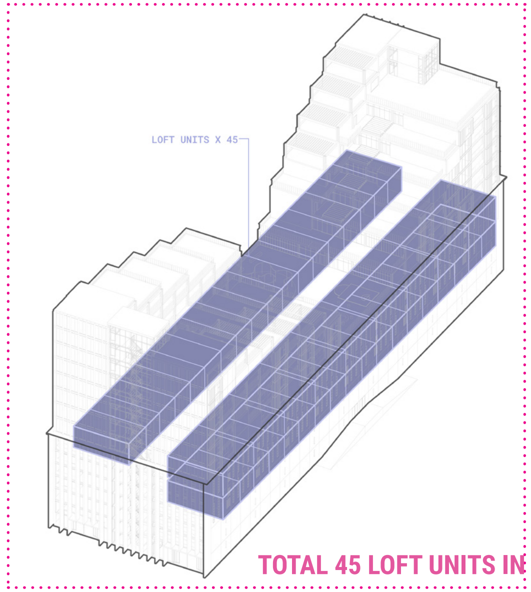


DUPLEX 4BED 2BATH

RESIDENTIAL UNITS

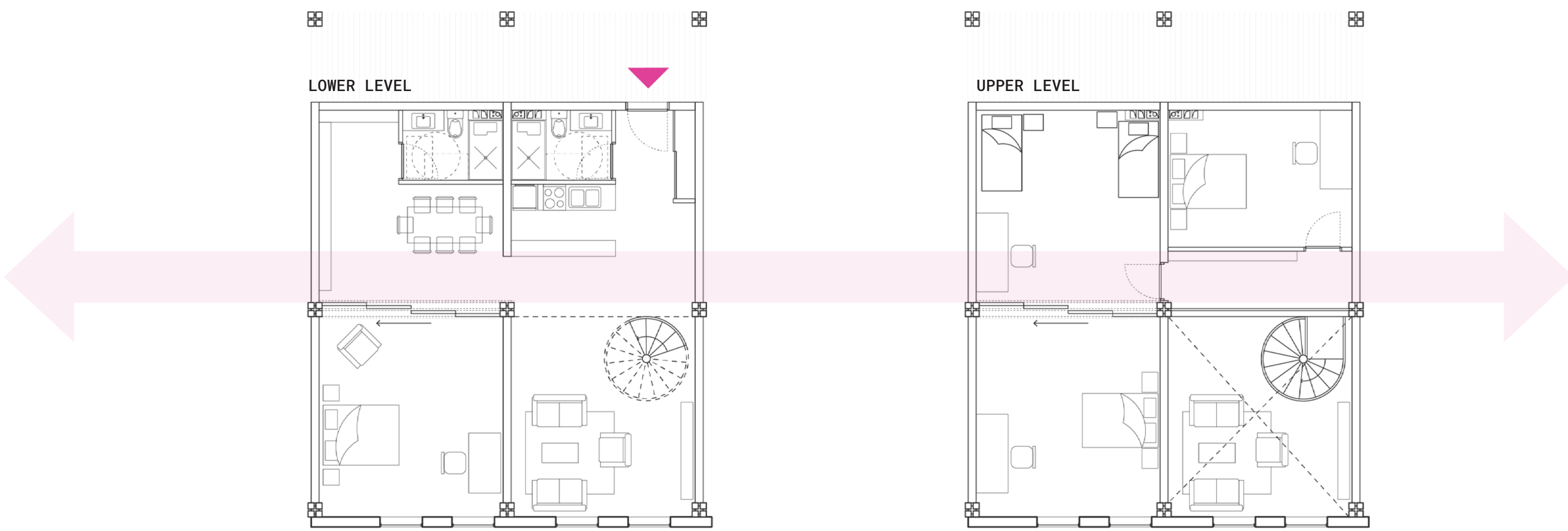


LOFT 1BED 1BATH + 2X



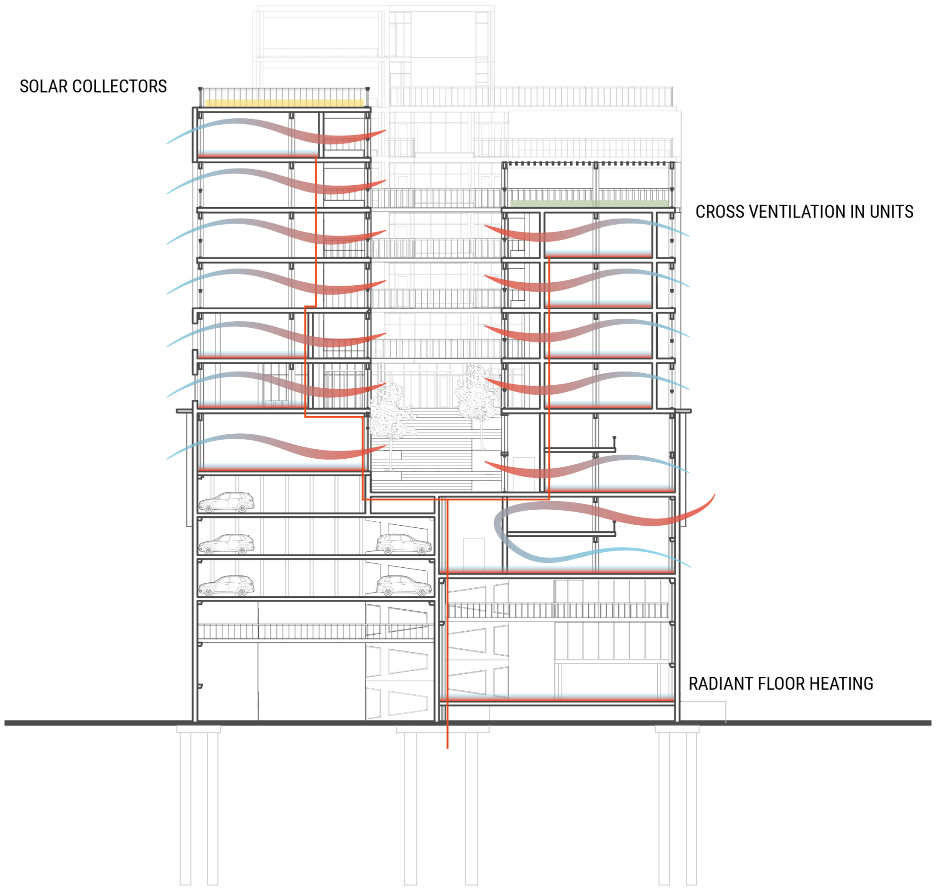
TOTAL 45 LOFT UNITS IN BUILDING

COMBINED LOFT

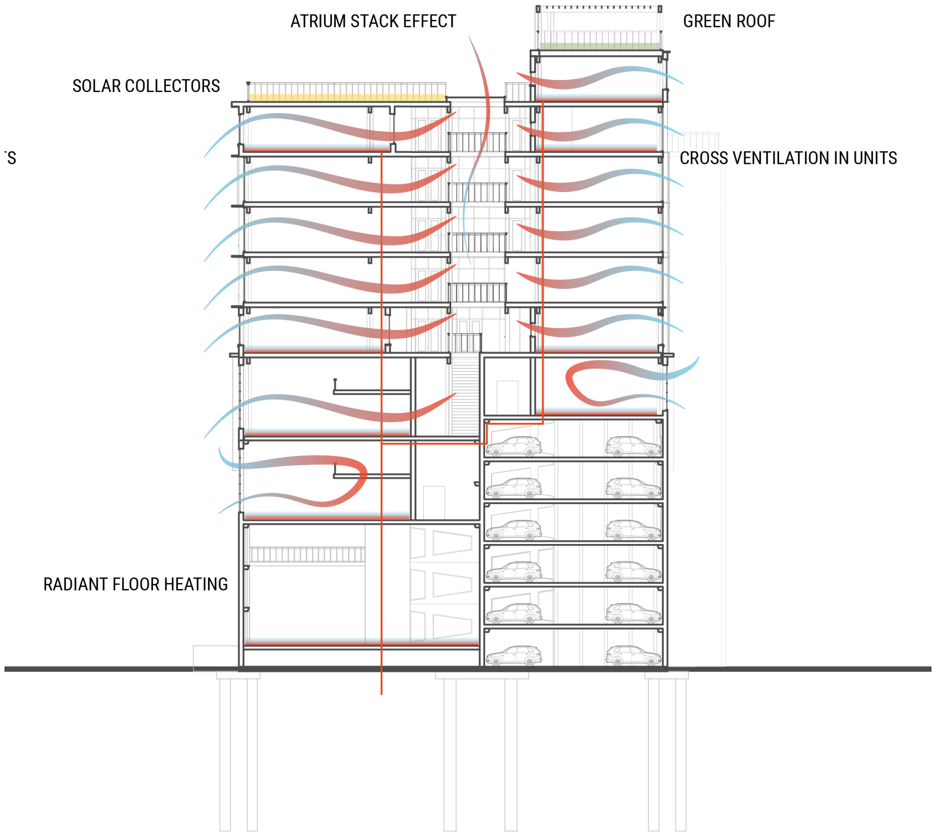


LOFT 4BED 2BATH

CLIMATE SYSTEMS

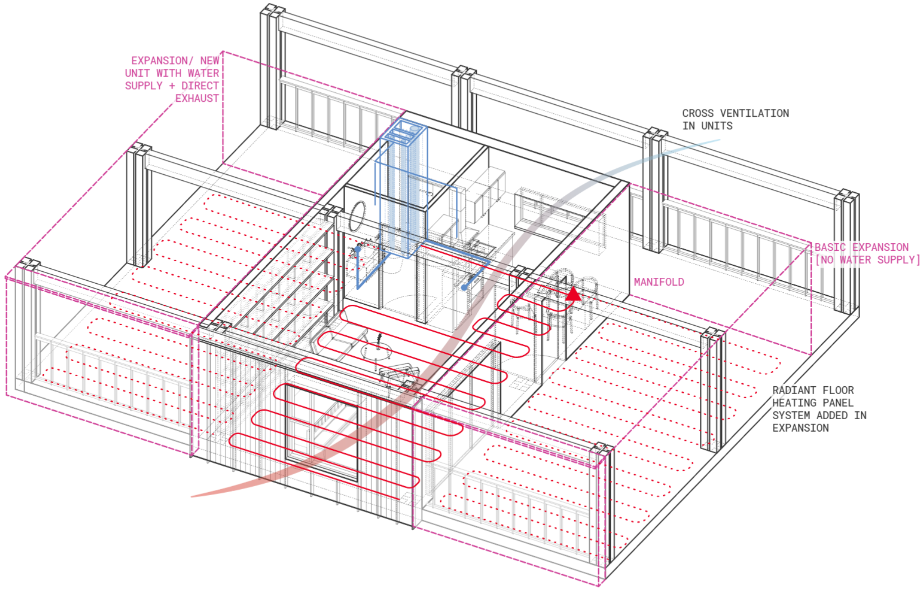


VENTILATION BLOCK A

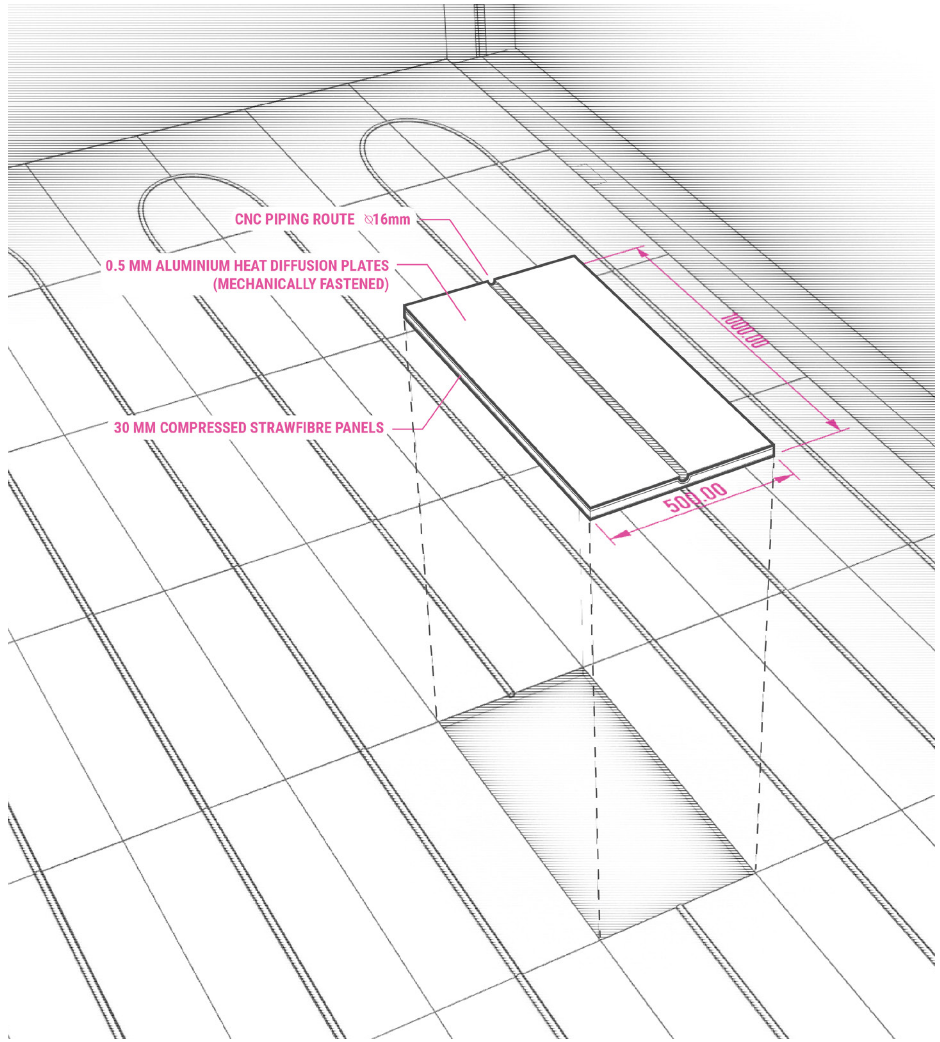


VENTILATION BLOCK B

CLIMATE SYSTEMS



UNIT INSTALLATIONS



JUPITER IDEAL STRAW PANEL SYSTEM

Technical Properties

30mm natural straw fibre radiant heating panel system
Chemical and plastic free
100% Recyclable – ∴ carbon neutral.
Carbon negative depending on aluminium evaluation
Panel dimensions 1000mm x 500mm x 30mm. Pipe distance 125mm.

Sustainable | Healthy living | Fire resistant | Robust
Compostable | Resource saving | Annually renewable | Anti-allergy

Thermal conductivity	0.050 W/(mK)
Thermal resistance	R=0.55 m²K/W
Acoustic improvement	ΔLw to 22 dB
Density	240 kg/m³
Compressive strength	150 kPa
Pipe distance	125mm
Pipe diameter	16mm
Fire class EN13501	E
Panel dimension	1000 x 500 x 30mm

RADIANT FLOOR HEATING

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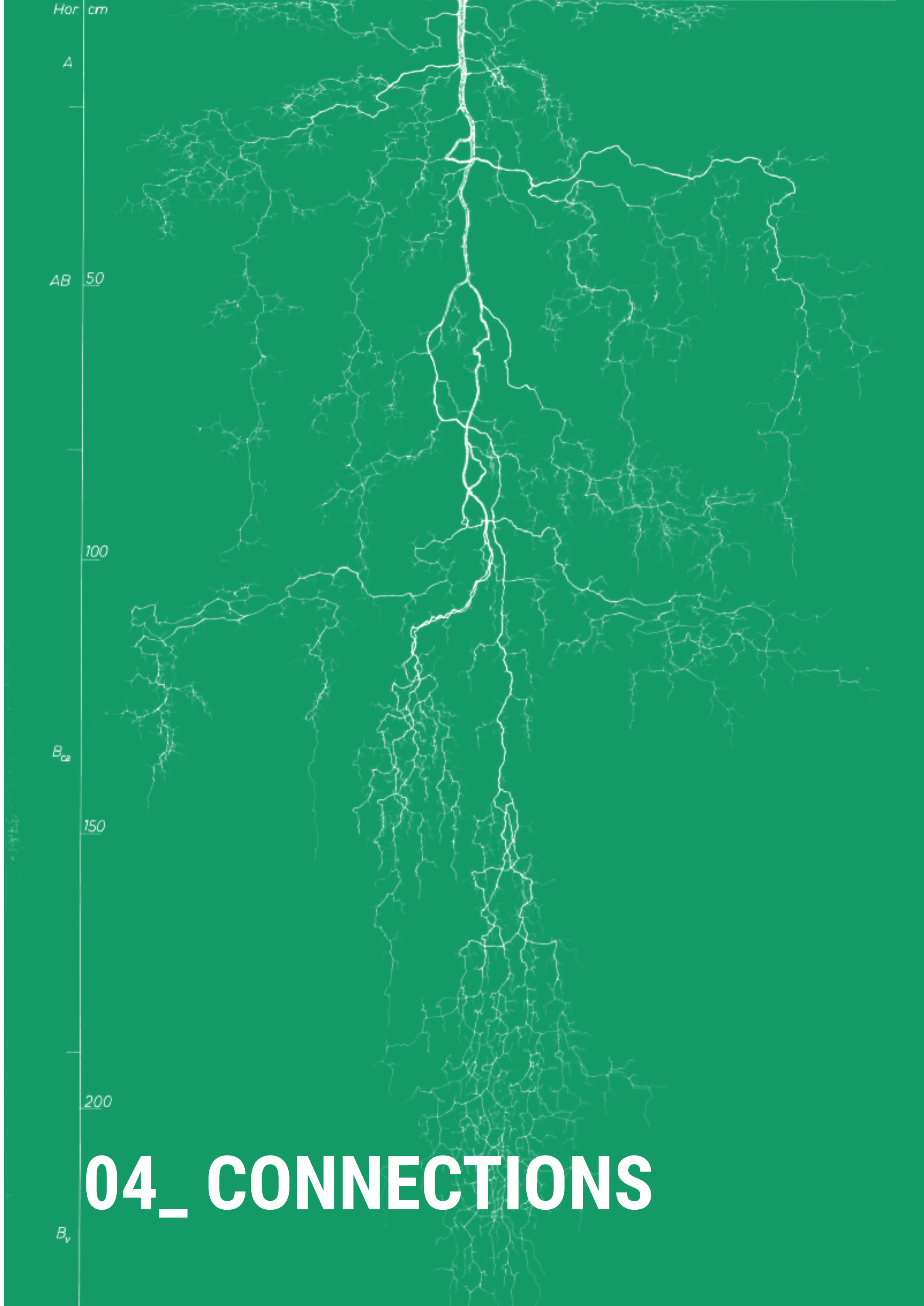


04_ CONNECTIONS

STRATEGIES FOR CONNECTION DESIGN

The design of the connections is crucial and one of the focal points of designing for adaptability. Specified connections are what enables the separation between building layers, allowing for the removal or replacement of different building components based on their functional or material lifespan. The use of mechanical, reversible connections instead of chemical ones allows components to be easily removed without damage to the integrity of the material, for either movement within the same building, or reuse in another. Within the scope of this research, connections between linear timber framing members as well as panel systems will be assessed.

In the context of adaptability in varying timescales, the design of the connections must also respond to the different requirements of each. Short-term flexibility may require simple and easy-to-implement connection strategies that would minimize disruption to the occupants and allow for quick reconfiguring or repair. On the other hand, medium to long-term adaptation methods might involve more complicated and less tactile connection systems. Although steel fasteners and connections are widely accepted as the demountable standard, within this framework, there may be varying degrees of permanence, opening possibilities for alternative solutions.

In order to categorize and assess the feasibility of potential connections, it is beneficial to first identify the guidelines for connections when it comes to adaptability. First, as the methods for adaptation are small-scale and for dwelling purposes, encouraging customization and renovation by the occupants themselves, the construction and joinery should be simple and tactile, and accomplished without any special skill, becoming more of an assembly task than construction.

Secondly, as timber and biogenic materials, in general, are known for their damage accumulation, It is important in designing for disassembly to be low-impact, limiting any damage or insertions into the material that would decrease its strength and reusability.

The third main consideration is the idea of scalability that comes from the “packaged house system”, which aims to create a system for accommodation of all materials. To allow for a larger capacity for customization, the selected connection type should also be a loose-fit design — something that can adapt and accommodate varying sizes of materials that can be used.

CATEGORIES OF REVERSIBLE TIMBER CONNECTIONS

STRAPPING

In order to better understand how to address the issue of social isolation, a literature review was performed to generate a list of evidence-based design features that can be used when retrofitting existing high-rises.

