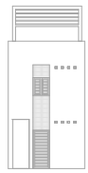

# The Dual Home:

## Creating Spaces for Living and Work in Ahmedabad

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GLOBAL HOUSING

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# The Dual Home:

Creating Spaces for Living and Work in Ahmedabad

This graduation project at Tu Delft represents my interest in how architecture can respond to everyday realities. Rooted in both personal experience and academic research, this research explores the role of dwellings as workspaces. This project is dedicated to to the residents of the Calico Mills, whose everyday practices form the foundation of this research, and my family, whose experiences shaped my perspective and.

**ဖဖေနဲ့မမေ ကျေးဇူးတင်ပါတယ်။**

# ABSTRACT

The urban fabric of Ahmedabad, India has witnessed a drastic structural change following its post-industrial decline. Shifting from salaried factory employment to casual and informal home-based labour. Consequently, environments originally designed for an only single domestic purpose were forced to take in economic activities, resulting in spatial conflation, spatial stress by overcrowding and inescapable visual confrontation with the labour. Addressing this reality, this graduation project researches how housing typologies in the Calico Mills can be designed as a dual use environment that supports home-based work without jeopardizing domestic wellbeing. The project reframes privacy not as a strict barrier but as a transitional zoning system of private, semi-public and shared spaces.

Using a context sensitive, mixed approach, the research utilizes ethnographic fieldwork, multi scalar architectural cataloging and case studies to develop a design proposal. Rejecting complete tabula rasa redevelopment, the project adopts site specific interventions to preserve existing urban familiarity and daily routines.

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# READING GUIDE

This book is structured into four parts to guide the reader from observation and problem context to the final design project.

Part 1 – Introduction
This chapter introduces the research topic, the problem statement, the objective and the motivation behind the research. Furthermore, it represents the questions for its research, the scope and explains the relevance of this research.

Part 2 – Theoretical framework and Methodology
The theoretical framework in this chapter will discuss relevant literature and theories about the project's subject matter. Additionally the methodology further explains the research approach, data collections methods and analysis techniques that will be used in this research.

Part 3 – Research and Design
This chapter documents the findings of the research. Data is analyzed and visualized into a design for this project where relevant. It will translate the findings into the design exploration of the project.

Part 4 – Conclusion
The last part will conclude the answers to the research questions and show how the outcome of the research is translated into the final design of the project. Lastly, it will reflect to the whole process of graduation how the methods, techniques and research have led up to the design and eventually also reflect to the final design.

Appendices
Additional materials, such as unused drawings that were part of the progress are included in the appendix and the bibliography with used literature and images.

Figure 1: Shop, P. Aung

# INTRODUCTION

Representing 7.9 percent of global employment (International Labour Organization [ILO], 2020), around 260 million all over the world there are women and men who work and produces for a wide range of industries within their own home for products that eventually you and I come to use. Most of them remain unaccounted and undercounted, hidden from public vier as an effect of their location in private spaces or misinterpretation of their worker status as leisure rather than work (Chen et al., 2014; ILO, 2020). The Indian National Sample Surveys define home-based workers as those operating within their own household enterprises. Home-based workers are also understood as who carry out work in their home or premises. Some are self-employed, others are dependent on enterprises. Despite contributing to production in basically all sectors of economy through centuries, homebased workers have remained unrecognized and undervalued.

Like in India, ''The Indian labour market is marked with massive informality…" (Samantroy, 2019,p. 2). Many Indians, particularly women are predominantly engaged in the informal sector through casual employment, piece rated work or other forms of home-based work. Engaged in a variety of occupations, homebased workers produce goods and services for the existing market from within or around their own home. Because of the informality of their work, they remain outside the sight of social protection and are often exploited and guaranteed no social security benefits.

Many of these homebased workers are women, studies pointed out that the engagement of women may be disadvantageous for them, as ''women is home centred roles are socially segregated into units defined by men in the family." (Ellina Samantroy, 2019,p. 3). The work remains invisible, unrecorded and treated as a 'free good" where her wages are supplementary to her husbands.

Home-based workers also face numerous challenges due to the usage of their home as workplace, including inadequate housing, sanitation and lack of basic amenities. This overlap between living and working can lead to occupational health hazards and risks. Historically, these workers were first involved in with labour intense sectors like manufacturing textile and leather or seasonal work like processing agricultural products. Nowadays it has extended to manufacturing machine parts, packaging, selling goods and services in both rural and urban areas (Chen, Madhav, & Kamala, 2014).

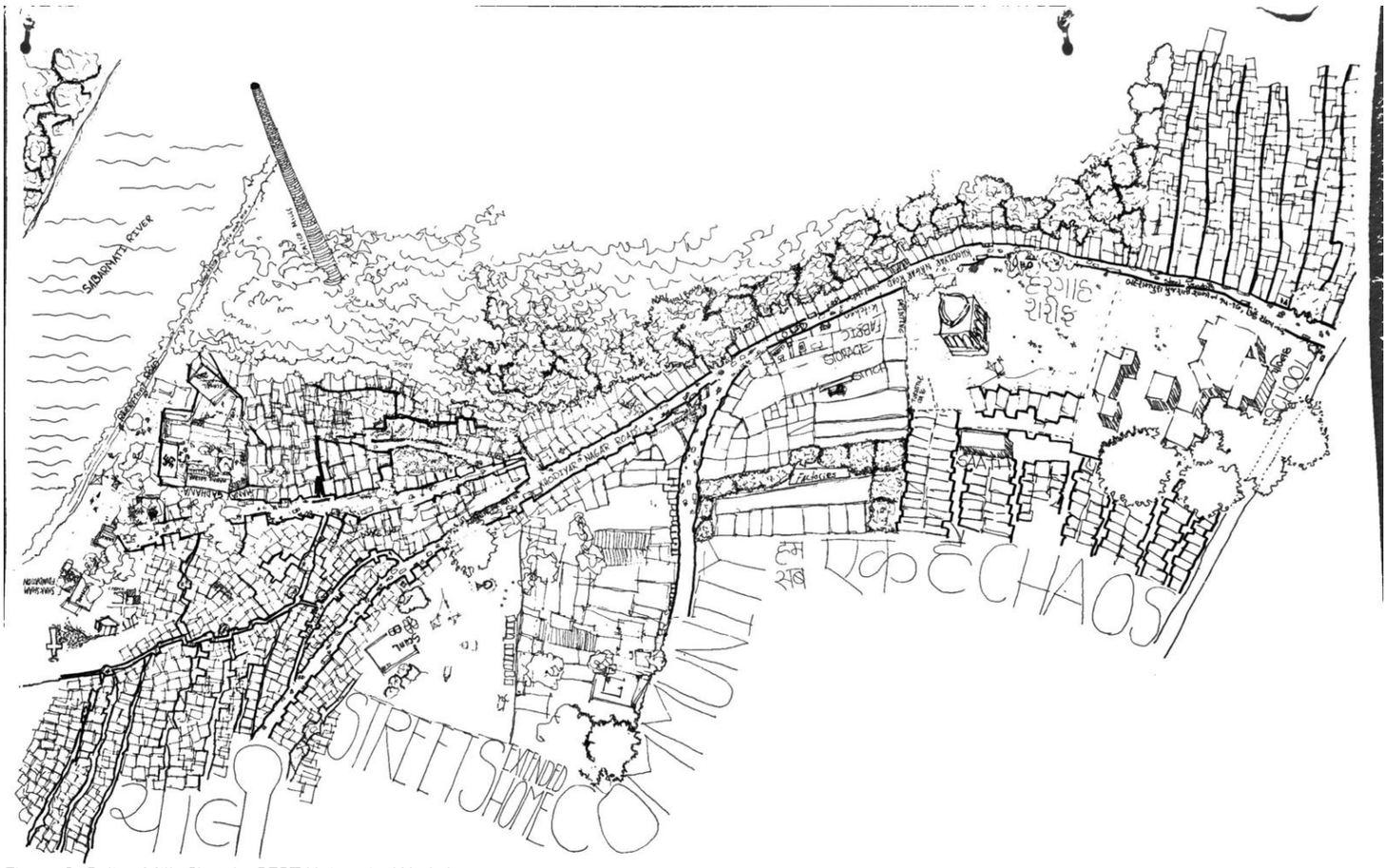


Figure 2: Calico Mills Sketch, CEPT University Workshop

Since the 15th century the city of Ahmadabad developed itself as a major industrial centre based on cotton textile industry during the British colonial rule. Owning to its popular textile industry Ahmedabad became famous as the 'Manchester of India' (Biwas, 2020). Because of the city's position to the coastal shored aided the export of the cotton products and the region's black soil was a advantage in cotton plantation.

Calico is one of India's oldest fabrics, traditionally a plain white or unbleached fabric made of cotton threads. Due to the increasing popularity of calico fabric in Western markets, The Calico Textile Mills was established in 1880 by the Sarabhai family. Workers employed at the mills migrated from across the Gujarat state and were housed in employee housing mill's terrain, gradually housing expanded further over the terrain creating settlements around the mill (Karnavati University, 2020).

With the decline of the cotton industry by various reasons like liberalized imports and more competition, eventually costs closure of the mill in 1998. Employment in the area encountered a major change. Salaried factory jobs were replaced by casual labour, informal work and self-employment (Awaya & Tomozawa, 2023). As a result, many homes in the neighbourhood began to function both as residential spaces and space for home-based economic activities.

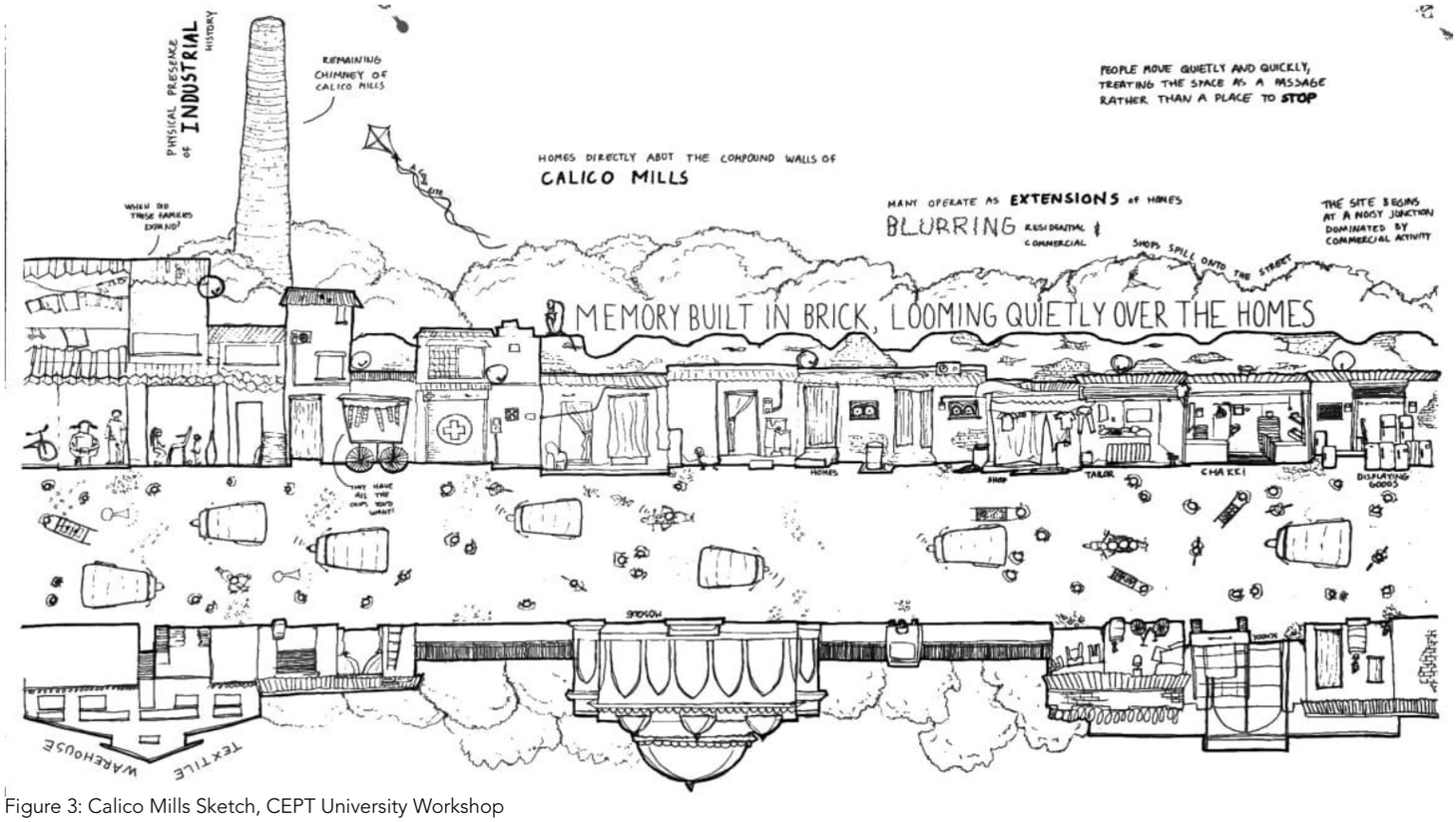


Figure 3: Calico Mills Sketch, CEPT University Workshop

During the visits to the Calico Mill, I was able to observe and get a better understanding of how the people of calico live and occupy their surroundings. The calico mills is a neighbourhood of 19,5 hectares with approximately 27143 buildings along side the Sabarmati river. While visiting, walked different routes through the neighbourhood at different times of the day. By doing this its helped me see how the area changed during the day. Together with other students, we were warmly welcomed by the residents. This allowed me to get a closer look at how they lived and their daily life.

Noticeable differences could be notice during the day. In the morning there is a rush, an active street with people going to work and children rushing to school by walking or hailing a rickshaw. Later it becomes slower and calm, fewer people on the street shopkeepers slowly opening up their shops and getting ready for their day, later in the day there is another moment of rush. This was during the time children are coming back from school and returning home. Unfortunately, I was not able to stay until the night fell, but from what I heard from the residents at night it is not busy.

The house did not stop at the front door but continues further into the street. People sit, sleep, work and socialize outside, making the boundary between public and private more unclear. While there is always work happening in the neighbourhood besides in the factories, workshops or stores, many people work from their homes. Often you see people working inside or at the thresholds of their houses, with their doors open for ventilation but also to stay connected with what happening outside their premises. When talking to residents, I noticed that many used the same room for both living and working. Many of these houses, the working part takes over most of the room if not the whole house.

## Home serves dual purposes

*In many low income household mostly women and elderly people work form home*

**Residential**

**Business**

## Individuals adapt their homes to accommodate work activities

*Limited access to commercial spaces and not enough space in their own houses*

## Compromised privacy and personal spaces

*Because of compromisation their is a vague line between work and private life within the house*

Figure 4: Problem Statement

# PROBLEM STATEMENT

Domestic workspaces, ranges from small tailoring jobs, food preparation for street vendors to butchers. These kinds of adaptations often results to overcrowded and cluttered surroundings. Negatively affecting the quality of life. The overlap between residential and commercial functions results in reduced privacy, as personal spaces are jeopardized by work-related activities. As work slowly takes over the whole house. The impact is especially more pronounced during the night, when many prepare for the following day, whether it be cooking food for sale or storing goods furthering limited spatial capacity and noise pollution. Blurring the boundaries between rest, family life and economic survival.

# RESEARCH QUESTION

With home-based working not disappearing anytime soon and many people continue to live in environments that do not support a better distinction between working and living. Highlight the need to explore housing models that can accommodate both functions, offering as spatial and conceptual strategy to make a differentiation between them within the house. Rather than approaching this research with a blank canvas, this research emphasizes the importance of working with the existing fabric. Building on the current spatial situation, allows residents to maintain their familiar routing and daily routines. In this context, the research explores how a system can be created that both respects the existing situation and enables a more effective distinction or buffer between working and living.

To investigate this housing approach the following question will be answered.

## Research Question:

*"How can a low-cost housing design create a spatial mediate between domestic life and home-based work, allowing for flexible spatial use to balance economic productivity with domestic privacy and social life?"*

## Subquestions:

*1. How are domestic and work activities currently arranged within and around the dwellings in the Calico Mills?*

*2. What spatial elements are used for privacy between living, working and socializing?*

*3. How do these mixed-use homes affect the neighborhood in terms of safety, noise, and the public perception of the area during the day and night?*

*4. How can shared infrastructure, like shared spaces relieve spatial pressure by externalizing the fixed spatial footprints of home-based work?*

Figure 5: Women at Threshold, P. Aung

# RELEVANCE

While Income generation is a topic inevitable when researching about lower income households, less attention has been paid to how this affects at the scale of the home. The study addresses spatial consequences that were faced after the post-industrial transformation in the Calico Mills, where more people from the surroundings shifted over to informal employment within their houses.
The increasing overlap between living and working spaces represents the serious challenges related to overcrowding and privacy. Housing originally designed for single purpose residential is now required to accommodate economic activities too, often without any spatial modification. Breman (2016) highlighted in his book 'At work in the informal economy of India', how informal labour in Indian cities is closely tied to the domestic environments. The interwoven practices shapes in ways that conventional planning and architectural design often overlook. These places put pressure on already limited housing resources and lead to environments that compromises both wellbeing and architectural performances. Informality is not simply a aftermath of poverty but actively shapes everyday life, urging design approaches that engage directly with labour and lived practiced rather than treating them as a secondary matter (Breman, 2016). Addressing these issues is urgent as informal and home-based work continues to exist and is not disappearing anytime soon. By improving spatial quality, privacy and habitability, it can demonstrate how architecture can support and be a mediator of the livelihoods of residents.

Figure 6: People on the street, P. Aung

# OBJECTIVE AND MOTIVATION

The topic of income generation and home-based workers sparked my interest because it plays a vital role in the lives of many lower income families and directly influences their usage of space within their house. Although I have frown up in The Netherlands, my family roots are in Myanmar, where all my relatives still live. Coming from a farmer's family, in which several members diversified their livelihoods beyond agricultural work. I have observed firsthand how homes are used not only for living but also for economic activities. Houses consisting of no more than two or three rooms used for business purposes, as convenience stores, small eateries, place for sewing and even the storing and selling of coconuts in large quantities. All these activities took place in, under and around the house, while everyday live went on. Visitors who stopped by, costumers purchasing their necessities and trucks arrived to collect or deliver goods all within the same spatial setting. The house functioned as a constantly evolving environment, where living working and social interaction coexisted.

This same concept of home-based workers and the use of the house as economic space do not differ may this be in Billin, Myanmar or Ahmedabad, India. In the Indian context, income generation and home-based work share similar characteristics, the house is simultaneously used for domestic activities and economic activities. Because of the dual usage of the house and continuous flow of people entering the house, the division of private (family life) and open (commercial life) becomes blurred. Question arises where work ends and private life begins?

Creating a separate space is often not possible, because of spatial limitations, leaving residents no choice but to adapt their house to accommodate their economic activities. Yet at the same time having the house open and welcoming enough to for costumers, visitors and small talk.

An important observation is that household and commercial activities do not stop at the front door but extend further to the streets. Sitting at threshold, selling goods outside the house or tailing the salesman to your house to purchase something. These spatial practices are frequently overlooked at conventional housing design, despite being central to the everyday lives who they design these housings for.

For this reason, my objective is to design housing typologies that enables the residents of the Calico Mills to easily combine their dual usage of the house more effectively, while creating strategies allowing for a clearer distinction between work and private life within the existing situation. The architectural ambition is not to enforce a rigid separation, but a transition between private, work and shared spaces. Where privacy is achieved by spatial layering rather than physical harsh barriers, maintaining the socials dynamic with the street while protecting domestic life.

Ultimately, demonstrating how architecture can support and be a mediator of the livelihoods of resident between living and working, acknowledging the informal economic realities without resorting to large-scale redevelopment. Instead, working with existing conditions, preserving the warmth and dynamic social atmosphere that currently define the neighbourhood.

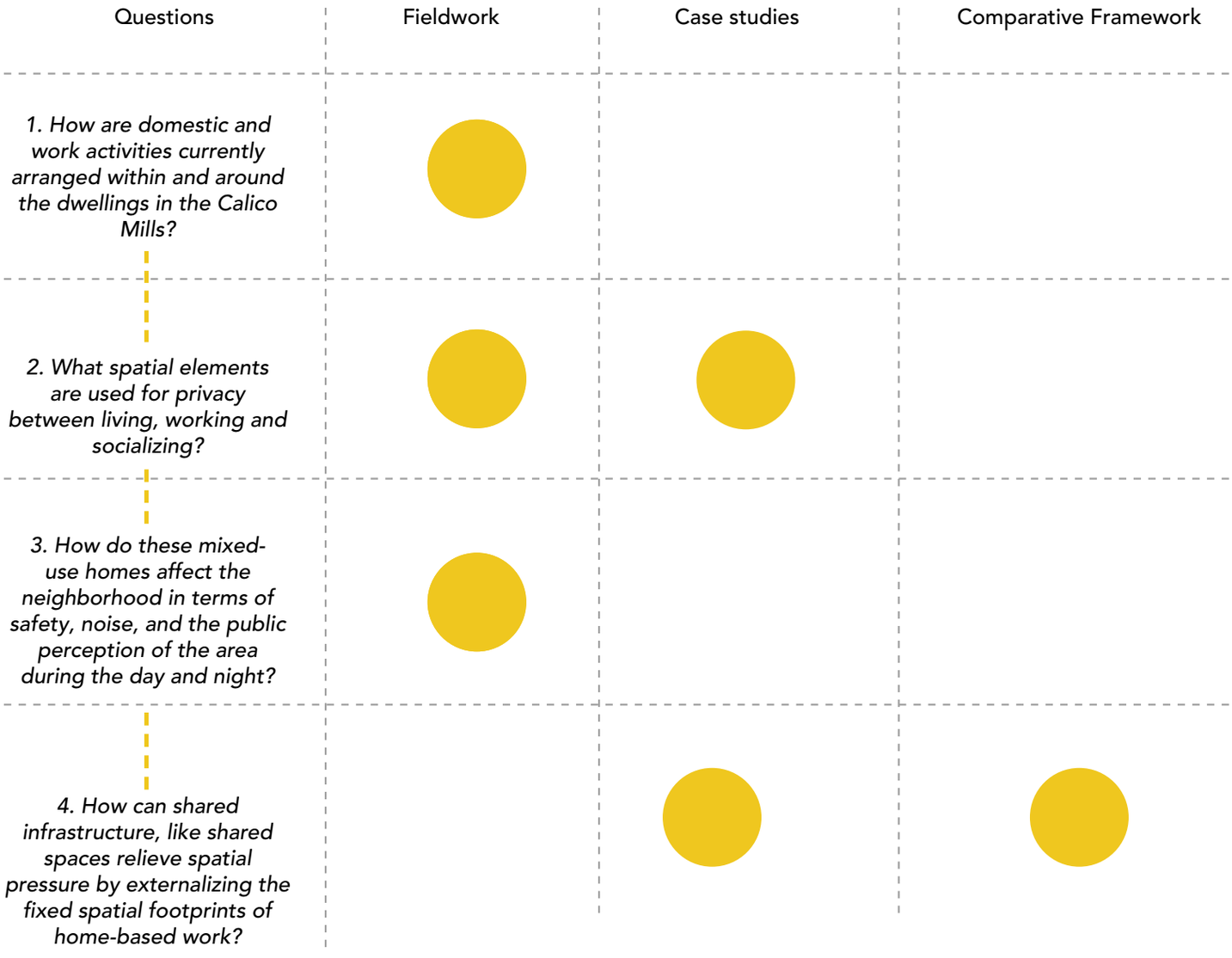
Figure 7: People on the street, P. Aung

# SCOPE

The project as mentioned before is situated in the Calico Mill neighbourhood of Ahmedabad, a former textile mill area. The scope of the project focuses on the settlements surrounding the former Calico Textile Mills, where former mill workers have settled after the closure of the mill. Going from salaried work to self employment and informal works, adapting their houses to accommodate these economic activities.

