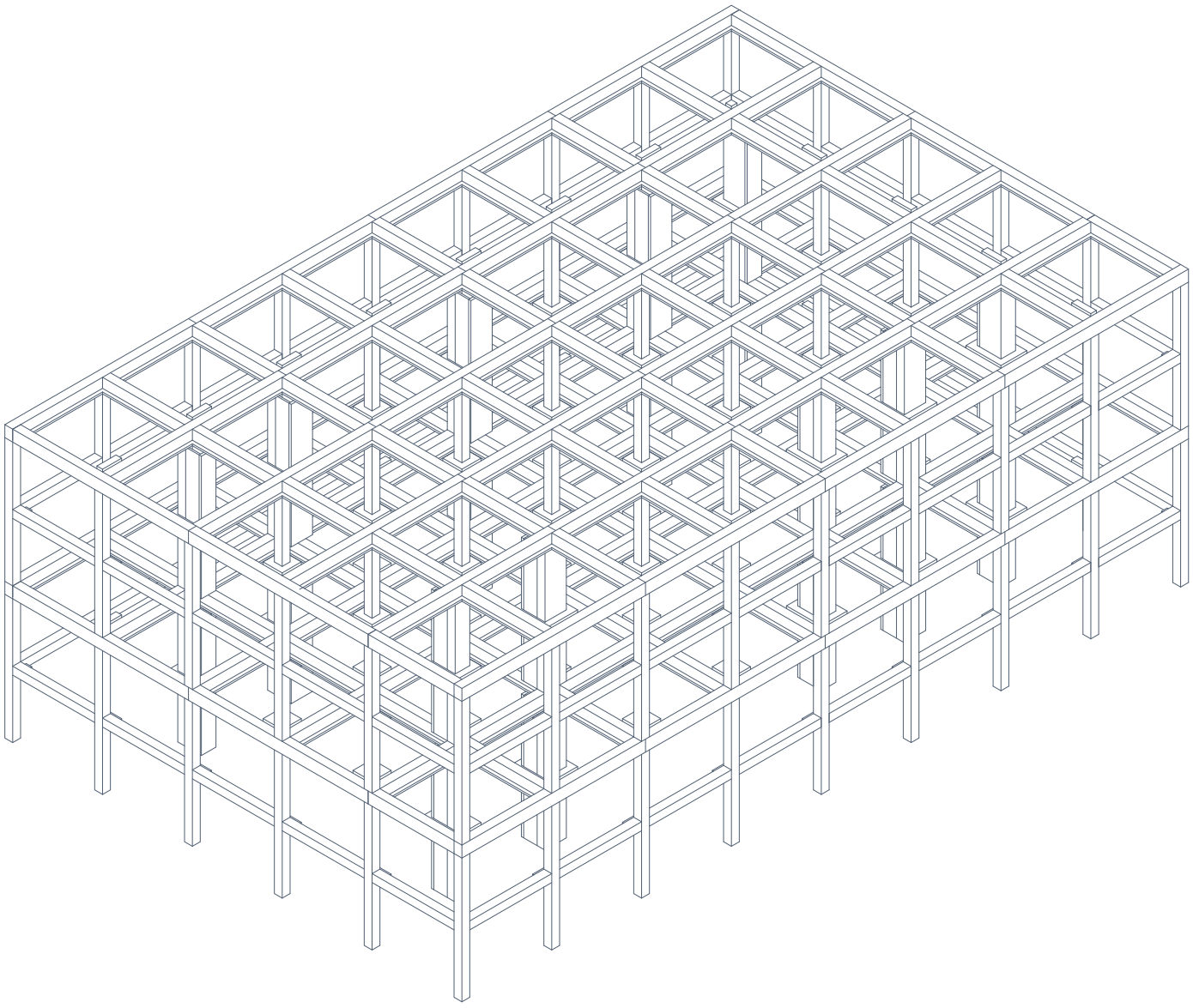
RIGID FREEDOM

structures for making



Lieke Pasman

Lieke Pasman
5862205
03-06-2026

Advanced Housing Design Studio
2025-2026
Robbert Guis and Olv Klijn

Foreword

The graduation project *rigid freedom; structures for making* expresses my personal fascination for architectural concrete within the *Advanced Housing Design Studio 2025-2026*. The project explores how a concrete structural framework can support adaptable live-work environments that contribute to the densification and transformation of the Spaanse Polder in Rotterdam.

Concrete is often radically rejected in contemporary architecture due to its environmental impact. By combining research and design, this thesis investigates how concrete frameworks can support changing needs over time, while responding to contemporary challenges surrounding affordability, sustainability and urban production.

The resulting design presents an honest story about concrete as a long-lasting structural framework for creative makers. With this project, I hope to contribute to the broader discussion surrounding architectural concrete, adaptability and alternative housing-models beyond mono-functional mass housing.

I would like to thank my supervisors, fellow students and everyone who supported me throughout this process.

Lieke Pasman
Delft, June 2026

Contents

01
introduction

1. Introduction

Problem statement and relevance

Due to rapid population growth and changing family compositions, the Netherlands is suffering from a structural housing crisis. In response, the Rijksoverheid aims to build 900.000 new homes by 2030. This ambition faces challenges including lengthy construction procedures, limited building land, high costs and a nitrogen crisis. (Ministerie van Algemene Zaken, 2023) This results in a quantitative, yet qualitative issue.

Research shows a significant misalignment between existing building typologies and the contemporary social needs. The Dutch housing stock is based on an outdated demographic and characterizes architectural homogeneity. Many neighborhoods consist of monofunctional living environments. The lack of diversity constraints flexibility and resilience of these neighborhoods. (Czischke et al., 2025)

Therefore, the housing shortage requires a shift towards inclusive and adaptable living environments. The graduation studio Advanced Housing Design: Ecologies of inclusion aims to find ways to tie together social, ecological and economic systems. Reducing the ecological footprint while assuring social inclusion is central to housing design. This reflects the broader need for a more sustainable, inclusive and healthier Dutch landscape. (Klijn et al., 2025)

Social inclusion can be defined as the process of enhancing participation in society for groups who face disadvantages due to age, gender, disability, race, ethnicity, economic position or migration status (United Nations, 2016). Affordability is under pressure in the current housing market while access to social infrastructure remains limited and unevenly distributed. Low-income households, elderly, migrants and disabled residents are often doubly disadvantaged, facing challenges in securing suitable housing and limited access to social infrastructure (Czischke et al., 2025).

With the aim of the Rijksoverheid to build 247.000 homes in Zuid-Holland by 2030 (Ministerie van Algemene Zaken, 2023), the Spaanse Polder in Rotterdam offers opportunities for redevelopment. A now monofunctional area, dominated by logistics and production and characterized by high crime rates, could be transformed to an integrated work-living environment.

The relevance of the Spaanse Polder relates to the regional vision established by ZUS for Midden-Delfland. They envision the landscape as a productive system, integrating spatial, ecological and economic systems (ZUS [Zones Urbaines Sensibles] et al., z.d.). Within this framework, the Spaanse Polder is designated as an area for urban densification, presenting an opportunity to serve as a transition zone that gradually bridges landscape and city without relying on hard boundaries.

This perspective of a productive landscape aligns with the vision of *Foundries of the Future*. The importance of integrating small-scale production and housing into urban areas is seen as essential for resilient local economies. Emphasizing the need for affordable makers spaces (Croxford et al., 2020). Statistics reveal that creative workers, including artists and makers, often face economic challenges. Creative occupations have a relatively low income compared to the general workforce, leaving them part of the low-income households (Centraal Bureau voor de Statistiek, 2025). Despite their contribution to urban vitality, this group faces difficulty in finding suitable housing and makers spaces.

Objective and motivation

As stated in the introduction, low-income households are often disadvantaged in their search for suitable housing. Creative makers, such as artists and craftsmen form a group within this classification, who in addition to affordable housing, also need makers spaces. Spaces to sustain and develop their practice. This project aims to contribute to social inclusion by offering creative makers an affordable work-living environment while critically addressing sustainability and long-term flexibility of the building's structural design.

As an architect my fascination lies within technical detailing. I believe technical performance and architectural quality should be regarded as equally important. Concrete, currently one of the most contested building materials, particularly interests me for its durability, versatility, and structural capacity. Current sustainability standards cause that concrete is often dismissed in favor of timber or biobased materials. These alternatives are valuable, though the radical rejection of concrete overlooks its potential when used responsibly and thoughtfully.

I argue that concrete's integral qualities deserve reconsideration instead of continuously emphasizing its negative aspects. Its long-term structural performance and durability still offer architectural value when applied selectively and responsibly. By giving an honest story about concrete and focusing on long-term adaptability and reuse, this project aims to reframe its value and encourage a more nuanced understanding of its role within sustainable architecture.

Research questions

The research question captures the project's ambition regarding social inclusion and sustainability. Each sub-question narrows down the research, giving specific insights for the project's core principles.

Main question

How can concrete function as a sustainable structural framework for affordable live–work typologies aimed at supporting small-scale production for creative makers in the Spaanse Polder?

SRQ01

How can concrete be applied as a sustainable and long-lasting structural material that enables adaptability and reuse over time?

SRQ02

What are the spatial and functional requirements of creative makers for combining living and small scale production?

SRQ03

Which live–work typologies can respond to these requirements while remaining affordable and compatible within a flexible framework?

Scope

The location of the project is the Spaanse Polder in Rotterdam, a now mono-functional industrial area. The area is characterized by large scale logistics, wide streets and industrial buildings. The specific site will be a sub-cluster in the northern part of the Spaanse Polder.

The programme of the project focuses on affordable work-living typologies for creative makers. The typologies combine working and living for small-scale production. These spaces assure that creative makers have the opportunity to sustain their practice; such as art, woodworking and graphic design.

The core of the design and research challenge is to explore how concrete frameworks are capable of accommodating both working and living while remaining adaptable. The project investigates how long-term sustainability can be integrated by providing a base for growth and changing user needs.

The intersection of a concrete framework, affordable work-living programme and small-scale urban production contribute to the Spaanse Polder's social inclusion.

02
approach

2.1 Methodology

The research strategy combines four complementary methodologies; literature studies, case studies, research by design and (physical) model making. Together these methods will examine how concrete structural frameworks can provide affordable work-living environments for small-scale production. The methods are applied iteratively, rather than following a linear order, allowing continuous insights. To establish a theoretical and architectural foundation, literature and case studies will be the initial focus.

Literature study

To provide a conceptual and theoretical framework, the research will be based on two main sources; *Foundries of the Future* and *De dragers en de mensen: het einde van de massawoningbouw*. Additional sources will be used during research. *Foundries of the Future* contextualizes the importance of manufacturing in cities, focusing on urban small-scale production. *De dragers en de mensen: het einde van de massawoningbouw*, written by John Habraken provides a structural framework for understanding buildings as long-standing structural supports, allowing user adaptation over time. Together, these sources establish both the conceptual and technical principles that guide the design exploration.

Case studies

A series of comparative case studies will be used to examine how work-living environments have been organized previously. The case studies; *Cité Montmartre aux Artistes* (Paris), *Piazza Céramique* (Maastricht), *WoonWerkPand Tetterode* (Amsterdam), *Zomerdijkstraat* (Amsterdam) and *Schiecentrale 4b* (Rotterdam) shows different typologies, architectural solutions and historical contexts.

The Superlofts model by Mark Koeheler architects will also be examined, representing how (concrete) frameworks can form a base for adaptable infills.

The case studies will be analyzed through concepts and drawings. Structural systems, spatial organization, the relationship between working and living and strategies for affordability and adaptability will be examined. The cases studies function as references to gather architectural principles.

Research by design

Research by design will be the core of the design process, determined through literature and case studies. Base principles will be tested through floor plans, sections and structural grids.

Model making

(Physical) models will not only be used as a presentation tool, they will also test the structural and spatial implications of the framework. By testing different infill scenarios within a fixed structural system, models allow the flexibility of the framework to be visualized and tested.