\+ **ease of assembly**

requires some knowledge or previous experience

\+ **number of incisions**

no incisions made to the timber members unless combined with carpentry joinery

\+ **ease of fabrication**

only simple cuts required

– **applicability**

limited by structural capacity

SIMPLE FASTENERS

In order to better understand how to address the issue of social isolation, a literature review was performed to generate a list of evidence-based design features that can be used when retrofitting existing high-rises.

\+ **ease of assembly**

– **number of incisions**

results in damage accumulation; this often leads to smaller members not being reused

\+ **ease of fabrication**

\+ **applicability**

PROPRIETARY STEEL CONNECTORS

In order to better understand how to address the issue of social isolation, a literature review was performed to generate a list of evidence-based design features that can be used when retrofitting existing high-rises.

\+ **ease of assembly**

– **number of incisions**

usually multiple incisions for knife plates or fasteners

= **ease of fabrication**

– **applicability**

each connector designed for specific members and connection

CARPENTRY JOINERY + WOOD CONNECTORS

In order to better understand how to address the issue of social isolation, a literature review was performed to generate a list of evidence-based design features that can be used when retrofitting existing high-rises.

\+ **ease of assembly**

joints like tongue and groove allow for self-aligning and require minimal tools

\+ **number of incisions**

specific incisions made by CNC; may limit type of future reuse to same function

= **ease of fabrication**

CNC fabrication

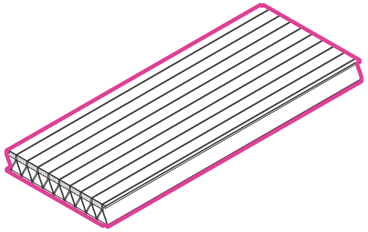
– **applicability**

x-fix connectors currently mostly designed for connecting mass timber panels

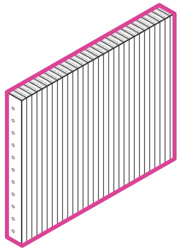
CONNECTION MATRIX

elements

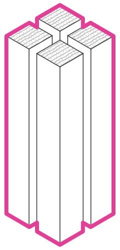
floors_ kielstag cassette system



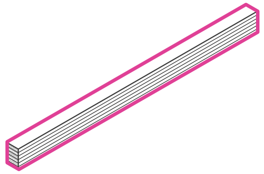
solid walls_ DLT



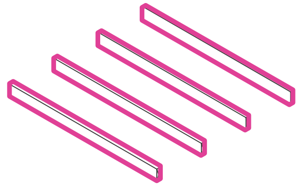
columns_ glulam



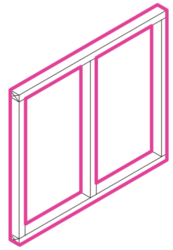
beams_ glulam



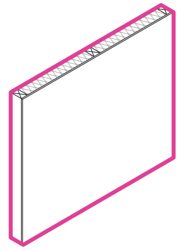
joists_ sawn timber



infill_ wood framing

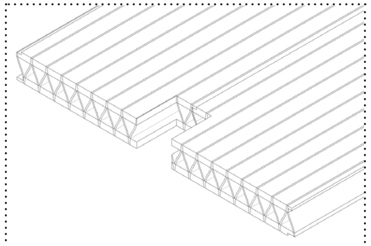


infill_ wall panels



connections [structural]

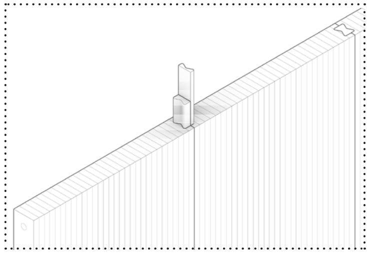
floor slabs



permanent

SIMPLE FASTENERS · STEEL CONNECTORS

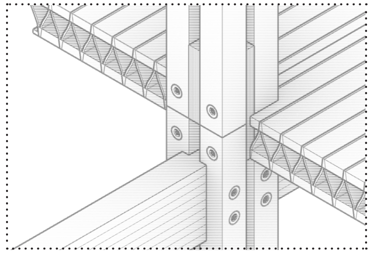
wall panels



permanent

WOOD CONNECTORS · STEEL CONNECTORS

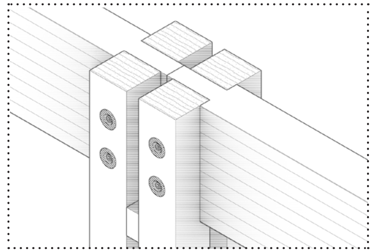
columns



permanent

WOOD CONNECTORS · SIMPLE FASTENERS

column - beam

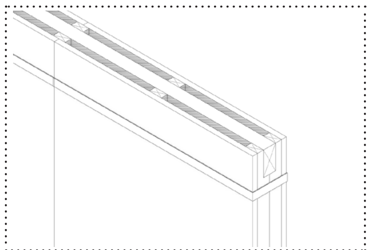


permanent

WOOD CONNECTORS · SIMPLE FASTENERS

connections [infill]

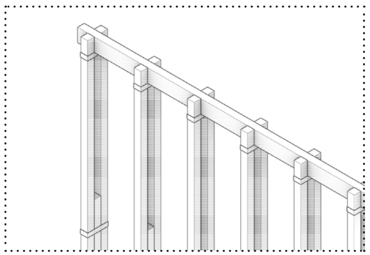
sheathing



short term

STRAPPING · SIMPLE FASTENERS · CARPENTRY JOINERY

framing

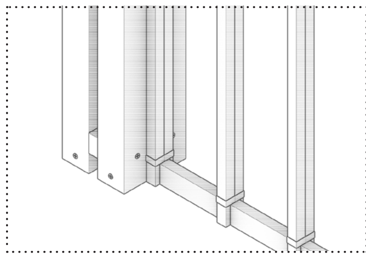


medium term

STRAPPING · SIMPLE FASTENERS · CARPENTRY JOINERY

connections [structural - infill]

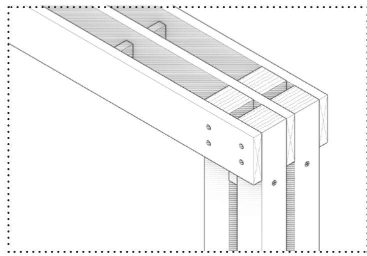
column - wall framing



medium term

STRAPPING · SIMPLE FASTENERS

column - ceiling joists

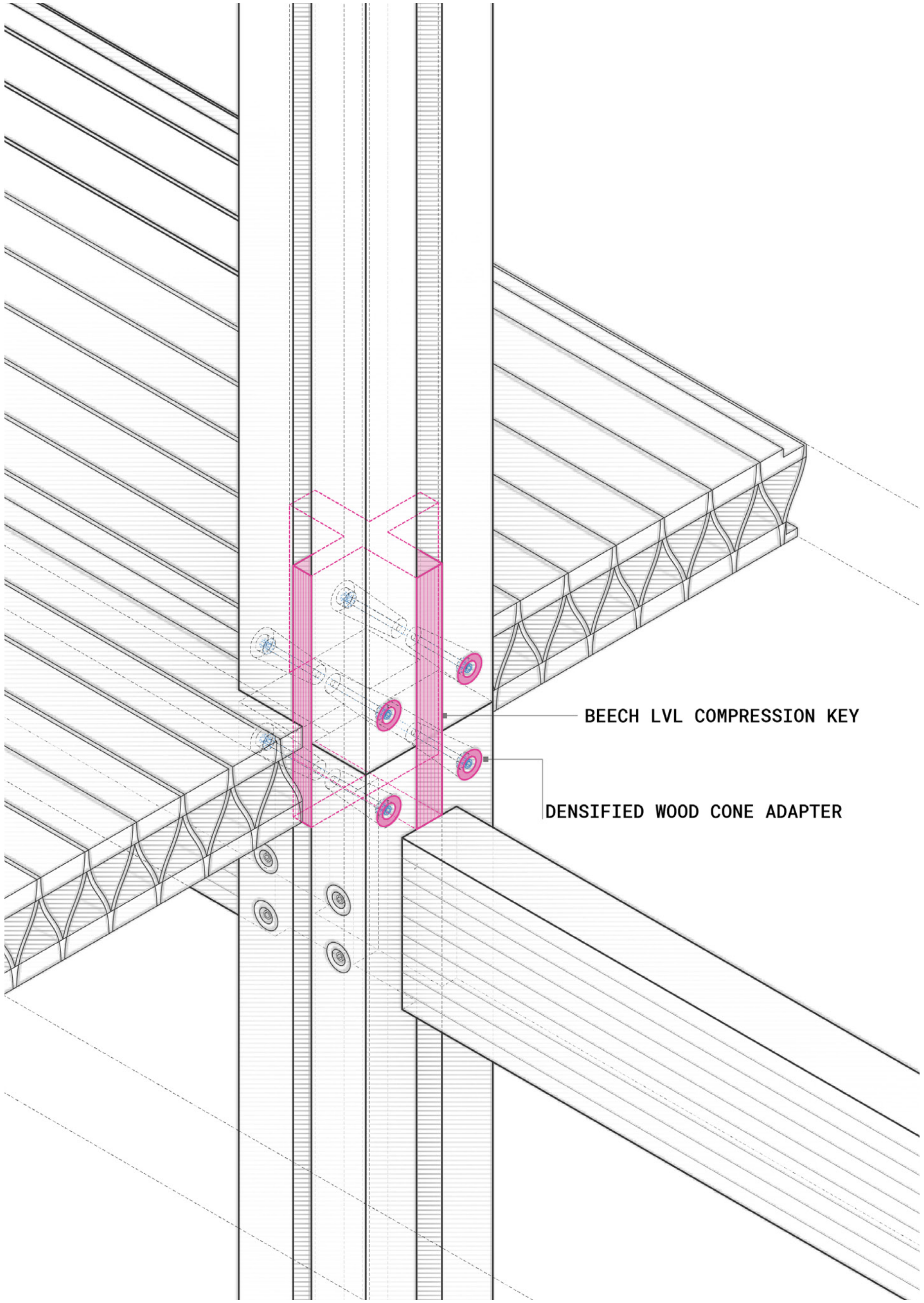


long term

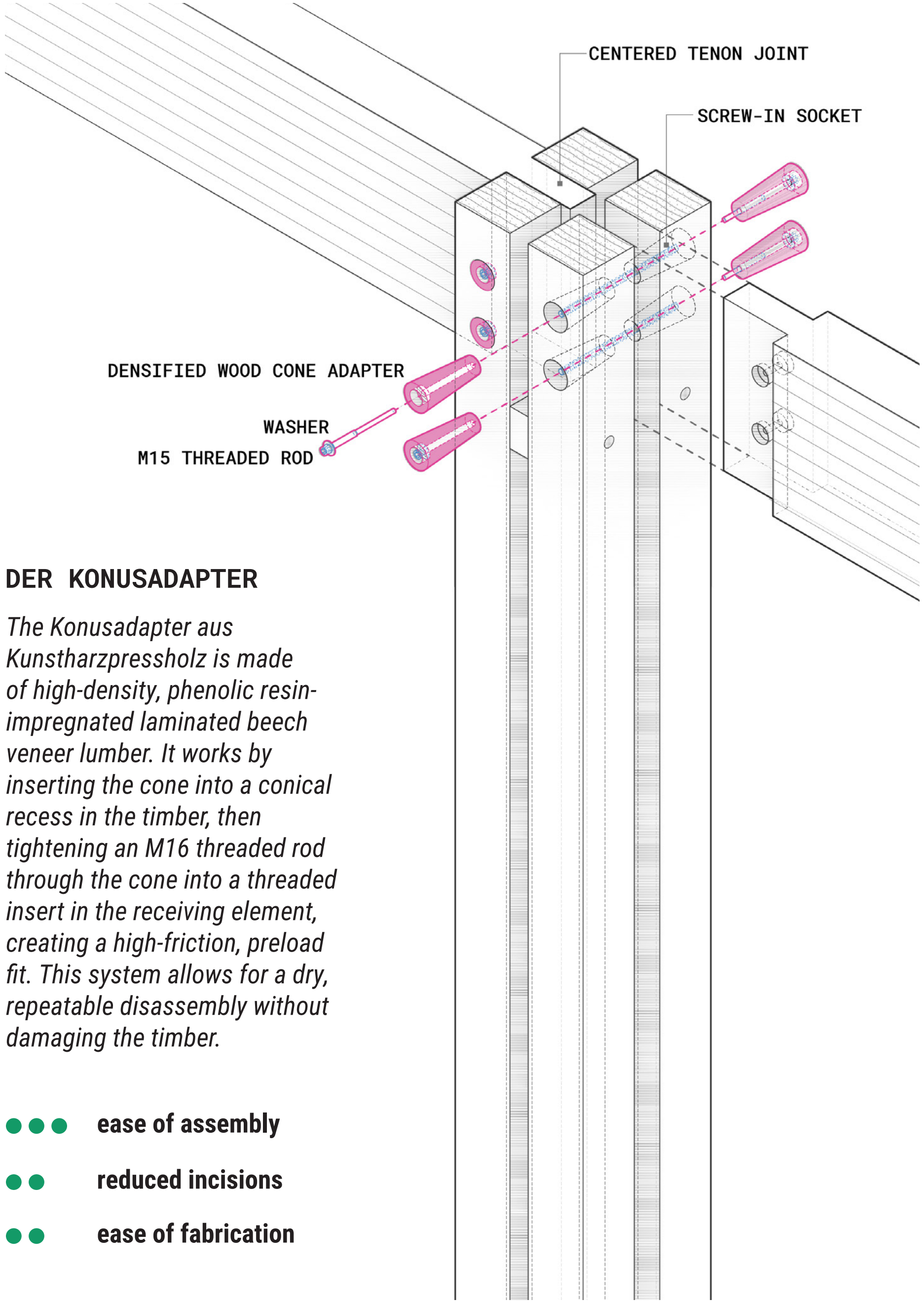
CARPENTRY JOINERY · SIMPLE FASTENERS

PERMANENT CONNECTIONS

COLUMN TO COLUMN



BEAMS TO COLUMNS



DER KONUSADAPTER

The Konusadapter aus Kunstharzpressholz is made of high-density, phenolic resin-impregnated laminated beech veneer lumber. It works by inserting the cone into a conical recess in the timber, then tightening an M16 threaded rod through the cone into a threaded insert in the receiving element, creating a high-friction, preload fit. This system allows for a dry, repeatable disassembly without damaging the timber.

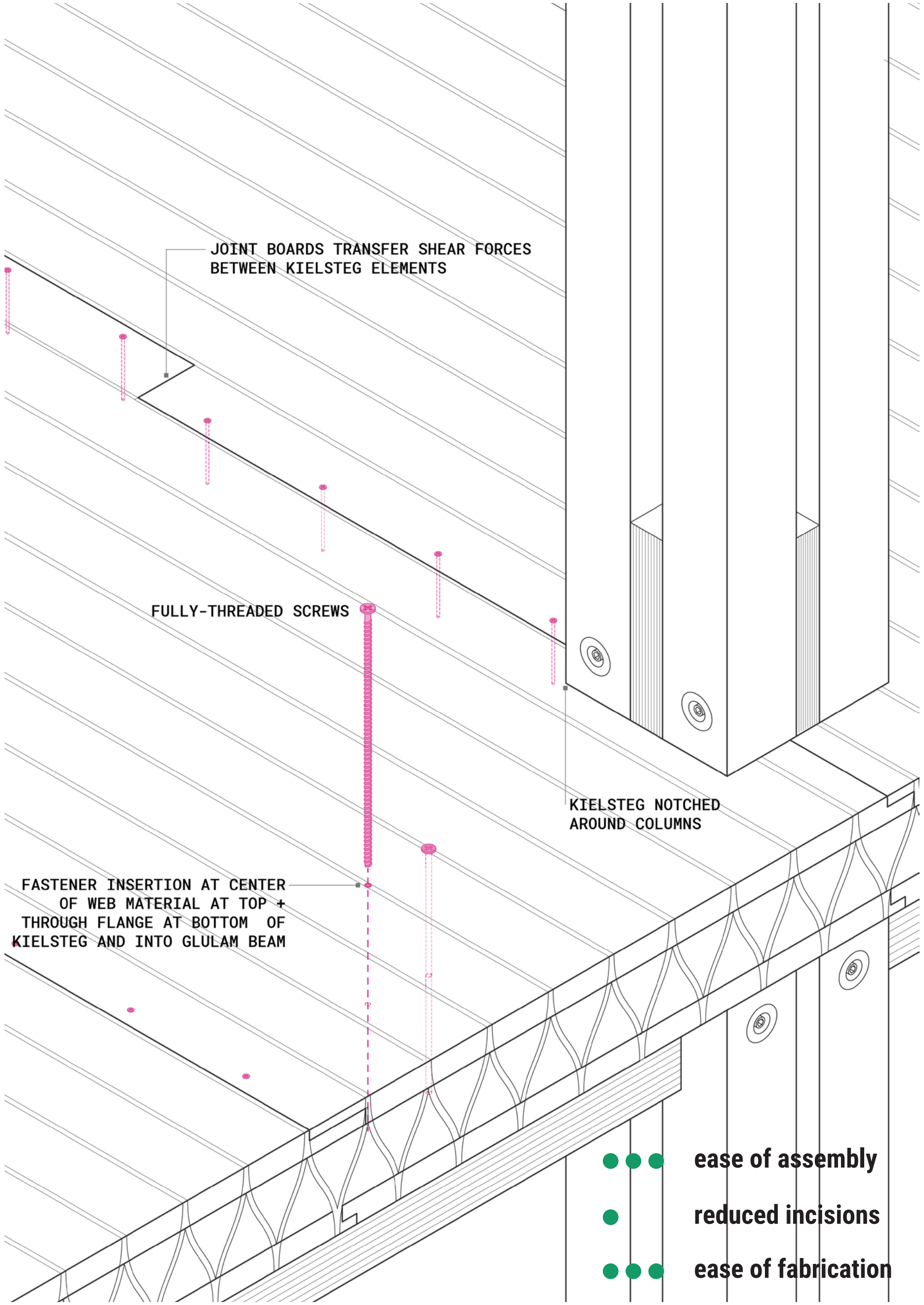
●●● **ease of assembly**

●● **reduced incisions**

●● **ease of fabrication**

PERMANENT CONNECTIONS

KIELSTEG FLOOR CASSETTE



●●● **ease of assembly**

● **reduced incisions**

●●● **ease of fabrication**

DLT WALL PANELS

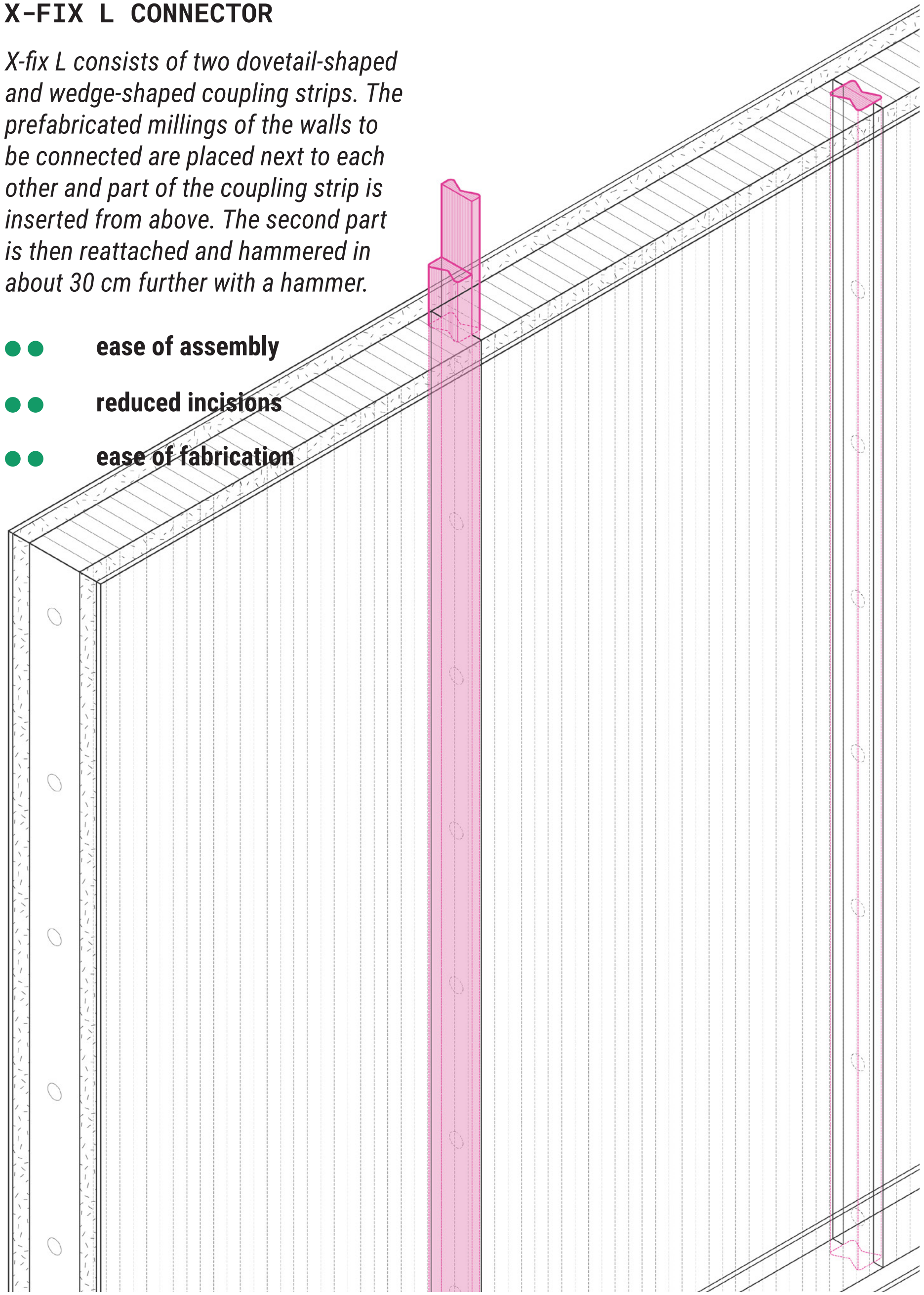
X-FIX L CONNECTOR

X-fix L consists of two dovetail-shaped and wedge-shaped coupling strips. The prefabricated millings of the walls to be connected are placed next to each other and part of the coupling strip is inserted from above. The second part is then reattached and hammered in about 30 cm further with a hammer.