In this program the focus is relies on building with the existing situation by creating a system that enables a more effective coexisting of working and living within a dwelling. The challenge lies in the integration of transitional spaces, such as the division within the dwelling, thresholds, shared working spaces, the semi-public area and public areas within the existing situation. Spaces that are intended to play the role of an mediator between private and public. The project touches multiple scales, from interior of the dwelling to the relationship of the house and the street, furthering it to shared spaces. The design proposes site specific interventions within the Calico Mills settlements and does not aim for large scale redevelopment as outcome. Instead, the project works withing the existing situation, prioritizing incremental and context sensitive design strategy

# METHODOLOGY




**"How can a low-cost housing design create a spatial mediate between domestic life and home-based work, allowing for flexible spatial use to balance economic productivity with domestic privacy and social life?"**

# METHODS

The methodological approach of this project uses a mixed methods approach, combining quantitative and qualitative methods to develop and present a more accurate understanding of the spatial and social dynamics of the Calico Mill settlement. The approach enables the research to address observable spatial patterns and lived experienced of residents. Furthermore, it focuses in a context sensitive, where it recognizes the settlement that shaped over time by its residents. Rather than treating the site as a tabula rasa, it will build on the existing urban fabric and everyday practices of the residents. This approach enables an exploration into how working and living can be spatially mediated, not only through physical separation but also through small spatial adaption and strategies.

**Fieldwork**
During a two weeks fieldtrip to India, the city of Ahmedabad will serve as the primary site for a contextual analysis. This entails documenting the site through photography, videography, interviews with residents and a NGO with the help of the students of CEPT University, mapping the site and engaging in activities of the winter school given by CEPT University.

**Case studies/ Comparative Framework**
Additionally, a few organisations whose work will be taken as case studies. This includes Prasanna Desai Architects slum rehabilitation in Yerawada, Pune, Bv Doshi's Aranya low-cost housing and Sanjaynagar Slum Redevelopment Project by Community Design Agency. These precedents provide examples of context sensitive design, incrementality and design strategies. It will be analysed at multiple scales: Dwelling, Cluster and Neighbourhood. Each scale will be catalogued based on photos and drawings. This multi scalar analysis will highlight spatial patters and overlaps between private, semi-public and public areas.

# THEORETICAL FRAMEWORK

Architecture is deeply entangled with the economic system it serves. For the Calico Mills in Ahmedabad, this entanglement is rooted in a rich historical timeline from a globally dominant handicraft industry to a colonial factory system and finally to an urban informality. As the textile industry shifted over time from independent artisan production to centralized wage labour and back to scattered production from people's homes. The domestic environment h as become and important place for economic benefits. To understand the Calico mills of today, one must look beyond the static dwelling and view it as a multifunctional environment, where domestic and productive activities share a space that is constantly negotiated though everyday practices.

1.1 The textile trajectory

The textile industry from South Asia has made major contribution to the global economy prior to colonial invasion. South Asia was renowned for producing textiles like muslins, silks and cotton fabrics, which exported widely across Asia, Africa and Europe and employed millions of skilled artisans. The textile production was deeply embedded in local economies and cultural practices. Textile production was highly specialized and gendered, where men where mainly the textile producers and merchant and women spinner, cotton pickers, cleaners and warpers (Wendt, 2009).

However, this prosperity suffered massive decline with the arrival and eventual dominance of European trading companies such as the British East India Company. What began as participation in trade slowly progressed in gaining political control, colonializing and reshaping the economy to serve European industrial interests. In the 19th century the handicraft textile industry experienced a major change because of the rise of machine textile. Independent textile artisan was no longer ubiquitous as they could not compete against factories and moved on to other income sources as agrarian work or wage labourers in the factories (Parthasarathi, 2009).

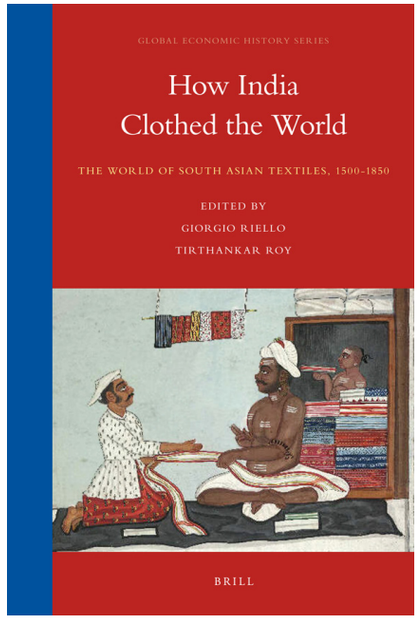



Figure 8: How India clothed the world: The world of South Asian textiles, 1500–1850

Figure 9: Two women ginning cotton; man carding cotton from How India clothed the world: The world of South Asian textiles, 1500–1850

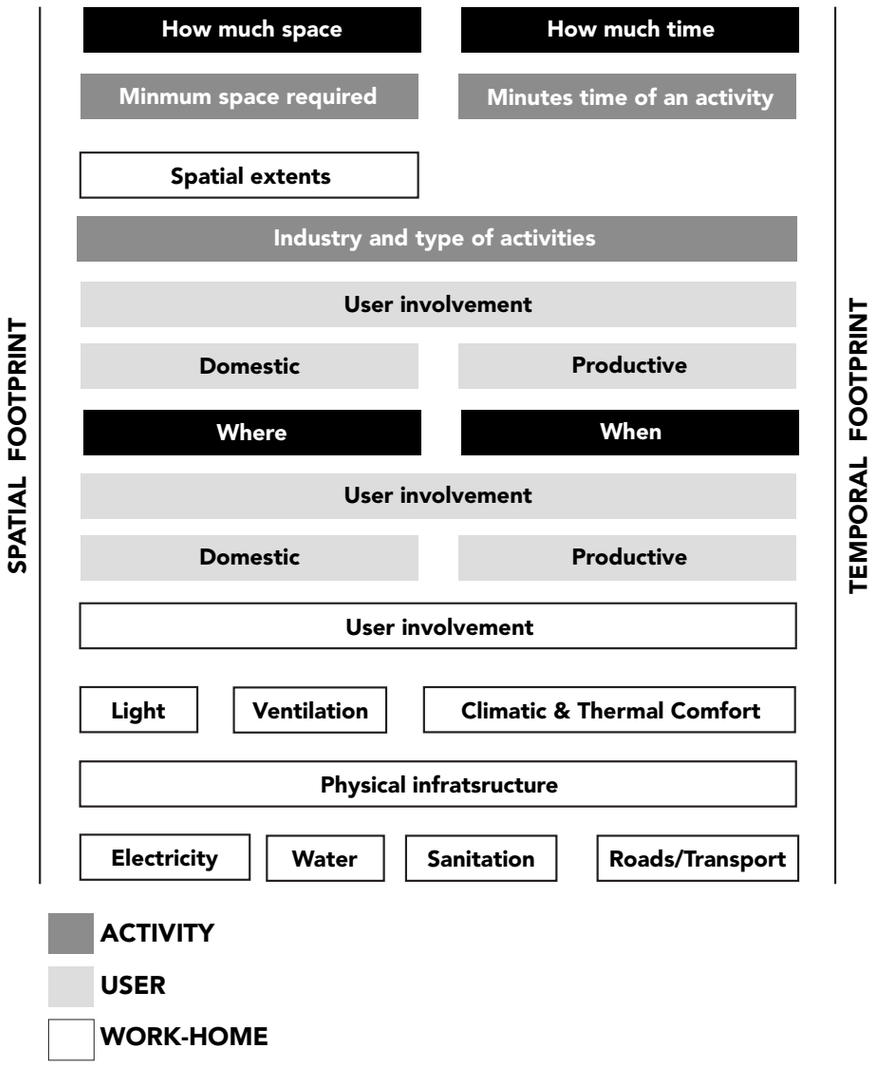



Figure 10: Factors affecting spatial and temporal footprints of activities, from A spatial reading of workhomes

1.2 The theory of the Work-Home
Home as workplace: A spatial reading of work-homes describes spatial footprint as the amount of space the activity occupies, as well the location in the space. Furthermore, it defines 'temporal footprint' as the amount of time the activity requires when performing an acitvity. Like the spatial footprint, temporal can be either fixed or flexible. (Sohane et al., 2021). Activities have different requirements of space, some more flexible than other.

For example, sewing typically requires a sowing machine, this sowing machine often needs electricity and therefore takes up a certain fixed space within the house. In contrast peeling vegetables can be done and placed anywhere and moved easily. Both activities are flexible in temporal footprint but not spatially. Domestic and economic activities therefore may align, overlap or be different to each other, both activities shape each other in the house.

Any activity needs a minimum amount of space whether this is domestic or commercial. Based on ergonomic requirements for an activity, this can be standardized. Most activities can be standardized and altered and combined depending on the limitations of their house. Same goes with the minimum amount of time each activity requires, does it need continuous involvement or not. So requires cooking mostly continuous involvement and sewing can be done more intermittently. An activity that can be done more intermittent is easier to be combined and clubbed with other activities and not only the worker is the user also customers are sometimes the users in the space (Sohane et al., 2021).

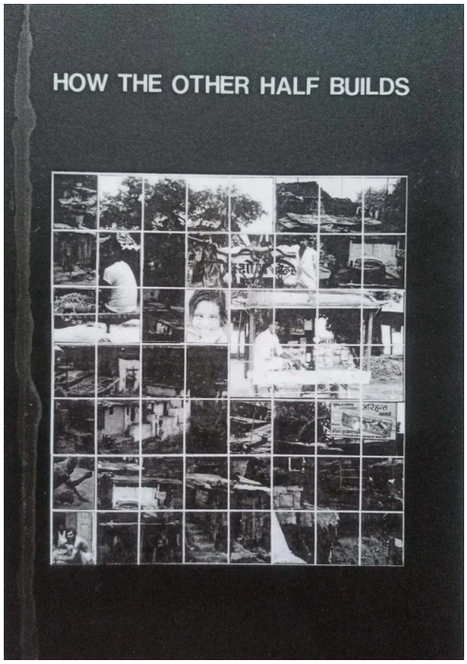



Figure 11: Book cover from HOW THE OTHER HALF BUILDS

1.3 Space over Permanence

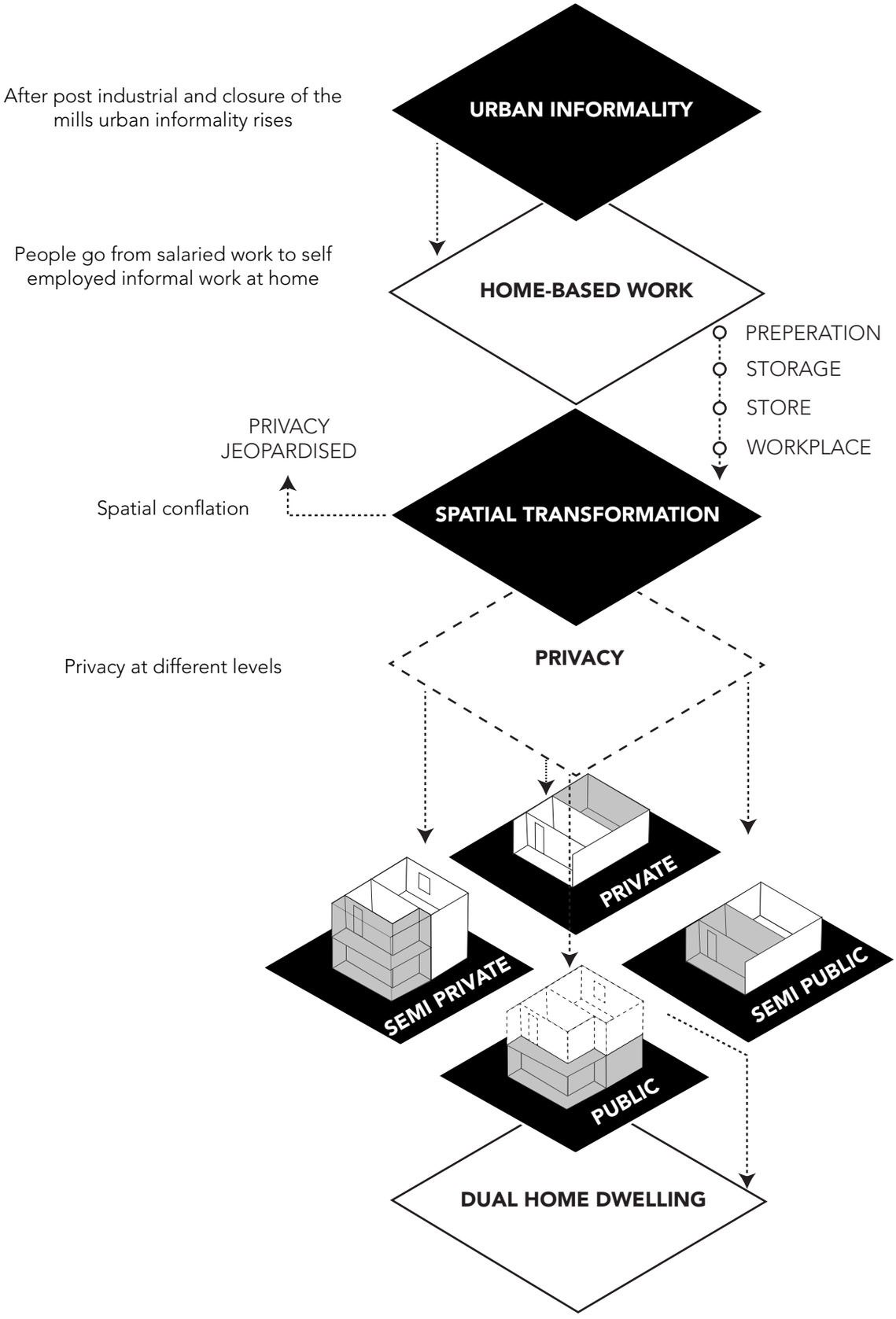
After the closure of the mills, due to the decline of the textile industry left mill workers no choice but to enter the informal sector, where home-based work and street-based activities became a primary source of income (Awaya & Tomozawa. 2023). These economic changes have directly altered the spatial organization of homes, as residents adapted their rooms and thresholds to accommodate both living and working functions (Samantroy, 2019). 'The informal sector can be characterized by decentralization, fragmentation, flexibility and by small scale of its entrepreneurial activities', (Rybczynski & others, 1986, p. 1).

Home-based work is closely interwoven with the domestic life, creating hybrid spaces challenging privacy and the zoning of a dwelling. Residents often convert their rooms into tailoring areas, kitchens into food preparation zones, small stores and parts if the house as a storage for goods (Breman, 2019). These adaptations shows that the house functions a dual function, as a productive space and a place for social interaction, both within the house and in the street. These practices highlight the necessity of interpreting privacy not as a strict separation between private and public, but as a transitional occurrence between private, semi-public and shared spaces, where threshold plays the role of a mediator between domestic life and economic activities.

This perspective challenges the dominant planning assumption that housing should follow formal standards and fixed functional separation. How the Other Half Builds argues, that existing informal housing sector is more a solution rather than a problem, where the priorities of a slum residents are often not those of the municipalities. 'Space takes precedence over permanence", (Rybczynski & others, 1986, p. 1. The writers argues that there is nothing basic about basic housing, and where present-day standards are a poor tool and reflect an optimal solution that culturally is inappropriate and inadequate. A new set of standards needs to be developed that accommodate, rather reorganize, reflect reality of the poot and respond to their spatial needs.

This statement is relevant for understanding the spatial organization of home-based work, where flexibility and multifunctionality are essential to their livelihoods. Rather than viewing informal housing as incomplete or less, 'How the other half builds', positions it as a prioritization of an spatial need over architectural permeance.

These ideas are supported by architectural precedents. For instance, B.V Doshi's Aranya Low-cost housing in Indore, India demonstrates how understanding the needs of the people and the fact that space revolve around the user. Instead of delivering a finished house, Doshi provided families with a basic framework of things, like a toilet block and a brick plinth to build over. This framework allowed families to shape their space accordingly to their needs and lifestyles and eventually to grow incrementally overtime (Hidden Architecture, n.d.). Similarly, the slum rehabilitation project in Yerawada, India, shows how housing intervention can be realised on the same site, rather than relocating the residents and imposing a new structure. The project preserved the original urban patterns and spatial logic of the settlement, allowing residents maintain their familiar circulation within their neighbourhood. Dwelling units were designed with standard layouts, with the expectation that residents will configurate their dwellings overtime to their needs. Small, shared spaces were integrated to encourage social interaction. This demonstrates that standardisation, incrementality and context sensitive approach can accommodate low-cost housing with evolving needs (Prasanna Desai Architects, 2011).


After post industrial and closure of the mills urban informality rises
URBAN INFORMALITY
People go from salaried work to self employed informal work at home
HOME-BASED WORK
PREPERATION
STORAGE
STORE
WORKPLACE
PRIVACY JEOPARDISED
Spatial conflation
SPATIAL TRANSFORMATION
Privacy at different levels
PRIVACY
PRIVATE
SEMI PRIVATE
SEMI PUBLIC
PUBLIC
DUAL HOME DWELLING

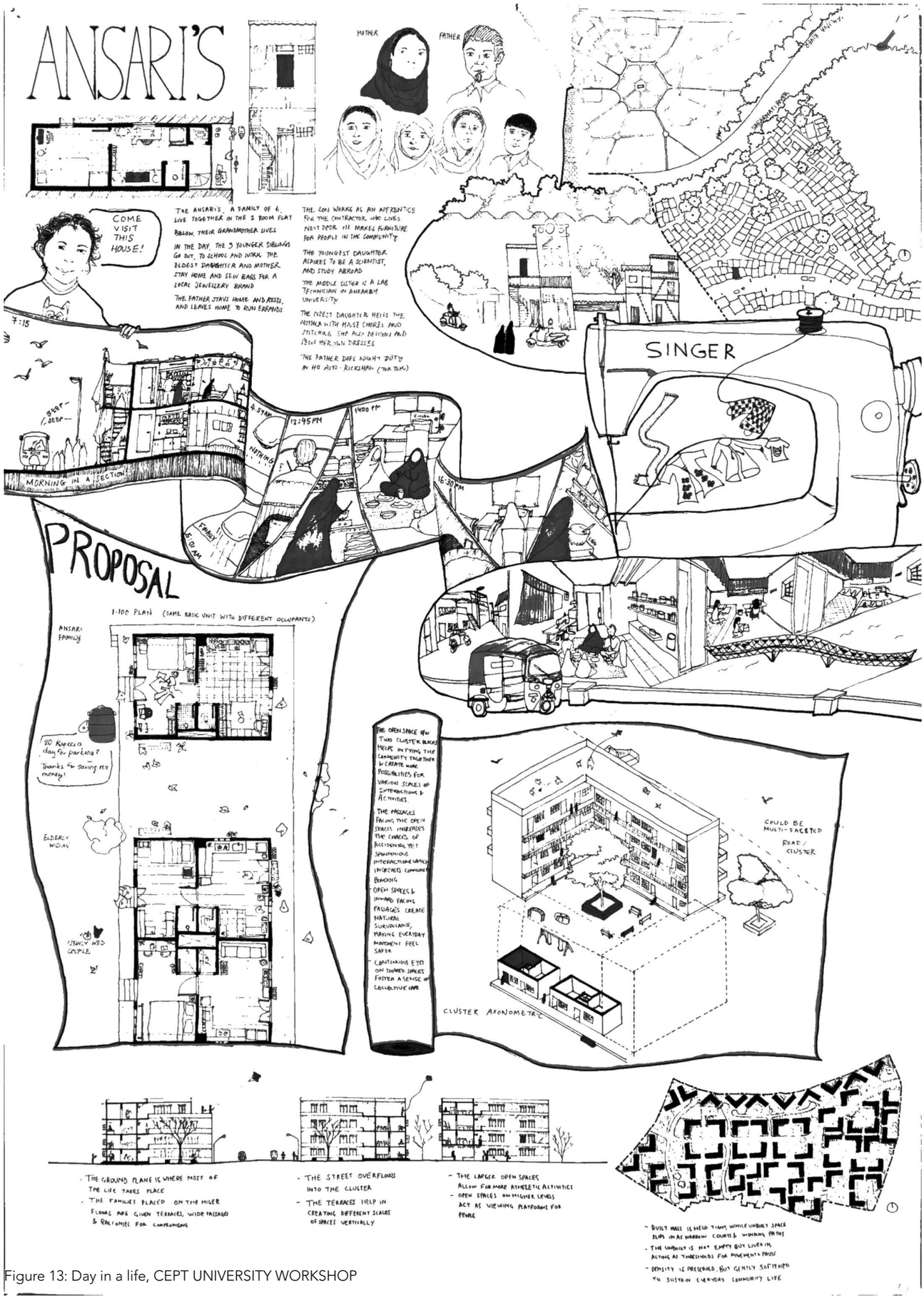



Figure 13: Day in a life, CEPT UNIVERSITY WORKSHOP

# SPATIAL CONFLATION

Figure 14: Calico Mills, P. Aung

In the Calico Mill settlement, the dwelling operates as essential economic production space rather than purely a domestic place for living. The field research revealed that the current interior dwelling layout, due to rigid and limited room forces conflation of the two activities.