Expected output

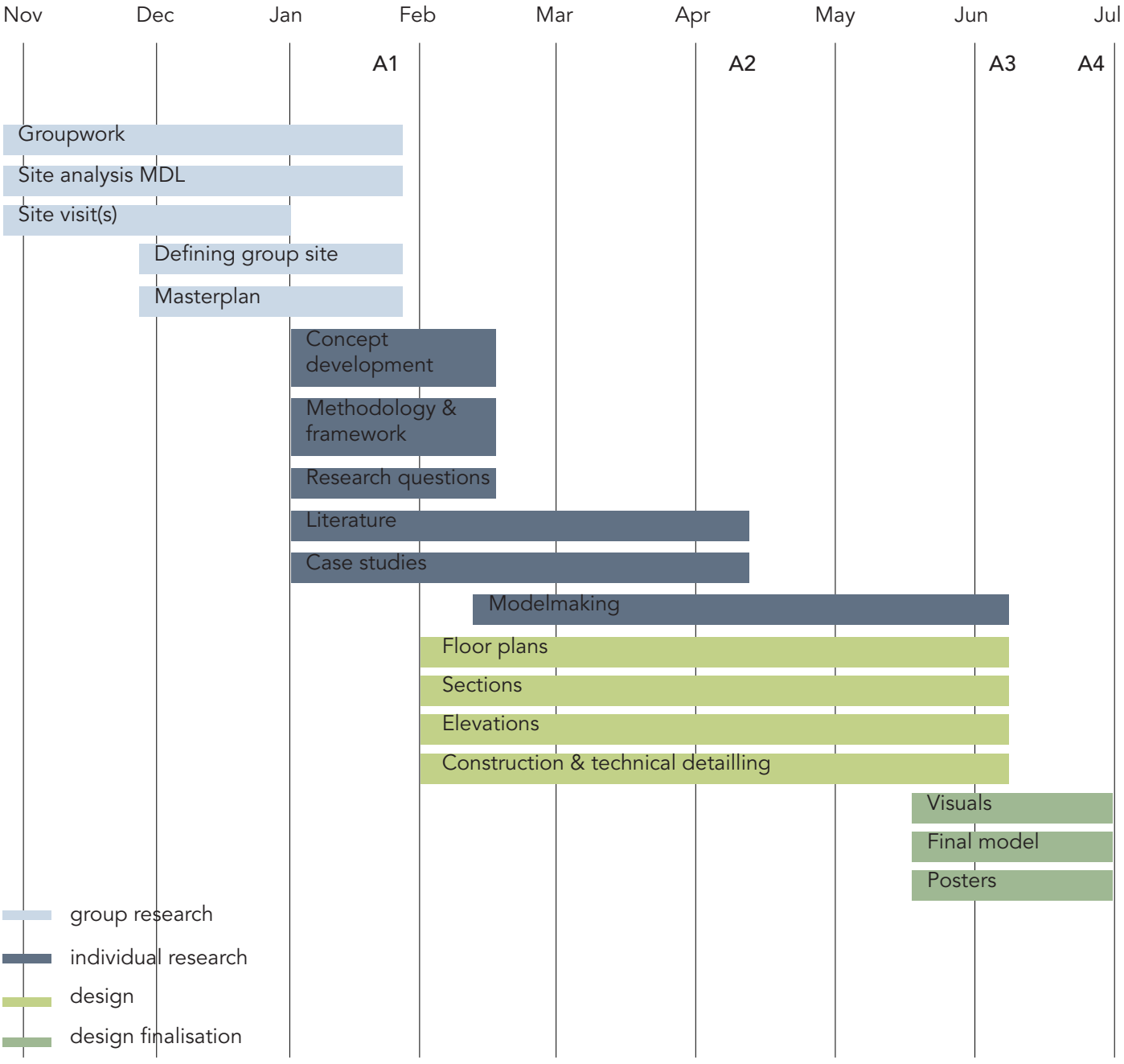
The expected output includes drawings and physical models that demonstrate how concrete structural frameworks can allow living and small-scale production to be integrated. Architectural principles and typologies will be determined from literature, case studies and design explorations.

Sub question	Method	Output	Contribution to design
SRQ01 How can concrete be applied as a sustainable and long-lasting structural material that enables adaptability and reuse over time?	Literature study Model making Research by design	Technical specifications (test) Models	Technical specifications will give base measurements for the construction and framework
SRQ02 What are the spatial and functional requirements of creative makers for combining living and small scale production?	Literature study Case studies Research by design	Design principles Programme of requirements Drawings	Clear principles, needs and wishes will be formulated Indication for the programme and m2
SRQ03 Which live–work typologies can respond to these requirements while remaining affordable and compatible within a flexible framework?	Case studies Model making Research by design	A clear building envelope and typologies Models & drawings	Defines the typologies which will fit into the structural framework

Planning

The planning gives an indication of the design process.

Project planning 2025-2026



2.2 Theoretical framework

The intersection of housing, small-scale production, long-term adaptability and architectural concrete forms the base of the project's theoretical framework. Five complementary sources address both the urban and building scale. Methods on urban production, the open building theory, the productive city and the workhome as a housing typology are described. Together, these sources provide the conceptual and architectural foundation of the project.

At the urban scale, *Foundries of the Future* and *IABR-2016-Atelier Rotterdam: The productive city* emphasize the importance of embedding manufacturing and production within cities, rather than placing them near its edges. Historically, there has been a shift from integration to segregation regarding small-scale manufacturing and housing in cities, as described in *Foundries of the Future.* More recently, there seems to be a shift toward cohabitation, in which manufacturing and housing are socially and economically connected within urban areas. Urban production stimulates resilient cities by supporting local economies and social inclusion through offering jobs and makers spaces. Fifty design solutions offer ingredients for integrating manufacturing architecturally. (Croxford et al., 2020). *IABR-2016-Atelier Rotterdam: The productive city* also challenges mono-functional industries and argues that manufacturing should be seen as economically and socially relevant to urban areas (International Architecture Biennale Rotterdam, 2016). Together these sources form a foundation for the project's urban scale.

At the building scale, *De dragers en de mensen: het einde van de massawoningbouw* by John Habraken and *The workhome* by Francis Holliss provide architectural and structural solutions for integrating working and living. The open building theory by John Habraken, explained in *De dragers en de mensen: het einde van de massawoningbouw,* critiques non-adaptable mass housing which has been dominating for decades. The theory introduces a distinction between long-lasting structural supports (support) and adaptable interiors (infill). The infill allows users to modify according to changing needs over time (Habraken, 1985). Habraken's theory supports the project's approach of creating a durable and adaptable structural framework (support), allowing working and living (infill) to evolve without demolition.

In addition to the building scale, *The Workhome* by Francis Holliss provides insights into the human scale of home-based work environments. Holliss outlines the history of integrating working and living, a common phenomenon in the early twentieth century, now re-emerging. *The Workhome* analyses diverse work-home typologies, identifying eight categories of home-based workers and their unique needs. Hollis distinguishes home-dominated and work-dominated typologies, organized into three degrees; live-with, live-adjacent and live-nearby. The research formulates design principles that explain why work-living typologies are socially and functionally viable. (Holliss, z.d.)

Finally, *Concrete construction: practical problems and solutions* provides insight into architectural concrete, emphasizing the material's structural qualities and its environmental impact.

Together, these theories form a coherent multi-scalar framework.

03
research

3.1 Literature study

The productive city

Foundries of the Future and *IABR-2016-Atelier Rotterdam: The productive city* emphasize the importance of integrating manufacturing within urban environments. Design strategies as '*making making visible'* and establishing a '*public facade'* help connect production with the surrounding neighborhood. Additionally, providing *'flexible makerspaces'* enables adaptability for diverse groups of creative makers over time (Croxford et al., 2020).

Support-Infill

The open building principle by John Habraken critiques mass housing and introduces a theory of support and infill to create a more flexible, adaptable, circular and resilient built environment (Habraken, 1985). In honour of Habraken's theory, architects within the OpenBuilding.co dedicate their work to extending the lifespan of buildings (Open Building, z.d.).

Architectural concrete

Concrete, a historical building material known for its durability, versatility in complex forms and structural capacity has faced major critiques throughout the last years regarding sustainability and CO2 emissions. However, concrete's durability and structural capacity seem suitable as a permanent support system. Concrete aligns with Habraken's principles of a resilient building due to its high performance characteristics regarding structural strength and wind- and fire resistancy (Surahyo & IBI Group, 2019).

A critical reflection on concrete

Contemporary architectural sustainability generally acknowledges two dominant approaches; the low-carbon material approach and the longevity and adaptability approach. The use of concrete exists within the tension between these two approaches. Despite concrete's structural advantages, it remains one of the most environmentally contested building materials with significant CO2 emissions. This critique is valid and emphasizes the urgent need to reduce emissions within the construction sector. Therefore, timber and bio-based materials are promoted because of their lower carbon footprint.

However, this research argues that sustainability should not only be assessed through short-term carbon reductions, but also through long-term adaptability, durability and flexibility. A building designed for multiple lifecycles could reduce future demolition, lowering material waste and consumption. Within this perspective concrete is not approached as a universally sustainable material, but as a strategic material for long-lasting support structures when applied responsibly and selectively.

Enabling reuse through structural longevity

Concrete can enable adaptability and reuse due to its durable and low-maintenance characteristics. When designed thoroughly, maintained well and protected from damage, internal concrete structures have a potential service life of 200 years, while the minimum lifespan is generally set at 50 years. Therefore, the actual lifespan of a concrete framework can significantly exceed the intended design life. (Surahyo & IBI Group, 2019)

Within a rapidly evolving urban environment, long-lasting structural systems can support spatial and functional transformation over time. Rather than requiring demolition, adaptable infill systems allow buildings to accommodate changing user needs and programs. Therefore the long-term value of concrete not only lies in structural performance, also in social and economic sustainability.

The manufacturing process

The current manufacturing process of cement produces approximately one ton of CO2, accountable for nearly 75% of concrete's total CO2 footprint (Surahyo & IBI Group, 2019). The "Betonakkoord" in The Netherlands strives to find sustainable measurements like the use of alternative binders (Duurzame Bindmiddelen Voor Milieuvriendelijk Beton | Betonhuis, z.d.).

Sustainability through Pozzolanic innovations

One of these alternative binders are pozzolans, a supplementary cementitious material (SCM) often used individually or in combination with cement to improve the sustainability and durability in concrete. Pozzolans are siliceous and aluminous materials with minimum cementitious properties, like volcanic ash. These materials have a finer pore structure that increases concrete's impermeability and resistance to chemical attack. By replacing 30% of cement with pozzolans, global CO2 emissions could be significantly reduced. (Surahyo & IBI Group, 2019)

The use of pozzolanic cement is a historically proven method which can be traced back to the ancient Romans, who discovered the use of volcanic ash to create cement in 500 BC. (Surahyo & IBI Group, 2019) Some structures like the Pantheon in Rome still stand today, 2000 years later (Roman Concrete, n.d.).

Sustainability through recycled aggregates

The use of recycled concrete aggregates (RCA) also reduces CO2 emissions. By harvesting RCA directly from demolished buildings on site, both raw material consumption and construction waste can be reduced. Research suggests that 30% of natural coarse aggregate can be replaced by RCA without significantly affecting the structural properties of concrete. (Surahyo & IBI Group, 2019)

While recycled aggregates are naturally more porous than virgin aggregates, the combination of pozzolans with recycled aggregates can improve material performance while reducing carbon emissions. Demolition waste can be transformed into a high-performance and low-carbon foundation. (Surahyo & IBI Group, 2019)

Conclusion

By combining concrete's structural performance with sustainable innovations such as pozzolanic binders and recycled aggregates, high performance concrete frameworks can support flexibility and adaptability through multiple building lifecycles.

What defines a workhome

The workhome, a building typology that combines dwellings and workplaces has existed for centuries. Workhomes can be categorized according to its dominant function; either home-dominated, work-dominated or equal status. Within these categories, three spatial design strategies further define the workhome; live-with (one front door with no separation), live-adjacent (separate entrances, yet connected) and live-nearby (completely separate spaces within a short walk). Furthermore, a distinction between determinate and indeterminate workhomes can be made. Determinate workhomes are designed for a fixed use, while indeterminate workhomes promote flexibility and shifting needs over time. (Holliss, z.d.)

Who are creative makers?

Hollis states 8 workhome user-groups. The intended target group of creative makers for the Spaanse Polder fit within the sub-groups; 24/7 artists, craftsmen and professional and managerial. (Holliss, z.d.)

24/7 artists typically prefer work-dominated workhomes, where boundaries fade between work and domestic life. The live-with arrangement with no spatial separation fits their preference of working throughout day and night. Yet, this group is therefore often prone to social isolation. (Holliss, z.d.)

Craftsmen also tend to prefer work-dominated workhomes, yet require more spatial separation. They often perform noisy and dirty practices, prioritizing a physical buffer, like the live-adjacent arrangement. (Holliss, z.d.)

Professionals prefer equal-status workhomes, the building is their "calling card". This group often performs digital work and interacts more often with clients. The right public - private balance is therefore important, prioritizing separate entrances to maintain domestic privacy. (Holliss, z.d.)

Spatial justifications

Nine primary design considerations should be made when designing the workhome effectively;

1. Flexibility
2. Determinacy vs indeterminacy
3. Public - prive interaction
4. Visibility vs invisibility
5. Acoustics
6. Pollutants
7. Environmental control
8. Exterior space
9. Storage

The building's ability to adapt to changing needs and residents over time increases the functionality. Therefore the relation between public and private space is important, keeping (seperate) entrance strategies in mind and considering buffer zones to help manage privacy. Buffer zones also regard acoustics and pollutants. Essential considerations, with a quarter of home-based occupations involving noisy and dirty processes. An effective design separates work and dwelling to prevent dust, odors or chemicals from spreading into the domestic space. (Holliss, z.d.)

For some creative makers their workhome is their "calling card". The use of signage or visibily exposing their work helps to advertise business, boosting the local economy. While other creative makers might like to work more invisible, a right balance should be sought to protect the residential character of the neighborhood. Exterior spaces could work well as a transition zone, by providing gardens which can serve as additional workspaces or a more neutral space for social interaction with the neighborhood. (Holliss, z.d.)