●● **ease of assembly**

●● **reduced incisions**

●● **ease of fabrication**

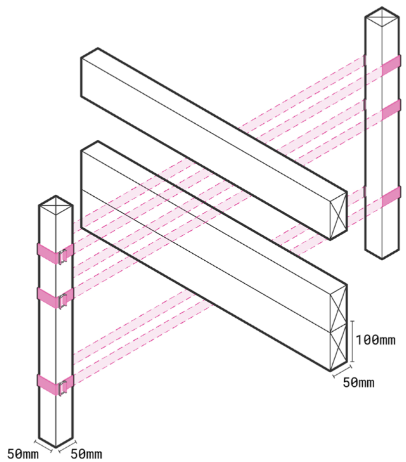


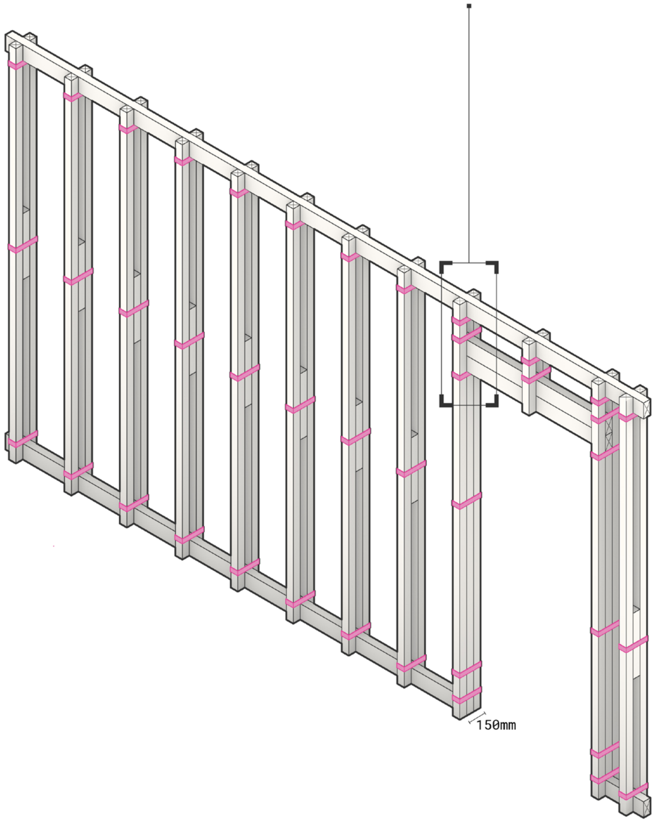
WALL FRAMING

STRAPPING METHOD

No incisions are made to the wood, allowing for maximum possible re-use. Straps are tied above and below horizontal members. Lateral stability is provided through sheathing. This build up uses smaller vertical members and results in a thicker wall assembly and more space in between for acoustic insulation.

- ●● ease of assembly
- ●●● reduced incisions
- ●●● ease of fabrication

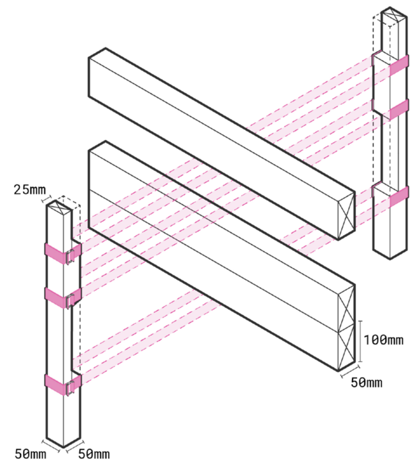


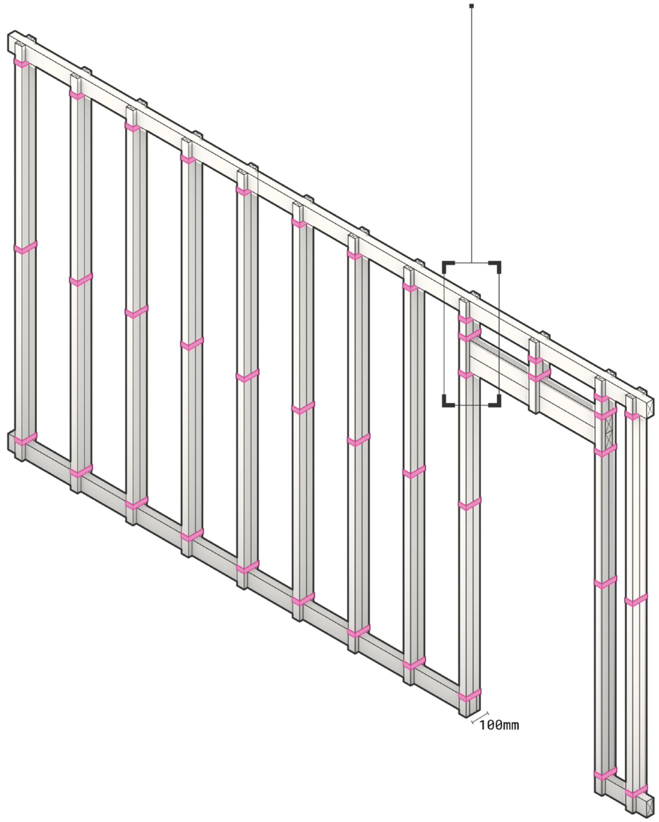


MODIFIED STRAPPING METHOD

Half-laps are CNC milled in the vertical studs for easy placement and assembly with crossing elements, adding extra stability. Vertical members are tied together directly, eliminating the need for blocking pieces in between, and results in a thinner wall compared to the simple strapping method.

- ●●● ease of assembly
- ●● reduced incisions
- ●● ease of fabrication





WALL FRAMING

WOVEN POLYESTER STRAPS

RECOMMENDED USE: *Lightweight applications (interior partitions/ non-load bearing framing)*

SOURCING: *Buy in rolls from hardware/ building stores or online. Buckles and tensioning tools also available.*

PRODUCT: Bonzo Band (UK)

PROJECT EXAMPLE: People's Pavilion (Eindhoven, NL)

STRENGTH:
Load capacity 400-1400 kg

FIRE SAFETY:
For framing, fire protection by encapsulation; fire-retardant variants also available

ADJUSTABILITY:
Moderate (manual tensioning) with strapping tensioning tools

RATCHET STRAPS

RECOMMENDED USE: *Larger, less frequent connections (securing composite beams or columns)*

SOURCING: *Buy as packs or individual from any hardware/ building store*

PRODUCT: Mitari (NL)

PROJECT EXAMPLE: Stable Stack (Veenhuizen, NL)

STRENGTH:
Load capacity ~816 kg

FIRE SAFETY:
Exposed connection; fire-retardant variants available

ADJUSTABILITY:
High (ratchet mechanism) without additional tools

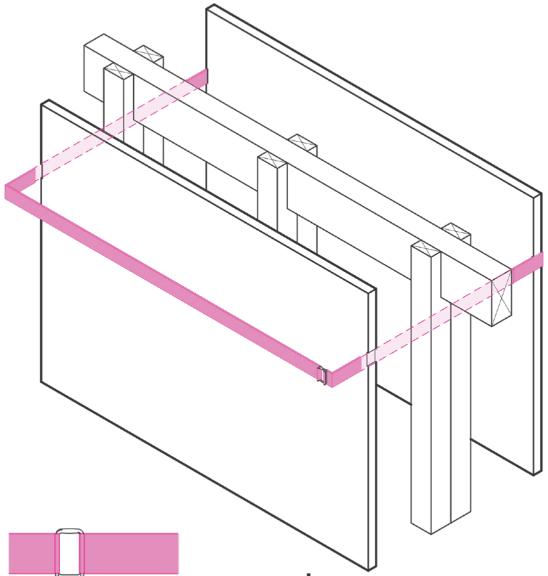
WALL PANELS

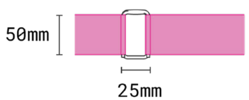
INFILL CONNECTIONS

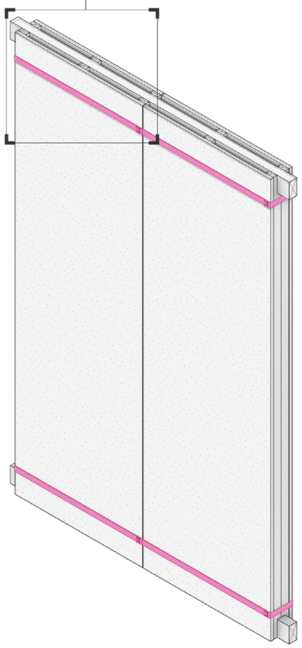
STRAPPING METHOD

Long straps wrap around the full 2 panels on either side of the timber framing. Each panel is 1.5x the spacing of the studs to act as lateral sheathing. A gap can be left between panels to leave space for the straps.

Alternatively, an incision can be made to the side of the panels to allow straps to pass through. This allows for easier assembly and reduces risk of slippage.







ease of assembly

●● *(if allowing gap between panels for straps)*

●●● *(if cutting indent for strap space)*

reduced incisions

●●● *(if allowing gap between panels for straps)*

●● *(if cutting indent for strap space)*

ease of fabrication

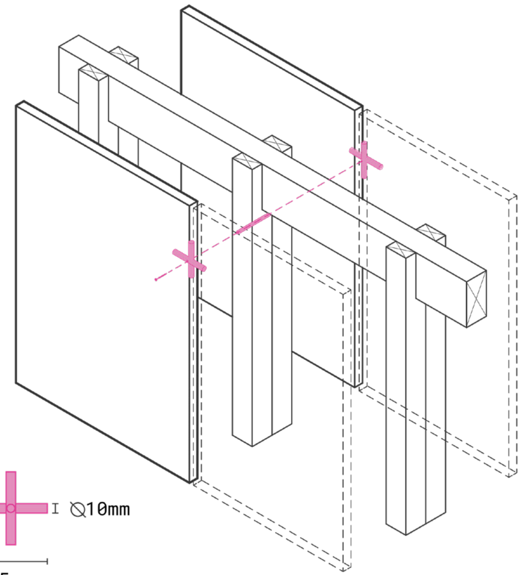
●●● *(if allowing gap between panels for straps)*

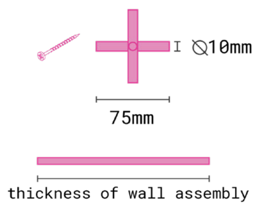
●● *(if cutting indent for strap space)*

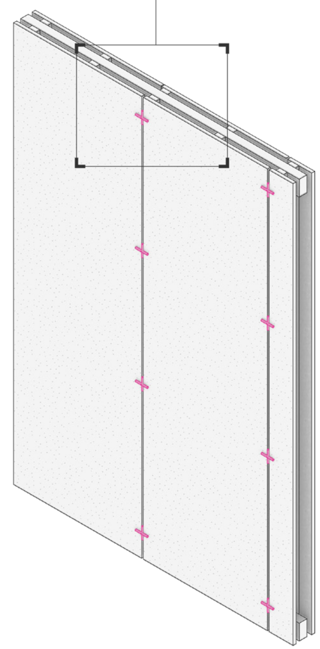
WOODEN TOGGLE CLAMPS

A pair of toggle elements on both sides of the stud wall screwed to a dowel that runs through the wall. By tightening, the toggles compress the panels against the stud, holding them in place via friction and pressure. No punctures to the panels or timber frame.

Alternatively, the toggles can be screwed directly into the wood studs for easier assembly.







ease of assembly

●● *(if using connective dowel)*

●●● *(if screwing into wood stud)*

reduced incisions

●●● *(if using connective dowel)*

●● *(if screwing into wood stud)*

●●● **ease of fabrication**

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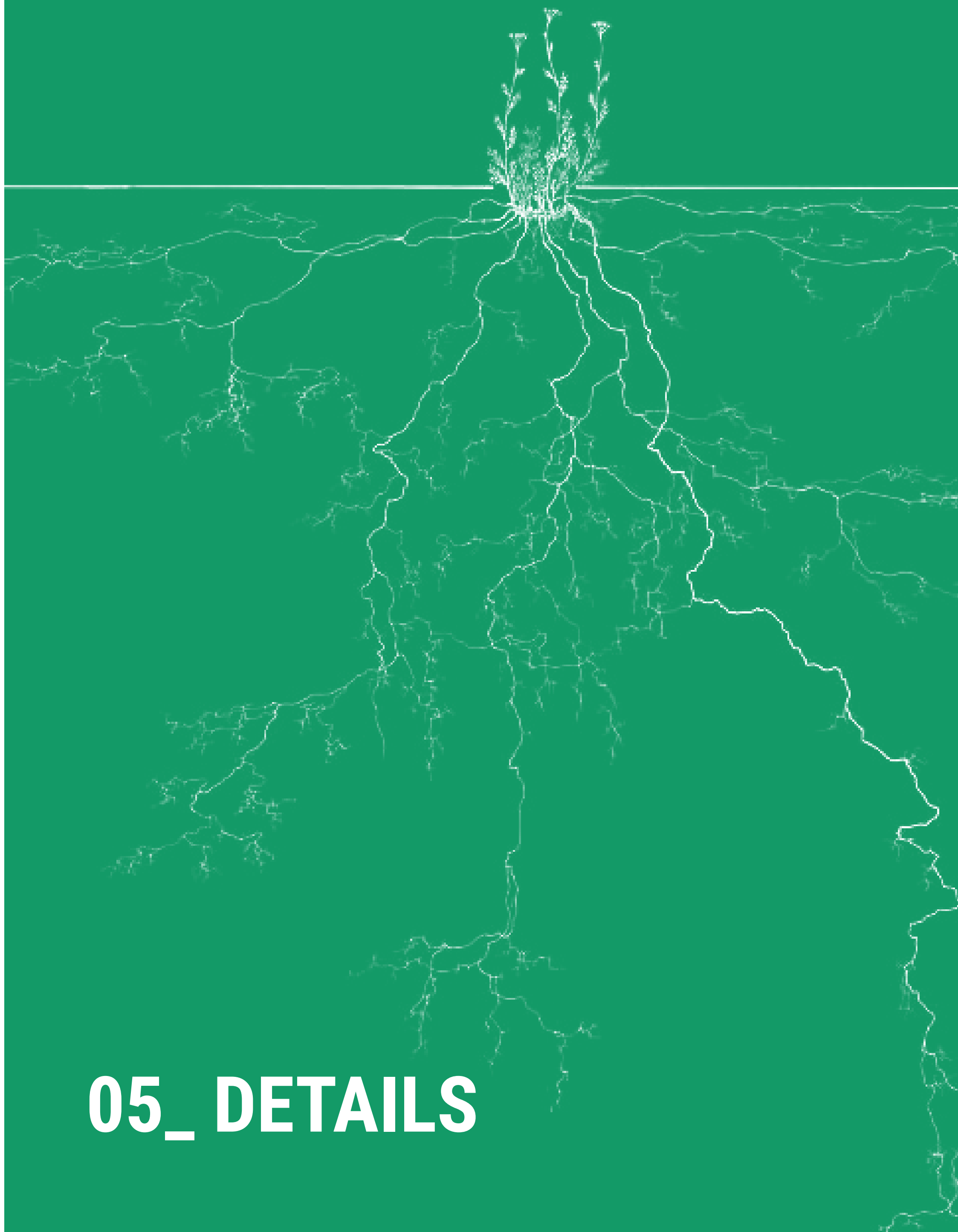


05_ DETAILS

STRATEGIES FOR A MATERIAL AGNOSTIC APPROACH

Through research based on local material sourcing and availability, the local building code, as well as a variety of sustainability guidelines, this section aims to introduce a scoring matrix for evaluating materials and assemblies based on their suitability for adaptive applications. The matrix considers factors such as ease of disassembly, durability, and compatibility with short-, medium-, and long-term adaptations. A selection of wall assembly examples are analyzed to illustrate how these criteria can be applied in practice, offering a tool for adopting a wider variety of various new materials for creating adaptable and sustainable material systems.

The wall assembly examples were selected to demonstrate the application of the scoring matrix using both prefabricated and in-situ construction approaches. The assemblies incorporate materials from established manufacturers, such as Ecococon, known for their prefabricated straw panels, or are based on assemblies proposed in reports from organizations like Material Cultures and Cinark – Center for Industrialized Architecture. Each assembly has been adapted to include materials readily sourced within 500 km of Amsterdam. Performance numbers, such as U-values, ECI, and embodied carbon, were derived from manufacturer data when available or from databases like the Nationale Milieudatabase and Ecoinvent. This approach aims to demonstrate the matrix's compatibility in comparing diverse systems while emphasizing regional and sustainable sourcing.

Ultimately, this chapter seeks to provide actionable strategies for integrating adaptability at the material level, ensuring that architectural systems can respond effectively to future challenges while promoting innovation and flexibility in material usage. By addressing the relationships between timescale, construction systems, and material performance, these strategies aim to support the development of a playbook for adaptable architecture that is both practical and future-proof.