Day and Night
The arrangement of the dwellings relies on the temporal footprint, where the exact square meters must be reorganized across a 24-hour cycle. During the day, economic activities take spatial priority in the dwelling. The dwelling turns into active workspace. At night it undergoes a minor metamorphosis, because of spatial constraints, materiasl and tools are stacked or pushes to the side to clear the floor for family time, dinner and eventually sleeping. This cycle can be named as inescapable gaze of labour. The lack of partitions and storage in dwellings causes residents to face a permanent visual confrontation with their work. Even during hours of rest, the physical presence of their work in their line of sight prevents phycological separation from their labour and creating persistent tension within the dwelling.

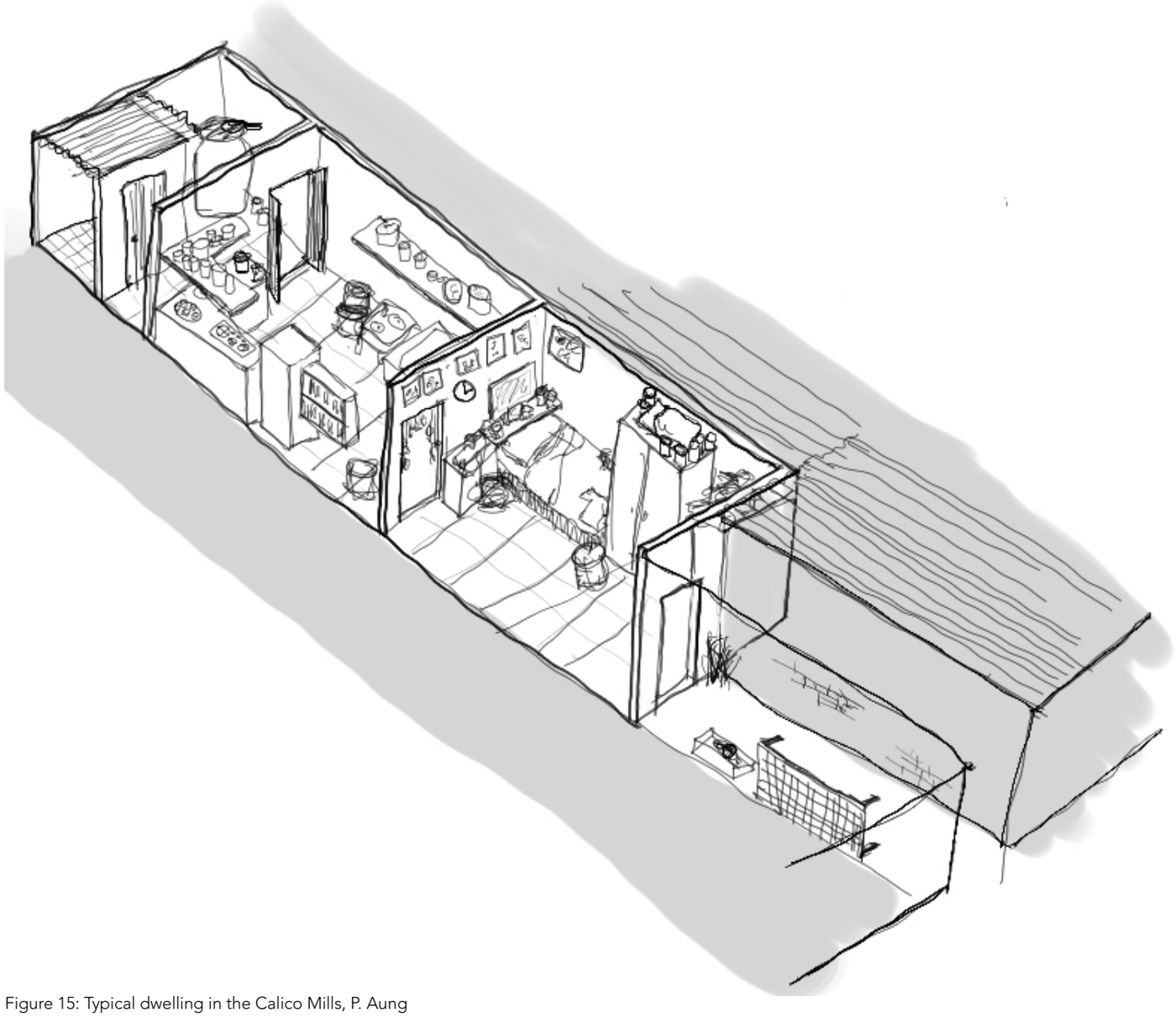


Figure 15: Typical dwelling in the Calico Mills, P. Aung

Figure 16: Typical dwelling in the Calico Mills, P. Aung

Dwelling Floor plan

Dimensions: 3x12m
Area: 36m2
Rooms: 2 with an outside wet area

Day

During the day economic activities like kite making, laundry services and vegetables peeling are practiced, dominating most of the space in the house.

Night

At night the economic activities are stowed away to the sides of the house to clear space for resting. However, economic activities are still in plain sight of the residents, as work related items are now occupying a different space within the dwelling.

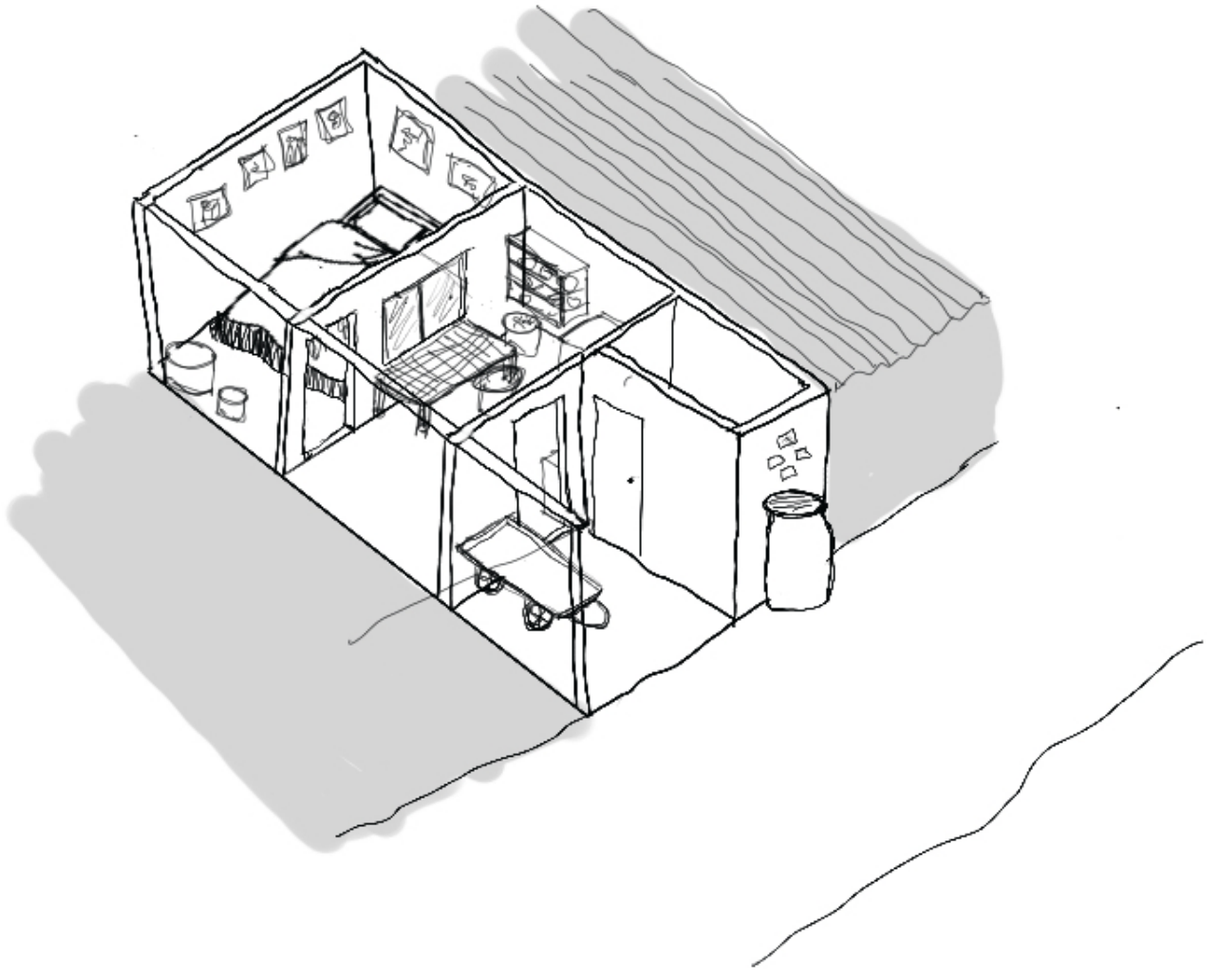


Figure 17: Typical dwelling in the Calico Mills, P. Aung

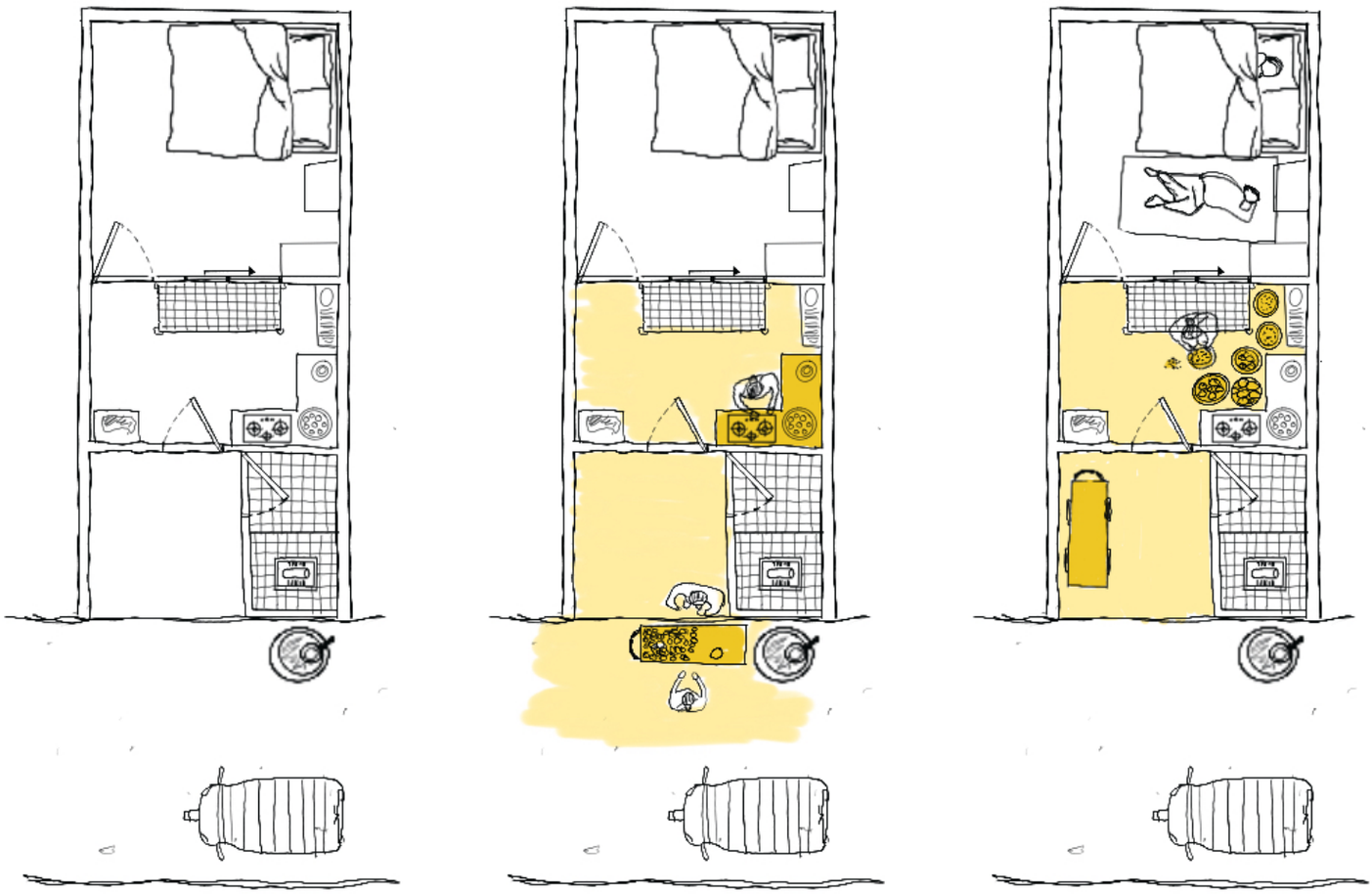


Figure 18: Typical dwelling in the Calico Mills, P. Aung

Dwelling Floor plan

Dimensions: 4x8m
Area: 32m2
Rooms: 2 with an front room

Day

During the day, economic activities like street vending and the preparation and cooking are done in and in front of the house.

Night

At night the vendor cart is stowed away in front of the house and preparations are made for the next day.

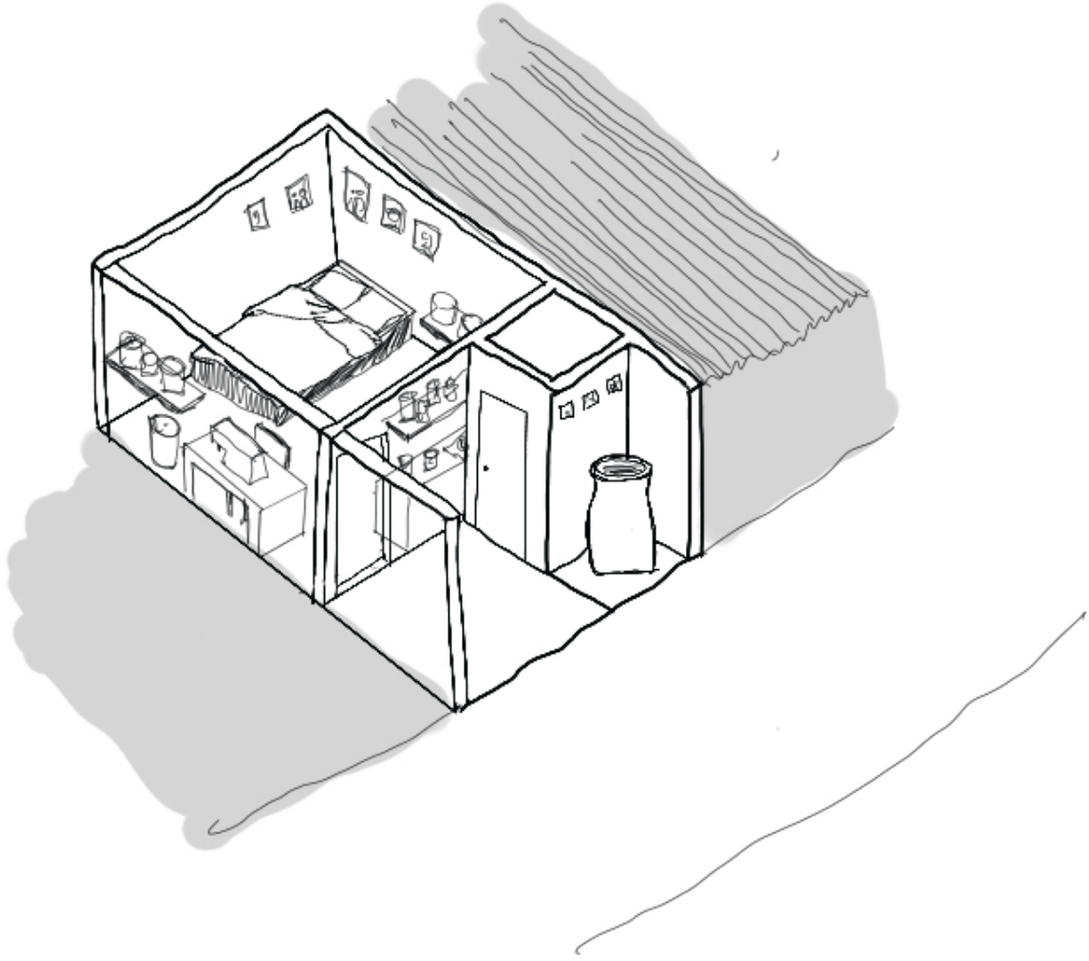


Figure 19: Typical dwelling in the Calico Mills, P. Aung

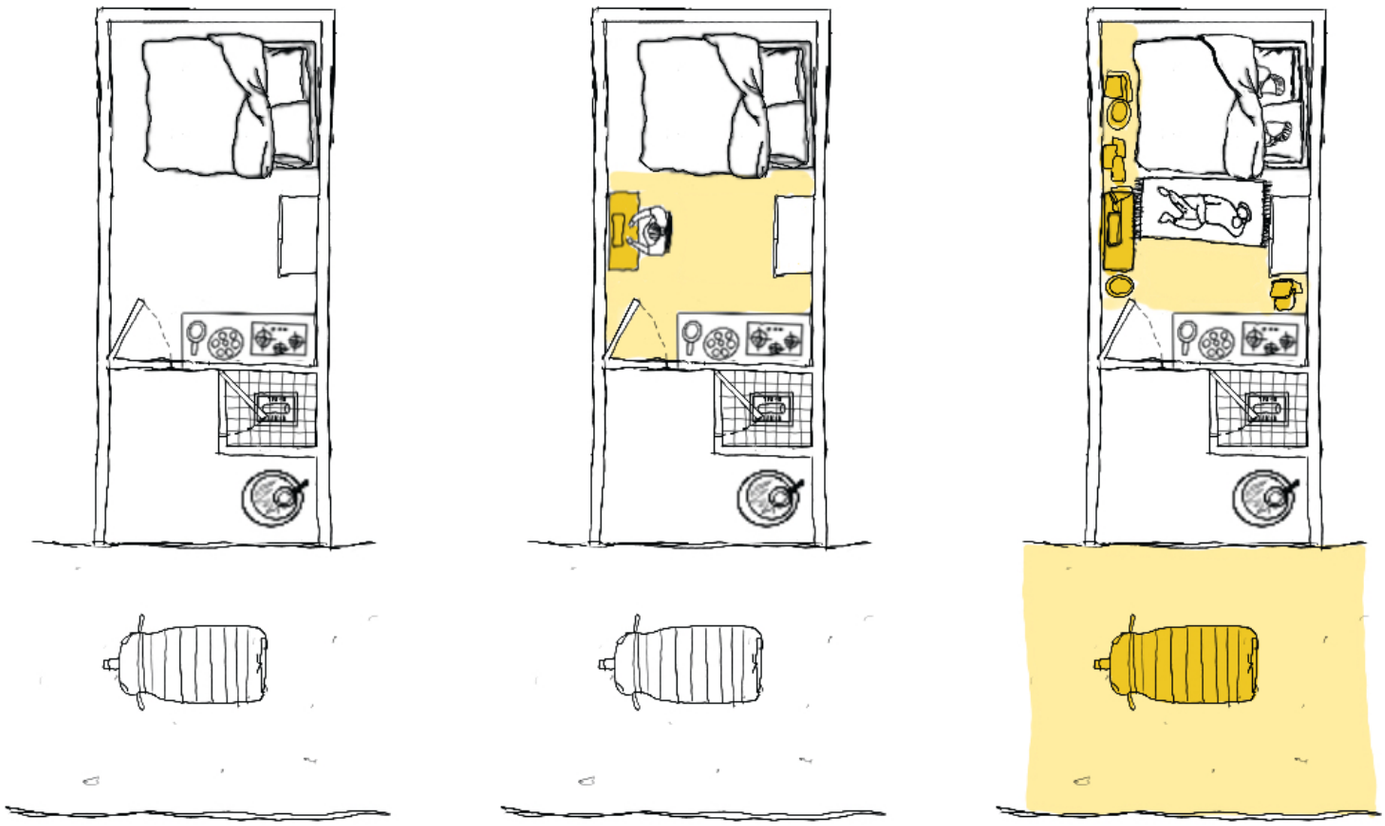


Figure 20: Typical dwelling in the Calico Mills, P. Aung

| Dwelling Floor plan | Day | Night |
|---|---|---|
| Dimensions: 3x6m<br>Area: 18m2<br>Rooms: 1 with an front room | During the day, economic activities like sewing is done in the 1 room dwelling, additionally to the fixed worktable it also occupies the rest of the room for raw material. | At night the sewing activities are halted and equipment is stowed away to the side of the room, while economic activity continues outside of the house. |

# MATRIX HOME-BASED

To provide an overview of the types of jobs that were observed during the field trip to the Calico Mills in Ahmadabad, a matrix was created.

The matrix summarizes the types of work that were identified, its location within or around the house, the number of people required to carry out the activity, the minimum space needed.

Furthermore, it also indicated whether storage is required, if it relies on vehicles and the types of pollution it generates, such as noise and waste.