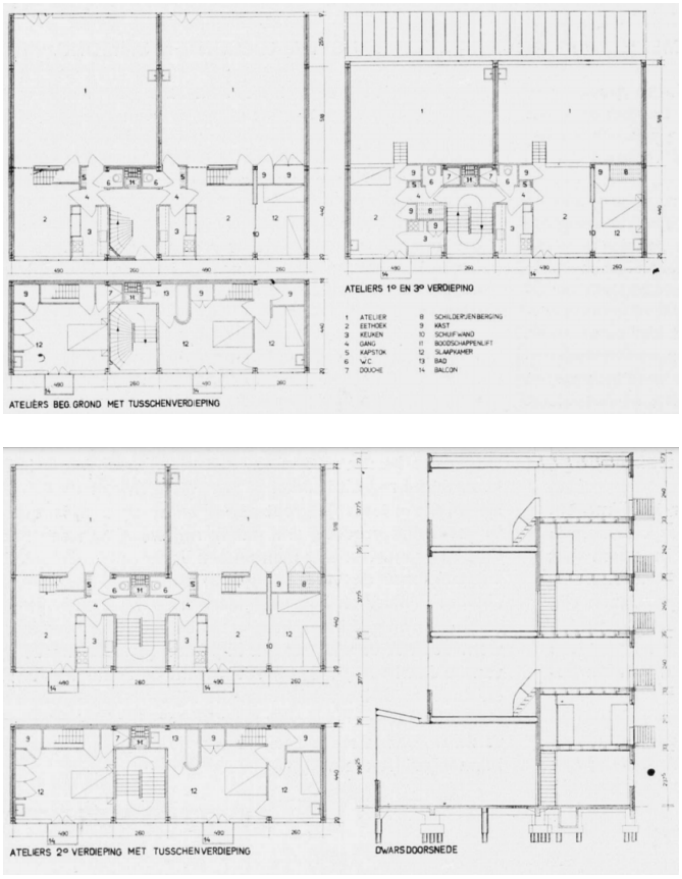
3.2 Workhome precedents

A variety of six workhome precedents have been analysed based on typology, the relationship between working and living, and spatial implementation. The overview below summarizes these aspects, forming a starting point for the design.

Precedent	Working m2	Living m2	Seperate entrances	Workhome typologies
Zomerdijkstraat	36-55m2	21-62m2	No	3
WWP Tetterode	20-50m2	44-80m2	No	2
Piazza Ceramique	26-49m2	100-122m2	Yes	4
Cite Montmartre	31-93m2	28-41m2	No	3
Pullens Estate	19m2	49m2	Yes	1
Schiecentrale	08-68m2	32-52m2	Yes	2

Zomerdijkstraat, Amsterdam is a small scale residential complex designed for artists and craftsmen in 1934. The building with 32 workhomes follows a north-south split, placing workspaces on the north for high-quality daylight .

Typologies:
1. working: 36m2 - living: 21m2
2. working: 36m2 - living: 62m2
3. working: 55m2 - living: 42m2



1
Typologies - Zomerdijkstraat, Amsterdam
From ArchiHis. (2021, May 4). Atelierwoningen Zomerdijkstraat.

2
Interior - Zomerdijkstraat, Amsterdam
From ArchiHis. (2021, May 4). Atelierwoningen Zomerdijkstraat.

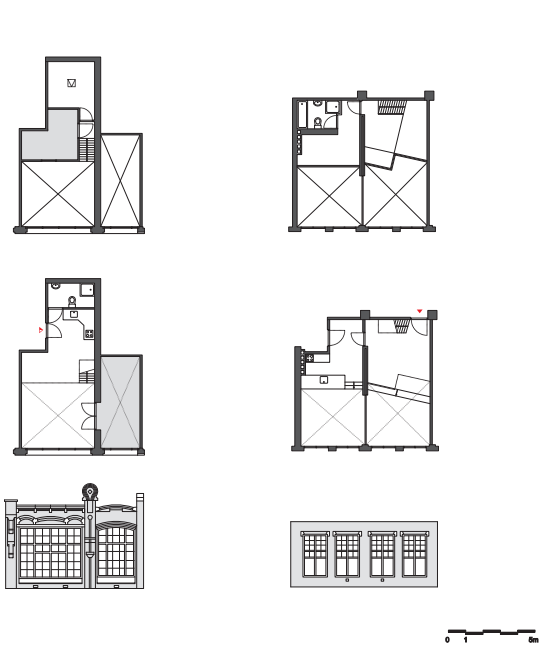
WoonWerkPand Tetterode, Amsterdam

A factory transformed into 169 double-height units with an average of 40m2 are based on the support-infill principle.

Typologies:
1. working: 20m2 - living: 44m2
2. working: 50m2 - living: 80m2

Atelierwoning aan Bilderdijkstraat, tweede verdieping, representatie (zuidwest)
Workhome on Bilderdijkstraat, second floor, representation (southwest)

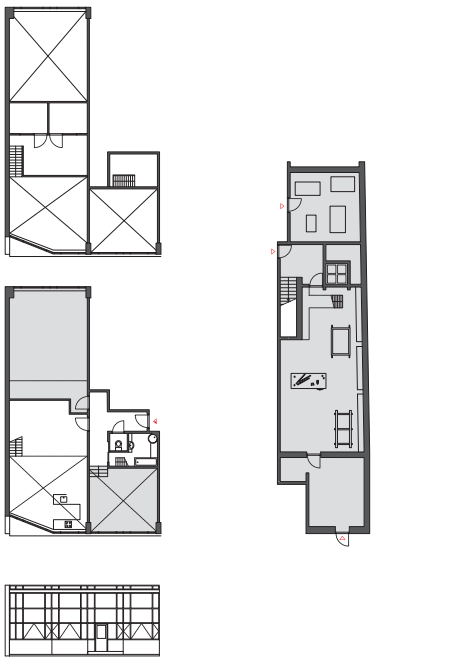
Appartement aan Da Costakade, derde verdieping, representatie (noordoost)
Apartment on da Costakade, third floor, representation (northeast)



3
Typologies WoonWerkPand Tetterode, Amsterdam
From DASH 15: Home Work City

Atelierwoning aan Da Costakade, derde verdieping, representatie (zuidwest)
Atelier apartment on Da Costakade, third floor, representation (southwest)

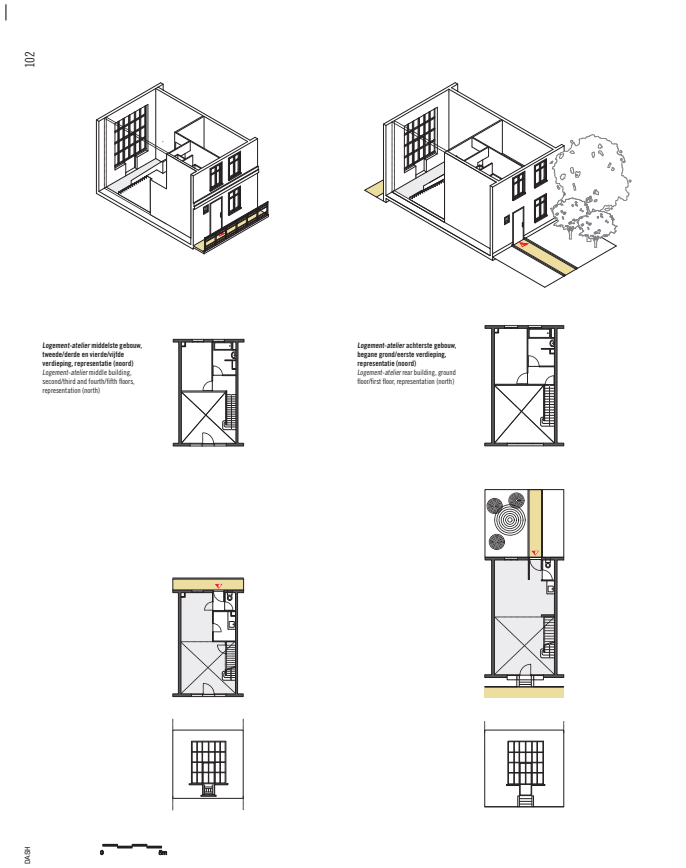
Metaalwerkplaats aan binnenplaats, begane grond
Metal workshop on courtyard, ground floor



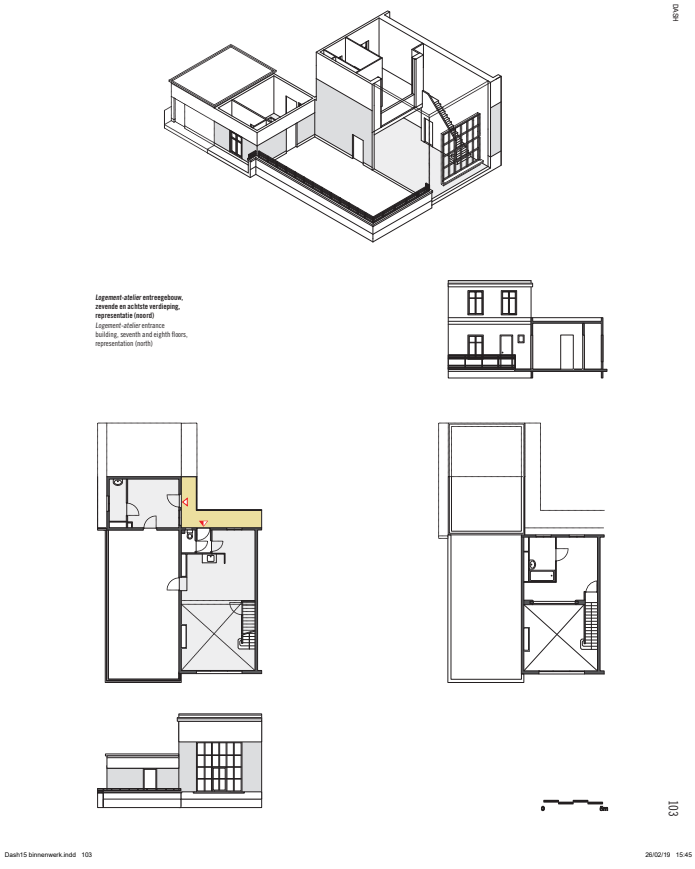
4
Typologies WoonWerkPand Tetterode, Amsterdam
From DASH 15: Home Work City

Cite Montmartre, Paris consists of three buildings, each with their own typology, designed specifically for artists. 165 workhomes with an avarage of 106m2 were realized after restoration.

Typologies:
1. working: 31m2 - living: 29m2
2. working: 47m2 - living: 28m2
3. working: 93m2 - living: 41m2



5
Typologies Cite Montmartre, Paris
From DASH 15: Home Work City



6
Typologies Cite Montmartre, Paris
From DASH 15: Home Work City

Pullens Estate, London consists of appartment blocks with inegrated workspaces designed for artists and small craftsmen. Each units has seperate entrances for a domestic space of 49m2 and workspace of 19m2. A private corridor connects both realms.

Typologies:
1. working: 19m2 - living: 49m2

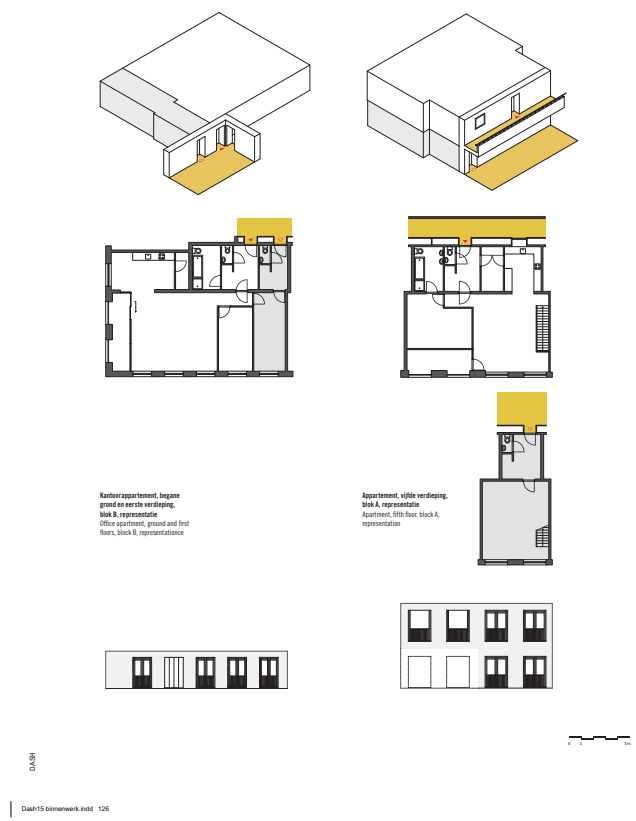
Appartementen en werkplaatsen, begane grond en eerste verdieping, representatie (boven: werf, onder: straat)
Apartments and workshops, ground and first floors, representation (top: yard, bottom: street)

Appartementen, tweede en derde verdieping; collectieve dak-terassen op tweede en vierde verdieping, representatie (boven: werf, onder: straat)
Apartments, second and third floors; shared roof terraces on second and fourth floors, representation (top: yard, bottom: street)

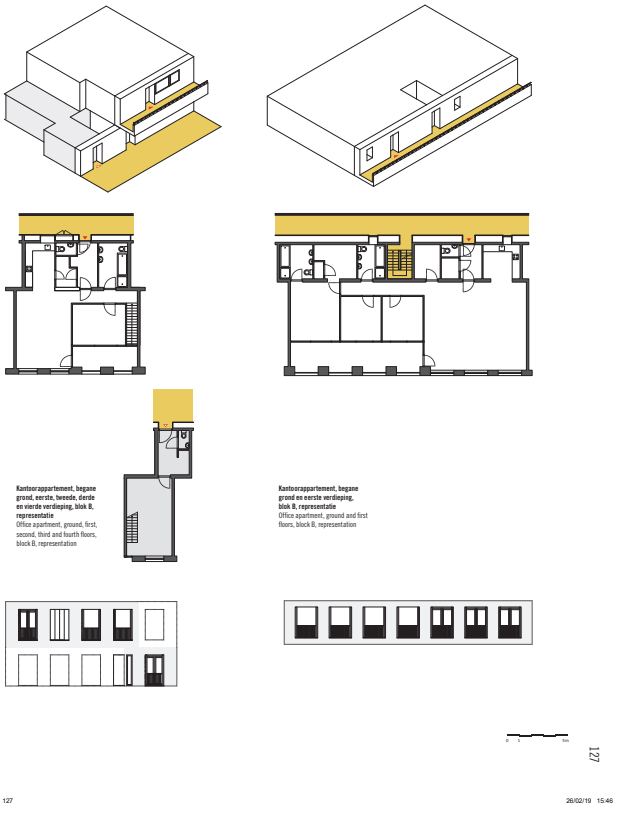
7
Typologies Pullens Estate, London
From DASH 15: Home Work City

Piazza Ceramique, Maastricht is an ensemble of two blocks (A&B) consisting of workhomes and seperate work units. The four workhome typlogies range from 87-182m2, with a seperate entrance for working and living.