EXTERIOR WALLS

RULES FOR EXTERIOR WALLS

TECHNICAL

- [ ] Use a ventilated rain-screen cladding system
- [ ] Use a non-load-bearing framing system supported from the top of the floor slab
- [ ] Material composition of assembly must function without the use of a vapour membrane to allow for breathable walls
- [ ] Complete wall build-up must meet fire performance of REI60
- [ ] Complete wall build-up must meet Rc Value of 4.5 m²·K/W
- [ ] Install water control layer as specified in details

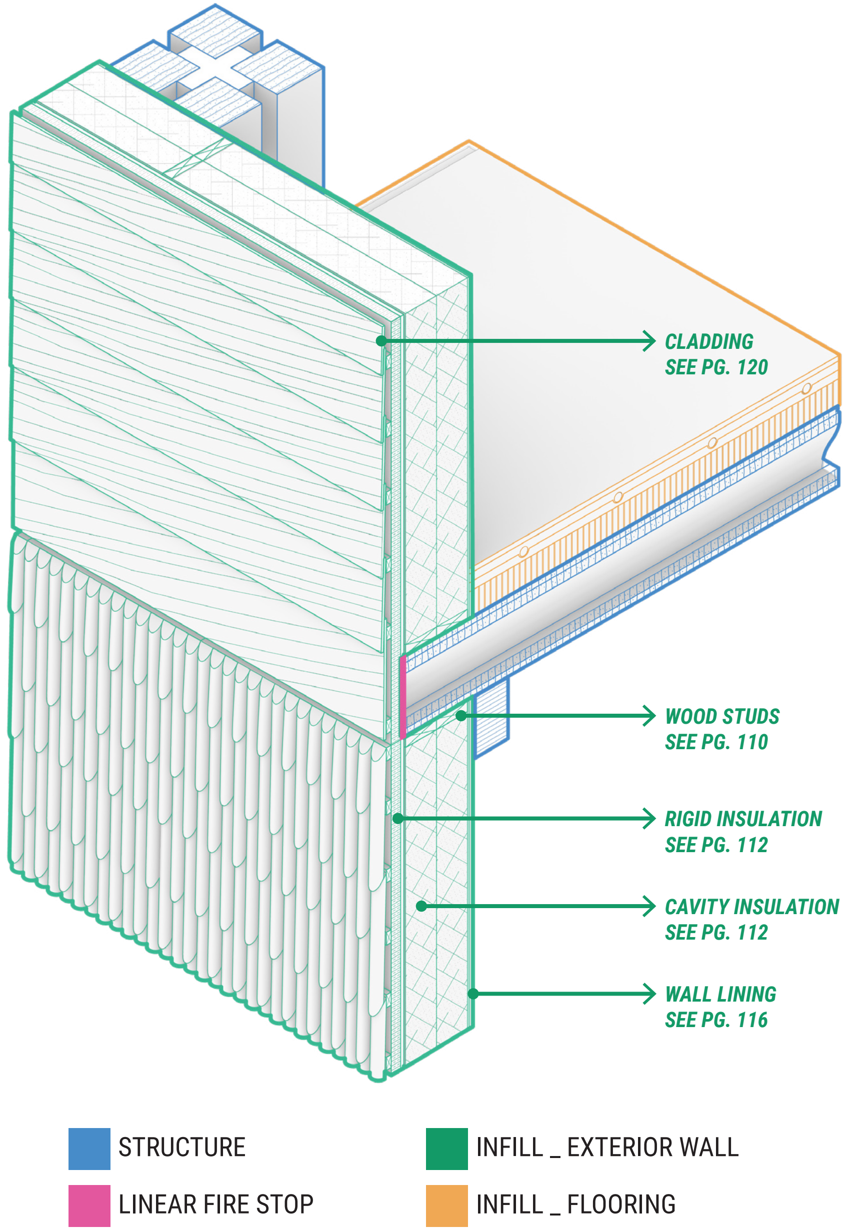
ENVIRONMENTAL

- [ ] Environmental Cost Indicator (ECI) < 0.8 ECI/m²/year
- [ ] Carbon Footprint: Embodied CO_2 emissions < x kg CO_2 eq
- [ ] VOC emissions ≤ 0.2 mg/m³
- [ ] Wood products: Must meet E1 grade formaldehyde emissions (≤ 0.124 mg/m³)
- [ ] 80% of materials sourced within 500 km of Amsterdam

CIRCULARITY

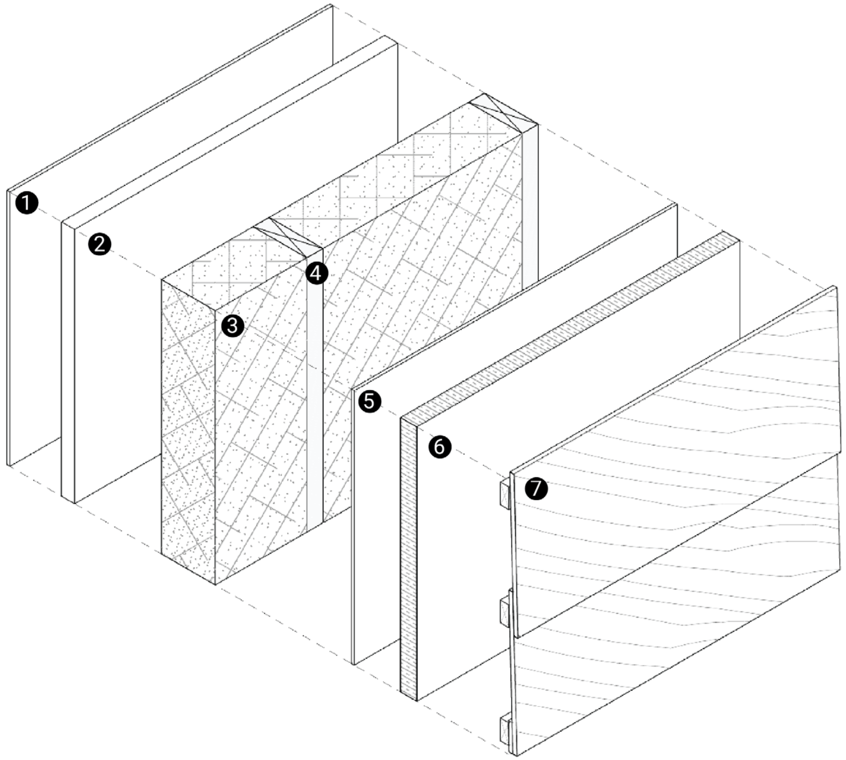
- [ ] Wood: Must be reclaimed, FSC-certified, or PEFC-certified
- [ ] Design for Disassembly: Materials must be removable without damaging adjacent components
- [ ] End-of-life Strategy: materials should include clear plans for material reuse or biodegradability
- [ ] At least 50% wt of materials should be biodegradable
- [ ] Separation of Material: Biogenic material should be fully removable from recyclable materials

OVERVIEW



ASSEMBLY EXAMPLES

LIGHT TIMBER FRAME/HEMPBATT INSULATION/HEMP-LIME BOARD



(Based on Material Cultures, Circular Biobased Construction Report, 2021)

Materials:
1.Clay Plaster
2.Hemp-Lime Board (Celenit Isohemp, Nl): 25 mm
3.Hempbatt Insulation (Thermo-Hemp, De): 145 mm
4.Timber Frame (FSC-Certified Spruce):45 mm x 145 mm
5. Wood Fiber Board (Gutex Thermosafe, De): 16 mm
6.Woodfibre Insulation (Glutex, De): 60 mm
7.Exterior Cladding (Reclaimed Timber): 25 mm

TECHNICAL

- ☑ Use a ventilated rain-screen cladding system
- ☑ Use a non-load-bearing framing system supported from the top of the floor slab
- ☑ Material composition of assembly must function without the use of a vapour membrane to allow for breathable walls
  - → *All materials used are vapour open*
- ☑ Complete wall build-up must meet fire performance of REI60
  - → *REI60 with lime plaster, Euroclass B-s1, d0*
- ☑ Complete wall build-up must meet Rc Value of 4.5 m²·K/W
  - → *achieved with 2 types of insulation*
- ☑ Install water control layer as specified in details

ENVIRONMENTAL

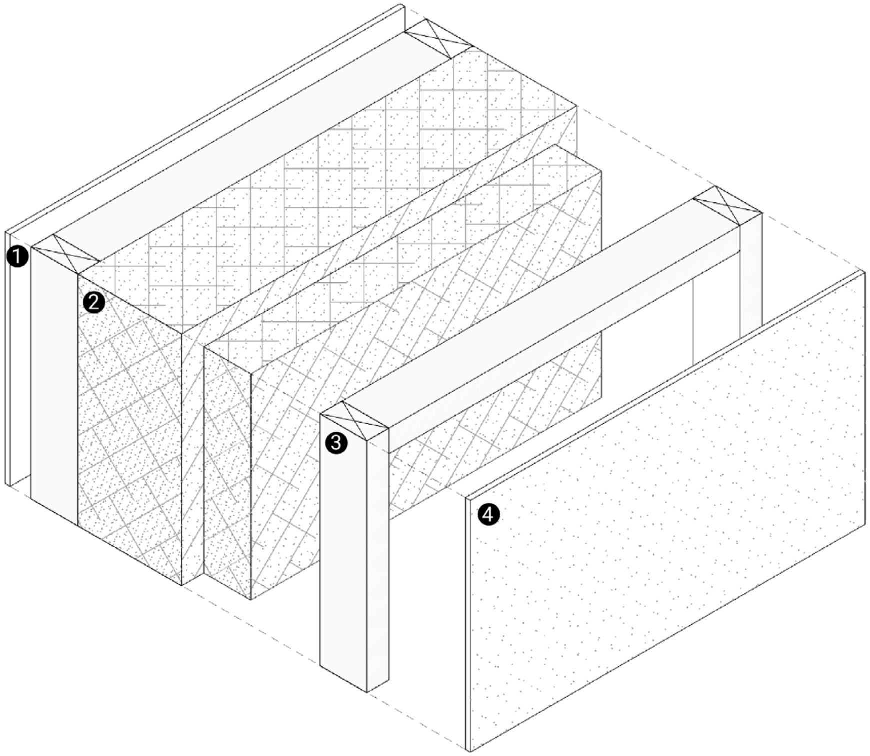
- ☑ Environmental Cost Indicator (ECI) < 0.8 ECI/m²/year
  - → *<0.5 ECI/m²/ year*
- ☑ Carbon Footprint: Embodied CO_2 emissions < x kg CO_2 eq
  - → *carbon negative*
- ☑ VOC emissions ≤ 0.2 mg/m³
- ☑ Wood products: Must meet E1 grade formaldehyde emissions (≤ 0.124 mg/m³)
- ☑ 80% of materials sourced within 500 km of Amsterdam
  - → *most materials sourced within NL and DE*

CIRCULARITY

- ☑ Wood: Must be reclaimed, FSC-certified, or PEFC-certified
  - → *reclaimed wood and FSC-certified spruce*
- ☑ Design for Disassembly: Materials must be removable without damaging adjacent components
- ☑ End-of-life Strategy: materials should include clear plans for material reuse or biodegradability
  - → *80% bio-degradable straw, hemp, timber*
- ☑ At least 50% of materials by weight should be biodegradable
- ☑ Separation of Material: Biogenic material should be fully removable from recyclable materials

ASSEMBLY EXAMPLES

ECCOCON PREFABRICATED STRAW WALL PANELS



(Eccocon, Germany/Netherlands)

Materials:
Interior Lime Plaster: 10 mm.
Straw Core (compressed straw): 400 mm .
Timber Frame (FSC-certified spruce): 60 mm.
Exterior Lime Plaster: 10 mm.

TECHNICAL

- ☑ Use a ventilated rain-screen cladding system
- ☑ Use a non-load-bearing framing system supported from the top of the floor slab
- ☑ Complete wall build-up must meet fire performance of REI60
  - → *REI60 with lime plaster, Euroclass B-s1, d0*
- ☑ Complete wall build-up must meet Rc Value of 4.5 $m^2 \cdot K/W$
  - → *achieved with 2 types of insulation*
- ☑ Install waterproof membrane and air tight vapour control layer as specified in details

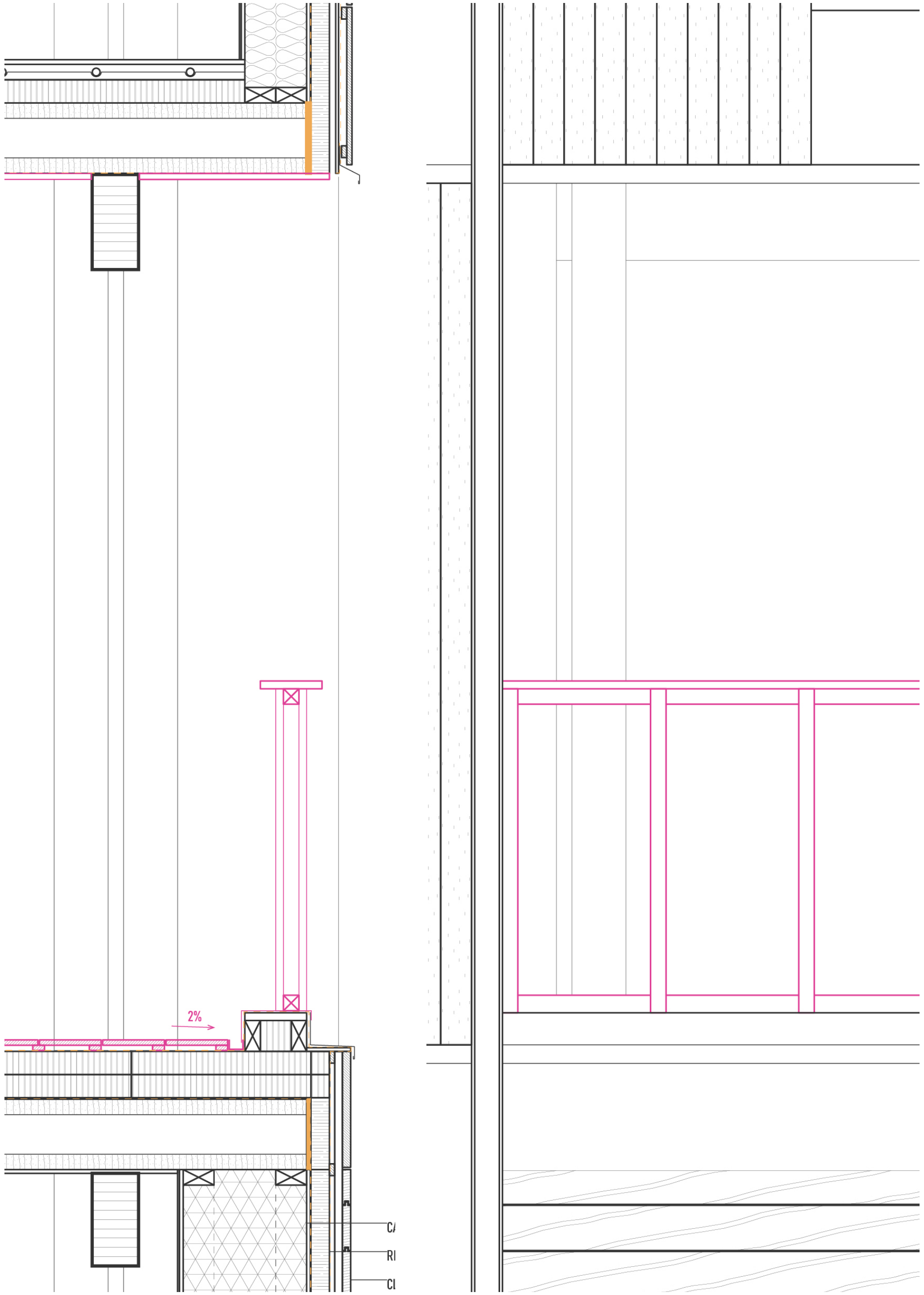
ENVIRONMENTAL

- ☑ Environmental Cost Indicator (ECI) < 0.8 ECI/m^2/year
  - → *<0.5 ECI/m^2/ year*
- ☑ Carbon Footprint: Embodied CO_2 emissions < x kg CO_2 eq
  - → *carbon negative*
- ☑ VOC emissions ≤ 0.2 mg/m^3
- ☑ Wood products: Must meet E1 grade formaldehyde emissions (≤ 0.124 mg/m^3)
- ☑ 80% of materials sourced within 500 km of Amsterdam
  - → *most materials sourced within NL and DE*

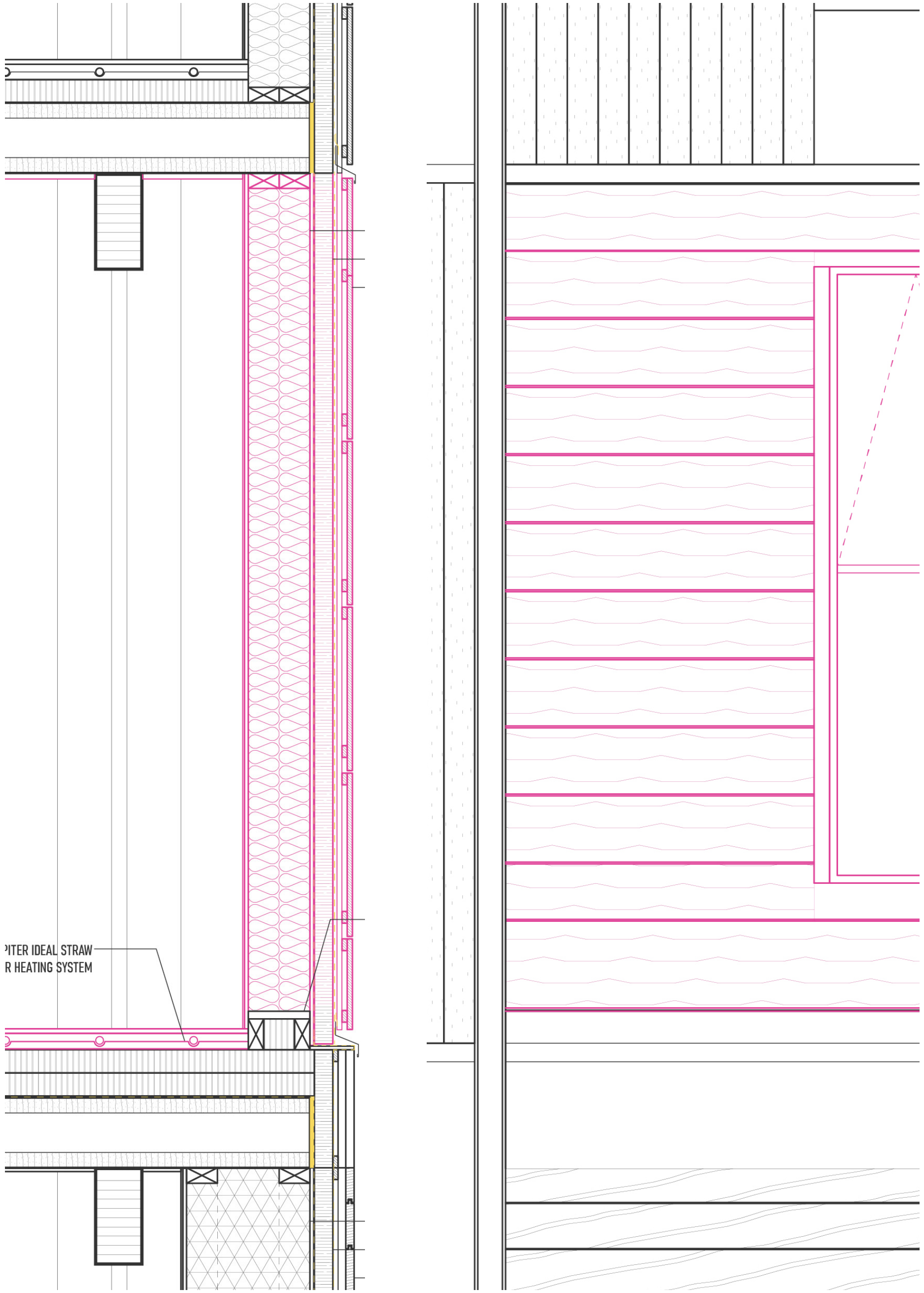
CIRCULARITY

- ☑ Wood: Must be reclaimed, FSC-certified, or PEFC-certified
  - → *reclaimed wood and FSC-certified spruce*
- ☑ Design for Disassembly: Materials must be removable without damaging adjacent components
- ☑ End-of-life Strategy: materials should include clear plans for material reuse or biodegradability
  - → *80% bio-degradable straw, hemp, timber*
- ☑ Biodegradability: At least 50% of materials by weight should be biodegradable
- ☑ Separation of Material: Biogenic material should be fully removable from recyclable materials