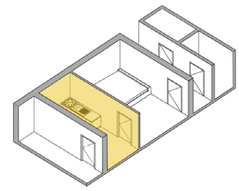
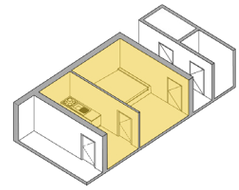
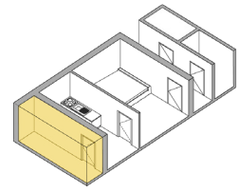
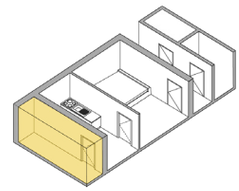
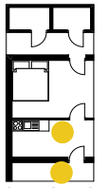
| WORK | HOME BASED | PEOPLE (one man job or more) | PRIVATE/PUBLIC |
|---|---|---|---|
| Kite making | Mostly home based | Mostly done alone (Potential for shared spaces) |  Private |
| Sewing | Home based | Mostly done alone or with two persons (Potential for shared spaces) |  Private |
| Stores | Both | Mostly done alone or with two persons |  Semi private/ Public |
| Education | No | Class full of students |  Public |

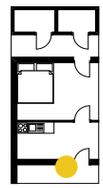
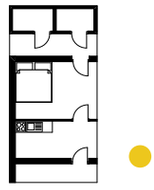
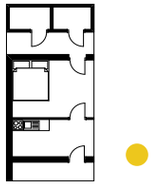
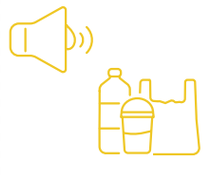
Figure 21: Calico Mills Home Based Work, P. Aung

| M2 REQUIRED | | WHERE CAN IT BE PLACED | VEHICLE REQUIRED | POLLUTION (NOISE, WASTE) |
|---|---|---|---|---|
| 0,5 m2 | Equipment: Sticks, Plastic, Glue, small table or floor<br>Storage: Yes, for the raw materials and product | <br>It can be placed anywhere, it does not need direct contact with the street or natural light | Not for the production, but needed for the delivery of the raw materials and sending out the finished products | Material scraps<br> |
| 0,9 m2 | Equipment: Sowing machine, material, table<br>Storage: Yes for material and products | <br>It can be placed anywhere, it does not need direct contact | Not for the production, but needed for the delivery of the raw materials and sending out the finished products | Material scraps<br> |
| 3 m2 | Equipment: Stock, table<br>Storage: Yes, for the products | <br>Needs to be directly along the street | Needed for the delivery of products | Noise, Waste<br> |
| 12 m2 | Equipment: Chalkboard, Tables<br>Storage: not necessarily needed, can be small |  <br>Needs to be directly along the street | Not needed | Noise<br> |

# MATRIX HOME-BASED

| WORK | HOME BASED | PEOPLE (one man job or more) | PRIVATE/PUBLIC |
|---|---|---|---|
| Service business | No | Mostly done alone or with a small group | Public |
| Mobility | No | Mostly done alone | Public |
| Healthcare | No | Mostly done with multiple, can be done alone | Public |
| Street vendors | No | Mostly done alone or with two persons | Public |

Figure 22: Calico Mills Home Based Work, P. Aung

| M2 REQUIRED | | WHERE CAN IT BE PLACED | VEHICLE REQUIRED | POLLUTION (NOISE, WASTE) |
|---|---|---|---|---|
| 7,5 m2 | Equipment: Equipment for various things, materials<br>Storage: is needed for the equipment and temporary storage |  <br>Needs to be directly along the street | Yes, for the delivery of the equipment and materials | Noise, Waste<br> |
| 3 m2 | Equipment: vehicle<br>Storage: parking spot |  <br>outside the house | Yes, the work revolves around the vehicle | Noise<br> |
| 7,5 m2 | Equipment: Health equipment, medicine<br>Storage: yes for the equipment and the medicine ect | <br>Needs to be directly along the street | Yes, for the delivery of the equipment and materials | Waste<br> |
| 1,2 m2 | Equipment: cart, food, ingredients<br>Storage: yes for the cart and the preparation of the ingredients |  <br>outside the house | Yes, for the delivery of the equipment and materials. But the job also enquirers for a form of vehicle | Noise, Waste<br>  |

# Homebased Neufert

Based on the range of jobs observed during the field trip to the Calico Mills, a home-based Neufert was developed to guide the design of the housing that can support dual functions. The purpose of this tool is to translate the spatial requirements into architectural guidelines. By creating this, it is better to understand how an domestic space can accommodate economic activities, and eventually without having to compromise regular living conditions.

The Neufert is based on average anthropometric data, which ensures that the proposed dimensions are adapted to the local context. This includes body size and ergonomic comfort in relation to different activities. By designing houses with these measurements, it results in a house that is practical and efficient.

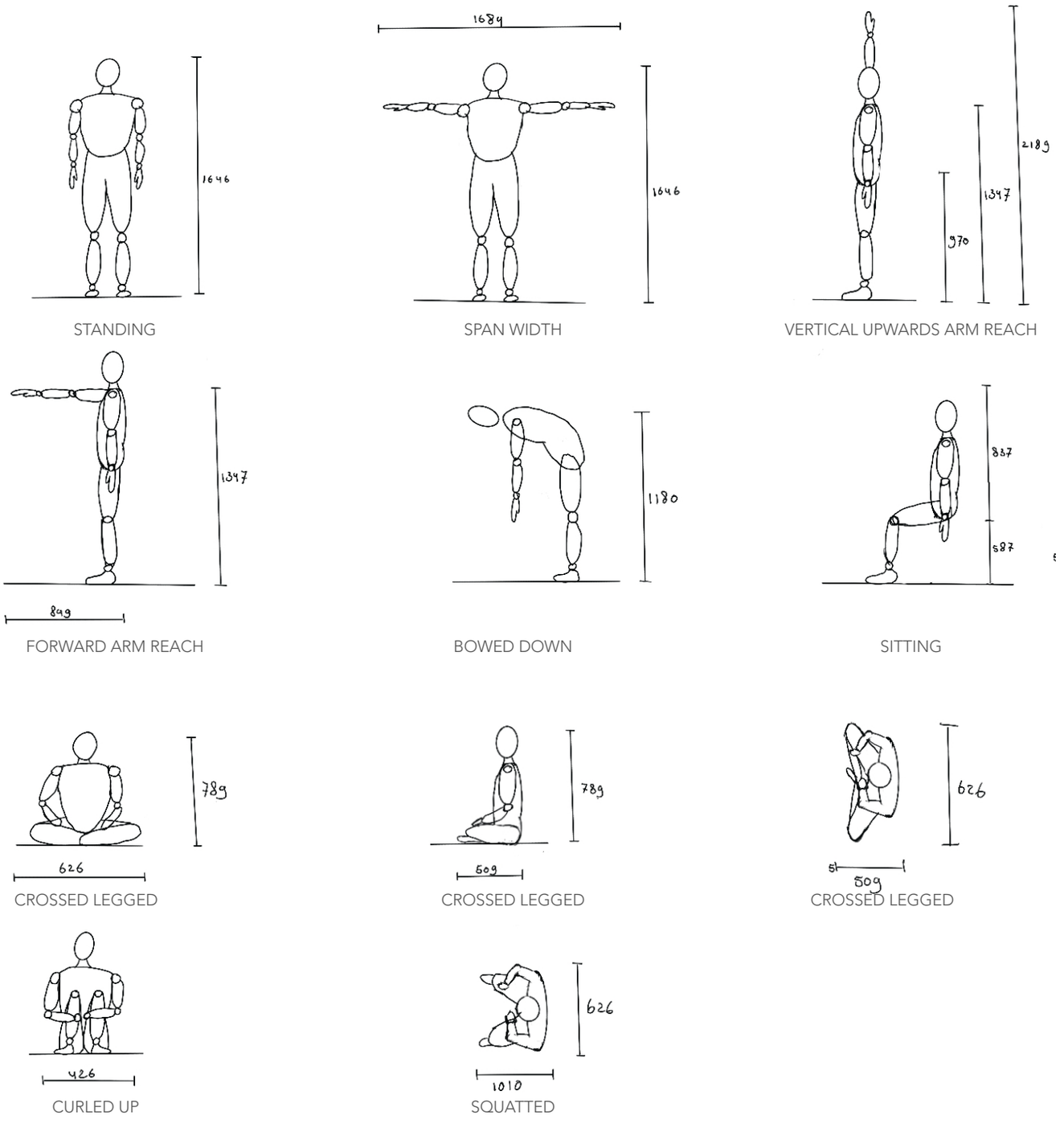
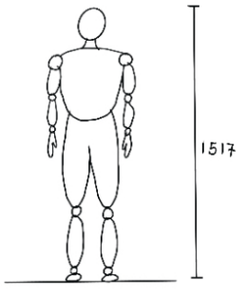
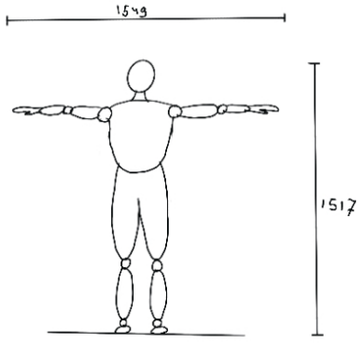


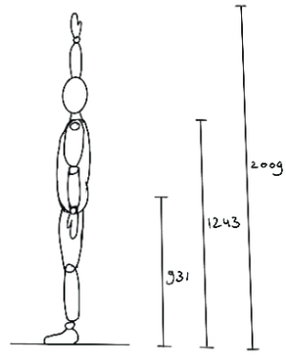

Figure 23: Neufert Home Based Work, P. Aung



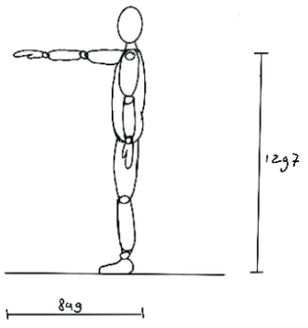

STANDING



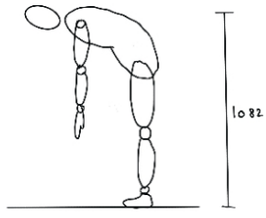

SPAN WIDTH



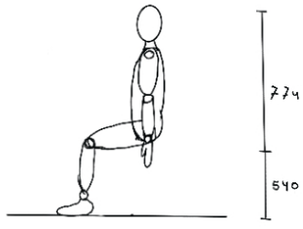

VERTICAL UPWARDS ARM REACH



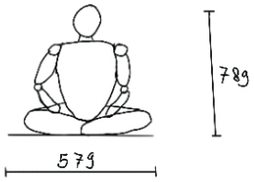

FORWARD ARM REACH



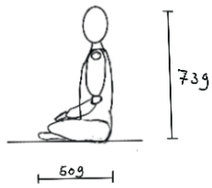

BOWED DOWN




SITTING




CROSSED LEGGED

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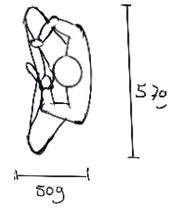


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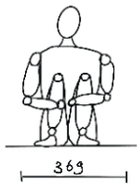
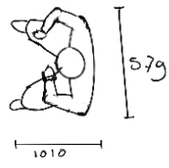



CURLED UP

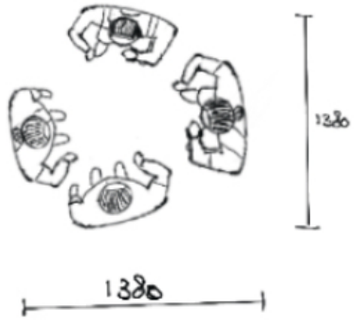



SQUATED

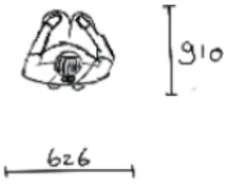
Figure 24: Neufert Home Based Work, P. Aung

SLEEPING IN A BED

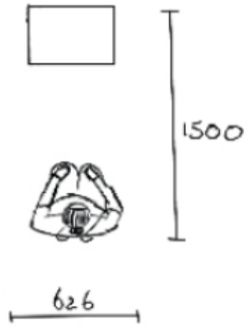
SLEEPING ON THE FLOOR



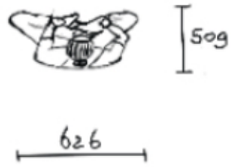

CHATTING



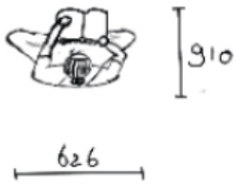

PRAYING



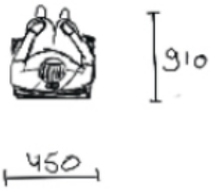

IN FRONT OF THE ALTAR



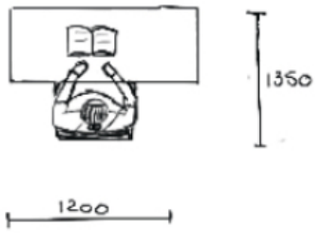

MEDITATING



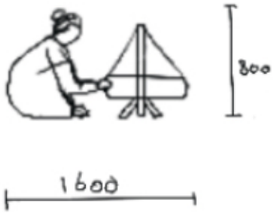

READING




SITTING

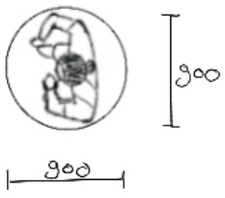



STUDYING

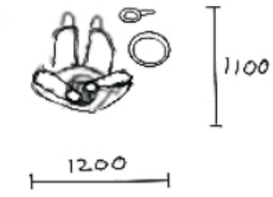



SWINGING THE CRADLE

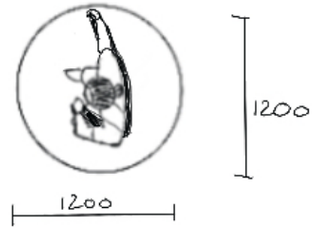
Figure 25: Neufert Home Based Work, P. Aung



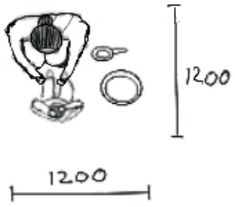

SHOWER



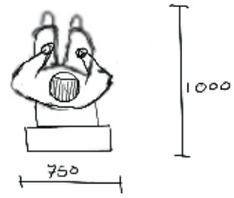

SQUATTING SHOWER



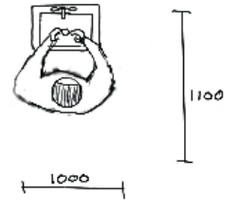

DRYING BODY



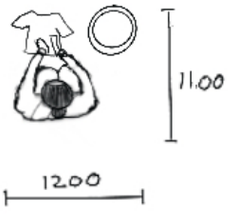

BATHING A CHILD




TOILET



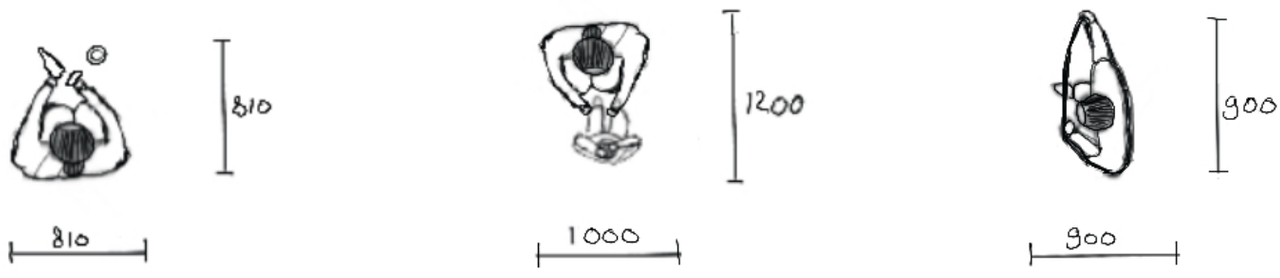

WASHING HANDS




WASHING LAUNDRY

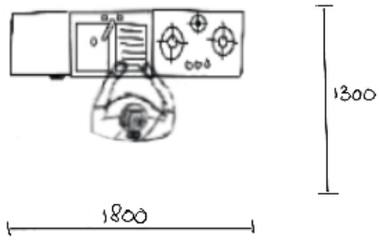
RINSING

Figure 26: Neufert Home Based Work, P. Aung

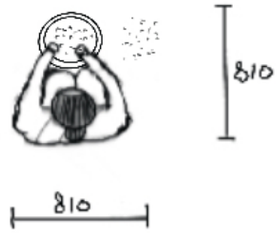



POLISHING CLOTHING A CHILD DRESSING

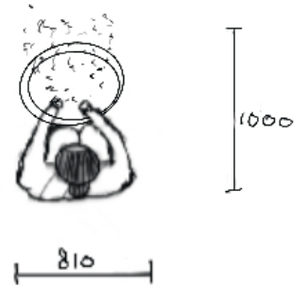
Figure 27: Neufert Home Based Work, P. Aung



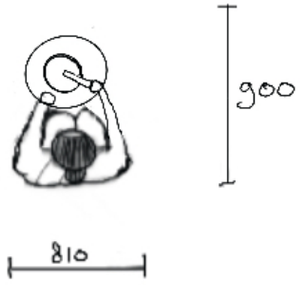

COOKING



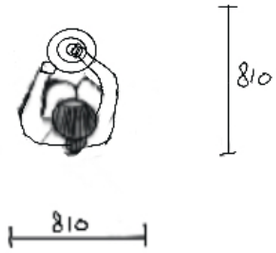

PICKING




WINNOWING

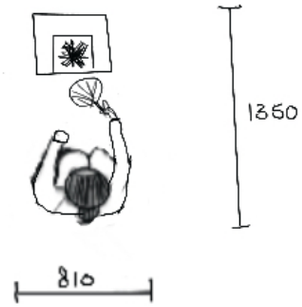



GRINDING

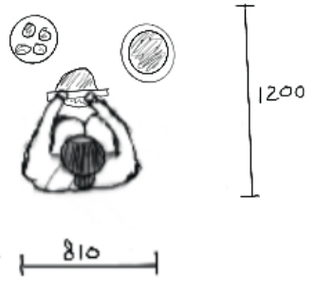



CHURNING

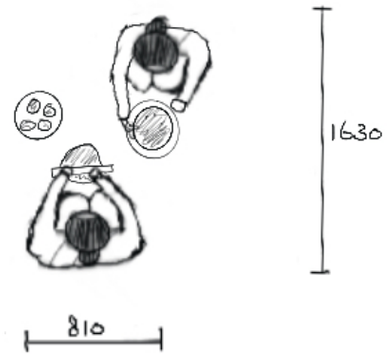
LIGHTING ANGITHI




LIGHTING CHULLAH

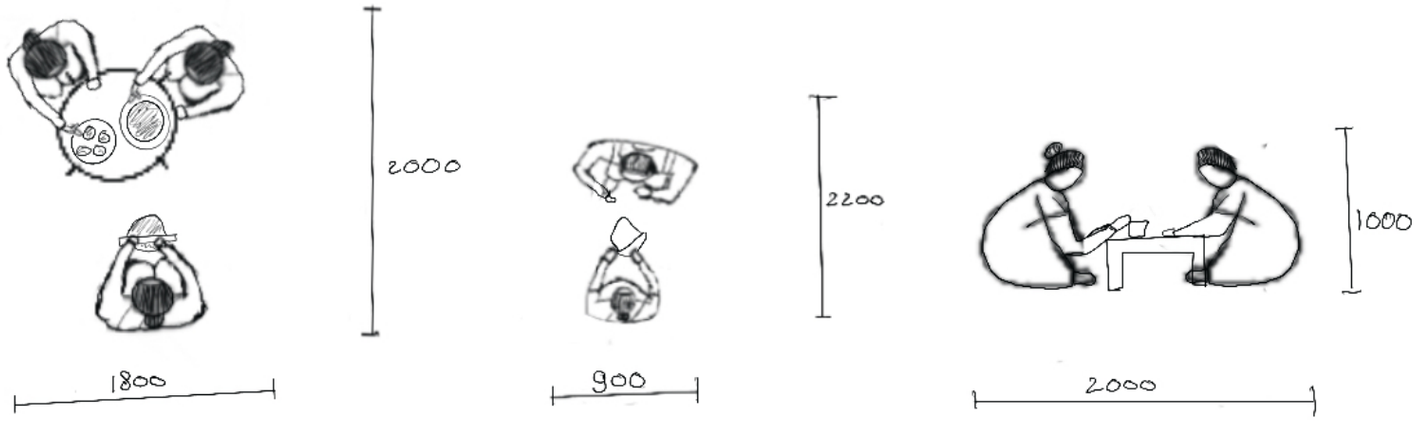



ROLLING

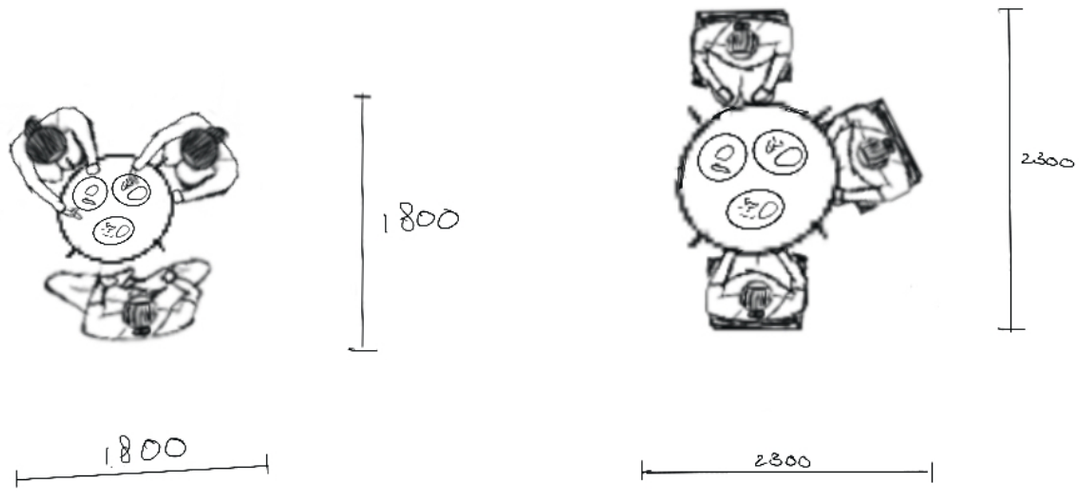



COOKING WITH ASSISTENCE

Figure 28: Neufert Home Based Work, P. Aung

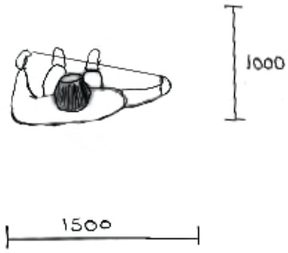



COOKING SERVICE RECEIVING VENDOR POURING AND SERVING

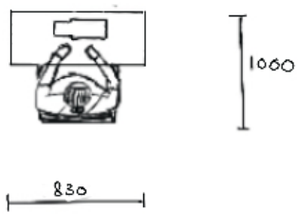



EATING ON CHOWKI DINING TABLE AND CHAIRS

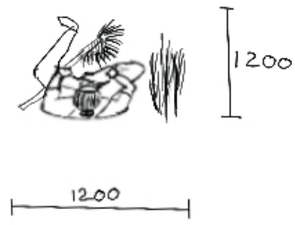
Figure 29: Neufert Home Based Work, P. Aung