Typologies:
1. working: 26m2 - living: 122m2
2. working: 35m2 - living: 100m2
3. working: 49m2 - living: 119m2
4. working & living: 200m2



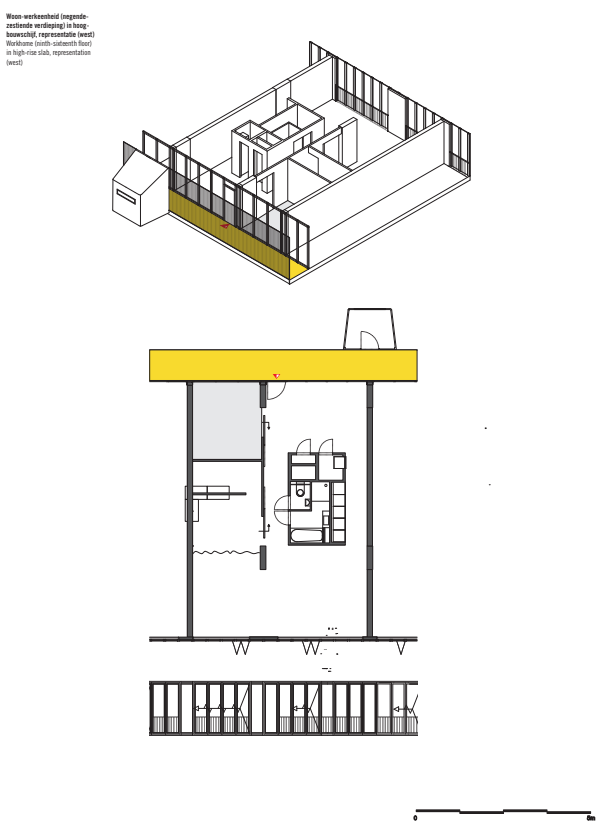
8
Typologies Piazza Ceramique, Maastricht
From DASH 15: Home Work City

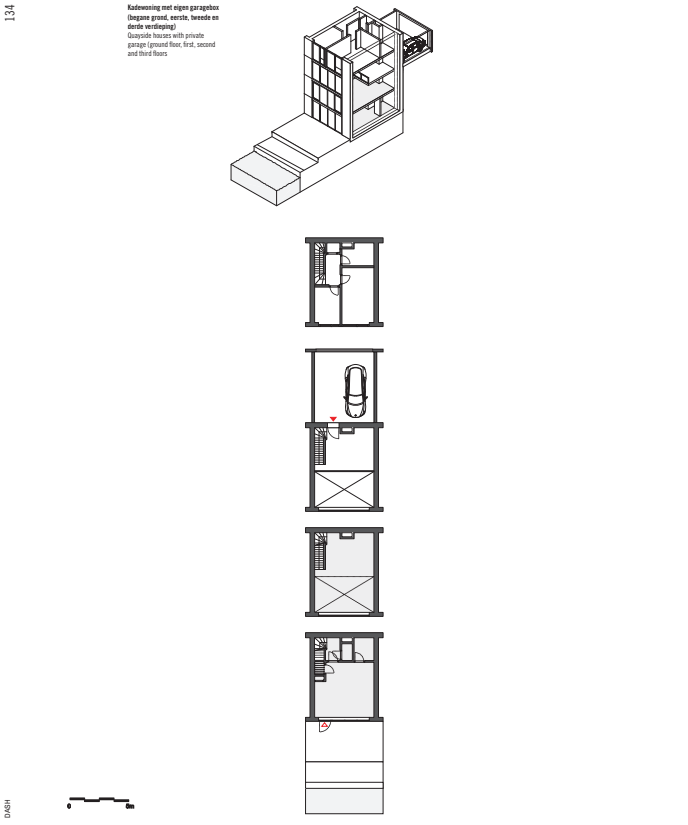


9
Typologies Piazza Ceramique, Maastricht
From DASH 15: Home Work City

Schiecentrale 4b, Rotterdam is a residential and commercial building with 156 workhomes ranging from 65-135m2 and 20 quayside houses (four floors with a private garage). The workhomes have a flexible layout, supporting adaptability and were left unfinished for the owner to design.

Typologies:
1. working: 08m2 - living: 32m2
2. working: 68m2 - living: 52m2





10
Typologies Schiecentrale 4b, Rotterdam
From DASH 15: Home Work City

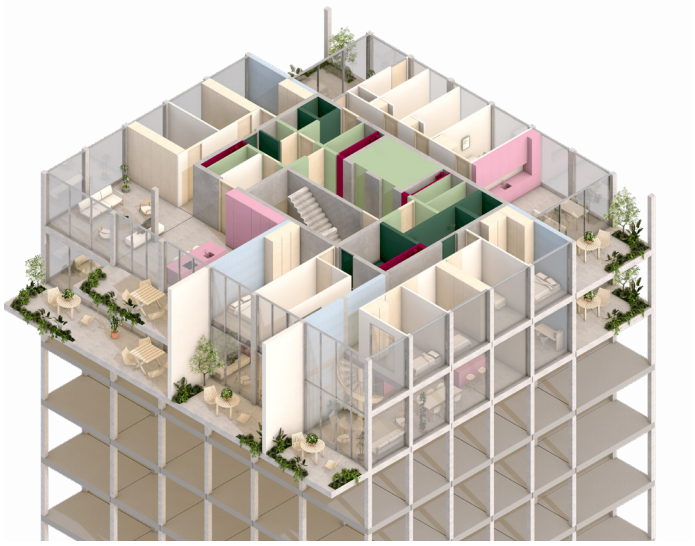
11
Typologies Schiecentrale 4b, Rotterdam
From DASH 15: Home Work City

3.3 Superlofts precedents

A grounded example of the open building principle is the Superlofts model, designed by Mark Koehler Associates. Prefabricated modular systems in concrete and timber provide flexible programs that can adapt over time (Superlofts, 2025). Two Superlofts with concrete frameworks are analysed; Hoorn and Houthavens.

Superlofts, Hoorn

A structural concrete grid of 2,7x2,7m provides a base for flexible units ranging from 72-149m2. Five basic unit types are designed by MKA, either duplex or single floor and are shown with various possible layouts, shown in figures 13-14. The top three floors offer full freedom, letting residents also choose the typology of the unit. The facade and installations are demountable and stand free from the load-bearing structure.



12
The top floor of Superlofts Hoorn
From Superlofts. (2025, 31 oktober). Superlofts

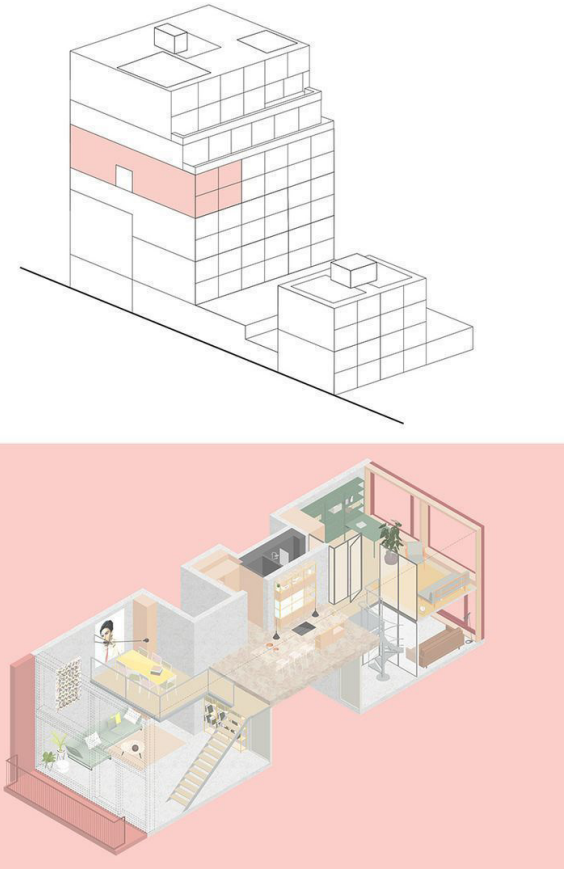
13
Type A with variation
From Superlofts. (2025, 31 oktober). Superlofts

14
Type C with variation
From Superlofts. (2025, 31 oktober). Superlofts

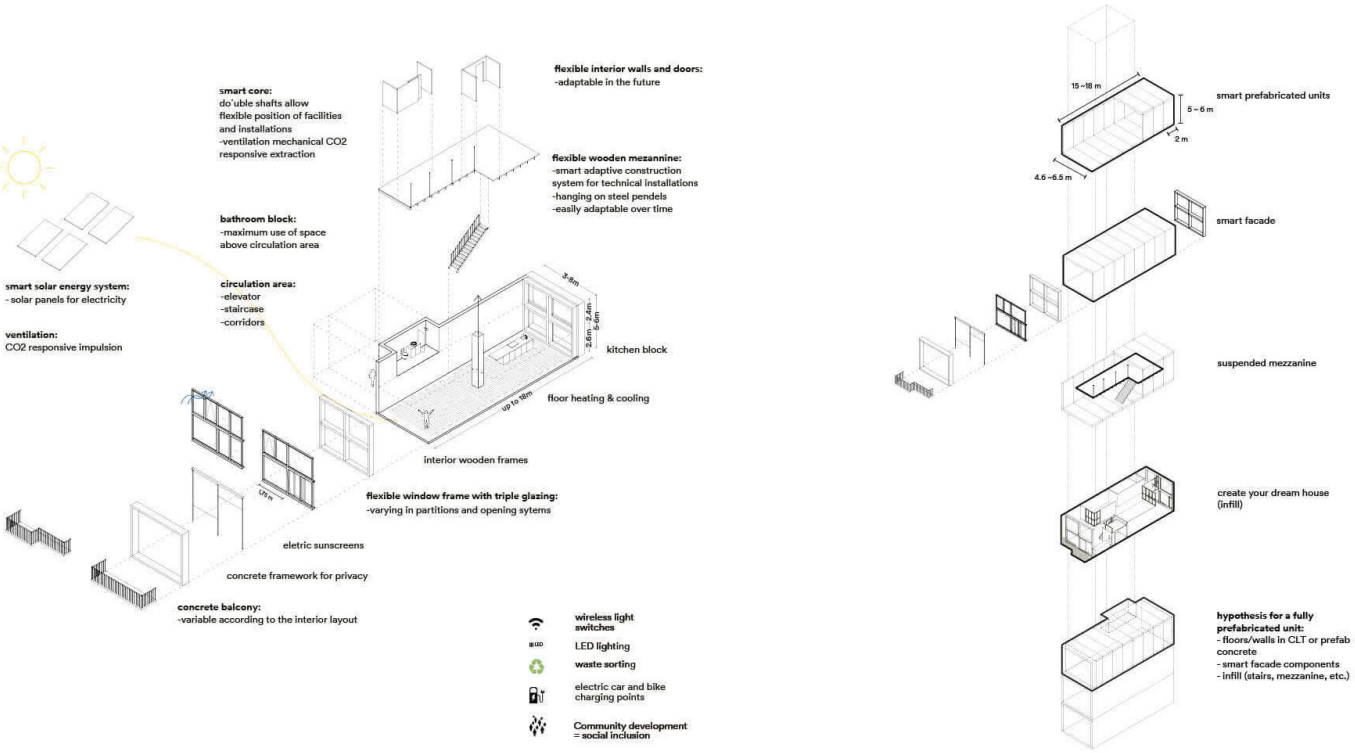
Superlofts, Houthavens

A prefabricated structure provides a base for 5.7m wide and three- to six-meter high casco-lofts that residents can cutomize. Houthavens is a cooperative development model offering units that range from 35m2 XS studios to 200m2 XL penthouses. (Marc Koehler Associates, 2025)

Figure 16 shows the basic principles of the core, climate, structure, facade and infill. With the support following basic principles, the facade and the infill can remain adaptable. The facade can be customized according to the layout of the unit within a concrete framework. This also applies to the interior of each unit, where walls and the mezzanine floors are made of wood allowing adaptation over time.