EXTERIOR WALLS

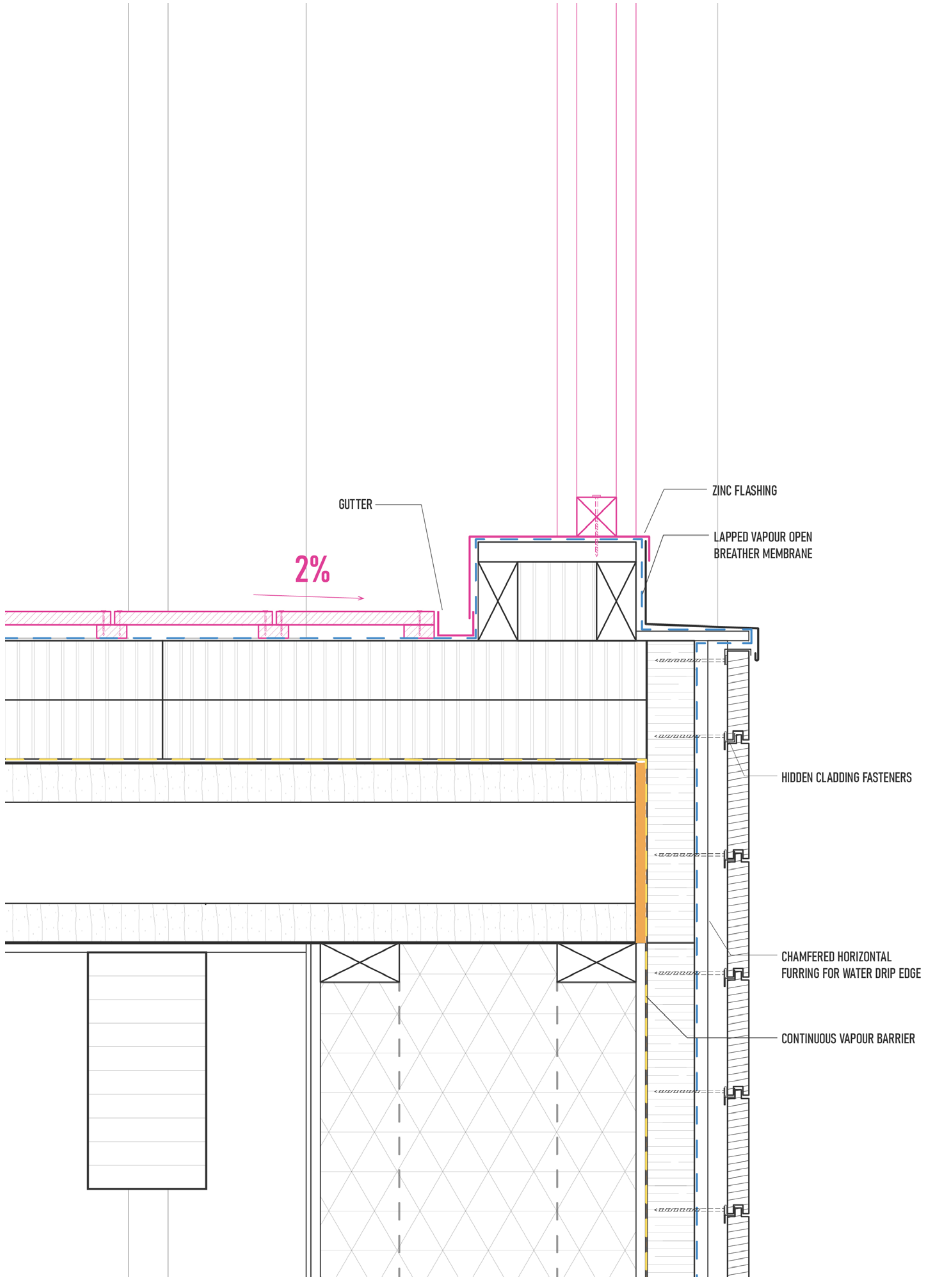


TYP. WALL _PATIO CONFIGURATION [1:20]

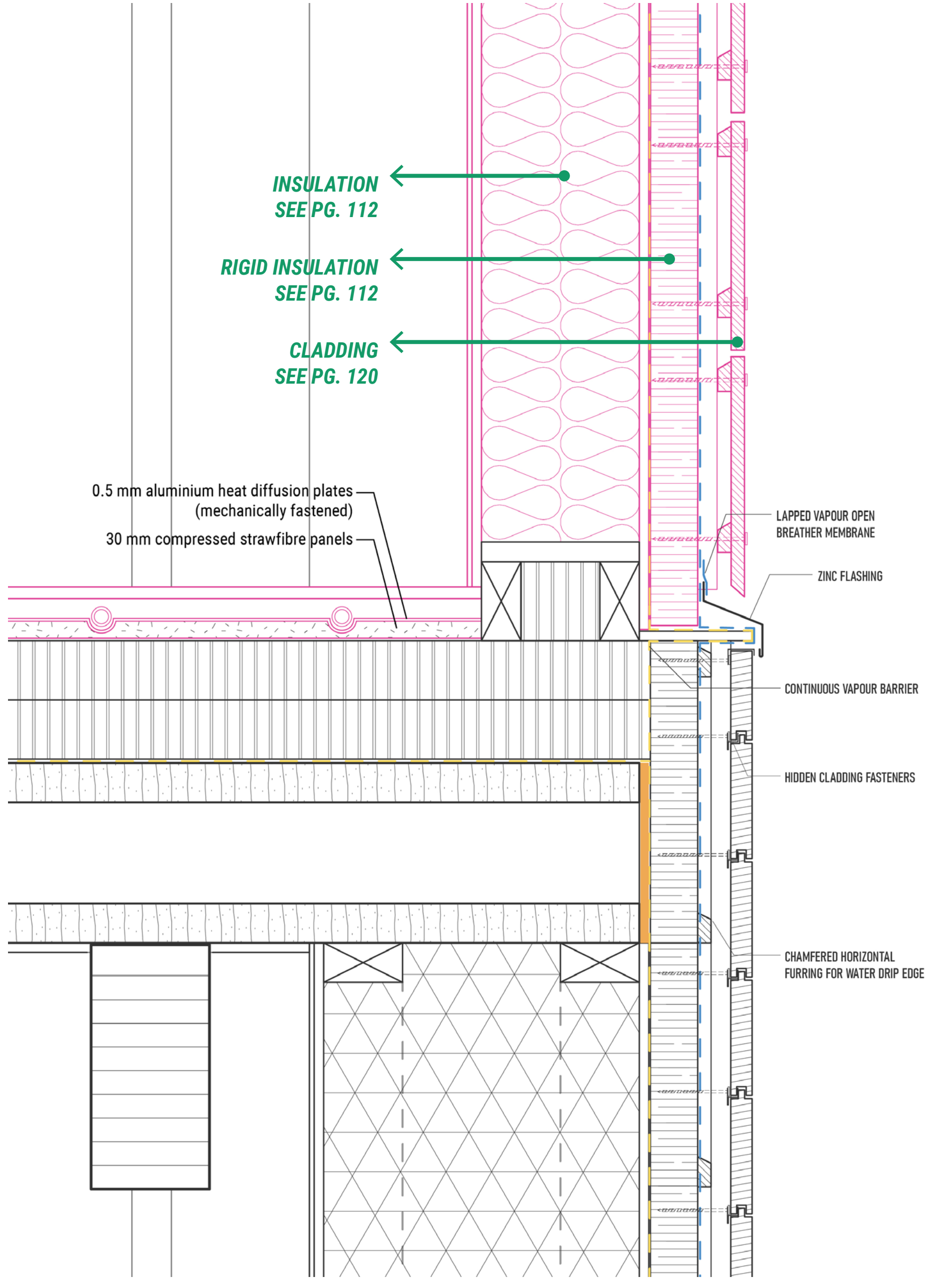


TYP. WALL _UNIT WALL CONFIGURATION [1:20]

EXTERIOR WALLS

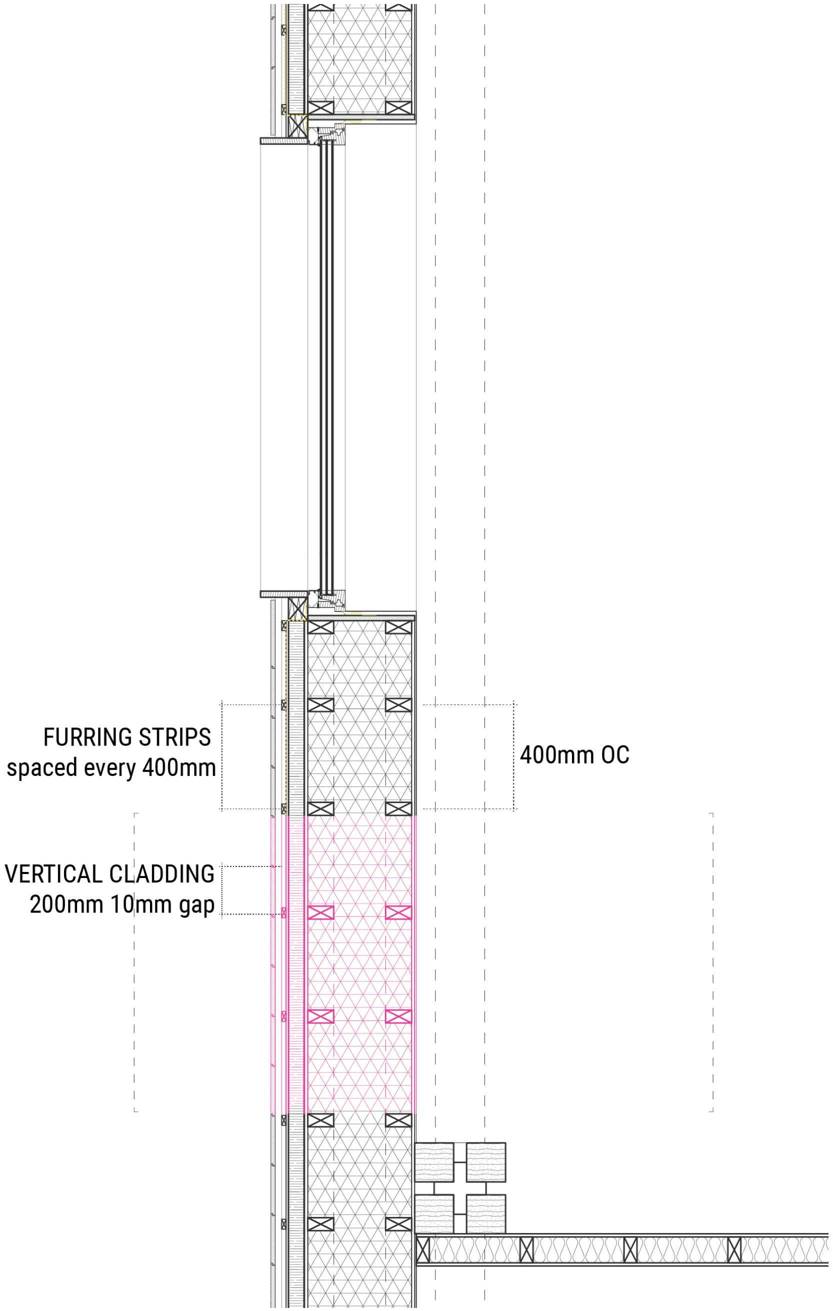


TYP. WALL _PATIO CONFIGURATION [1:5]

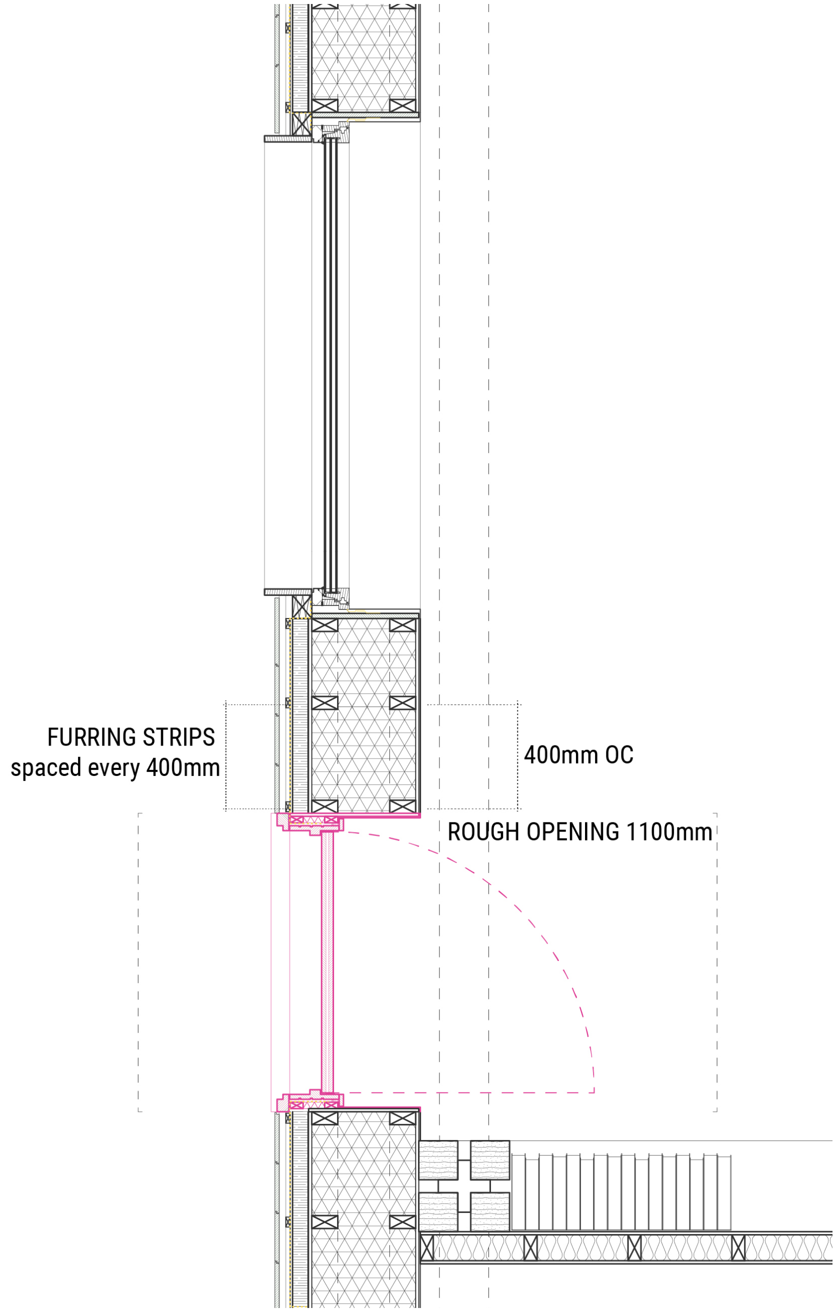


TYP. WALL _UNIT WALL CONFIGURATION [1:5]

EXTERIOR WALLS

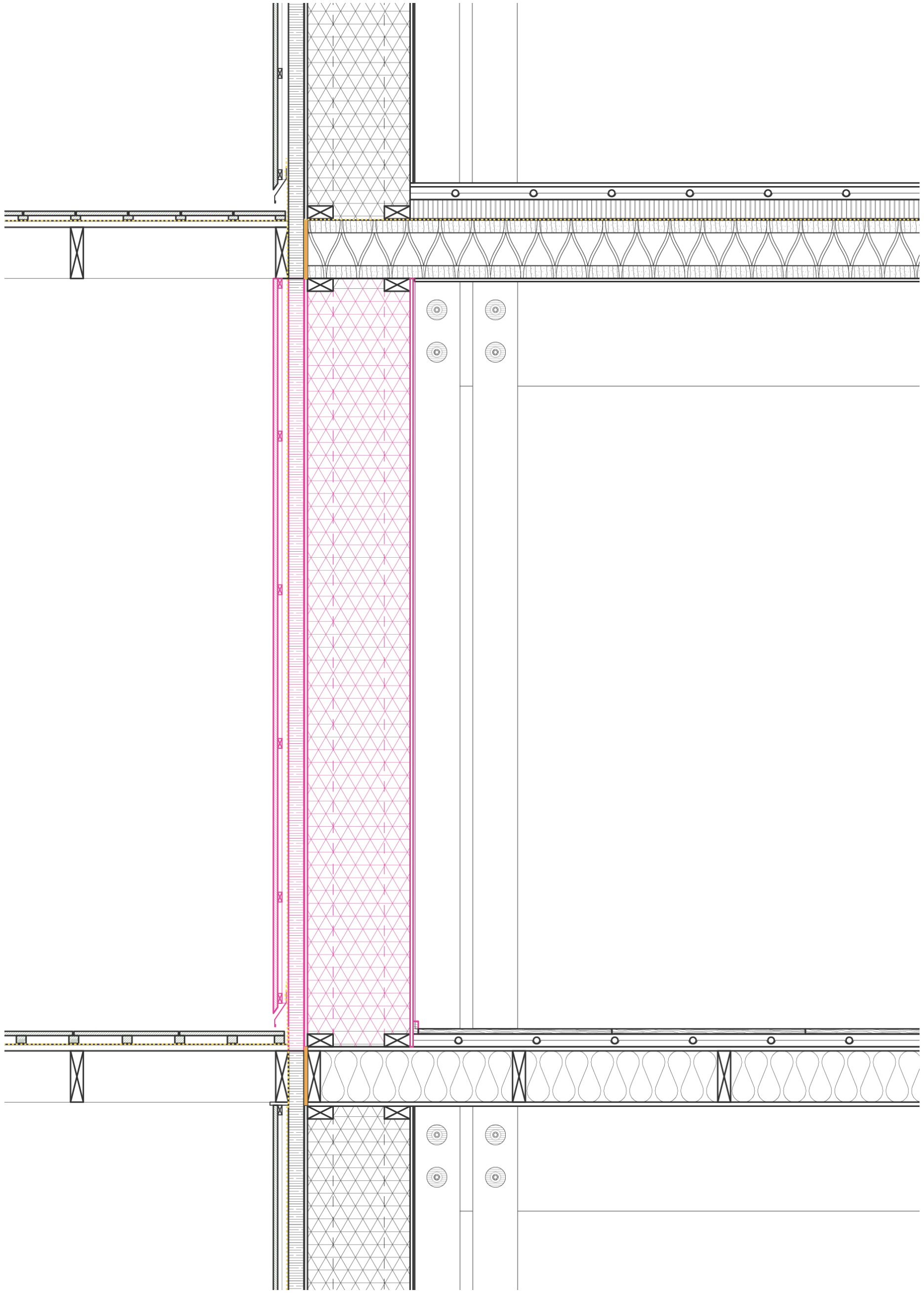


COURTYARD WALL_ PLAN _WALL CONFIGURATION [1:20]

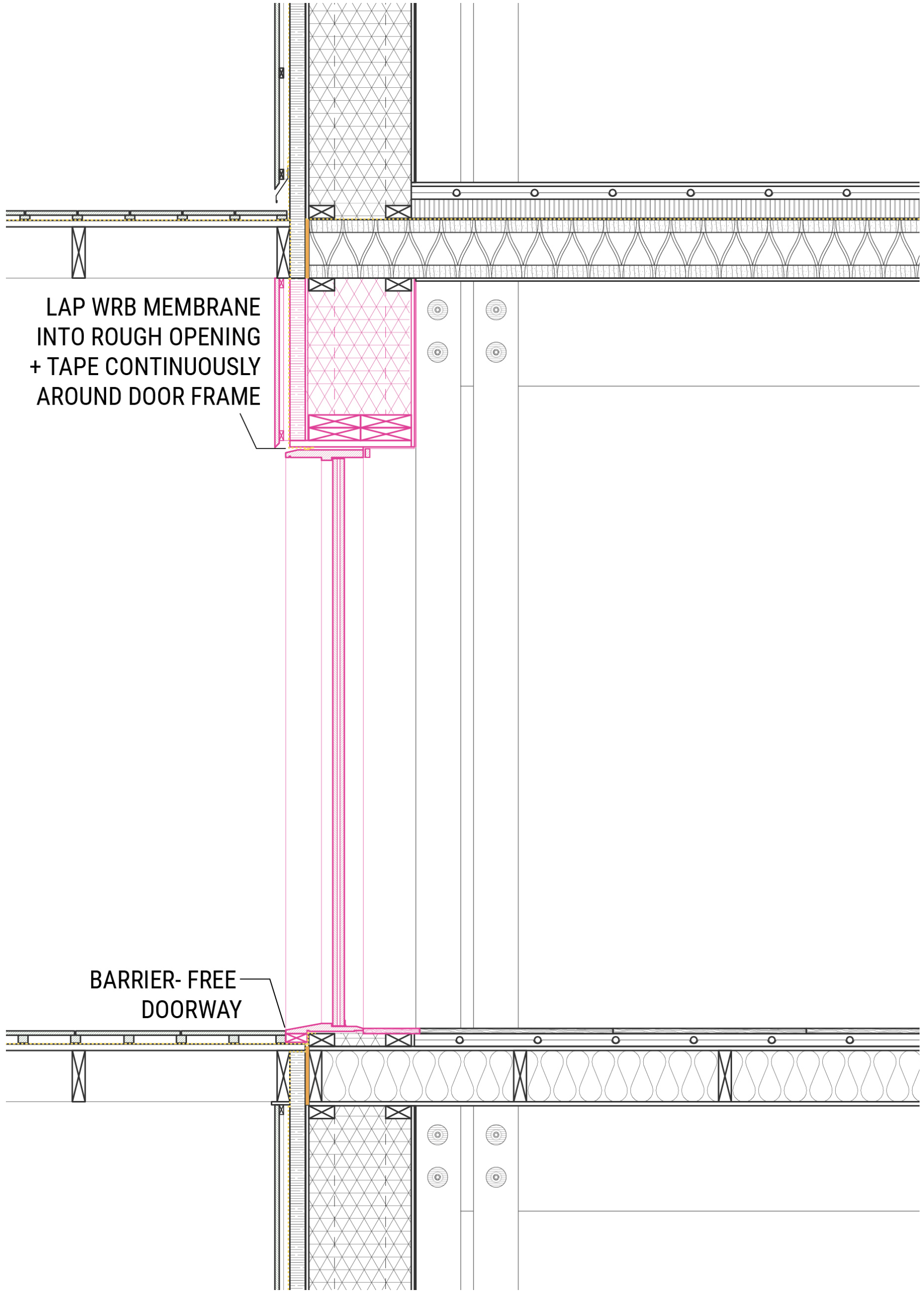


COURTYARD WALL_ PLAN _DOOR CONFIGURATION [1:20]