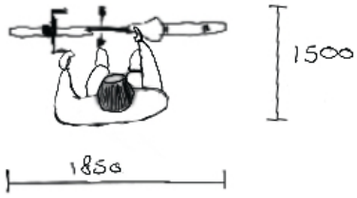

SPINNING



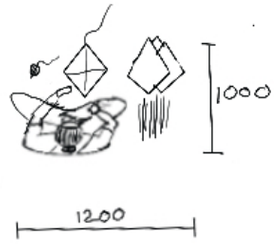

SEWING



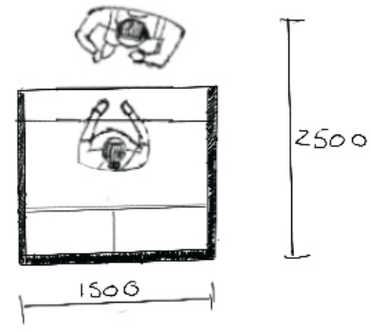

BROOM MAKING



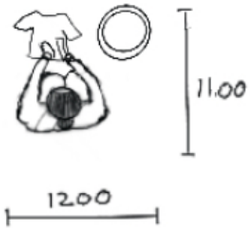

BICYCLE REPAIR



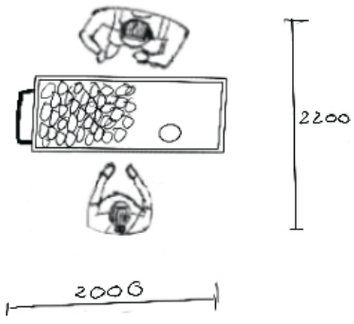

KITE MAKING



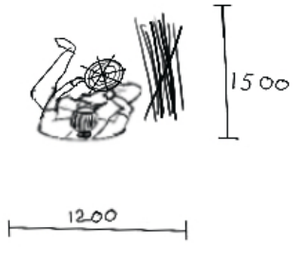

STORE




WASHING CLOTHES

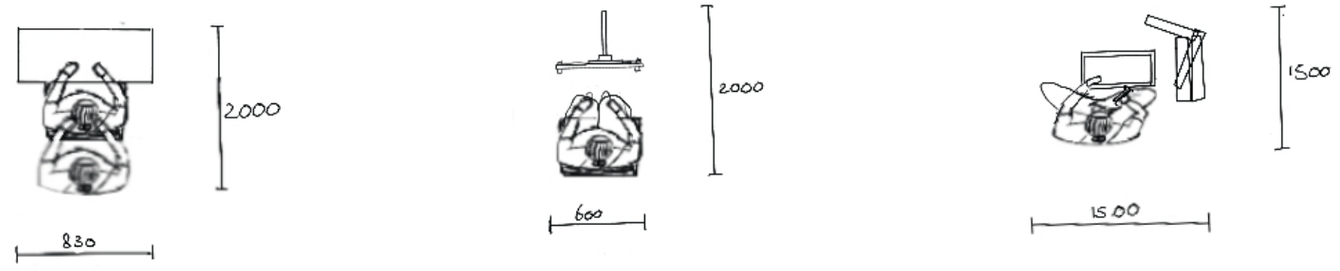



STREET VENDOR




BASKET WEAVING

Figure 29: Neufert Home Based Work, P. Aung




BEAUTY PARLOR PAINTING CARPENTRY

Figure 30: Neufert Home Based Work, P. Aung

Thresholds
While the interior bears the main burdens of homebased work, work around and outside the house adapts itself to their environment. Through a matrix of all the observed occupations, the footprint, its location within or around the house, the number of people required to carry out the activity, the minimum space needed and infrastructural demand. The different occupations can be distinguished into three typologies:

1. Public facing:
This typology must be located directly with the public space to survive economically. For example, shops and service and healthcare related work. Because of its crucial demand of facing the public space, residential facades and thresholds transform from private and domestic to public and commercial.

2. External facilitation:
With occupation regarding external facilitation, it means occupation that are tied to transport like rickshaw drivers, deliverymen, street vendors and labour that is done in a space away from home like workshops or factories. While the labour is done outside of the dwelling, the dwelling is still sometimes utilized for the labour that is happening outside of the home as storage or preparation space.

3.Domestic production:
This typology operates strictly within the private space of the dwelling. It utilizes space that I is used for domestic activities.

In conclusion, the arrangement of domestic and economic activities within and around the dwellings in the Calico Mills are dictated by the economic functions. Indoors, activities are arranged temporarily rather physically. During the day the home is used as a production site before rearranging at night allow space for rest. Outdoors, activities are arranged by the scale of the activity this can be limited to the threshold of the dwelling extending it outwards to the street or even to a completely different site away from the house. Work and life currently do not coexist side by side in separated spaces, instead the space of the dwelling is constantly negotiated during the day.

# Privacy and Separation

During the field observations showed that residents rely on low-cost elements to create more privacy. The dwellings in the Calico Mills privacy between activities like living, working and socializing are managed through different elements:

1. Textile:
Dwelling throughout the Calico Mills have fabric hanging at their façade. This fabric multifunction as sunshade and are substitutions for doors and temporary walls. Fabrics hung from overhead wire or curtain rod are used as a soft boundary serving as a adaptable visual buffer, capable of providing multiple levels of privacy depending on how fully drawn the fabric is.

2. Furniture:
In the absence of interior walls, large objects like wardrobes are used in dwellings as walls to create more privacy, especially with single room dwellings. This strategy turns a simple wardrobe into a vital element for zoning the small dwelling. The furniture blocks the line of sight between the entrance to the sleeping area, interrupting or narrowing the sight to the private area. Furthermore, it forces a person to move around the object unconsciously, creating a physical and psychological sense of transitions between socializing and workspace to private space.

3. Thresholds:
Socializing happens indoors but is also externalized to the street. The house does not stop at their front door but is extended to the street. The thresholds or otla's in Gujarati, plays an important role in the livelihoods of the residents of the Calico Mills. Residents use their front step or space as an second living room to greet and talk with neighbours and guests keeping the interior in that way private. But next to socializing residents also use their otla as an economic space, where they create small convenience shops, storage or production space for example making kites.

4. Interior walls and extra floor
Lastly. The most conventional element is the traditional division by a wall. A wall creates a direct and clear separation between two activities. Next to the wall, noticeably was the second floor of dwellings, where residents separates private life and public by placing all private rooms like bedroom upstairs and utilizes the ground floor as a more semi-public space where guests are hosted and where economic activity can be practiced.

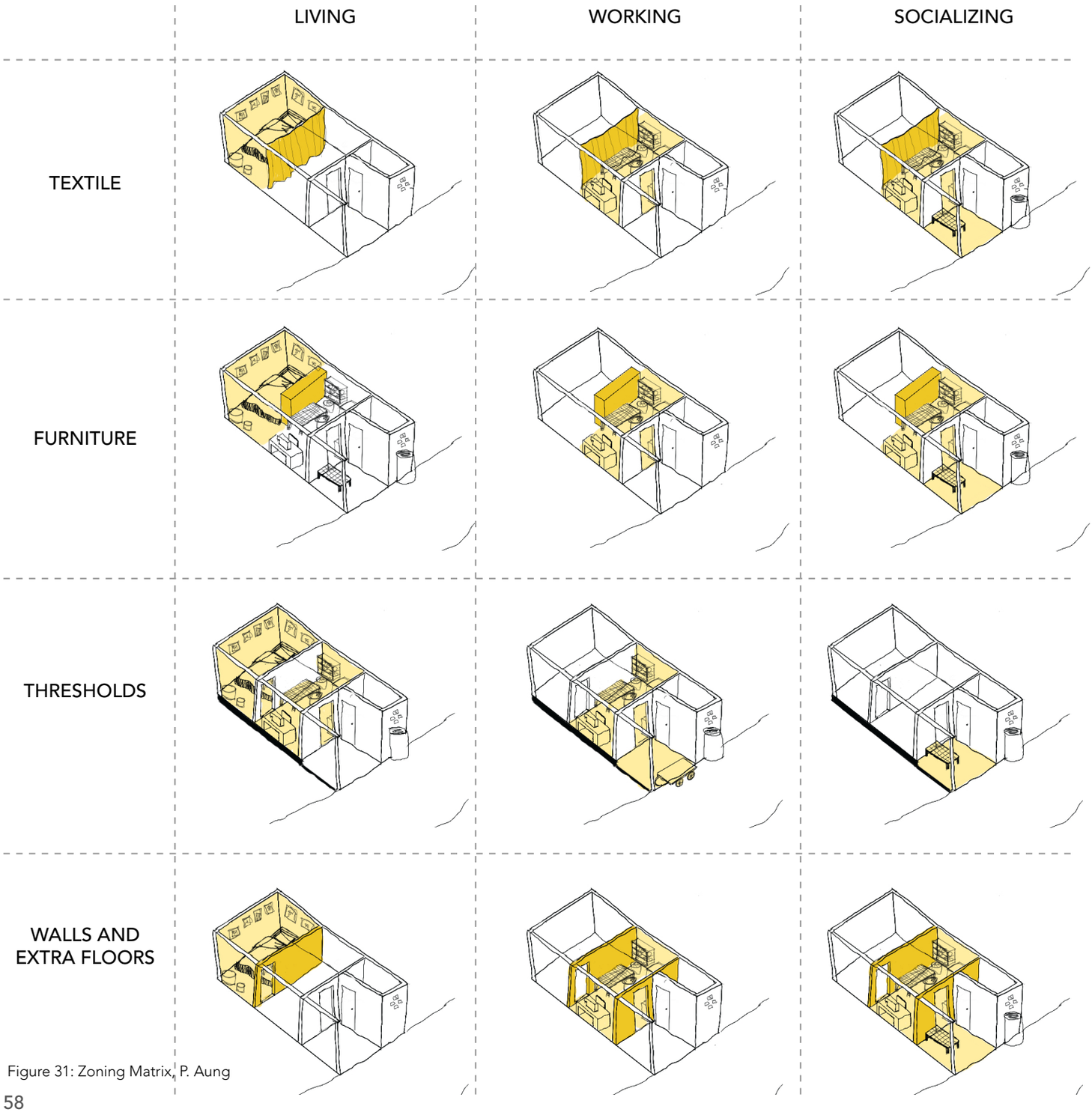



Figure 31: Zoning Matrix, P. Aung

Rather viewing the low-cost, adaptive elements found during the fieldwork in the Calico Millfs as spatial shortfalls. It can instead be recognized as responsive interventions, these temporal interventions represents ongoing negotiation of space that allow living, working and socializing to coexist. To understand and explore how architectural design can further support existing systems, a comparative framework with case studies is conducted.

The matrix analyses the built environment breaking them into different lenses:

1. Neighbourhood:
Layout of the master plan of the project, the income division and play with the built and unbuilt environment

2. Shared infrastructures:
Assessing ways how and in what ways collecting spaces are designed

3. urban clustering:
Relation between the dwelling and the public space

4. Module:
Dimensional boundaries

5. Structure:
Evaluating the construction methodology and reasoning

6. Dwelling:
Mapping how daily functions are placed in the dwelling and how activities within the dwelling are potentially separated or combined.

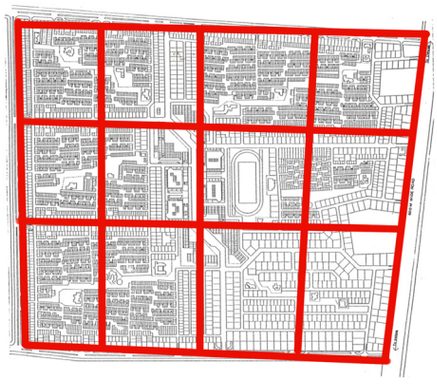
Ultimately, resolving the privacy issue in a dual function home does not require a choice between completely open floor plans or rigid walls. The fieldwork and case study analysis shows that privacy can be integrated through spatial adaptability. Upgrading textile dividers to folding or sliding doors and organizing dwellings around courtyards or open spaces. This allows residents to expand their environments when needed or close them off when seeking more privacy. Furthermore, the strategic usage of furniture can play a vital role, because lack of storage often prevents residents from psychologically detaching from their labour Utilizing furniture as a multifunctional dividing element provides spatial separation and storage capacity without losing limited area. This ensures that economic activities can be combined without compromising domestic activities.

# Aranya Low-cost Housing

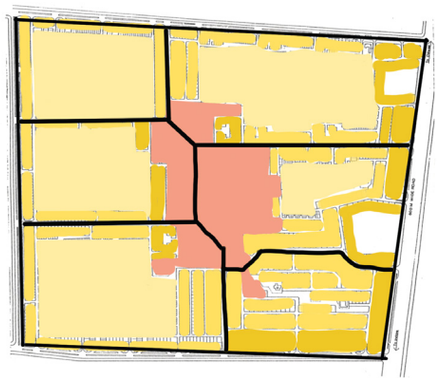
Project: Aranya Low-Cost Housing
Location: Indore, India
Year: 1989
Architect: B.V. Doshi
Tenure: Homeownership
Plot Area: 85ha
Density: 76 dw/ha
Dwellings: 6500
Unit size: 40m2
FSI: 0.31
GSI: 0.12
Decription:
Aranya low cost housing is a incremental housing project. The project accommodates approximtely 60000 to 80000 individuals. The dwellings are organized around a hierarchical network of street and open space. The residents of the project received a plot with the essentials a room and the wet rooms, where they can expand their homes over time according to their means and needs.
All images are adapted from drawings and photographs by B.V Doshi (hiddenarchitecture.net).

Figure 32: Aranya Low Cost Houding, by B.V Doshi.

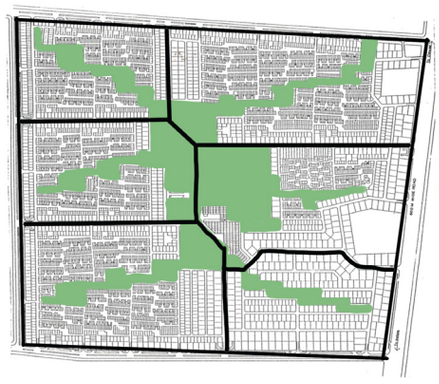
## NEIGHBOURHOOD



Grid layout of the neighbourhood

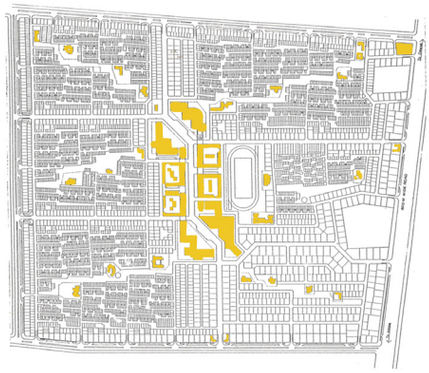


Core
Low income
Middle income
High income



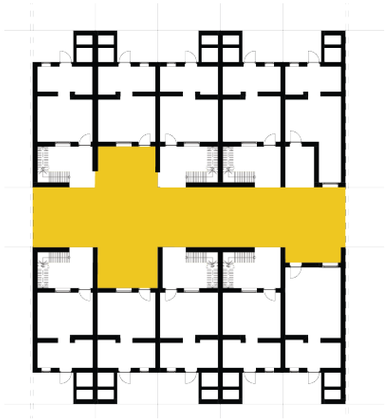
Green spaces, vegetation are present in different forms, trees and fields

## SHARED SPACES



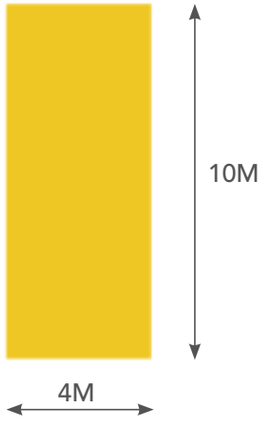
- Core with facilities
- Facilities spread evenly for better accessibility
-Green spaces are also used for facilities
- Facilities: Retail, Education, Health, Religion, Recreation

## CLUSTER

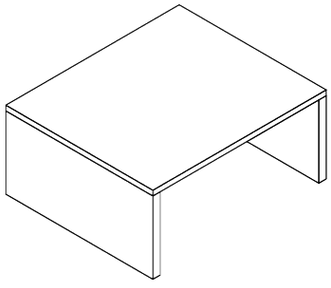


With each residents having their own choice of their house size withing the 4x10m plot it creates indirectly open spaces

## MODULE SIZE

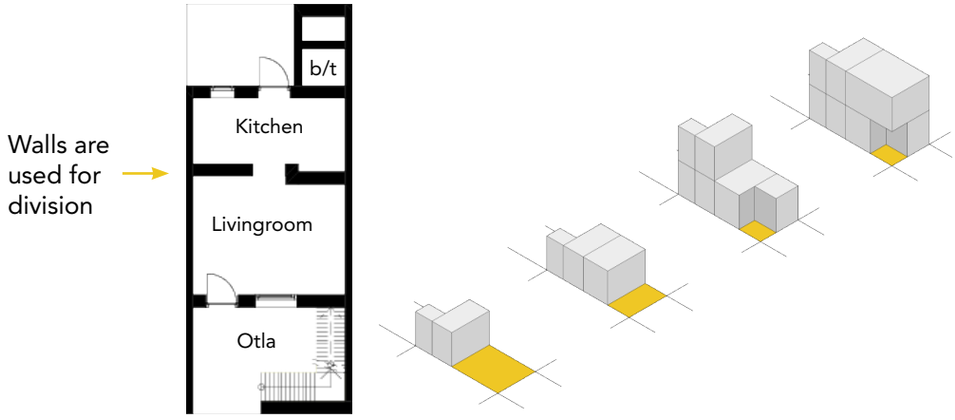



## STRUCTURE



Construction most likely consist from load bearing walls. Incase of incrementality, walls will be added or the existing walls will be extended.

## DWELLING




Typical floor plan exist from 2 rooms and a wet are in the back, with potential expansion horizontal and vertical

# Pune Slum Redevelopment

Project: Pune Slum Redevelopment
Location: Pune, India
Year: 2012
Architect: Prasanna Desai Architects
Tenure: Homeownership
Plot Area: NA
Density: NA
Dwellings: NA
Unit size: 21m2
FSI: NA
GSI: NA
Decription:
The Yerawada slum rehabilitation project is a in situ participatory project to rehabilitate informal settlements without displacement. The strategy preserves existing social and spatial networks while improving dwellings in the neighbourhood. Furthermore the residents can incremental grow their dwelling to their needs.

All images are adapted from drawings and photographs by Prasnna Desai Architects (prasannadesaiarchitects.blogspot.com).

Figure 33: Insitu Slum Rehabilitation Project, by Prasanna Desai Architects.

**NEIGHBOURHOOD**

Structure of the neighbourhood, is labyrinthine, but divide formed by informal incrementality

Low income

Module size it created excess plot area which is given back to the public space

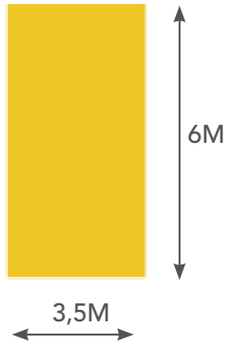
## SHARED SPACES

There is not a community spaces designed as residents did not want to give away part of their land, instead the open public space was en is still used as a community space.

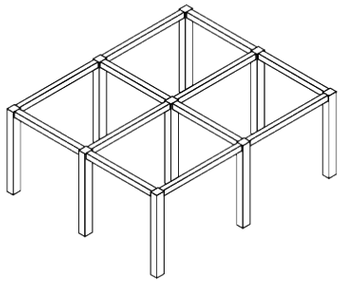
## CLUSTER

Clustering happens in a row house typology, with dwelling next to each other, but also as a combination of intervened plots that are connected to each other by the shared circulation space.

## MODULE SIZE

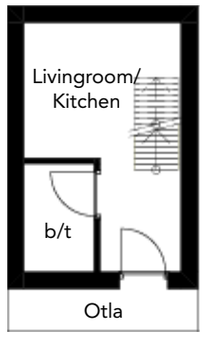


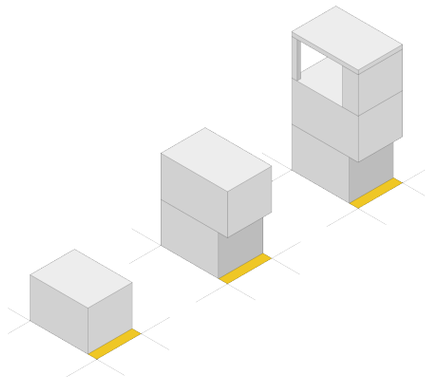

## STRUCTURE



Construction is made out of a column structure which gives the residents more flexibility to adapt their dwelling to their needs over time.

## DWELLING



Typical floor plan exist from 1 room with the wet area in the front of the house because of the sewage.

# Sanjaynagar Slum Redevelopment

Project: Sanjay Slum Redevelopment
Location: Ahmednagar, India
Year: 2022
Architect: Community Design Agency
Tenure: Homeownership
Plot Area: 0.14ha
Density: 368 dw/ha
Dwellings: 298
Unit size: 40m2
FSI: 1.1
GSI: 0.37
Decription:
The project is an in situ rehabilitation projects accommodating 298 dwellings. The project is organized in 8 G+2 blocks around shared courtyards. These courtyards acts like collective spaces prioritizing community interaction.

All images are adapted from drawings and photographs by Community Design Agency (communitydesignagency.com).

Figure 34: Insitu Slum Rehabilitation Project, by community design agency

## NEIGHBOURHOOD

The building blocks are mostly in L-shape places within a grid

Low income

The building are designed around 8 courtyards

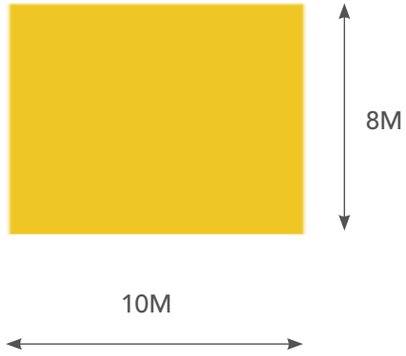
## SHARED SPACES

Shared spaces in this project can be found in different varieties. The wide corridors, courtyards but also the shared roof terrace on each building.