15
Superlofts Houthavens
Marc Koehler Associates. (2025, 14 mei). Superlofts Houthavens,

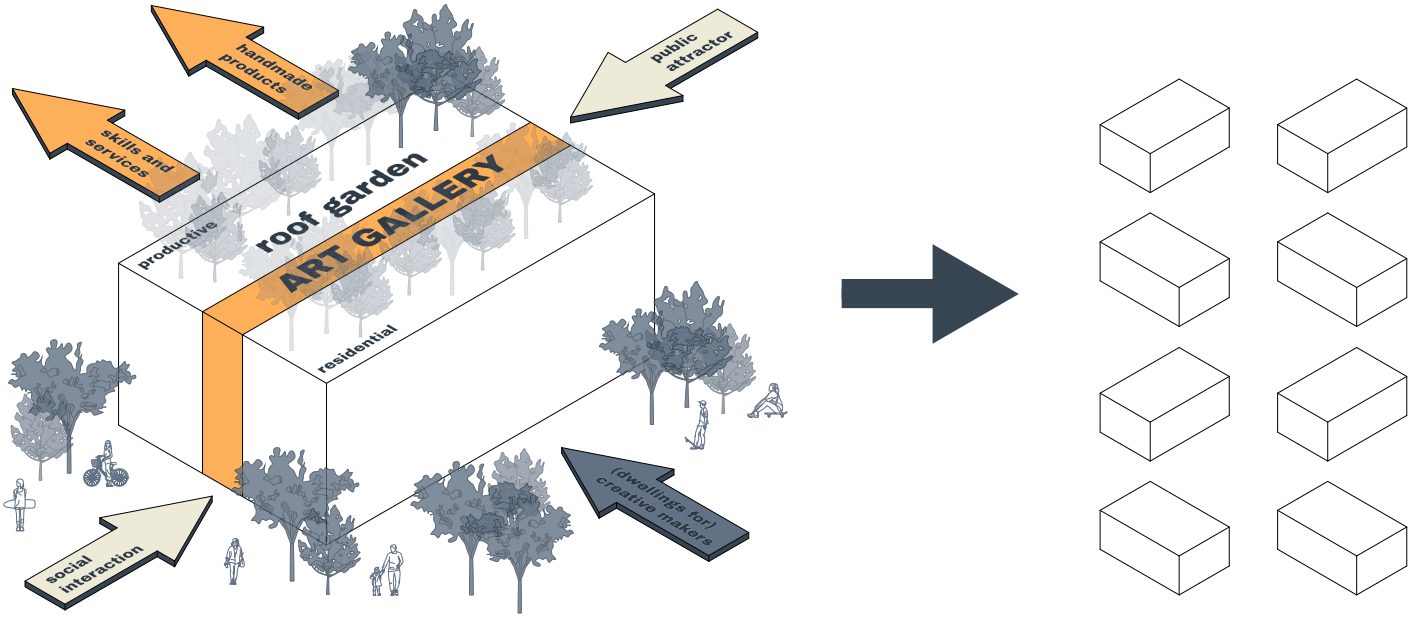


16
Main principles of Houthavens
Marc Koehler Associates. (2025, 14 mei). Superlofts Houthavens,

04
design integration

4.1 Urban integration

As research indicates, the integration of small-scale production within urban environments supports the local economy and social inclusion. Rather than introducing a single structure, the architectural framework is repeated eight times throughout the masterplan. Together, these frameworks establish a productive urban network, connecting working, living and public interaction throughout the neighborhood. The framework acts as an urban connector through public-facing productive spaces.



17
The urban connector
own work

4.2 Architectural integration

The literature study and precedent analysis revealed four reocurring design principles that form the foundation for the architectural design. These principles follow Habraken's support-infill theory and Holliss' workhome classifications. Together, these strategies establish a long-term adaptable, flexible and affordable framework.

Design feature	Designers	24/7 artists	Craftsmen
North facing - working	Medium	High	Medium
South facing - living	High	High	High
Separate entrances for working/living	High	Medium	High
Corridor - private connection	High	High	High
Concrete support - adaptable infill	High	High	High

1. North-south orientation

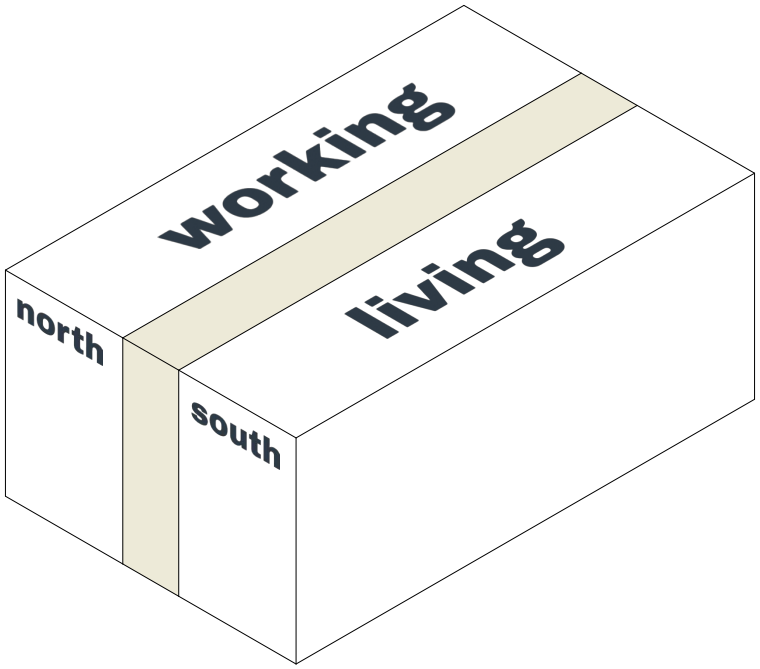
The first principle relates to the spatial orientation of the building. As observed in the Zomerdijkstraat Amsterdam precedent, a strict distinction between north-facing workspaces and south-facing dwellings improves the coexistence between working and living. North-oriented workspaces provide stable daylight conditions for artists and craftsmen while south-oriented dwellings improve domestic comfort. This spatial hierarchy additionally creates a buffer zone, separating noise, odor and clutter from the domestic space.

2. Seperate entrances

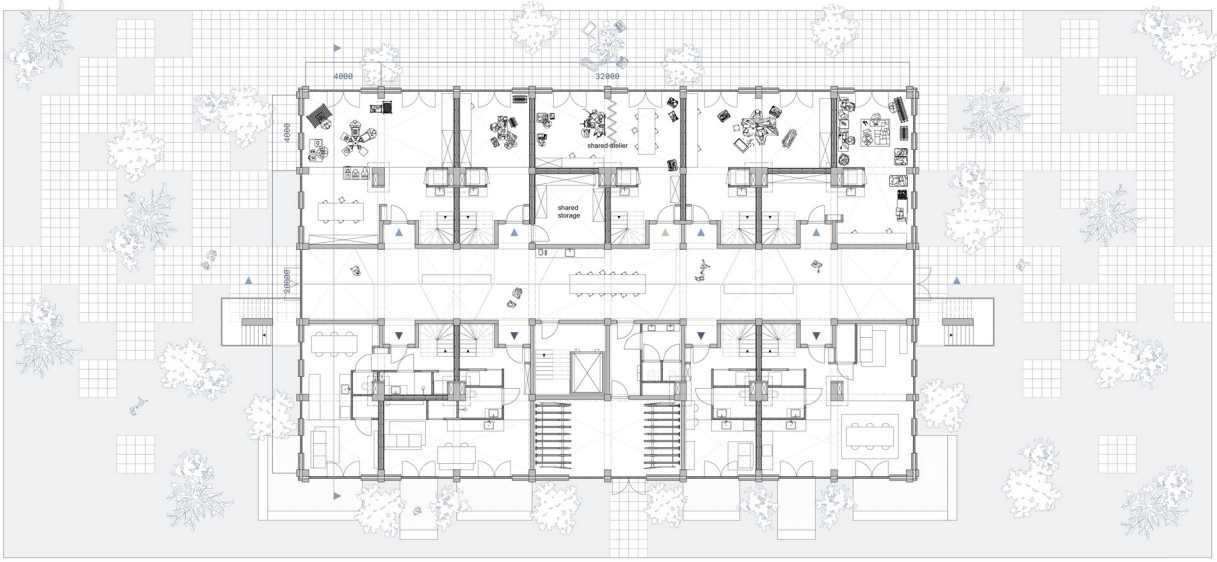
The strategy of seperate entrances allows the workhome to operate simultaneously, creating a balance between public accessibility and residential privacy. For many craftsmen and professionals, their workspace forms an important part of their professional identity. A clear distinction accomodates professional interaction and strengthens visibility while improving accessibility for visitors and residents.

3. Corridor and private connection

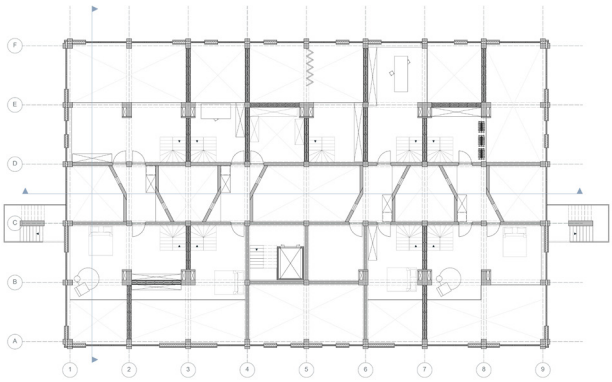
The main workhome typology integrated within the architectural design is the live-adjacent typology, supported by a private internal connection between working and living. The north-south orientation and seperate entrances establish a corridor zone, that functions as a spatial transition between the the public work environment and the private domestic realm. This space supports interaction between creative makers, visitors and residents. The adaptability of this zone allows the relationship between living and working to evolve over time.

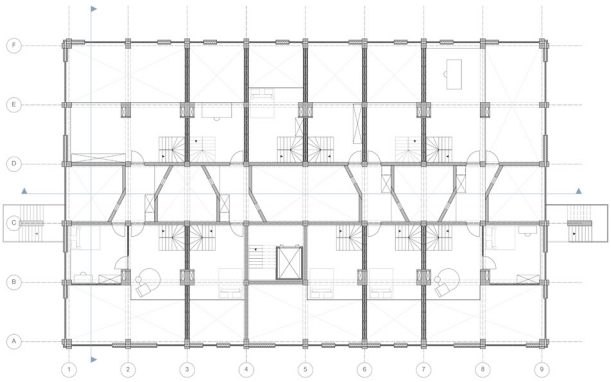


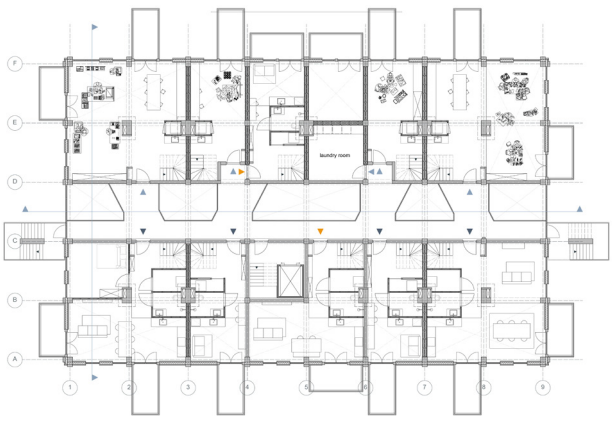
18
North-south seperation
own work

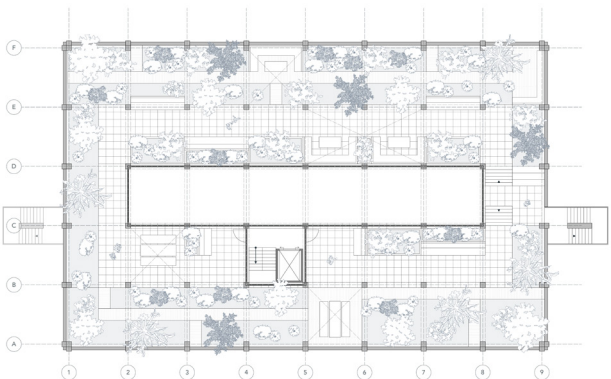


19
Ground floor - design
own work









20
1st, 2nd & 3rd floor - design
own work

21
roof terrace - design
own work

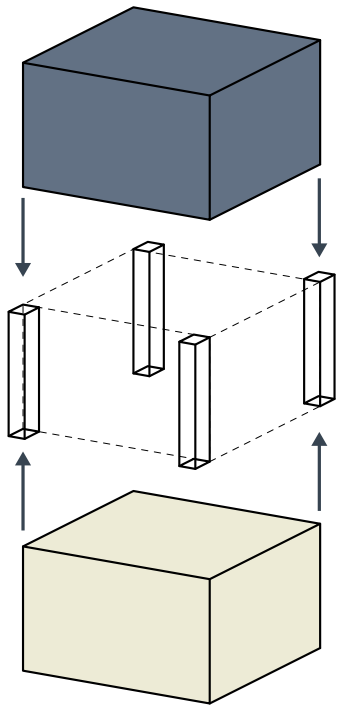
4. Concrete support and adaptable infill

The foundation of the project is a permanent concrete support structure which offers an adaptable infill (figure 22), inspired by Habraken's theory and Superlofts precedents. The concrete framework is designed to accommodate spatial and programmatic change over time within a 4x4m grid. Starting with the workhome typologies, the framework allows future transformation into fully residential or fully productive spaces without demolition. This adaptability is achieved through a load-bearing structure of beams and columns from recycled and pozzolanic concrete. Within this structure, removable timber infill elements (figure 24) allow for different typologies and spatial configurations to emerge over time (figure 23).