EXTERIOR WALLS

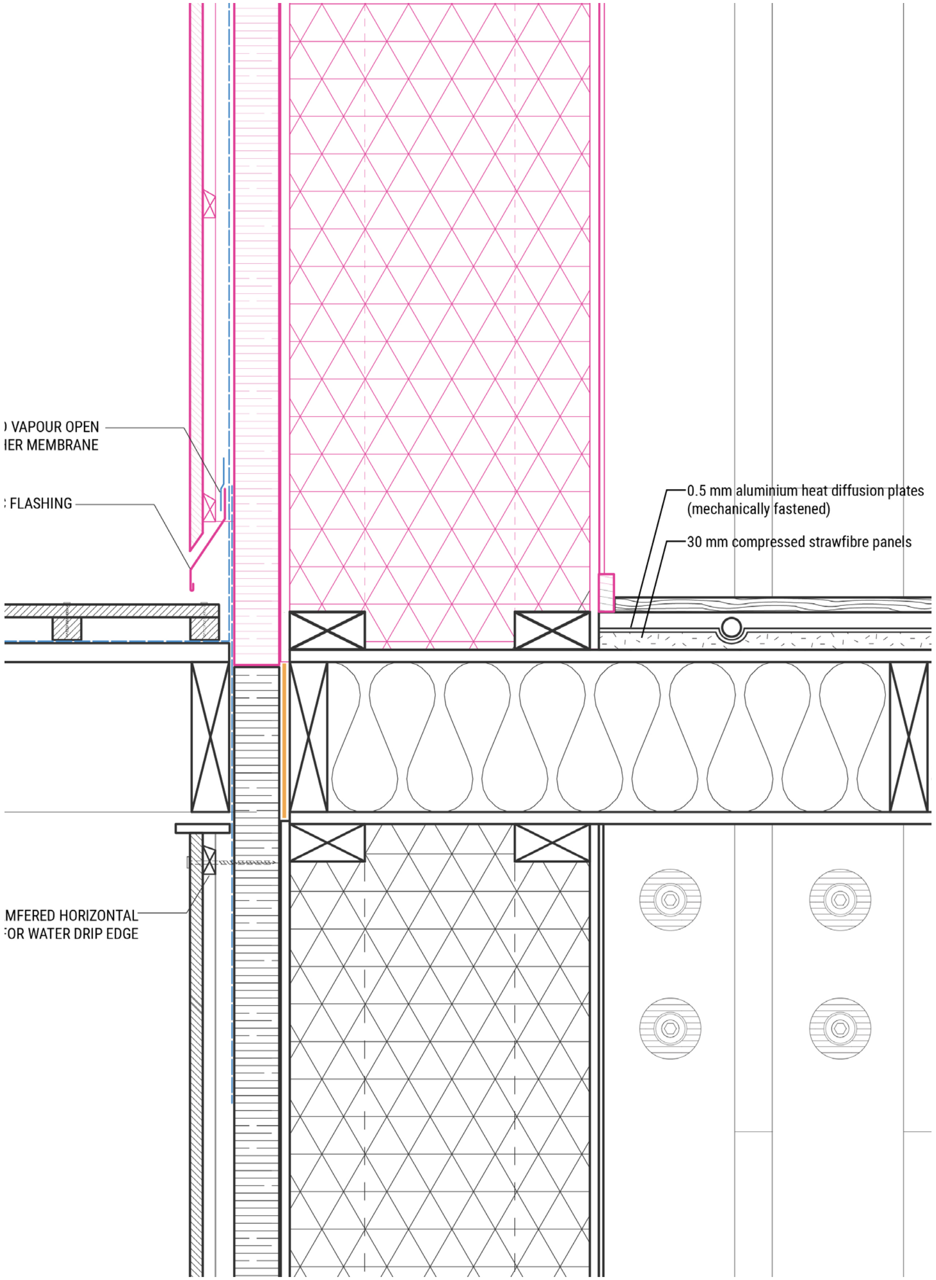


COURTYARD WALL_ SECTION _WALL CONFIGURATION [1:20]

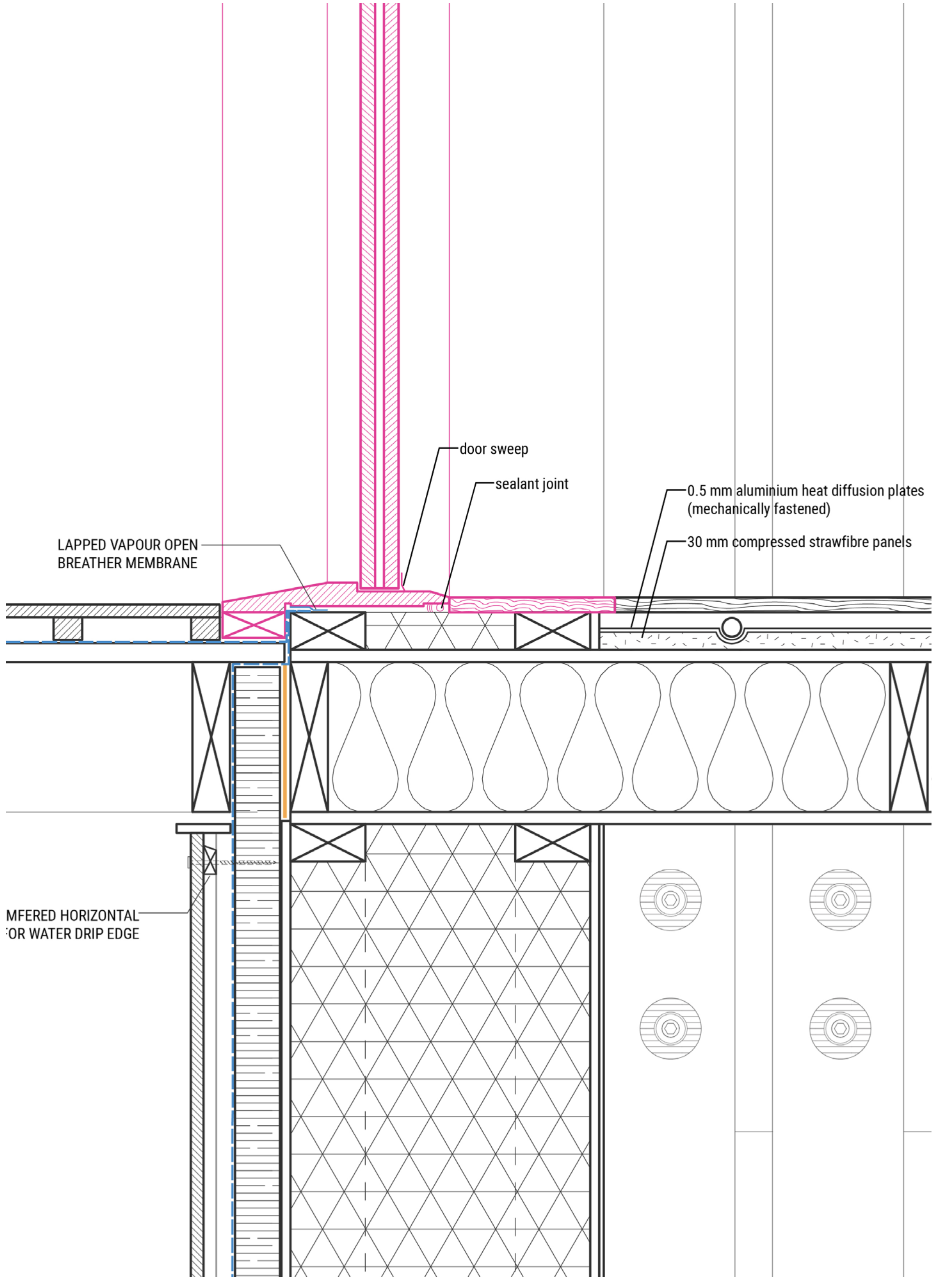


COURTYARD WALL_ SECTION _DOOR CONFIGURATION [1:20]

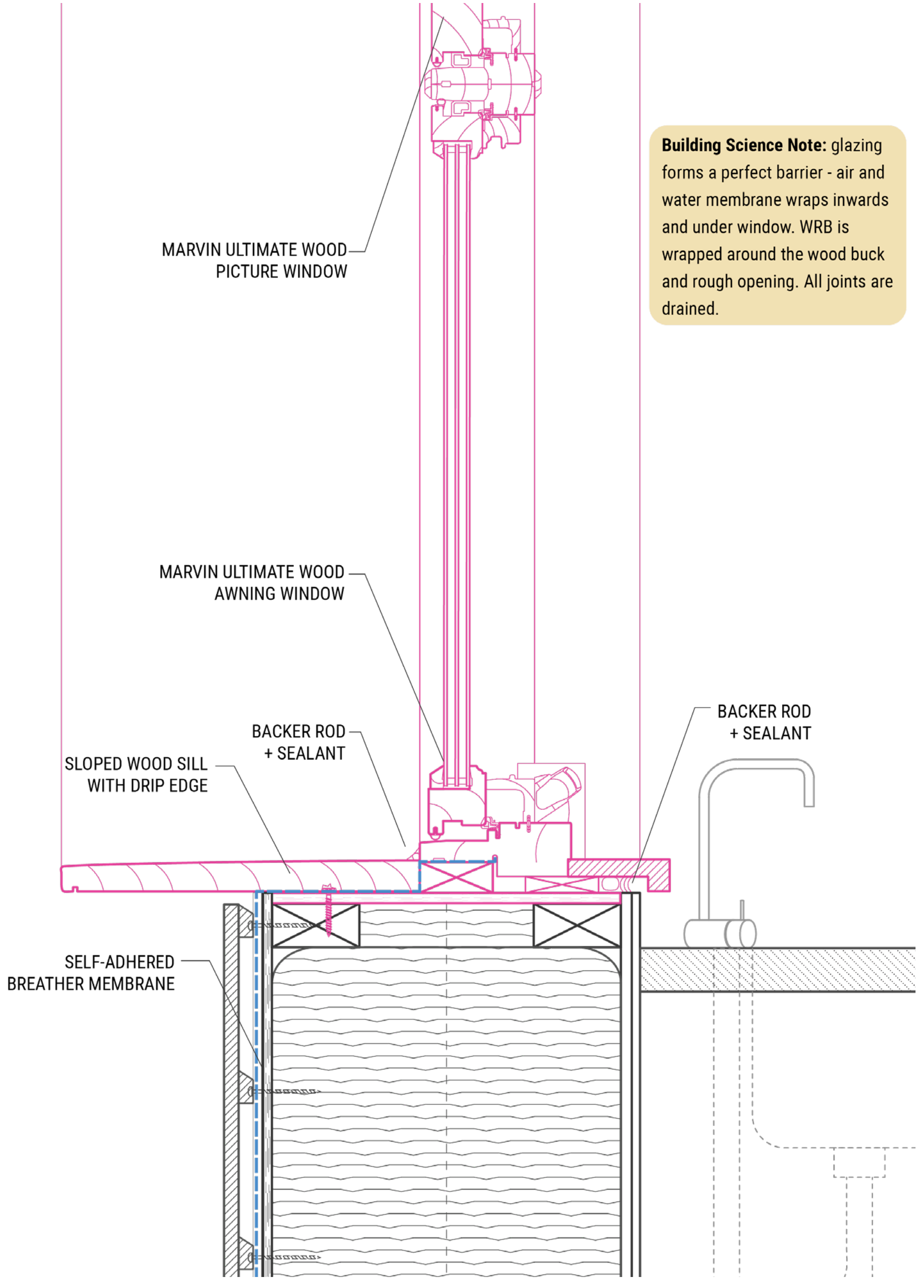
EXTERIOR WALLS



COURTYARD WALL_ WALL CONFIGURATION [1:5]

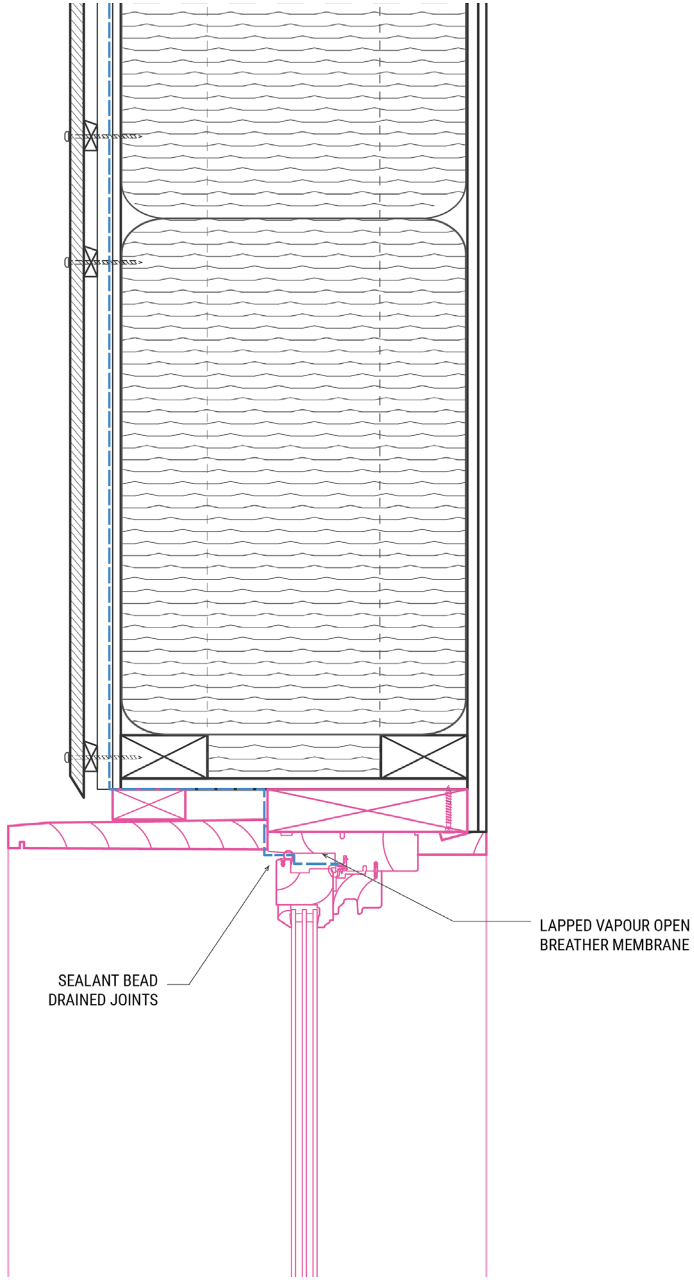


COURTYARD WALL_ DOOR CONFIGURATION [1:5]



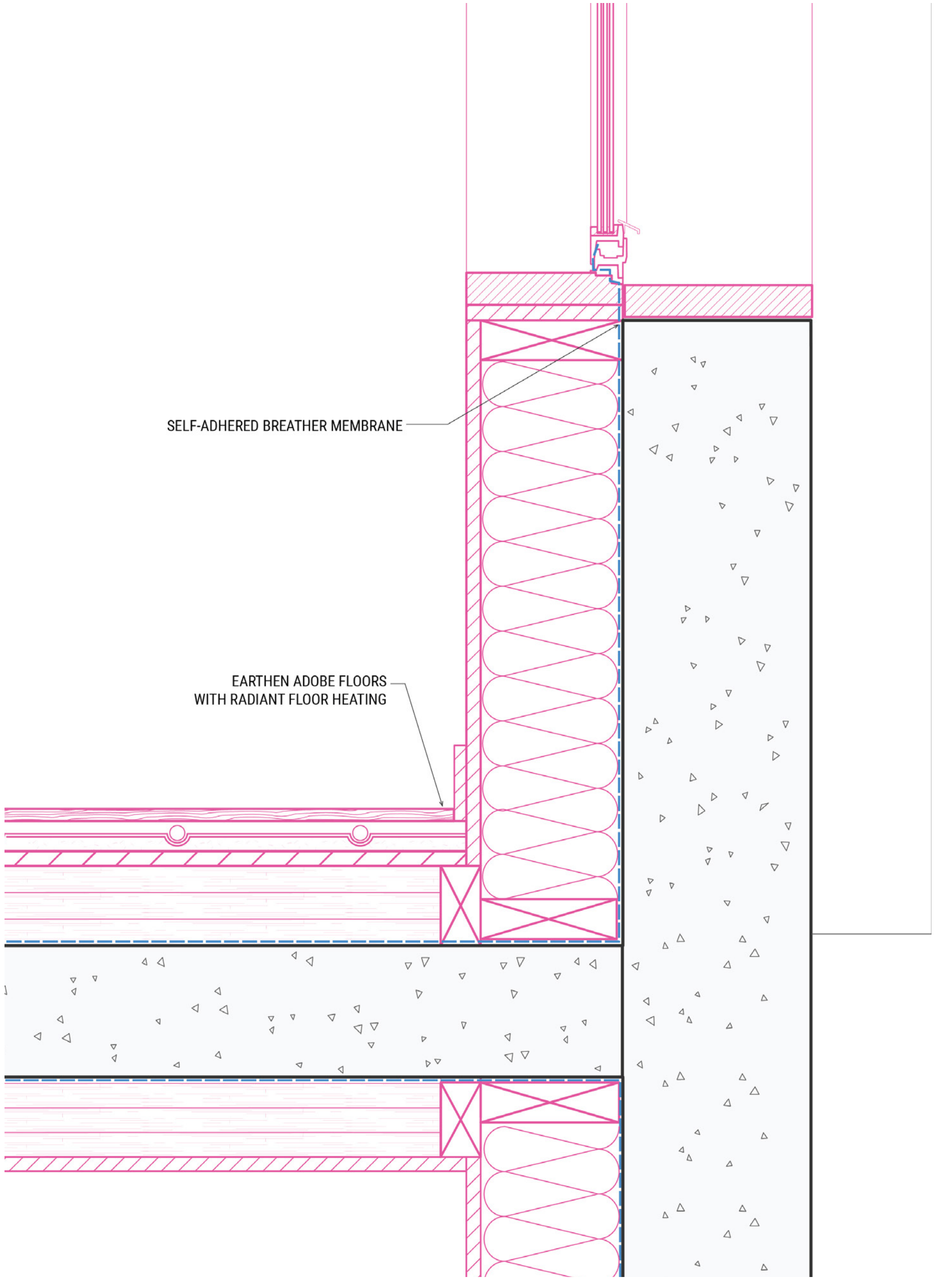
Building Science Note: glazing forms a perfect barrier - air and water membrane wraps inwards and under window. WRB is wrapped around the wood buck and rough opening. All joints are drained.