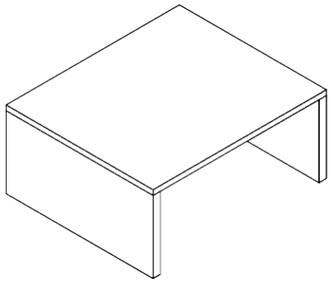
## CLUSTER

The project has wide corridors to have space for interaction and natural light and ventilation.

## MODULE SIZE

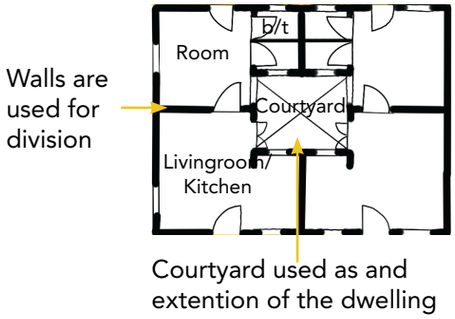


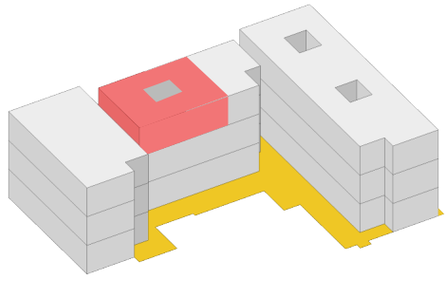

## STRUCTURE



The building has load-bearing, reinforced walls, with a vernacular plank and joist slab system

## DWELLING



A typical dwelling in the building block has 2 rooms and a wet area

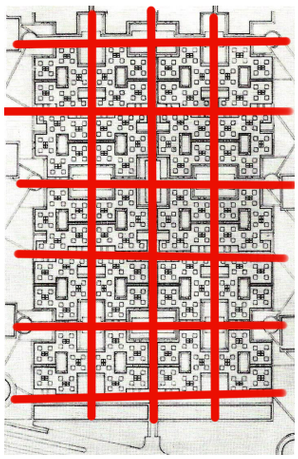
# Previ

Project: Previ Low Cost Housing
Location: Lima, Peru
Year: 1969
Architect: James Stirling
Tenure: NA
Plot Area: 40ha the whole Previ project
Density: NA
Dwellings: NA
Unit size:
FSI: NA
GSI: NA
Decription:
The PREVI Experimental housing project van a UN supported housing project located in the outskirts of Lima and included multiple architects. It pioneered the incremental home model that allowed low income residents to expands their home as their finances grew.

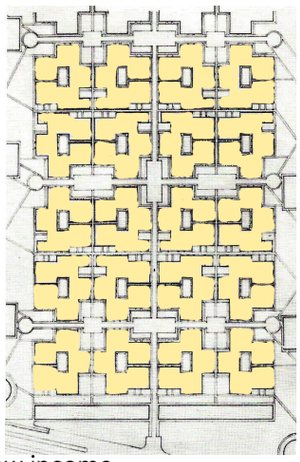
All images are adapted from drawings and photographs are from Hidden Architecture (hiddenarchitecture.net).

Figure 35: Previ Low Cost Housing, By James Stirling.

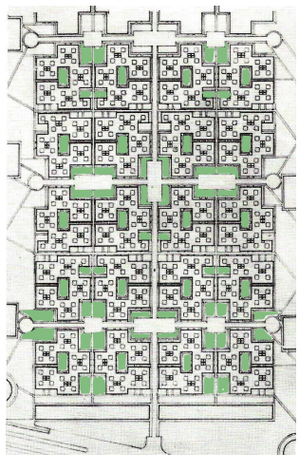
## NEIGHBOURHOOD



Grid layout

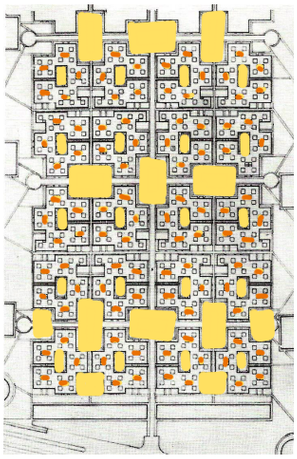


Low income



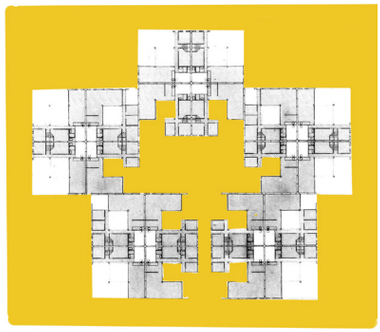
Green space can be found in the public space and within the individual courtyards

## SHARED SPACES



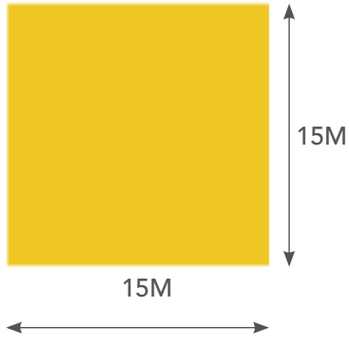
Shared spaces in this project can be found in different varieties. The wide corridors, courtyards but also the shared roof terrace on each building.

## CLUSTER

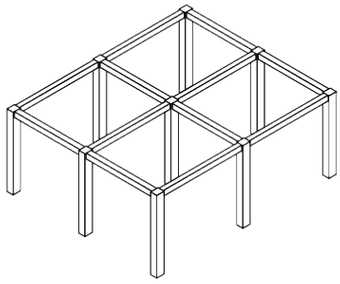


4 dwellings make 1 cluster and 5 clusters make 1 one bigger cluster. Together they make a big inner shared space

## MODULE SIZE




## STRUCTURE

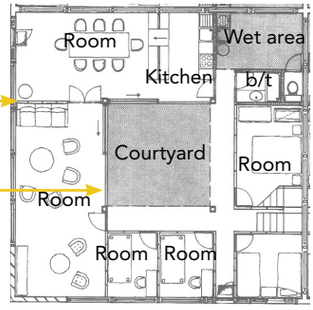


Construction is made out of a column structure. It starts with a minimal base, and can grow and developed with the needs of the residents.

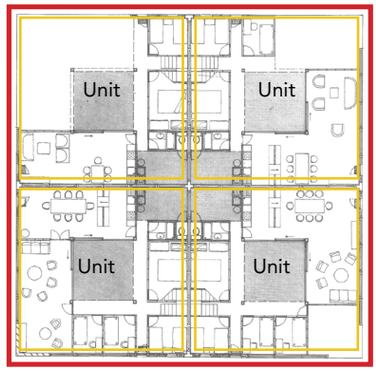
## DWELLING

Walls are used for division

Sliding doors as temopral walls




Block




The unit is made for 4 persons, with a inner ‘core courtyard’ and can be expanded to a dwelling for 6 or 8 on one floor.

# QUINTA MONROY

Project: Quinta Monroy
Location: Iquique, Chile
Year: 2003
Architect: ELEMENTAL
Tenure: Homeownership
Plot Area: 0.5ha
Density: 186 dw/ha
Dwellings: 93
Unit size: 36m2
FSI: 0.67
GSI: 0.22
Decription:
Quinta Monroy Housing is an incremental social housing project that uses a "half-house" strategy, providing a basic structural framework that allows residents to expand both vertically and horizontally over time.

All images are adapted from drawings and photographs by ELEMENTAL (elementalchile.cl).

Figure 36: Quinta Monroy by ELEMENTAL

## NEIGHBOURHOOD

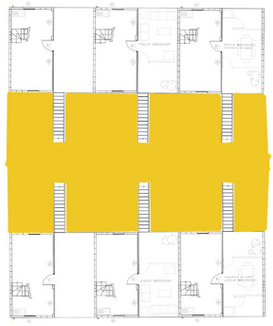
The dwellings are placed around 4 common spaces

Low income

## SHARED SPACES

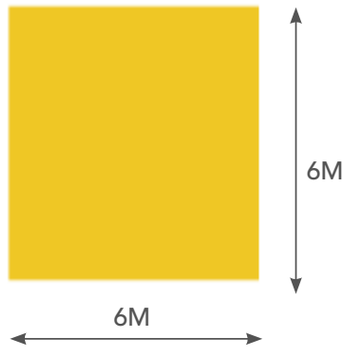
The dwellings are placed around a communal space. It acts as a transition between the street and the private space and encourage a sense of sense of community

## CLUSTER

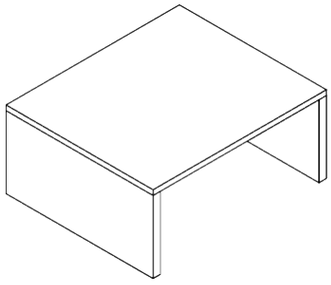


The houses are clustered lined up next to each other, but with one module left open for future expansion

## MODULE SIZE

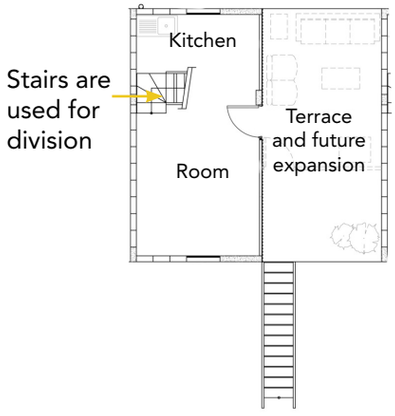


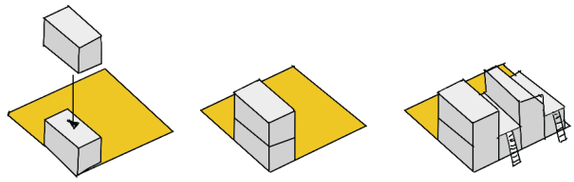

## STRUCTURE



The building has load-bearing, reinforced walls,

## DWELLING



The houses are clustered lined up next to each other, but with one module left open for future expansion

# Sola Road

Project: Sola Road
Location: Ahmedabad, India
Year: 1984
Architect: Unknown
Tenure: Mixed
Plot Area: 13.2ha
Density: 116 dw/ha
Dwellings: 1536
Unit size: 36m2
FSI: 1.74
GSI: 0.58
Decription:
Sola Road neighborhood consists of approximately 16 super blocks arranged like a windmill, with 128 buildings, 384 units, and 1,536 dwellings. The neighborhood can accommodate around 18,400 residents.

All images are adapted from drawings and photographs by the Global housing Case study book

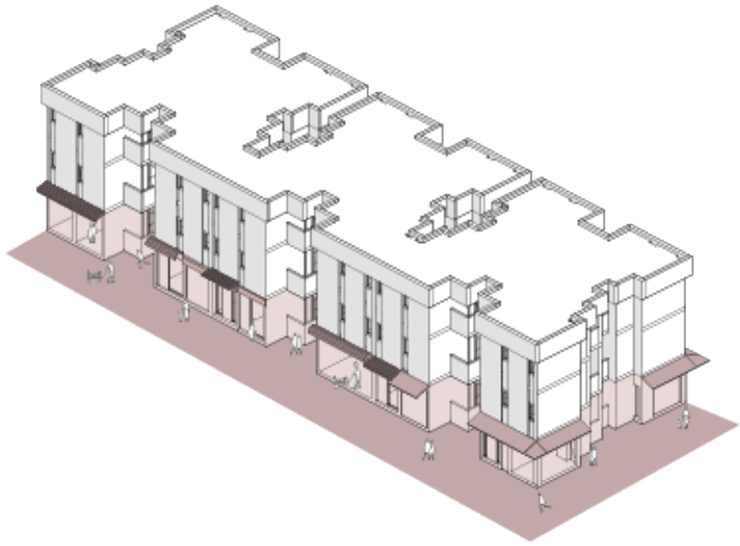


Figure 37: Sola Road By P. Aung and Ruveyda Han

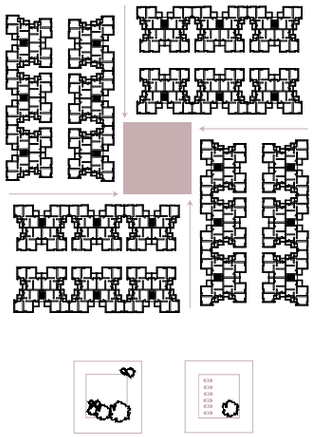
## NEIGHBOURHOOD

Grid

Low income

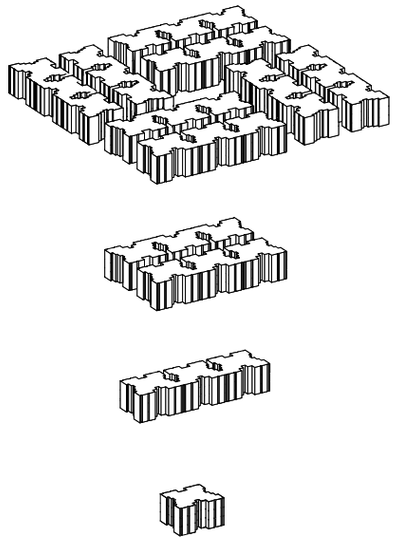
Shared spaces are found int the courtyards

## SHARED SPACES

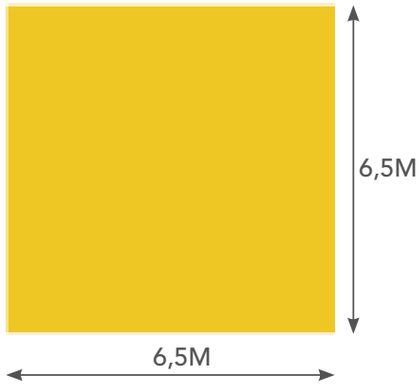


Shared space is found in the stamp level of the project in the form of a courtyard. This courtyard function is different for windmill cluster, parking, market or sports

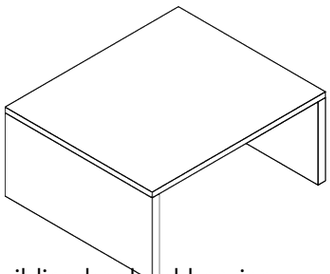
## CLUSTER



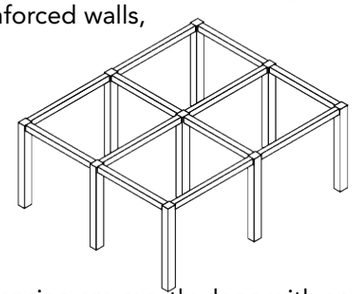
## MODULE SIZE




## STRUCTURE

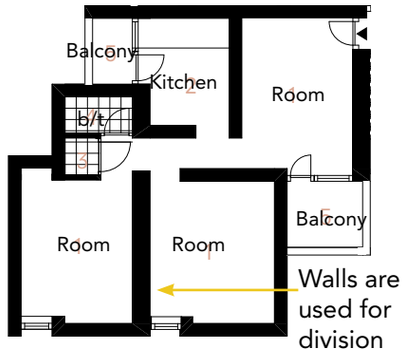


The building has load-bearing, reinforced walls,

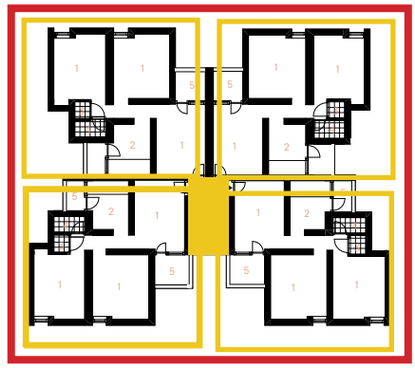


Extension are mostly done with an column structure

## DWELLING




A dwelling is made out of 3 rooms, kitchen and bathroom



A cluster is made out of 4 units and a circulation space. circulation space is small and does not ask for a lot of m2

# Pollutions

Figure 38 :Noise pollution during the day, P. Aung

During the daytime hours, the boundary between private and public are blurred. The home extends to the street, transforming it into a more economic place. Activities inside dwellings blends in with the activities happening on the street, like beauty parlors giving their services while people are having conversation on their otla's. The Neighbourhood during the day overlapped by multiple sounds, scooters and rickshaws driving by kids walking to school, people buying their groceries and sounds of machines coming from the workshops. The sounds that come from inside buildings blend in with the sounds that are produced on the street.

This blend of activities can be perceived as chaotic, unregulated and dense for an outsider. However, from an urban perspective this very active environment can also create a secure environment. The presence of homebased workers, shopkeepers and costumers creates an natural surveillance, providing continuous eyes on the road that naturally hinder crime, like Jane Jacobs argues in her book 'The death and life of great American cities', that a safe urban environment cannot primarily be maintained by formal policing but also needs unconscious and regular surveillance from residents themselves (Jacobs, 1961). Because of the thresholds overflowing to the streets, the street achieves an organic form of unconscious surveillance.

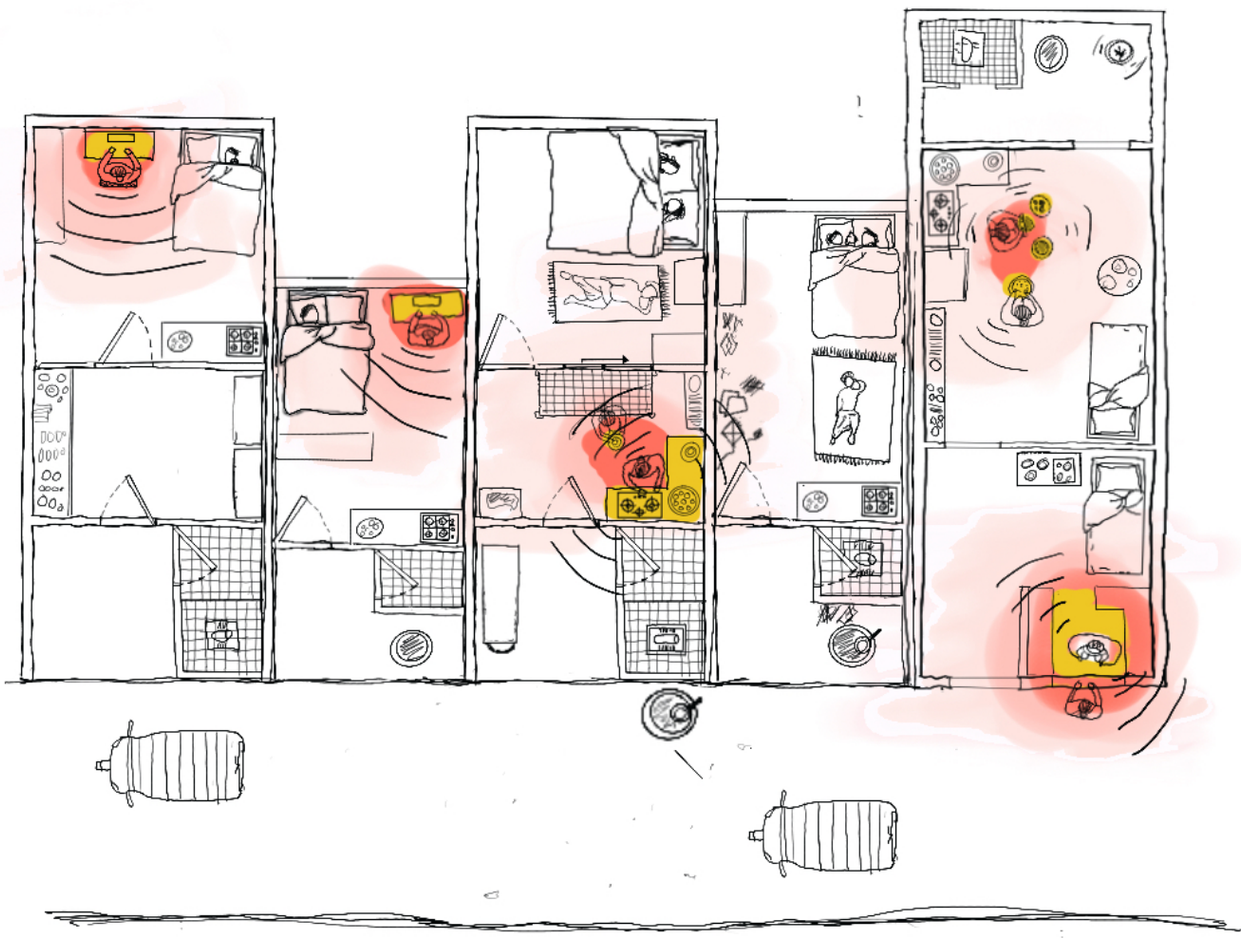


Figure 39: Noise pollution during the evening, P. Aung

As the sun sets the neighbourhood undergoes a spatial and acoustic transformation. The activities that happened during the day outside, retract back inside the dwelling changing the public space. At night the street noise drops significantly as workshops are closed, no street vendors and little shops are open, it transforms itself into an quiet residential area.

However, work does not completely stop. Work lingers insides of the dwellings where residents continue to work on their unfished work or prepare materials for the next day.

Because of the night transformation the natural surveillance of the street diminishes, it shifts from vibrant streets to quiet residential streets. Safety at night becomes dependent on minimal streetlight and soft murmurs that leak though people's houses.

Figure 40: Street Section Daytime, P. Aung

Following up on the plan, the section shows the relationship between the street and the dwelling. The floor acts next to a regular function of a street as an economic ground occupied by residents, rickshaws and vendors. The section highlights that homebased work occupies multi levels of space and urban safety is achieved through this.

Figure 41: Street Section Night Time, P. Aung

As night falls, the section shows that the street clears up, the economic activities retract back into the dwelling and the street functions back purely being a street. The street parallelly loses its 'active eyes, its shift from active, visible presence to passive awareness. Safety is created not because it is policed but because it is an arm reach or shout away.