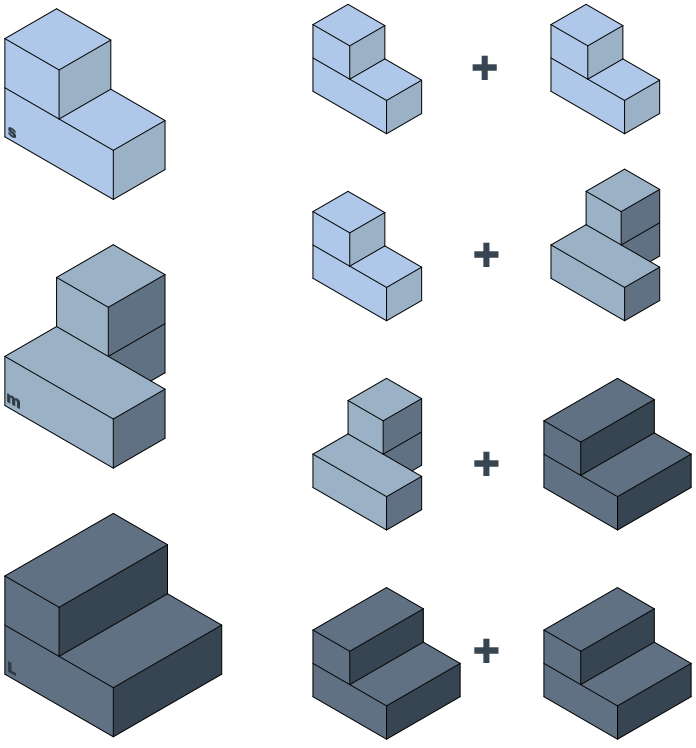
The design simplifies construction and maintenance over time by limiting additional material finishes and exposing the concrete structure. The minimal finishing of the concrete framework reduces construction costs while supporting an efficient building process. This approach contributes to offering affordable makerspaces.

Environmental impact

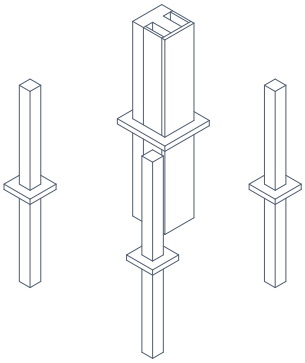
In order to evaluate the environmental impact of each framework, the total volume of concrete is calculated and expected to be approximately 890m3. Using conventional concrete results in a substantial CO2 emission of 238 ton. By integrating recycled concrete and pozzolanic aggregates, a 42% reduction results in a CO2 emission of 100 ton. This reduction supports the project's argument that concrete's environmental impact can be mitigated when used selectively.



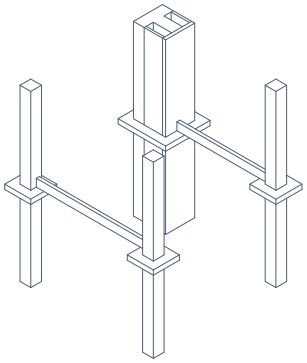
22
Support-infill
own work



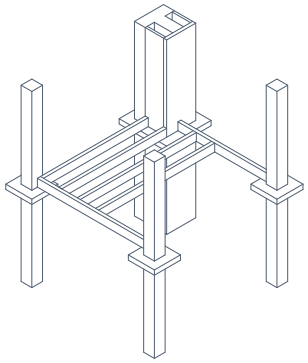
23
The infill typologies
own work



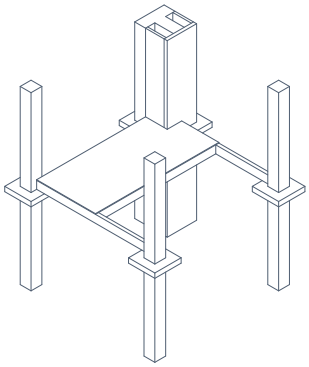
1. concrete construction



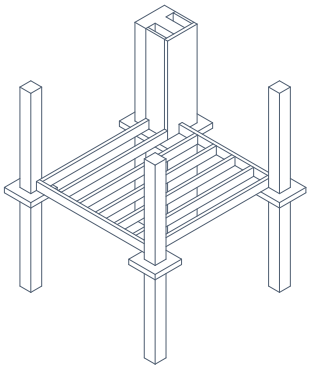
2. timber beams



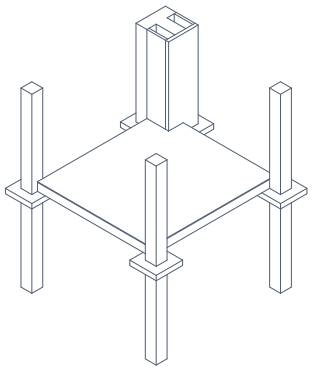
3. timber frame



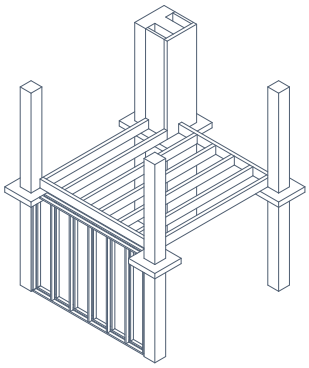
4. OSB



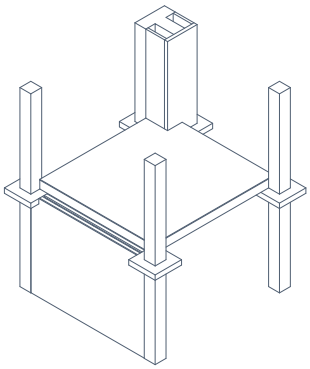
5. (expansion)



6. (expansion)



7. timber wall frame

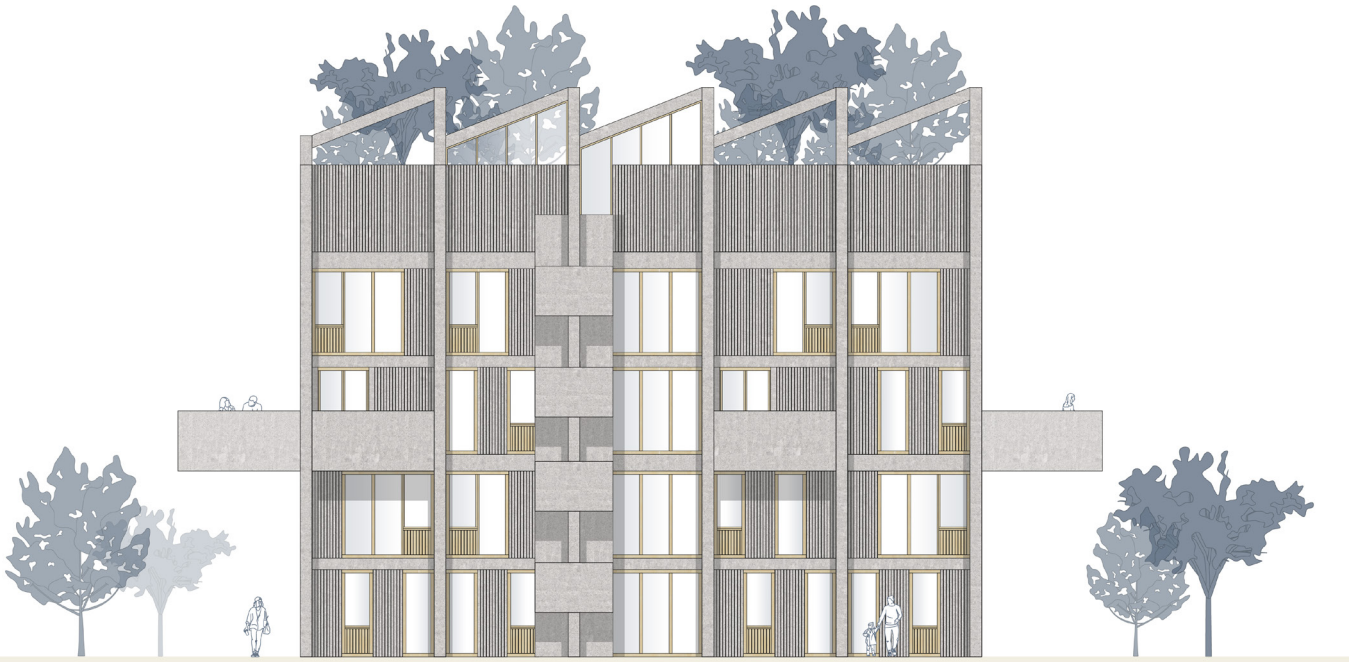


8.drywall

24
The construction principles
own work

Conclusion

Together, these design strategies establish a long-lasting, adaptable framework in which working and living coexist over time. The project therefore shifts from mono-functional housing toward a resilient framework capable of responding to changing domestic, productive and social needs while supporting social interaction and the local economy.