TYP. WINDOW SILL [1:5]

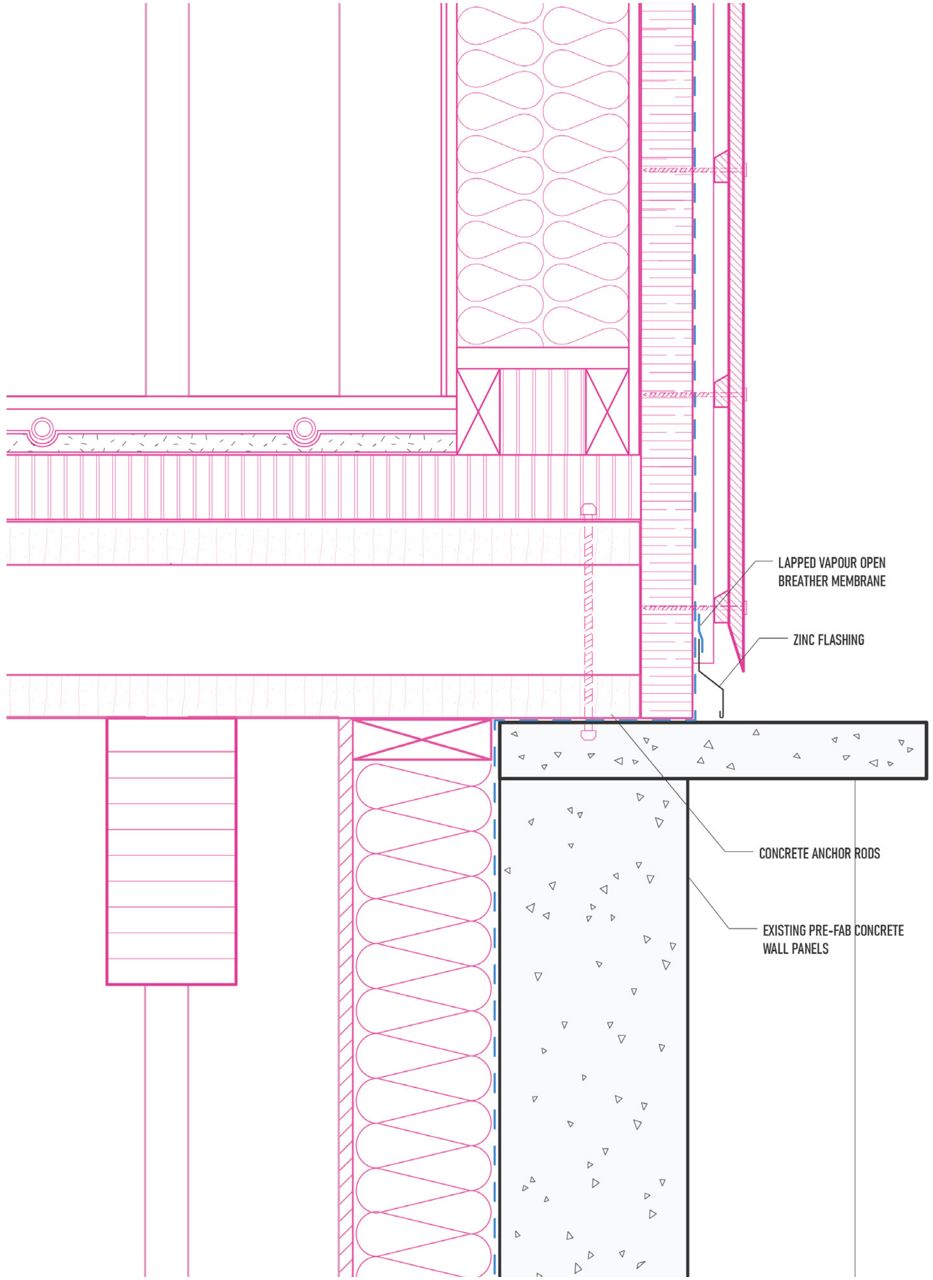


TYP. WINDOW HEADER [1:5]

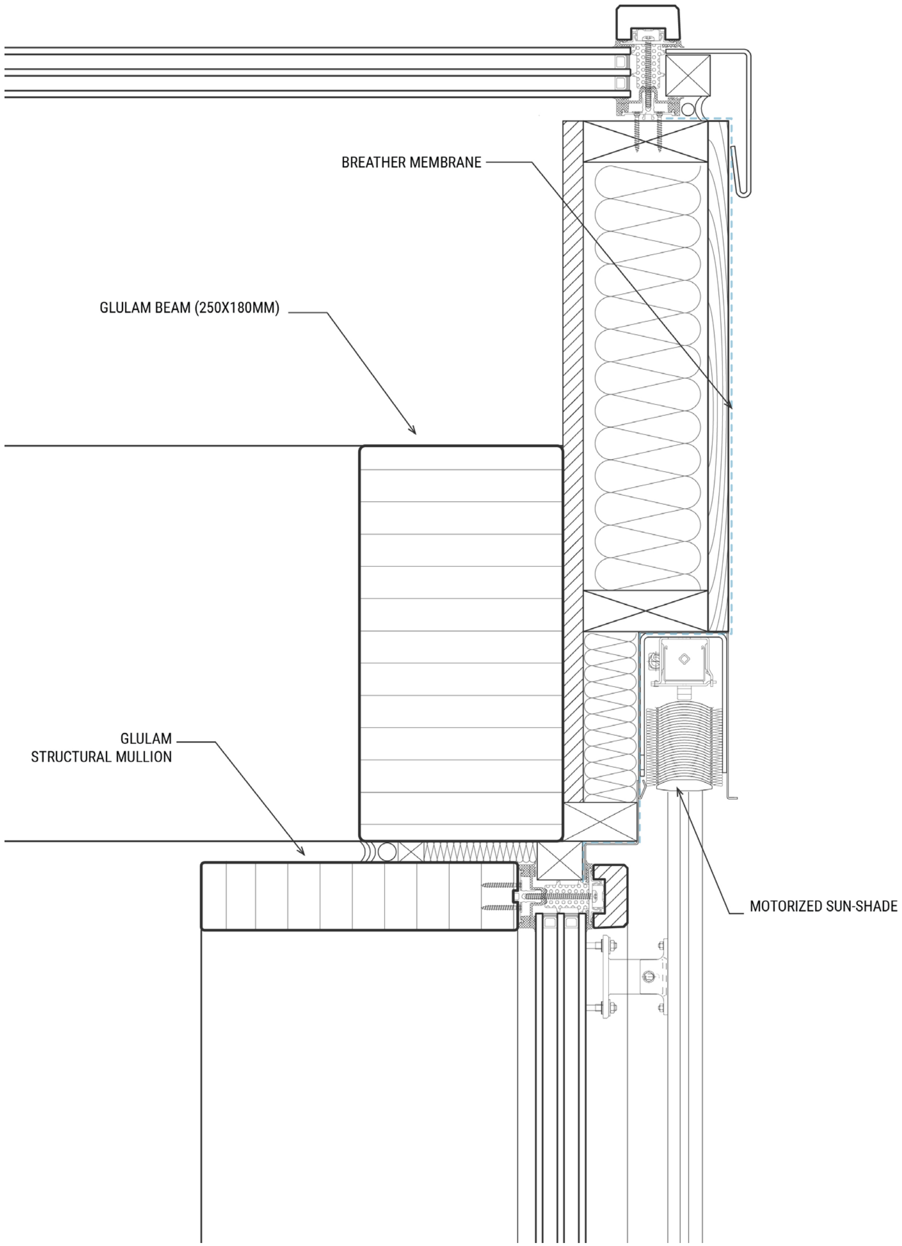
RENOVATION + OPTOPPEN



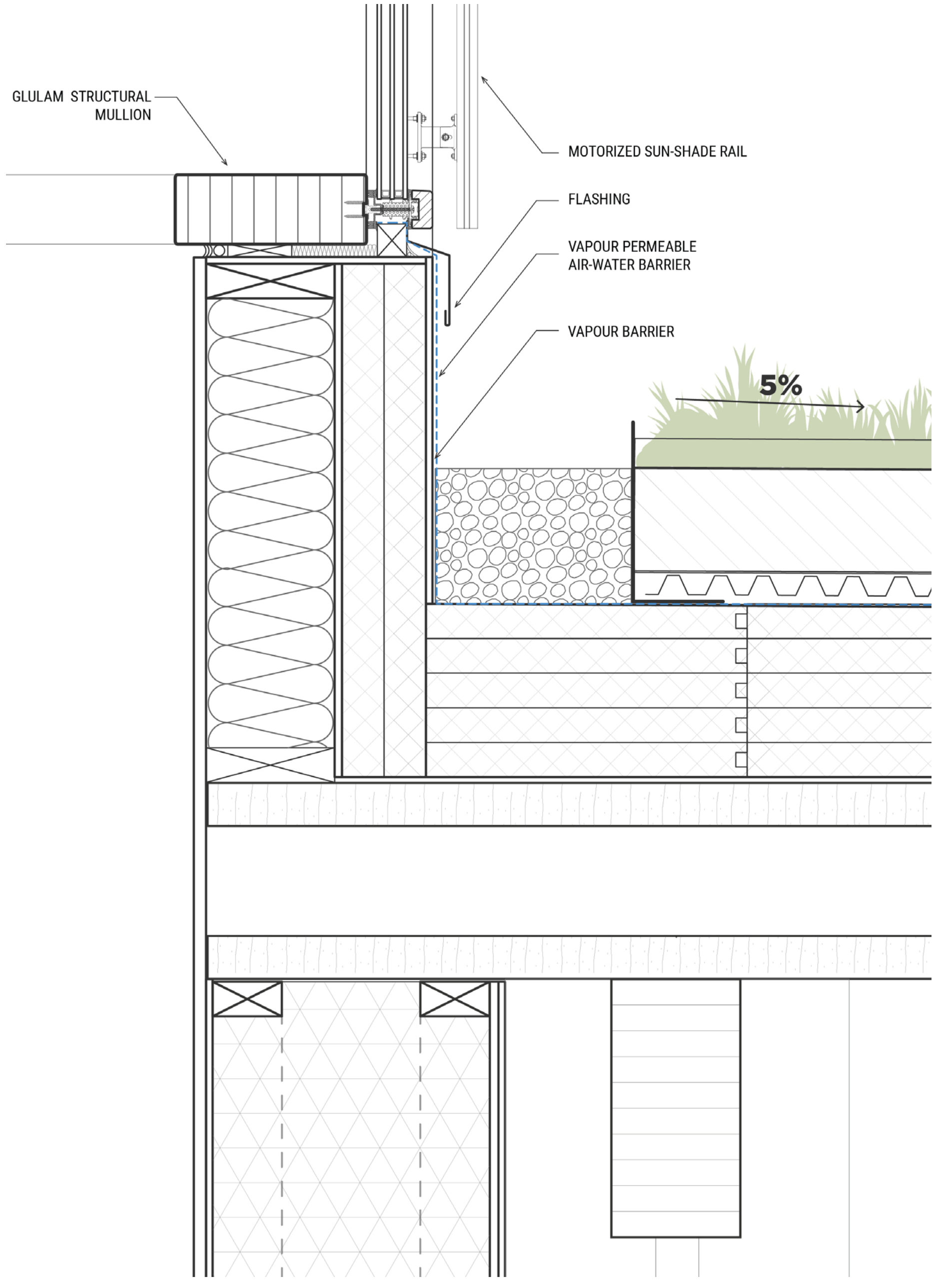
TYP. RENOVATED WINDOW SILL [1:5]



OPTOPPEN TO EXT. CONCRETE STRUCTURE [1:5]



[1:5 scale details_WINDOW WALL CORNER SECTION)



[1:5 scale details_WINDOW WALL CORNER SECTION)

INTERIOR WALLS

RULES FOR INTERIOR WALLS

TECHNICAL

- [ ] [WALL A] must meet min sound insulation rating of Rw 40 dB
- [ ] [WALL A] must meet fire performance of REI 30
- [ ] [WALL B] uses a timber wall framing system

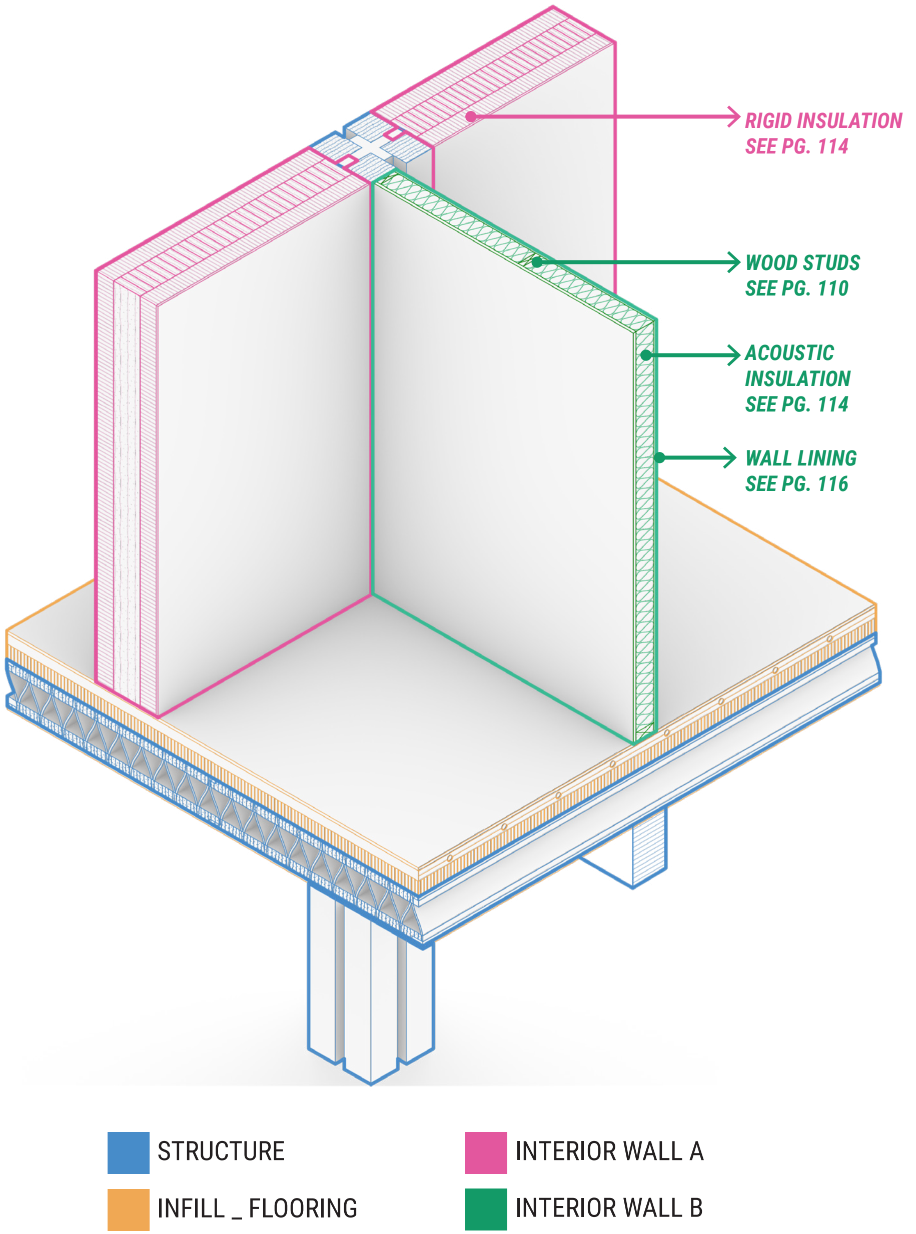
ENVIRONMENTAL

- [ ] Environmental Cost Indicator (ECI) < 0.8 ECI/m²/year
- [ ] Carbon Footprint: Embodied CO_2 emissions < x kg CO_2 eq
- [ ] VOC emissions ≤ 0.2 mg/m³
- [ ] Wood products: Must meet E1 grade formaldehyde emissions (≤ 0.124 mg/m³)
- [ ] 80% of materials sourced within 500 km of Amsterdam

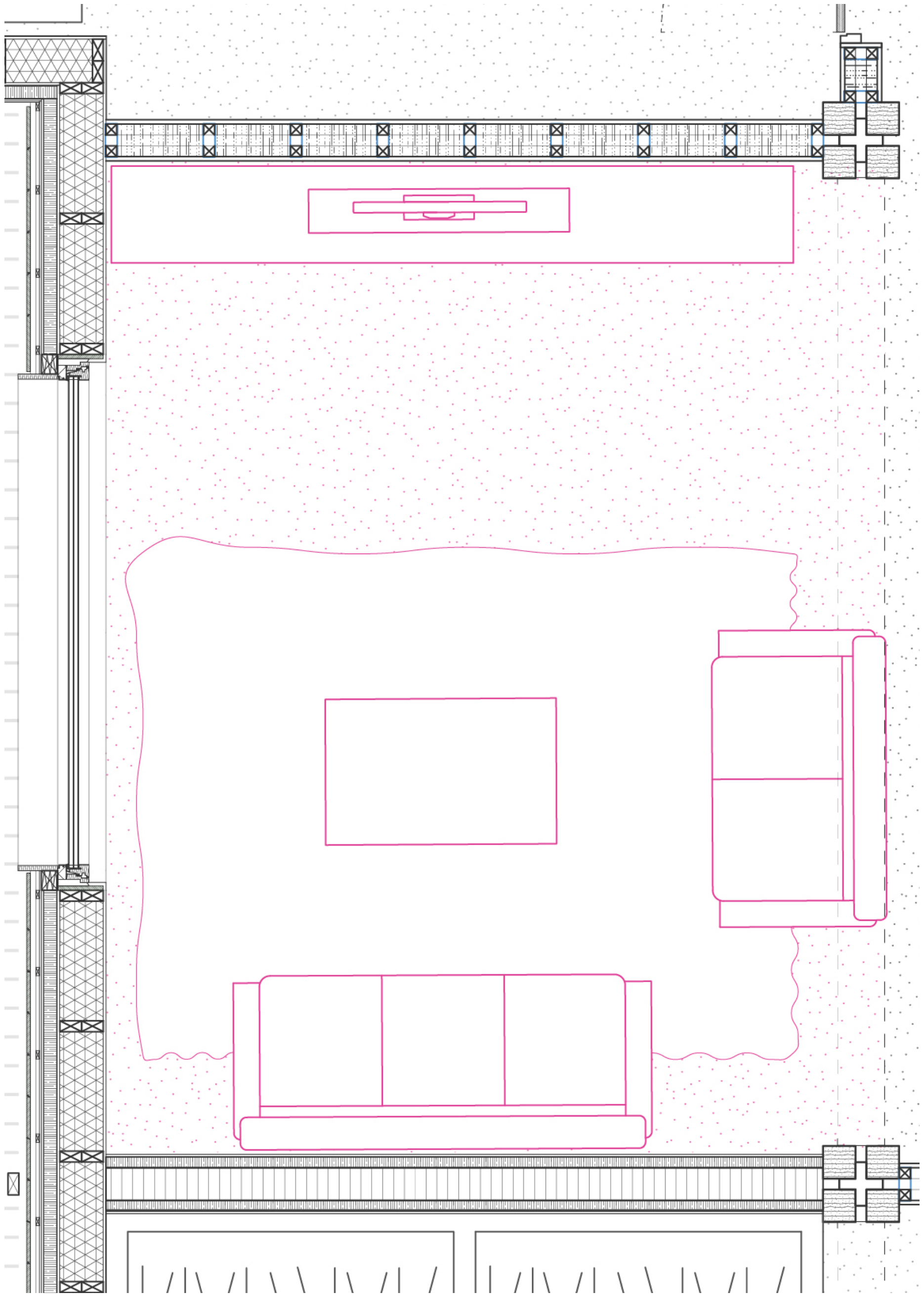
CIRCULARITY

- [ ] Wood: Must be reclaimed, FSC-certified, or PEFC-certified
- [ ] Design for Disassembly: small timber members must be connected using [a method outlined in the connections section] that allows >50% of members to be re-used
- [ ] End-of-life Strategy: materials should include clear plans for material reuse or biodegradability
- [ ] Biodegradability: At least 50% of materials by weight should be biodegradable
- [ ] Separation of Material: Biogenic material should be fully removable from recyclable materials

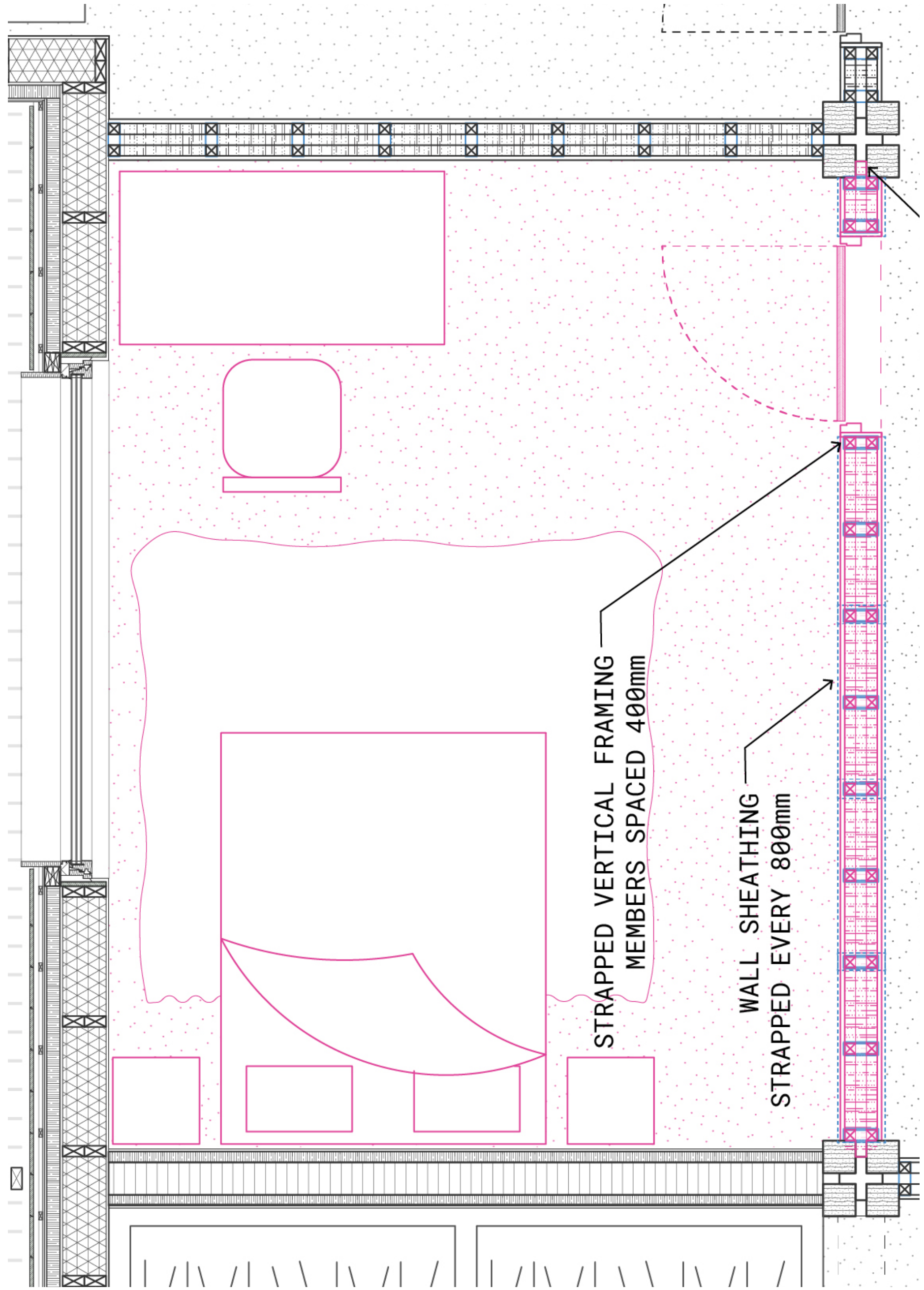
OVERVIEW



INTERIOR WALLS



COURTYARD WALL_ PLAN _WALL CONFIGURATION [1:20]