# SHARED INFRASTRUCTURE

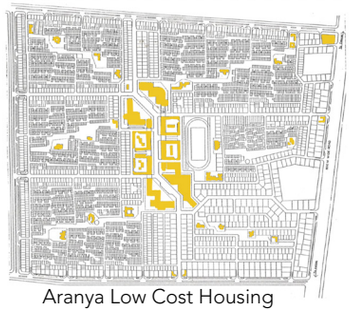
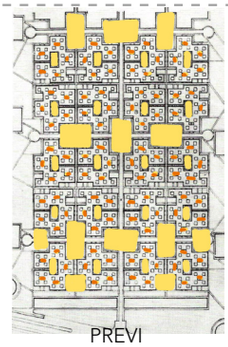
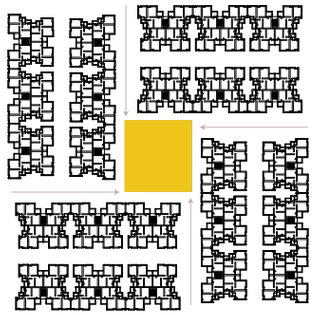
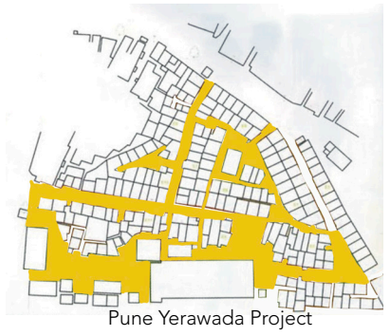
| | Social Housing | Renewal | Redevelopment |
|---|---|---|---|
| Production Pockets |  Aranya Low Cost Housing | | |
| Courtyards |  PREVI | | |
| Public Open Spaces |  Sola Road |  Pune Yerawada Project | Quinta Monroy |
| Otla's and galleries | | | Sanjaynagar |

Figure 42: Comaprative Frameworok Shared Spaces, P. Aung

Next to low-cost adaptive elements inside the home, integrating shared infrastructure can offer an alternative strategy for relieving spatial pressure within dual homes. Based on the case study analysis conducted earlier, a comparative frame was developed to categorize the shared spaces in four typologies:

Production pockets:
Creating designated zones within the neighbourhood to gather, socialise and practice economic activities. This externalises work from the house but also creates pockets that can zone different pollutants like sound and waste.

Courtyard:
Courtyards are a open air extension of the dwelling, these are voids that can be combined with the neighbour to form a larger plot, it offer flexibility and direct access.

Public open space:
The public space is a space accesble for everyone, in lack of space people reach out to the streets. Creating bigger pockets of open space in the urban fabric allow residents to use these pockets as gathering space.

Otlas and Galleries:
As mentioned before the otla plays a vital role in residence daily live. Formalizing these elements expanded provides the community with more functionality

Concluding, the spatial pressure does not only require you to only choose between open or a rigid floorplan. It must be integrated into a layered spatial adaptivity. A solution to overcrowding in high-density urban environment is not a matter of expanding private square footage, but of purposefully designing the collective spaces. When production, material storage, gathering places are incorporated in shared infrastructure, the physical spatial pressure on the home drops. This externalization ensures that local economic productivity can actively thrive within the public while restoring the privacy of domestic activities.

# CONCLUSION

Driven by the main research question "How can a low-cost housing design create a spatial mediate between domestic life and home-based work, allowing for flexible spatial use to balance economic productivity with domestic privacy and social life?", the research concludes that the solution lies in a multilayer spatial adaptivity and is supported by four sub-questions:

At the dwelling scale, the fieldwork reveals that the dwelling functions as an intensive economic space rather than only residential. Because this dwelling experience spatial pressure, residents endure an inescapable gaze of labour, rearranging their homes across a 24-hour cycle to prioritize work by day and clear space for sleeping at night. This permanent visual confrontation with tools and materials blocks essential psychological detachment, causing constant domestic strain. To relieve the strain a bit micro zoning interventions are implemented. Residence uses low cost element as visual buffers, like textile or position of large furniture like wardrobes to interrupt sightlines. But also externally, the otla (threshold) are used as an extension of the house, acting like a secondary living room that shields private interior from the public and can also be used as an economic space.

At the dwelling scale, the fieldwork reveals that the dwelling functions as an intensive economic space rather than only residential. Because this dwelling experience spatial pressure, residents endure an inescapable gaze of labour, rearranging their homes across a 24-hour cycle to prioritize work by day and clear space for sleeping at night. This permanent visual confrontation with tools and materials blocks essential psychological detachment, causing constant domestic strain. To relieve the strain a bit micro zoning interventions are implemented. Residence uses low cost element as visual buffers, like textile or position of large furniture like wardrobes to interrupt sightlines. But also externally, the otla (threshold) are used as an extension of the house, acting like a secondary living room that shields private interior from the public and can also be used as an economic space.

These interventions have externally effects, shaping acoustic and social safety around the dwelling and street. During the day, expansion od the home towards the street, for socialising but also economic activities making the neighbourhood vibrant and dynamic. While this dynamic along the street can appear chaotic to an outsider, it creates organically a safe environment because of the natural surveillance, where their continuous eyes on the street. When the sunsets, the public realm undergoes a metamorphosis. Workshops close, homebased economic activities retract back inside and people preparing to rest. While the bustling street empties out, the urban safety transitions into a state of passive awareness knowing there is help is always within a simple shout or arm's reach.

Ultimately, finding a solution requires looking beyond the private property lines. The case studies shows that this constraint within homes can be systematically relieved by party externalizing labour into a shared infrastructure.

By establishing dedicated neighbourhood production pockets to isolate occupation practiced by many, designing courtyards as flexible temporal expansion zones, shaping public open spaces as places to come together and integrated otlas and galleries as extension of the private dwelling. Together this creates a shared network system stat can unload the spatial pressure, providing the physical infrastructure necessary to protect privacy while sustaining economic livelihoods

In conclusion an effective spatial mediator within high-density urban fabric, design interventions must operate across two scales: Internal Micro-Adaptability and External Shared Infrastructure.
Internally, design must break the inescapable gaze of labour. Upgrading fabric division elements to folding or sliding doors allowing the room to expand for production or close for more privacy. This can be paired with furniture walls. Providing built-in storage allows raw materials and tools to be completely stowed away during hours of rest, providing residents to achieve psychological detachment from labour while preserving scarce space.
Externally, the solution is not expanding privately to achieve privacy but designing a shared network system. Shared production pockets isolate industrial noise, while clustering housing units around communal courtyards creates an unbuilt buffer zone that can absorbs daily economic activities and preserves the home as a private domestic space for the family. This 2 scala framework ensures economic productivity without having to compromise privacy and safety of the home.

# SITE ANALYSES

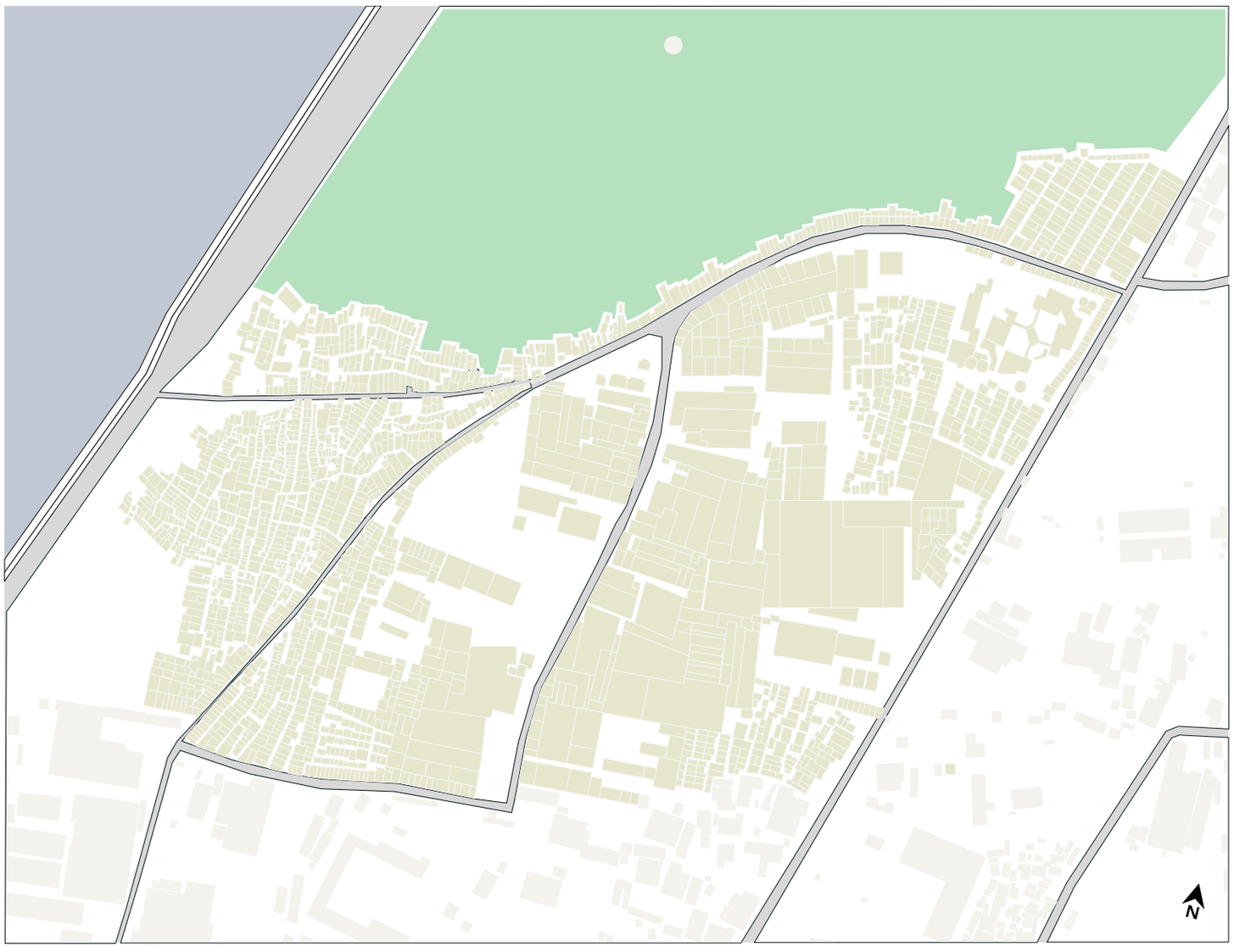



Figure 43: Current Calico Mill site

The design process began with a layers site analysis, mapping the built and unbuilt, street network and land use. This revealed shortfalls in amenities and open space in the neighbourhood. To improve the infrastructure strategic demolition will be executed, resulting to a masterplan with enhanced connectivity, amenities and accessible open space.

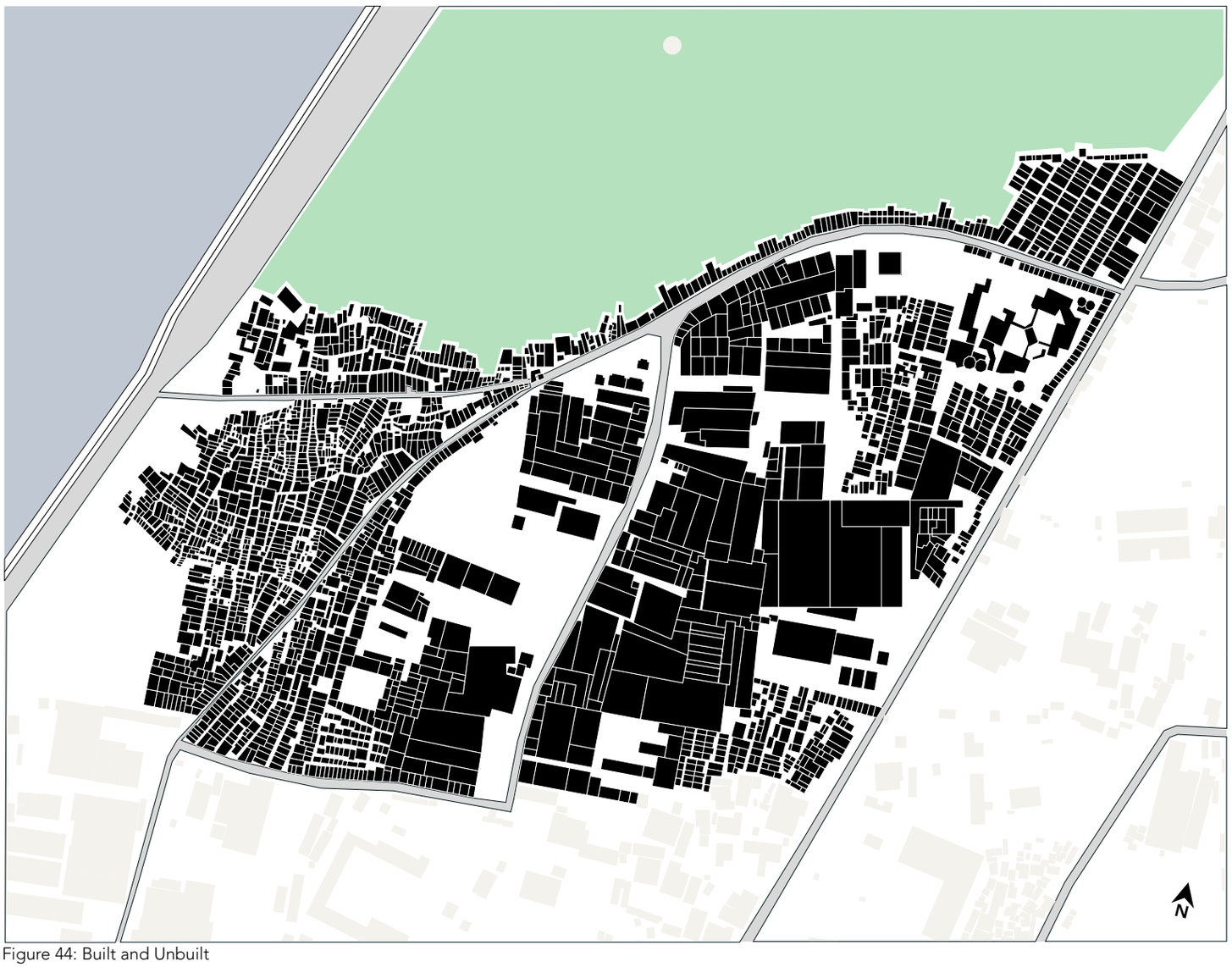



Figure 44: Built and Unbuilt

Built-Up Area

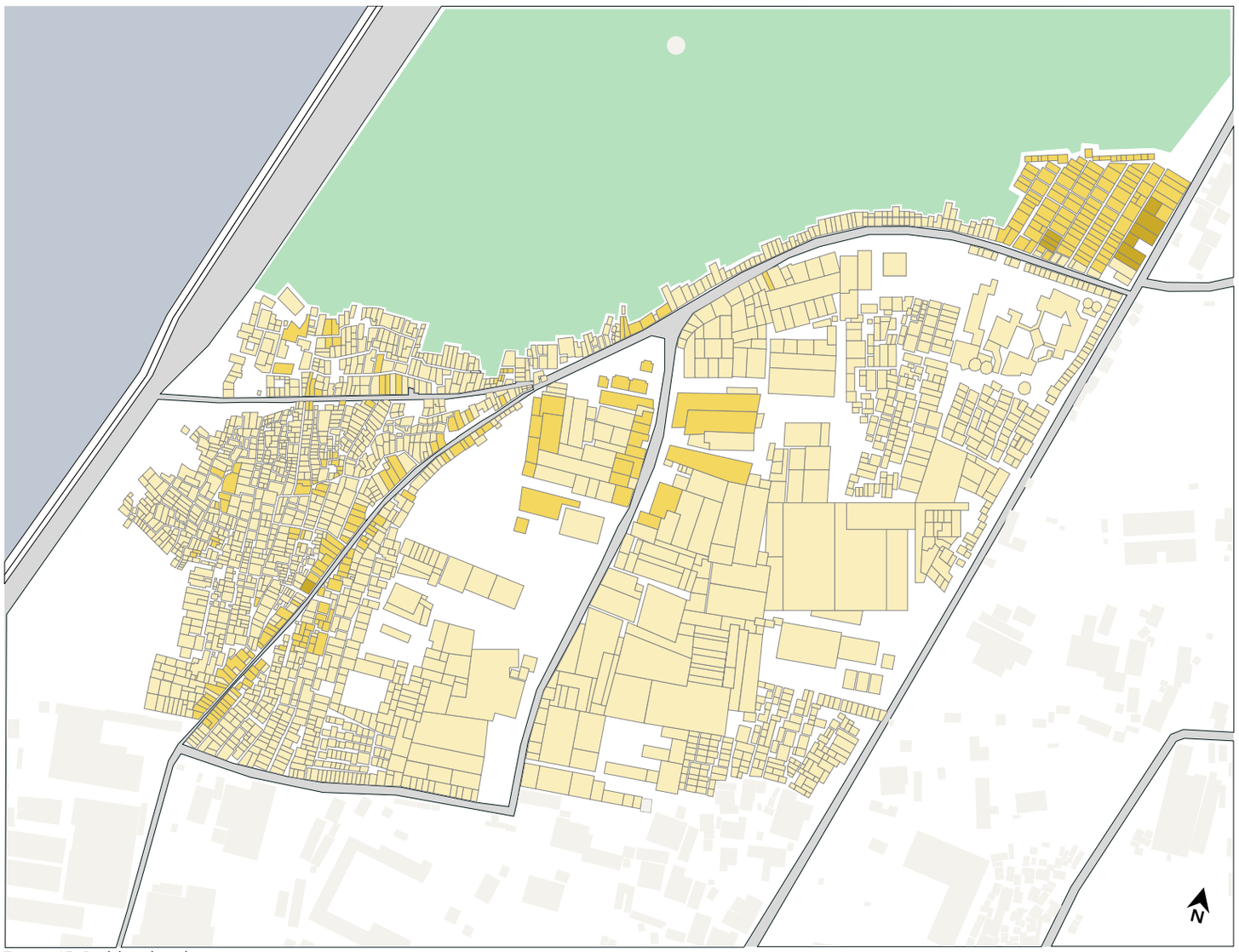



Figure 45: Building heights

G

G +1

G +2

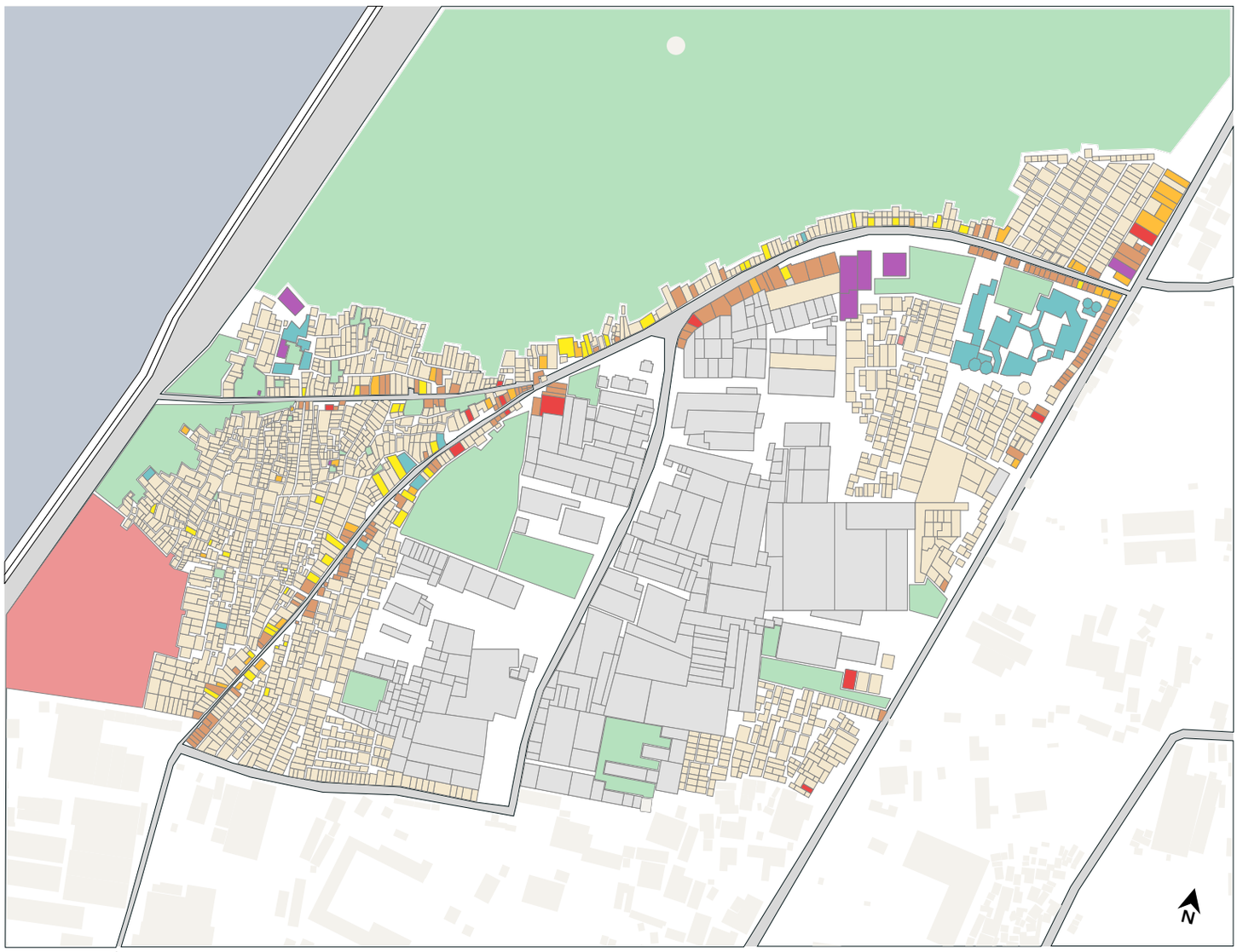



Figure 46: Land use

Residential
Commercial
Food and Drinks
Living and Work
Religious
Social
Medical
Education
Factories
Open Space