25
East elevation - design
own work

26
South elevation - design
own work

27
North elevation - design
own work

Impressions

28
entrance
own work

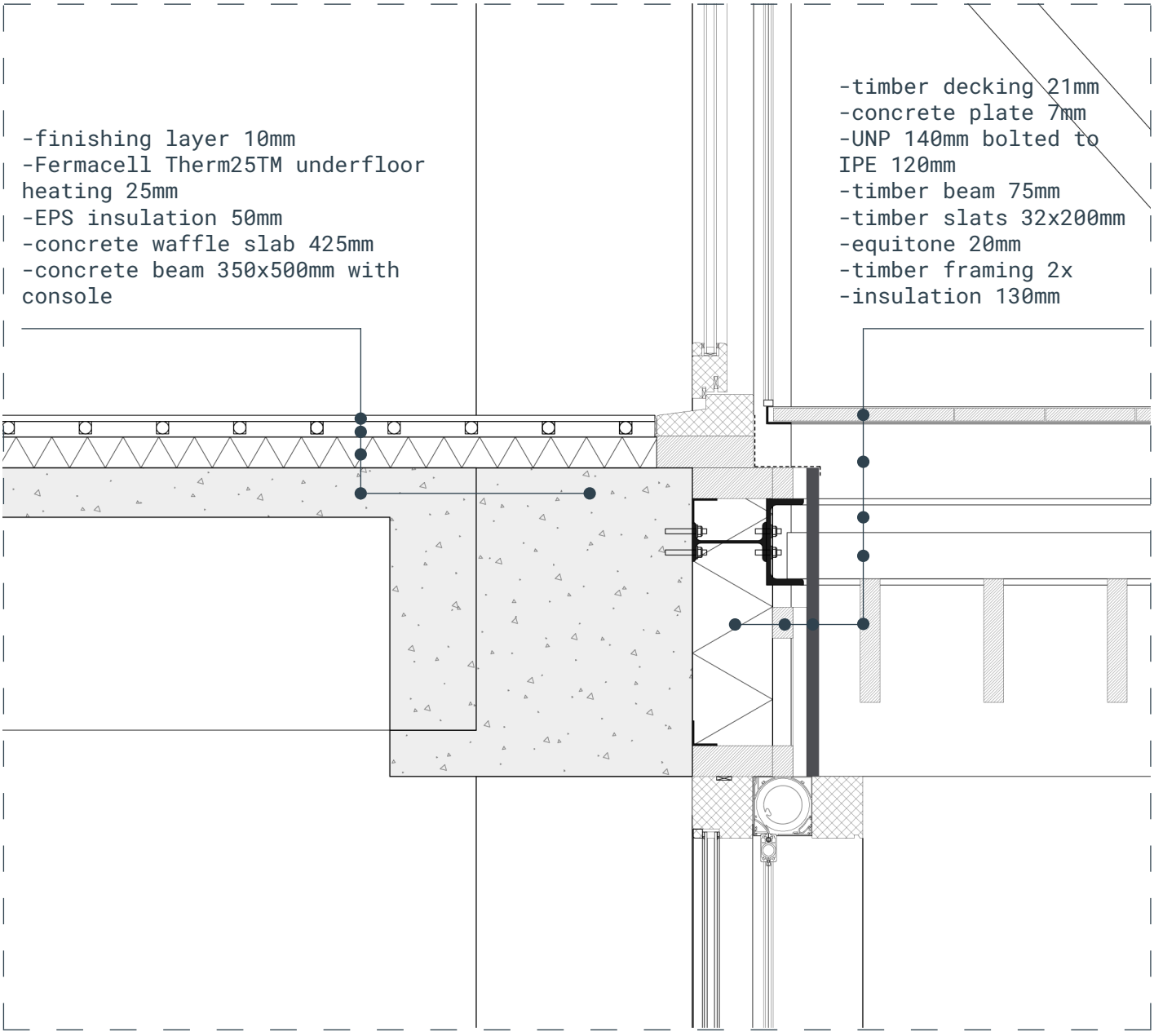
29
(art) gallery
own work

30
workhome - living unit
own work

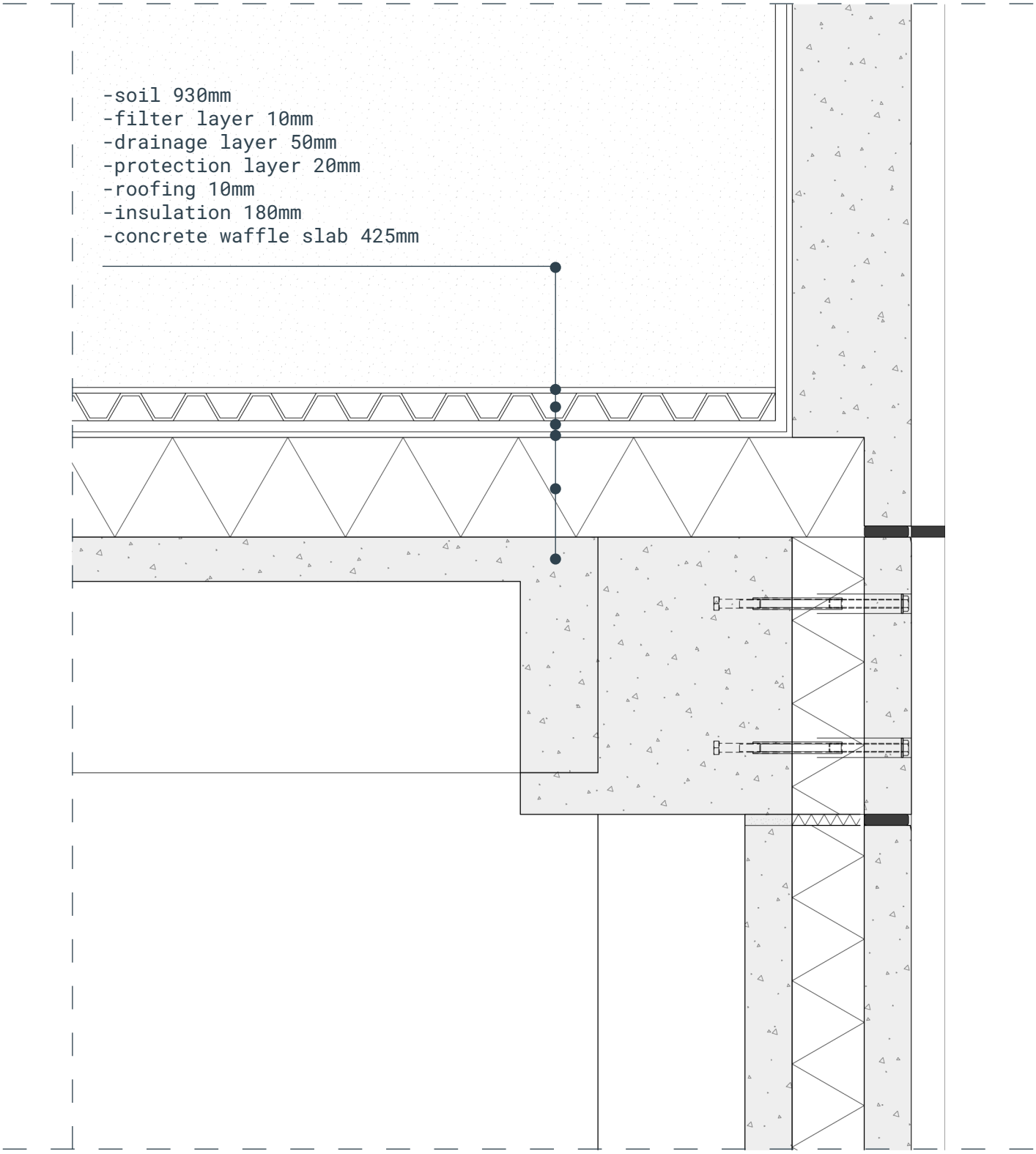
31
workhome - working unit
own work

32
roof terrace
own work

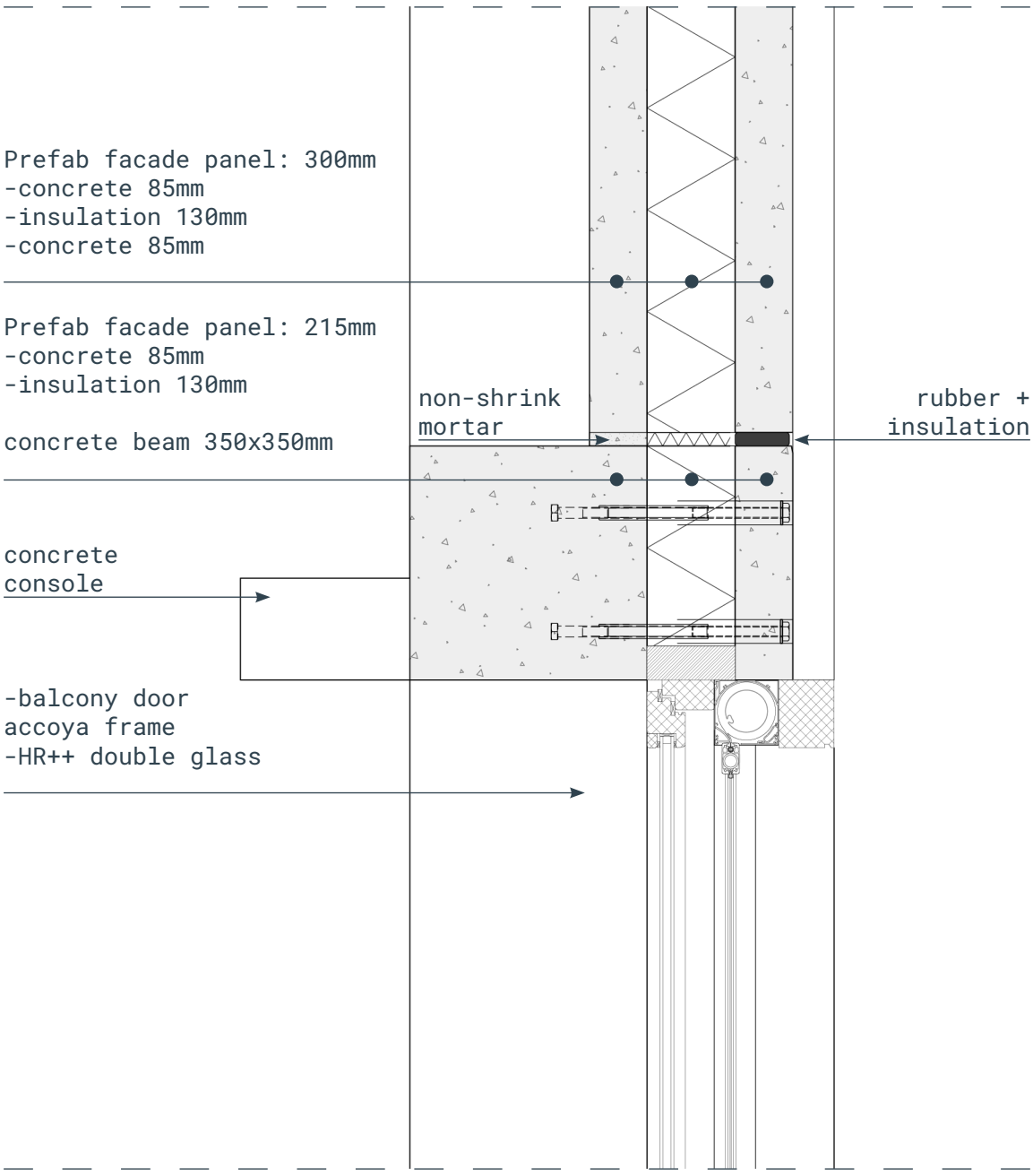
DETAIL A
V - balcony
1:10



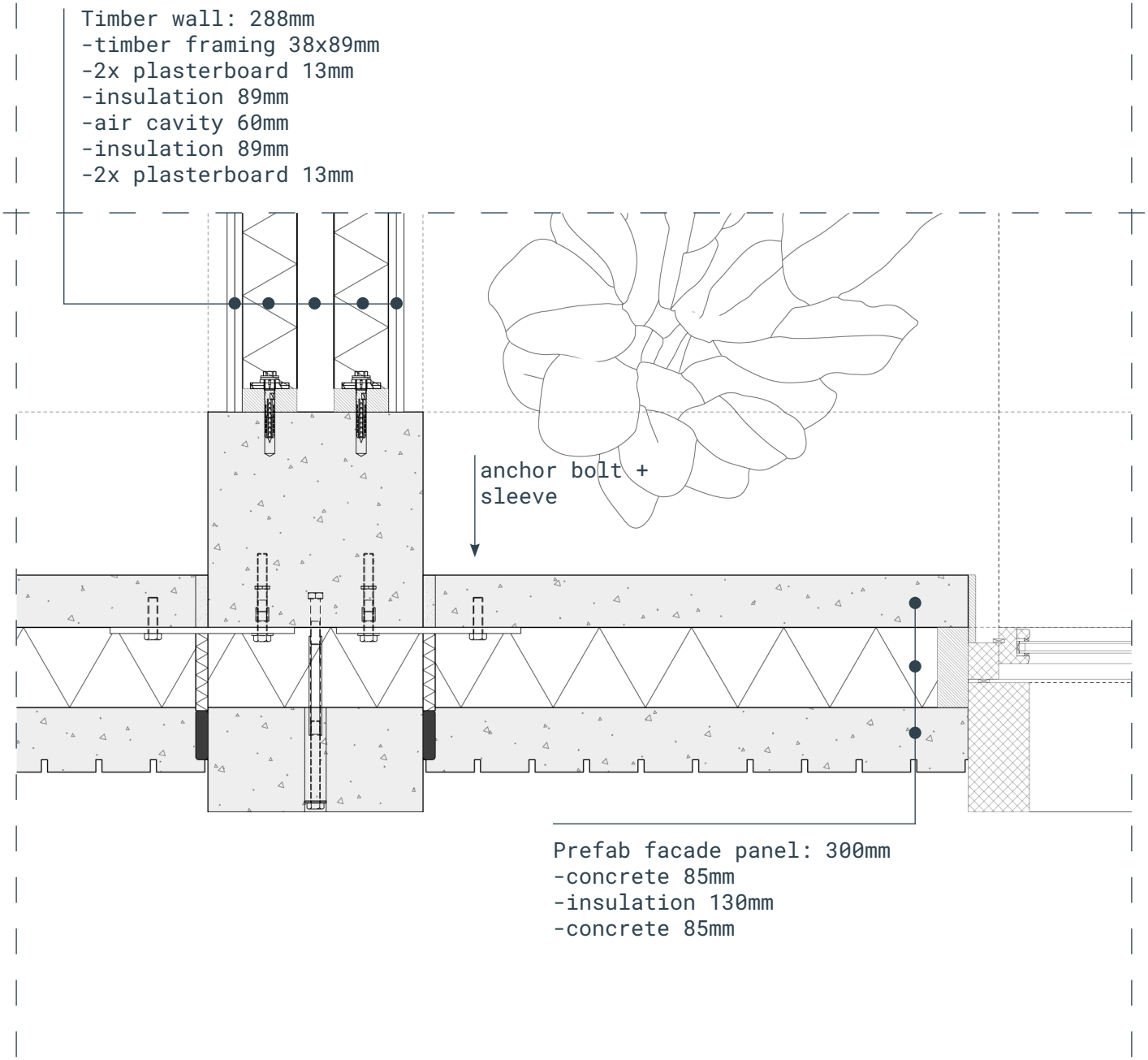
DETAIL B
V - roof
1:10



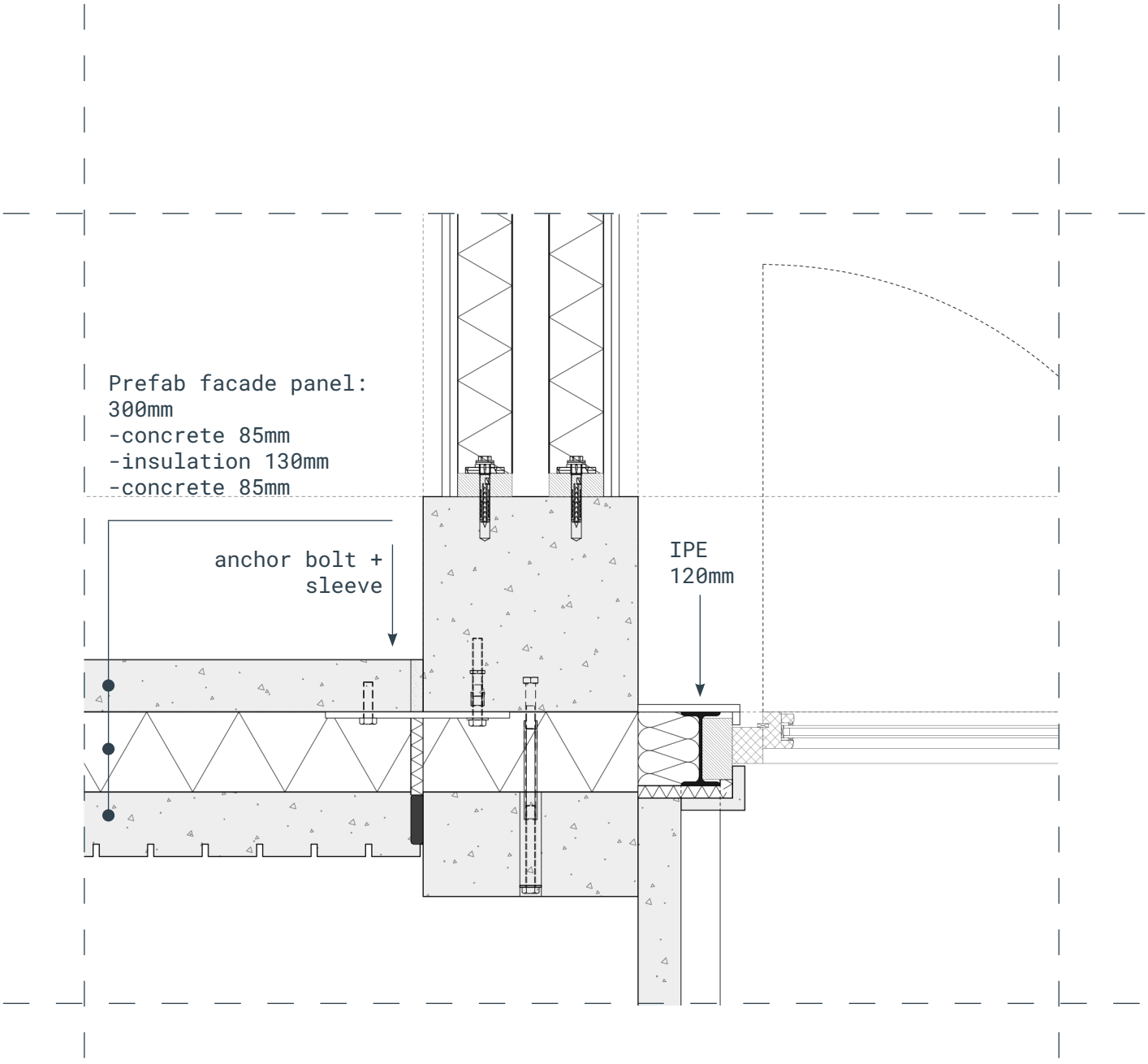
DETAIL C
V - window
1:10



DETAIL D
H - prefab facade
1:10



DETAIL E
H - balcony
1:10



05

conclusion & discussion

5.1 Conclusion

This thesis investigated how concrete can function as a sustainable structural framework for affordable live-work typologies aimed at supporting small-scale production in the Spaanse Polder. Through a combination of literature studies, precedent analysis and research by design the research argues that concrete can contribute to long-term sustainability when applied selectively as a durable support structure within adaptable live-work frameworks.

The sustainability of longevity

The research explored how architectural concrete can be applied as a sustainable and long-lasting structural material that enables adaptability and reuse over time. Although concrete is associated with high carbon emissions, the environmental impact of architectural concrete can be reduced by implementing material innovations like the use of recycled and pozzolanic aggregates. Based on the estimated structural volume, a substantial CO2 reduction of 42% could be achieved when partly replacing cement with innovative binders.

Despite this reduction, concrete is not positioned as a universal sustainable material. Within this project, concrete is approached as a strategic long-lasting adaptable system which may reduce demolition and material consumption. Low-carbon concrete still maintains the same structural properties as conventional concrete, enabling a structural framework which provides a high load-bearing capacity. Within this framework, timber infill elements allow for adaptable configurations. With a potential lifespan of up to 200 years, the framework can support multiple cycles of reuse and transformation without structural demolition.

Designing for creative makers' needs

The spatial and functional requirements of creative makers for combining living and small scale production is analysed through Holliss' research on the workhome typologies. The target group of creative makers; including artists, craftsmen and professionals benefit from a work-dominated workhome when spatial seperation and flexibility are thoughtfully integrated. Design considerations as flexibility, public-private interaction, visibility, acoustics and pollutant control make the live-adjacent typology suitable within the proposed framework. The north-south orientation stimulates public interaction within the buffer zone and allows the relationship between working and living to coexist.

The minimal finishing of the concrete framework lowers construction costs while allowing users to adapt their spaces over time, stimulating personalisation. This approach supports affordability.

Social inclusion

The framework contributes to the broader transformation of the Spaanse Polder to a productive urban network. Therefore, the framework contributes to both the urban and architectural scale. By integrating affordable and adaptable live-work typologies, the project challenges mono-functional housing, currently dominant in many urban environments.

Creative makers are a group pressured and disadvantaged in the current housing market. The framework creates spaces for creative makers, integrating small-scale production within urban environments supporting social interaction, the local economy and urban resilience.

Most importantly, this thesis argues that sustainability should not only be improved through short-term carbon reductions. Architectural concrete's longevity and ability to adapt, supports long-term sustainability, providing multiple programmatic lifecycles within one structure.

5.2 Implications

Reframing concrete

The project challenges the ongoing tension in architectural sustainability between short-term carbon reduction (low-carbon and bio-based materials) and long-term durability (concrete). The goal is not to frame concrete as a universal sustainable material, but to encourage a nuanced understanding of its valuable role as a strategic choice for permanent support structures. An honest story about concrete acknowledges its high carbon emissions while emphasizing a potential lifespan of up to 200 years. By implementing material innovations, demolition and material consumption is reduced. This shifts the focus from a negative environmental impact to a broader perspective of long-term sustainability.

Support-infill model

The integration of Habraken's support-infill theory for live-work environments critiques the Dutch housing culture, characterized by mono-functional housing and architectural homogeneity. The project demonstrates how the approach of combining a permanent support structure with an adaptable infill can accommodate multiple lifecycles within a single structure. This framework offers a blueprint for stepping away from mass housing toward resilient systems that can evolve alongside changing social and economic needs.

Urban productivity

The proposed framework acts as an urban connector, reintegrating manufacturing into domestic urban environments rather than isolating it at the city's edges. This framework is significant as it offers a blueprint for densification that can be introduced in other (post)industrial areas dealing with housing shortages. Architecture can support the development of productive urban networks by designing for creative makers, a group often disadvantaged from the housing market. Balancing public and private interaction while making production visible through public-facing spaces, architects can enhance local economies, urban resilience and social inclusion.

5.3 Reflection

The methodology of the thesis followed an iterative, multi-scalar approach continuously moving between the urban and architectural scale. This approach was essential to the project, emphasizing how the framework responds both to the urban fabric of the Spaanse Polder and to the spatial needs of creative makers. One of the main challenges throughout the process was designing a framework that responded specifically to the site while functioning as a transferable strategy for other industrial transformations.

Research by design therefore became the main method for testing how a structural grid could support live-work typologies and change over time. Throughout the process, I tested how diversity and flexibility could emerge within a strict structural grid without introducing unwanted complexity. Further testing through (physical)models could have proposed more diversity and spatial variation.