COURTYARD WALL_ PLAN _DOOR CONFIGURATION [1:20]

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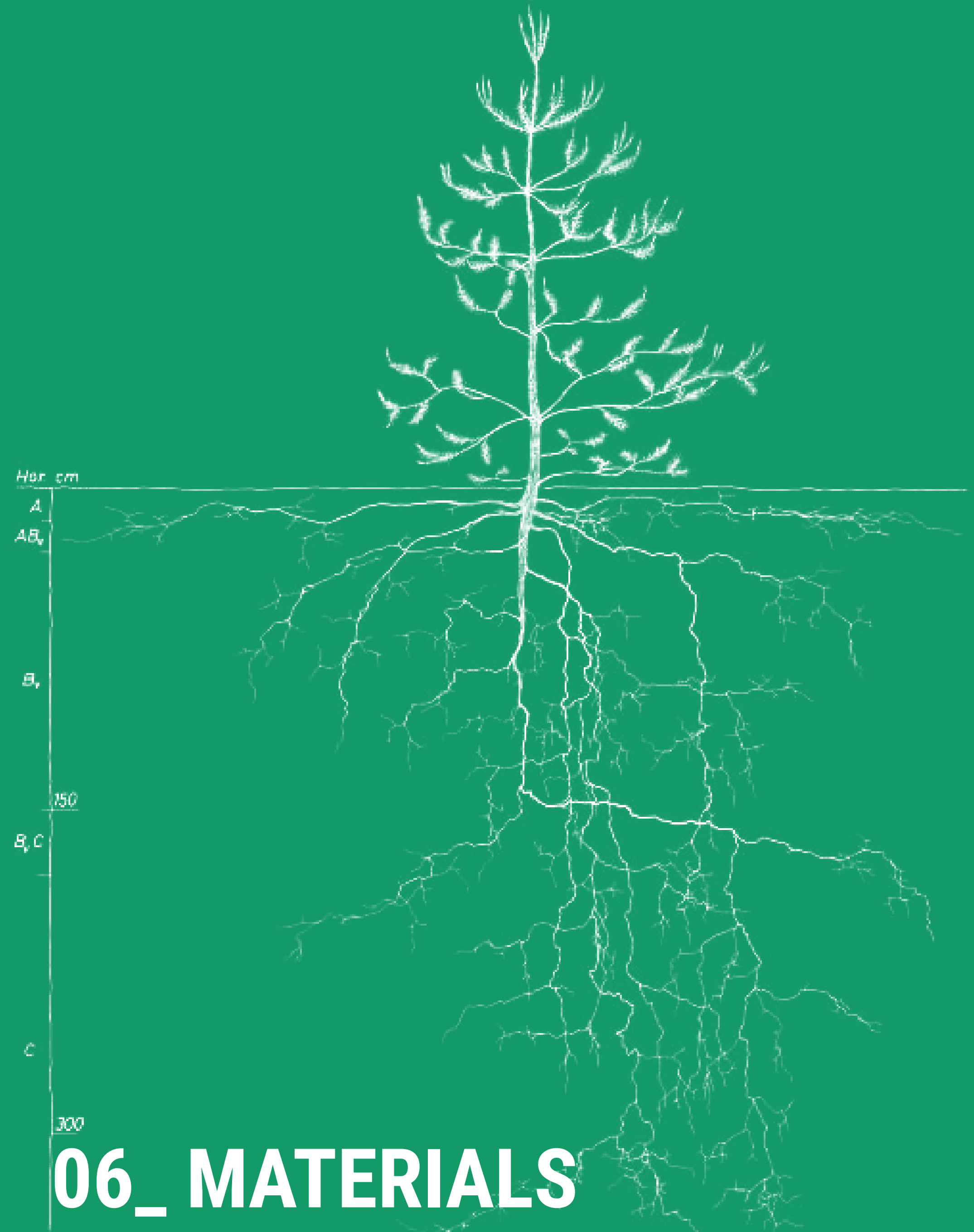


06_ MATERIALS

STRATEGIES FOR PERFORMANCE-BASED MATERIAL SPECIFICATIONS

When the building is first constructed, the materials in the building assembly are selected by the architect, and sourced all together for the best performance and architectural quality.

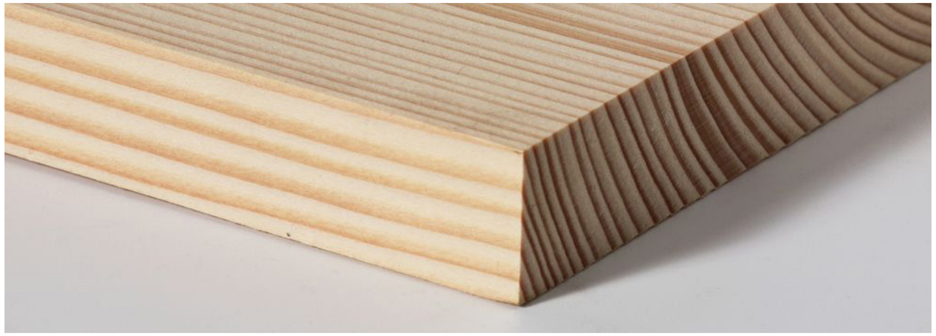
However, as the empty pockets are filled up by either new residents or existing residences expanding their space, they are they building at a much smaller scale, using a bottom up method, likely sourcing materials that are easier to obtain in small quantities rather than pre-fabricated elements.

Within this playbook, a set of criteria is presented to allow residents to assess the new materials theyre adding to their homes -- whether its the wood studs, insulation or new cladding.

Within this section, a collection of biogenic materials are presented and weighed according to technical, environmental, cost and end of life performances.

For each category of material selection, the materials used for the phase 1 construction are presented, with their corresponding performance in each category. Several other possible materials are also listed, as a starting point in choosing materials in later adaptive build-ups.

TIMBER STUDS



SPRUCE (Picea abies)

TECHNICAL PERFORMANCE

Strength class: C24

Density: ~450 kg/m³
Modulus of elasticity: ~11,000 N/mm²

Durability: Class 4 (needs protection from moisture)

Fire resistance: Euroclass D-s2, d0 (untreated)

ENVIRONMENTAL PERFORMANCE

FSC-certified timber

CO_2 sequestration: ~0.9–1.0 kg CO_2/m³ stored

LIFECYCLE & CIRCULARITY

- Widely available across Europe (especially Scandinavia and Central Europe)
- Fast-growing, plantation-managed softwood
- FSC/PEFC certified sources available

Douglas Fir (Pseudotsuga menziesii)

TECHNICAL PERFORMANCE

Strength class: C24–C30

Density: ~500–550 kg/m³

Modulus of elasticity: ~12,000–13,000 N/mm²

Durability: Class 3

Fire resistance: Euroclass D-s2, d0 (untreated)

ENVIRONMENTAL PERFORMANCE

FSC-certified timber

CO_2 sequestration: ~0.9–1.0 kg CO_2/m³ stored

LIFECYCLE & CIRCULARITY

- Grown in Europe (France, Germany, Netherlands), North America
- PEFC/FSC available
- Higher durability = longer lifespan in service (good for exposed elements)

Straw bales or loose straw, compressed and optionally mineralised, offer a breathable and high-performing thermal insulation derived from a low-cost agricultural by-product.

Raw Materials: dried straw from agricultural waste

Insulation Type: Cavity OR Rigid

STRAW

TECHNICAL PERFORMANCE

B-s1, d0 (EN 13501-1)

λ: 0.040W/m

thickness required: 220-240mm

ENVIRONMENTAL PERFORMANCE

Vapour permeability: High (μ ≈ 2–5)

GWP: -88.7 kgCO2-eq/kg/m^2

LIFECYCLE & CIRCULARITY

- Agricultural by-product, widely available and often local
- Can be sourced from regenerative, no-till farming systems
- Biodegradable and compostable, but must be managed to avoid carbon release at end-of-life
- Recyclable or usable as animal bedding or biomass fuel

INSULATION

Wood fiber insulation boards, made from sawmill offcuts and softwood chips, provide a robust, vapor-open alternative to mineral wool with excellent thermal and acoustic buffering.

Raw Materials: waste wood from forestry and lumber operations

Insulation Type: Cavity OR Rigid

WOOD FIBER

TECHNICAL PERFORMANCE

E (EN 13501-1)

λ: 0,036 W/mK

thickness required: 180-220mm

ENVIRONMENTAL PERFORMANCE

Vapour permeability: High (μ ≈ 3–5)

GWP:-84kg CO2-eq/m^3

LIFECYCLE & CIRCULARITY

- Made from sawmill residues and forest thinnings
- Certified by FSC/PEFC for sustainable forestry
- Unbonded products are recyclable; bonded often incinerated as biomass
- End-of-life emissions depend on binder type

Hemp insulation uses the fast-growing stalk of the plant to produce flexible, breathable batts that regulate humidity and sequester carbon throughout their lifecycle.

Raw Materials: 80-90% industrial hemp, natural binders such as Polylactic acid

Insulation Type: Cavity/ Infill

HEMP FIBRE/ WOOL INSULATION

TECHNICAL PERFORMANCE

B2, E (EN 13501-1)

λ: 0.040W/m

thickness required: 220-220mm

ENVIRONMENTAL PERFORMANCE

Vapour permeability: High (μ ≈ 1–3)

GWP: -53,50 kgCO2-eq/m³

LIFECYCLE & CIRCULARITY

- Rapid growth with minimal inputs, no pesticides
- Cultivation improves soil health, high carbon sink per hectare even compared to forests
- Can be composted or recycled depending on binder
- Low environmental impact across full cycle

INSULATION

Seagrass collected from the beaches as a natural waste product is dried, sanded and chopped, resulting in a quick-drying, mould-resistant material for insulation without the need for chemical additives.

Raw Materials: Processed from the seagrass species (ex. Posidonia oceanica)
Insulation Type: semi-rigid/ rigid
Material Analysis based on: Sould [Denmark]

FLAME RETARDANT EEL-GRASS PANEL

TECHNICAL PERFORMANCE

B2, E (EN 13501-1)

λ: 0.038W/m

thickness required: 180–200 mm

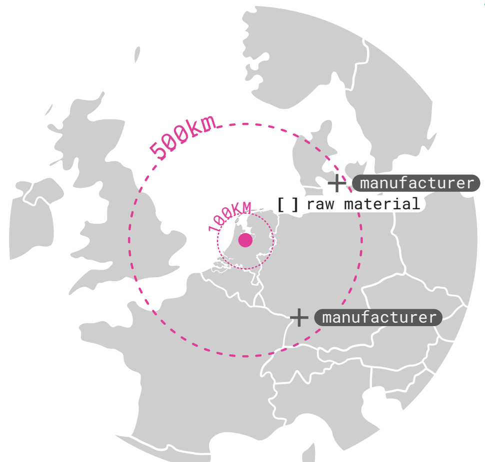
ENVIRONMENTAL PERFORMANCE

Vapour permeability: High (μ ≈ 2–5)

GWP: -125,42 kgCO2-eq/m³

LIFECYCLE & CIRCULARITY

- Harvested as coastal waste, no new extraction needed
- Regulated collection needed to protect coastal ecosystems
- Can be returned to the soil if untreated



COMPRESSED STRAW BOARDS (CSB)

Compressed straw board, made by pressing straw and often bound with natural adhesives, creates a smooth, rigid, and carbon-sequestering surface ideal for internal dry lining.

Raw Materials: 50 % Cattail (Typha Angustifolia); 50% magensite

TECHNICAL PERFORMANCE

- E (EN 13501-1)
- λ: 0.040W/m
- Moderate acoustics

ENVIRONMENTAL PERFORMANCE

- Vapour permeability: High (μ ≈ 3–6)
- GWP: -88.7 kgCO2-eq/kg/m²

LIFECYCLE & CIRCULARITY

- Made from straw and wastepaper, no new crops needed
- Source depends on cereal farming methods (no-till preferred)
- Recyclable and biodegradable
- Easily dismantled and composted if binder-free

WALL LINING

TYPHA BOARDS

Typha boards harness fast-growing wetland plants to create a soft but sturdy bio-based board with superior moisture buffering and natural fire resistance.

Raw Materials: 50 % Cattail (Typha Angustifolia); 50% magensite

Material Analysis based on:

TECHNICAL PERFORMANCE

- B2, E (EN 13501-1)
- λ: 0.045–0.050 W/m·K
- Good acoustic performance

ENVIRONMENTAL PERFORMANCE

- Vapour permeability: High (μ ≈ 3–6)
- GWP: N/A (Low)

LIFECYCLE & CIRCULARITY

- Harvested from wetlands, promotes biodiversity and water filtration
- Non-food crop, grows on marginal land
- Biodegradable and compostable, depending on binder
- Can be reused or crushed and returned to soil

WALL LINING

Wood fiber boards pressed from leftover sawdust and chips provide breathable, sound-dampening internal linings with low embodied carbon and a soft, workable finish.

Raw Materials: waste wood chips/ sawdust from forestry and lumber operations

WOOD FIBRE BOARD

TECHNICAL PERFORMANCE

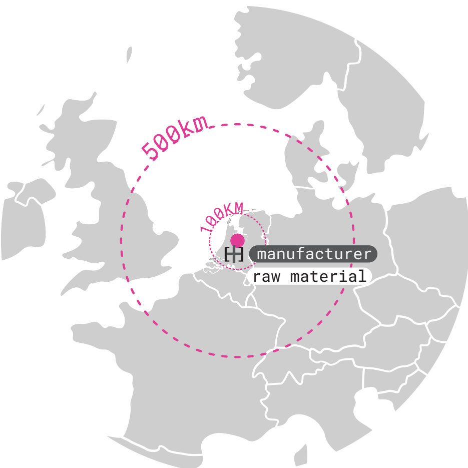
- B2(EN 13501-1)
- λ: 0.040W/m
- Good acoustic performance

ENVIRONMENTAL PERFORMANCE

- Vapour permeability: High (μ ≈ 2–5)
- GWP: -21.6 kgCO2-eq/m³

LIFECYCLE & CIRCULARITY

- Sawmill by-product from certified forestry (FSC, PEFC)
- Unbonded boards recyclable; bonded often incinerated
- Circular when untreated or used in non-structural contexts



Mycelium boards are grown from fungal networks feeding on agricultural waste, producing a lightweight, biodegradable material that resists flame and insulates thermally and acoustically.

Raw Materials: Mycelium (fungi) and a substrate made from agricultural waste (ex. hemp)

Material Analysis based on: Grown bio [NL]

MYCELIUM INSULATION BOARDS

TECHNICAL PERFORMANCE

- B2, E (EN 13501-1)
- λ: 0.040W/m
- Sound Absorption α: 0,40

ENVIRONMENTAL PERFORMANCE

- Vapour permeability: High (μ ≈ 2–4)
- GWP: -21.6 kgCO2-eq/m³

LIFECYCLE & CIRCULARITY

- Grown on agricultural waste (e.g., corn husks, wood chips)
- Fast growth, low energy input, renewable feedstock
- Fully biodegradable if untreated
- Circular by reusing waste and returning to soil

FIRE TREATED PINE

TECHNICAL PERFORMANCE

Improved dimensional stability, reduced water uptake

Durability: Class 2–3

Density: 400–500 kg/m³

Fire classification: Typically B-s2, d0 with fire-retardant treatment

ENVIRONMENTAL PERFORMANCE

Modified through thermal treatment (no chemicals)

CO_2 stored ~0.9 kg/kg

Moderate embodied energy due to kiln drying process

Sourced from European managed forests

CLAY TILING

TECHNICAL PERFORMANCE

Durability: (Class 1, 50–100+ year life)

Non-combustible: Euroclass A1

Good thermal mass

ENVIRONMENTAL PERFORMANCE

High embodied energy from firing process

Zero VOCs, fully inert over lifetime

Regionally produced (NL, DE, BE)

Long life span for reuse + recycling

CLADDING

FIRE TREATED POPLAR

TECHNICAL PERFORMANCE

Durability: Class 2–3 after thermal treatment

Density: ~370–420 kg/m³

Fire class: Typically D-s2, d0 untreated; up to B with added fire retardant

ENVIRONMENTAL PERFORMANCE

Can be locally sourced (Europe) to minimize transport

Lower carbon footprint due to rapid growth and low density

Rapidly renewable species

PILED WILLOW BRANCH

TECHNICAL PERFORMANCE

Density: 200–300 kg/m³

Fire class: E–F untreated (must be fire-retarded)

ENVIRONMENTAL PERFORMANCE

Rapidly renewable (annual to 3-year harvest cycles)

High carbon sequestration during growth

Sourced from willow plantations (NL)

Harvested with coppicing

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DISCUSSION

The presented research aims to demonstrate the potential of timber and bio-based materials to enable planet-conscious and adaptive design solutions, focusing on their suitability for addressing both immediate and long-term architectural needs. Timber, in particular, exemplifies adaptability through its light weight, inherent manageability, and compatibility with design-for-disassembly (DfD) principles.

The methodology develops a comprehensive framework for adaptable architecture, discussing the different aspects of adaptability within spatial considerations, material strategies, and evolving user needs over time. The literature review established the foundational principles of adaptation, such as life spans, loose fit, and planning for change, providing the theoretical basis for design that can accommodate ongoing change while satisfying the immediate demands. This foundation informed the exploration of case studies into intergenerational living typologies as a response to urban densification and household demographic trends. Through these case studies, specific spatial requirements and design considerations were identified within intergenerational and co-living scenarios.

Accordingly, the shearing layers and main building components at play in those actions for adaptation are then examined. This analysis covered the role of building components, such as structure, enclosure, and interior elements, in supporting adaptability. Strategies for design for disassembly were determined as the ideal strategy for flexibility, ensuring that components could be replaced, reconfigured, or reused efficiently over a building's functional and material lifespan. An assessment system was developed to evaluate these strategies, linking specific actions for adaptation to corresponding temporal layers and building components. Aligning with these spatial and structural strategies, material research has identified criteria for selecting biogenic materials, ensuring they support low-impact construction while accommodating the flexibility required.

Based on the Dutch Government's goal in the addition of 100,00 units of housing each year until 2030, the concept of adaptation is an often cited solution for the incorporation of much higher levels of spatial efficiency to make use of the current building stock. In the context of urban densification, flexibility must extend beyond individual units to encompass broader neighbourhood systems, accommodating evolving scenarios over time. Phasing and incremental additions provide a viable strategy to balance present housing needs with future uncertainties, avoiding speculative over-densification and its associated risks, such as vacant units and underutilized spaces.

The design strategies outlined in this research, while primarily focused on individual households and small clusters, serve as a foundation for larger-scale applications. At the household level, strategies for flexible living spaces enable incremental increases in occupancy or functionality within individual units. Building-level adaptations can incorporate these principles through the conversion and modification of spaces, optimizing circulation, porosity, and access to shared resources. At the neighbourhood scale, adaptability supports the reconfiguration of shared spaces, circulation networks, and infrastructure to respond to shifting demographic, economic, or policy-driven changes, facilitating a phased approach to densification.

The proposed playbook integrates these adaptive strategies, offering guidelines in response to the challenges of urban densification. By emphasizing flexibility, phased development, and performance-based material criteria, the playbook provides a replicable model for creating a dense but identifiably human-centred city through its accommodation to the real needs and complexities of life. This design strategy not only addresses the immediate housing demand but also provides a framework for future-proof adaptation.