Another challenge was to balance affordability, adaptability and architectural quality. The ambition to rethink concrete as a long-lasting support structure required moving beyond the idea of creating a rational concrete framework, towards an architectural design capable of maintaining social value over time. Concrete is often associated with a brutalist appearance. I therefore gradually introduced timber elements to create a warmer and more welcoming architectural identity.

Critically speaking, more extensive research into contemporary concrete and material innovations could have strengthened the environmental argument further. Nevertheless, the project addresses the broader tension surrounding the use of concrete in contemporary architecture, arguing that the support-infill model can contribute to long-lasting sustainable environments.

06
references

References

ArchiHis. (2021, 17 december). Atelierwoningen Zomerdijkstraat. ArchiHis. https://archihis.blog/2021/05/04/atelierwoningen-zomerdijkstraat/

Centraal Bureau voor de Statistiek. (2025b, maart 31). Monitor Kunstenaars en andere werkenden met een creatief beroep, editie 2025. Centraal Bureau Voor de Statistiek. https://www.cbs.nl/nl-nl/longread/aanvullende-statistische-diensten/2025/monitor-kunstenaars-en-andere-werkenden-met-een-creatief-beroep-editie-2025

Croxford, B., Domenech, T., Hausleitner, B., Hill, A. V., Meyer, H., Orban, A., Sanz, V. M., Vanin, F., & Warden, J. (2020). FOUNDRIES OF THE FUTURE: A Guide for 21st Century Cities of Making. In TU Delft Bouwkunde eBooks. https://doi.org/10.47982/bookrxiv.9

Czischke, D., Van Bortel, G., Hackauf, U., Jürgenhake, B., Konstantinou, T., Mooij, H., & Newton, C. (2025). Veerkrachtige Wijken in Nederland: Een op wetenschappelijk onderzoek gebaseerde handreiking voor actie.

Duurzame bindmiddelen voor milieuvriendelijk beton | Betonhuis. (z.d.). Betonhuis. https://betonhuis.nl/betonhuis/duurzame-bindmiddelen-voor-milieuvriendelijk-beton#:~:text=Puzzolanen%20worden%20vaak%20gebruikt%20als,verharding%20in%20aanwezigheid%20van%20water.

Habraken, N. J. (1985). De dragers en de mensen: het einde van de massawoningbouw.

Holliss, F. (z.d.). Huis werk stad.

International Architecture Biennale Rotterdam. (2016). IABR–2016–Atelier Rotterdam: The productive city. International Architecture Biennale Rotterdam.

Klijn, O., Guis, R., & TU Delft Faculty of Architecture and the Built Environment. (2025). Advanced housing design.

Leupen, B., & Heijne, W. (Eds.). (2018). DASH 15: Home work city. nai010 publishers.

Marc Koehler Associates. (2025, 14 mei). Superlofts Houthavens, giving 70 families personal freedom, views and community | Marc Koehler Associates. https://marckoehler.com/project/superlofts-houthavens/

Ministerie van Algemene Zaken. (2023, 24 juli). 900.000 nieuwe woningen om aan groeiende vraag te voldoen. Volkshuisvesting | Rijksoverheid.nl. https://www.rijksoverheid.nl/onderwerpen/volkshuisvesting/nieuwe-woningen

Open building. (z.d.). Open Building. https://www.openbuilding.co/

Roman concrete. (n.d.). Ancient Engineering Technologies. https://ancientengrtech.wisc.edu/roman-concrete/

Superlofts. (2025, 31 oktober). Superlofts. Superlofts. https://superlofts.co/

Surahyo, A. & IBI Group. (2019). Concrete construction: practical problems and solutions (Door Oxford University Press). https://www.rexresearch1.com/ConcreteManufacture2Library/ConcreteConstructionPracticalProblemsSolutionsSurahyo.pdf

References

ZUS [Zones Urbaines Sensibles], Flux, Sweco, & Urbanism, D. (z.d.). REDESIGNING DELTA NATIONAL PRODUCTIVE PARK DELFTLAND.

United Nations. (2016). Leaving no one behind: the imperative of inclusive development. https://www.un.org/esa/socdev/rwss/2016/full-report.pdf

07
appendices

VI. DATA MANAGEMENT CHECKLIST

Instruction

This checklist is relevant for all graduation projects of the Master AUBS. The form is intended to highlight common aspects of graduation projects that require particular attention with regard to planning the research and data management. Relevant information and supplementary sources regarding each question are provided below each question.

With this checklist, the faculty wants to avoid that students unexpectedly find themselves in complex and stressful situations, in which ethical or privacy matters and/or other laws and regulations become an issue. In projects involving humans, certain types of data processing increase the risks to the human participants: planning such projects requires additional evaluations and advice from university staff before ethical approval can be received and the project can begin. In the case of a graduation project, obtaining additional advice or permits may delay the project with an extra education period or semester. To avoid this, it is recommended that students set up a graduation project with a low level of risk. Therefore, all students have to check their risk, by completing this checklist before their A1.

The first section of the checklist (A) should be completed by all students, together with their supervisor, during the planning of the graduation project, before the A1. It does not need to be submitted to anyone for review or approval. Please consider questions 1 to 3 carefully in relation to the intended graduation project, and answer with 'yes' or 'no'.

The second section of the checklist (B) should only be completed if the graduation project involves working with data from human participants. In that case, the student and their supervisor must apply for and receive ethical approval from the Human Research Ethics Committee (HREC) before the project can begin (see the paragraph 'Explanation and follow-up' after the questions). The student can submit the application to the HREC, but the supervisor is responsible for making sure that the project is compliant with relevant privacy regulations and ethical policies.

Section A. General considerations	yes	no
1. Is the graduation project conducted as part of an internship (at a company), or as part of a research project at TU Delft? If a student's graduation project is conducted at a company or as part of a research project at the university, questions of data ownership and intellectual property rights need to be addressed in a written graduation or internship agreement before the project begins. Student and supervisor should consult the Intellectual Property Rights of Students webpage. Additional information can also be found in the Extended Personal Research Data Workflow. If applicable, complete the Confidentiality Agreement.		x
2. Does the project involve conducting (part of) the research outside the Netherlands? Students who intend to travel abroad (even to other EU countries) for study, exchange, research, internship, or graduation project purposes need to follow the Travel Safety Protocol. This includes attending a mandatory Travel Safety Training Session: see the Disclaimer.		x
3. Will the research involve processing data from humans, such as running a survey, conducting interviews or workshops, collecting data through social media or internet forums, or re-using existing datasets about humans provided by a third party? (If 'yes', see follow-up questions 4 to 13 in Checklist B.) Students who work with data from human participants must complete the next section and apply for and receive ethical approval from the Human Research Ethics Committee (HREC) before conducting the research.		x