Figure 47: Seen Dual Homes

Living and Work

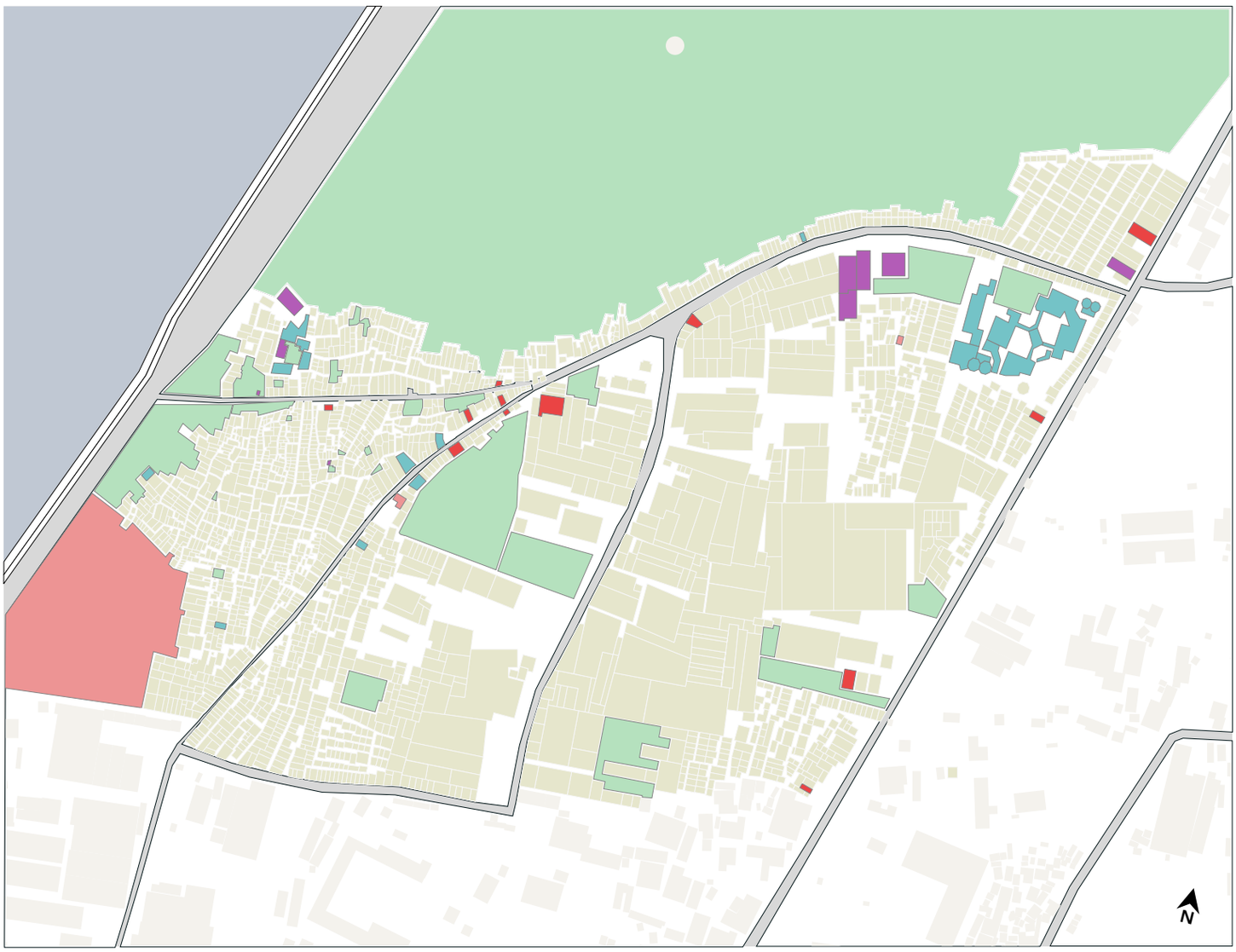



Figure 48: Amenities

Religious
Medical
Social
Education
Open Space

Figure 49: Open Space

Private Open Space

Public Open Space

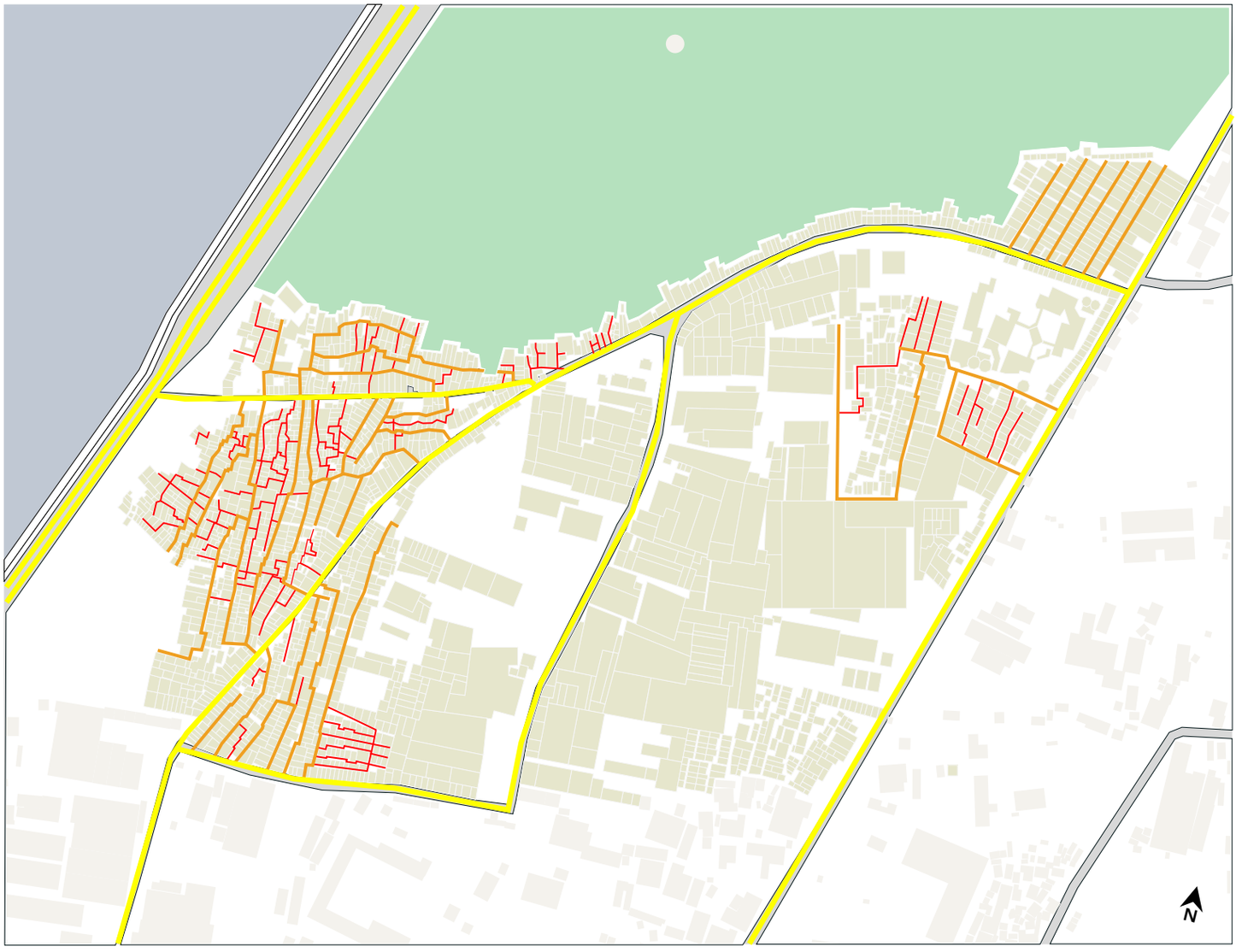



Figure 50: Existing Road Network

Main Road

Secondary Road

Tertiary Road

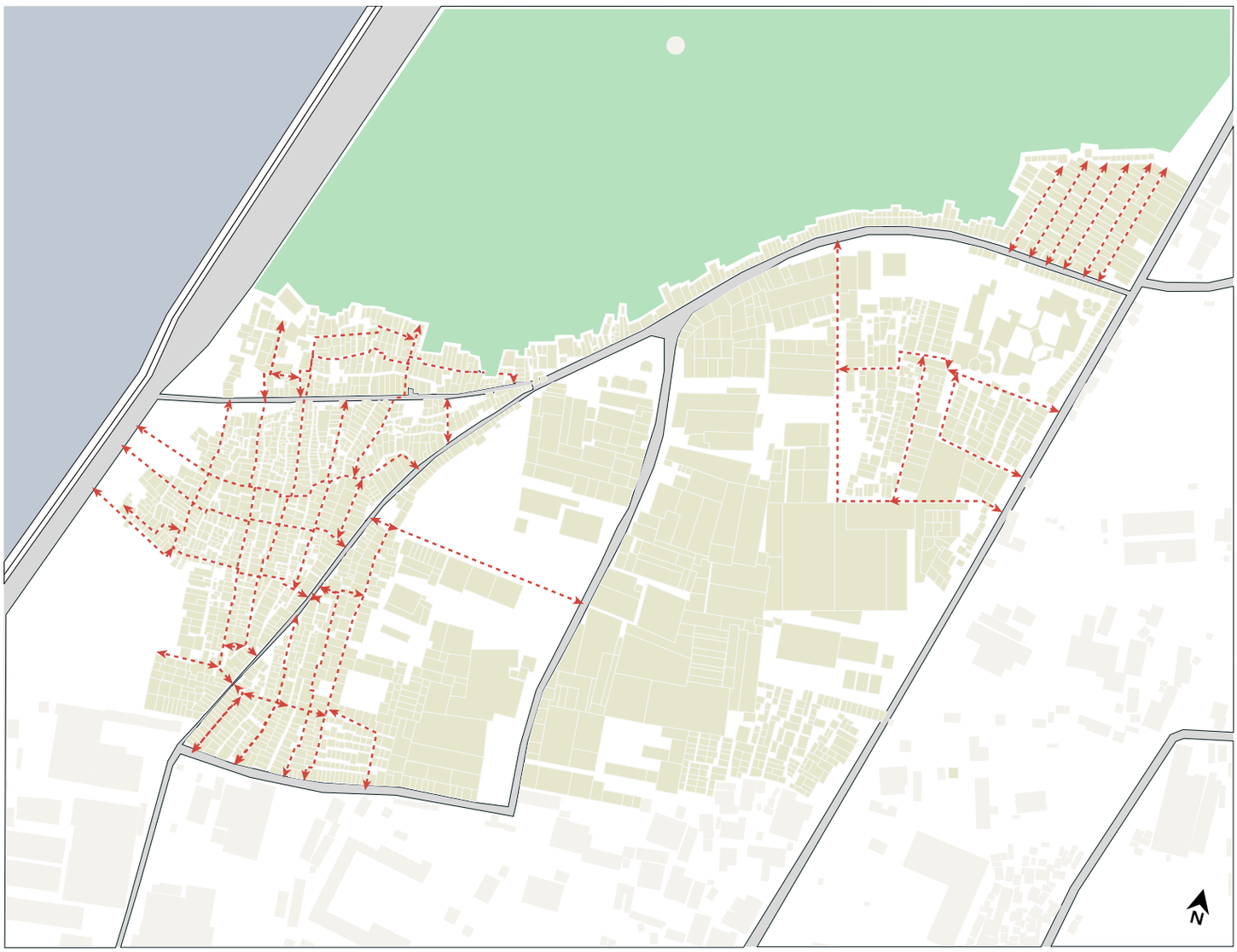



Figure 51: Reconeccting Roads in the new situation

Strenghtening Existing Roads

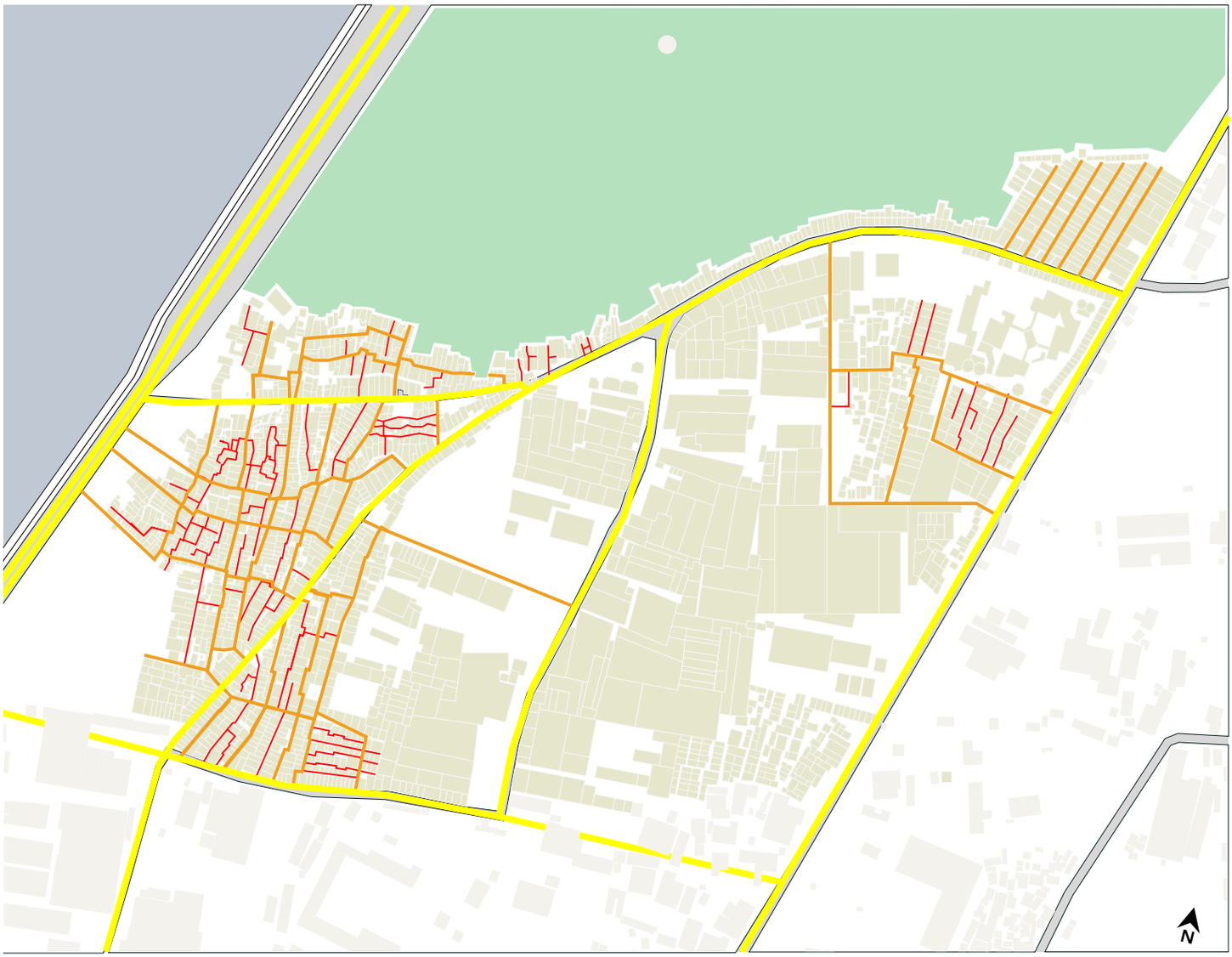



Figure 56: New Situation Road Network

Main Road

Secondary Road

Tertiary Road

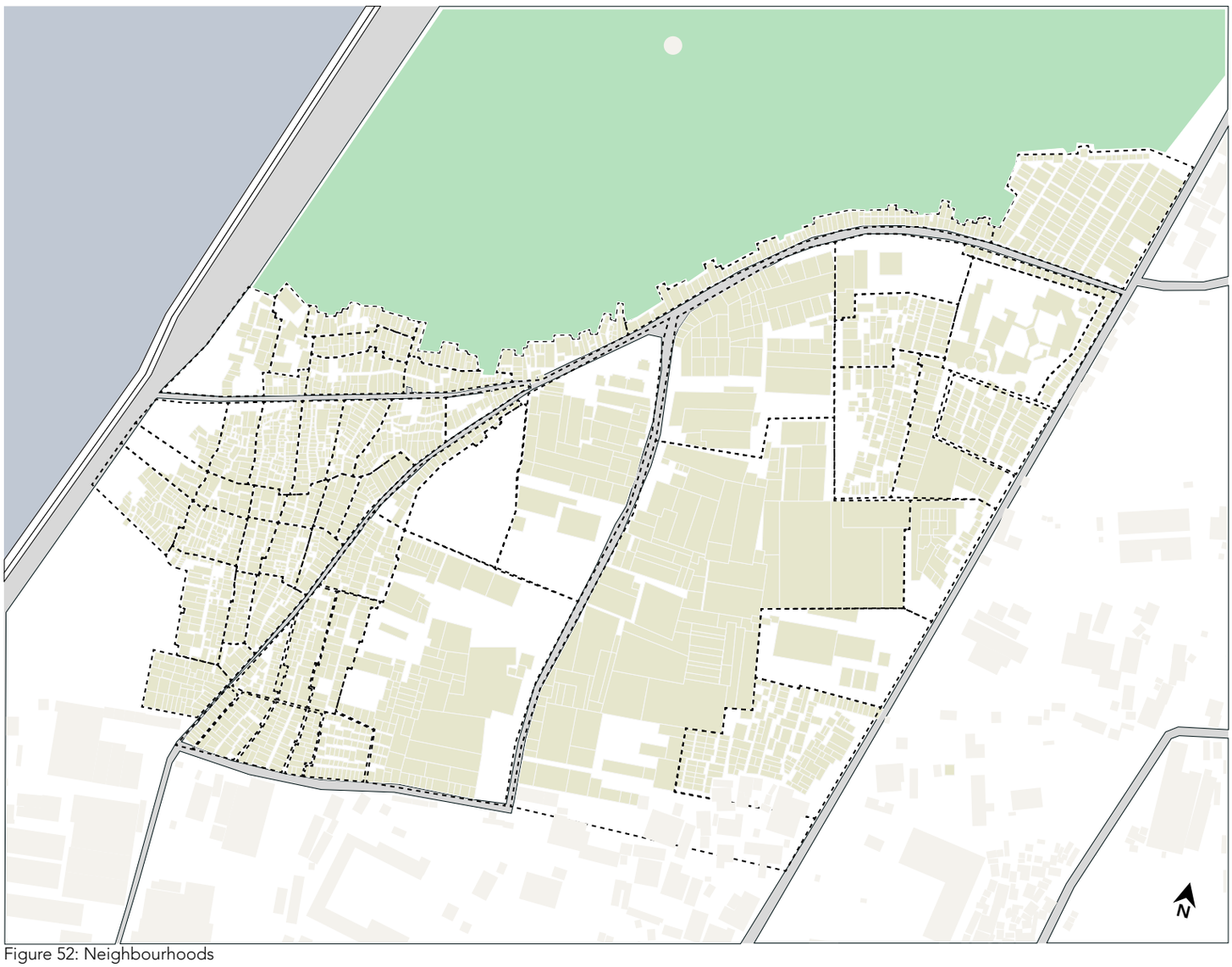


Figure 52: Neighbourhoods

---- Districts

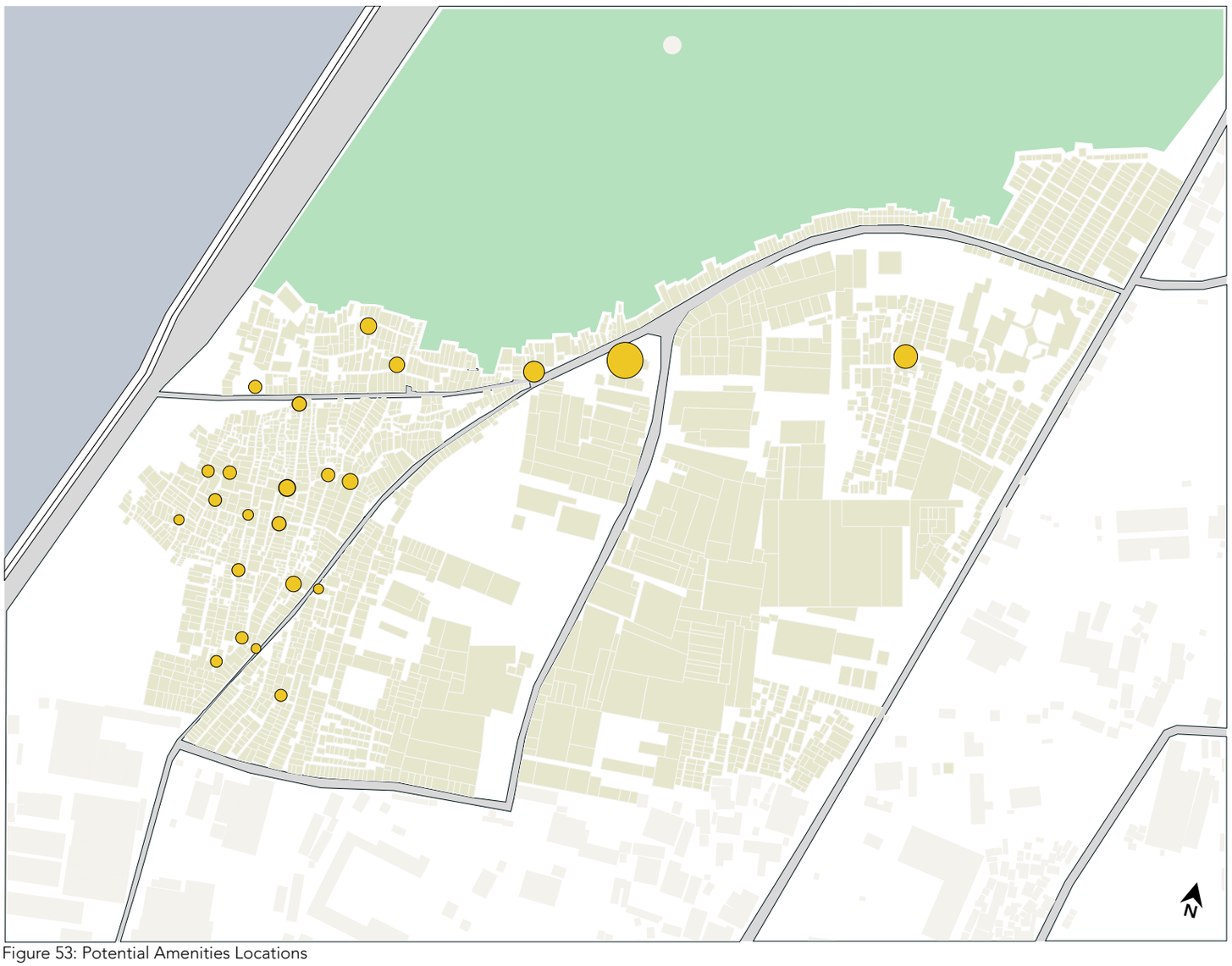



Figure 53: Potential Amenities Locations

Potential New Amenity Location

At every intersection of district is a opportunity to place a amenity, this can be in the form of a open space where people can gather for festivities or economic activities like a market. But also spaces for schools, healthcare or shared workspaces and shared storage spaces for the home-based workers.

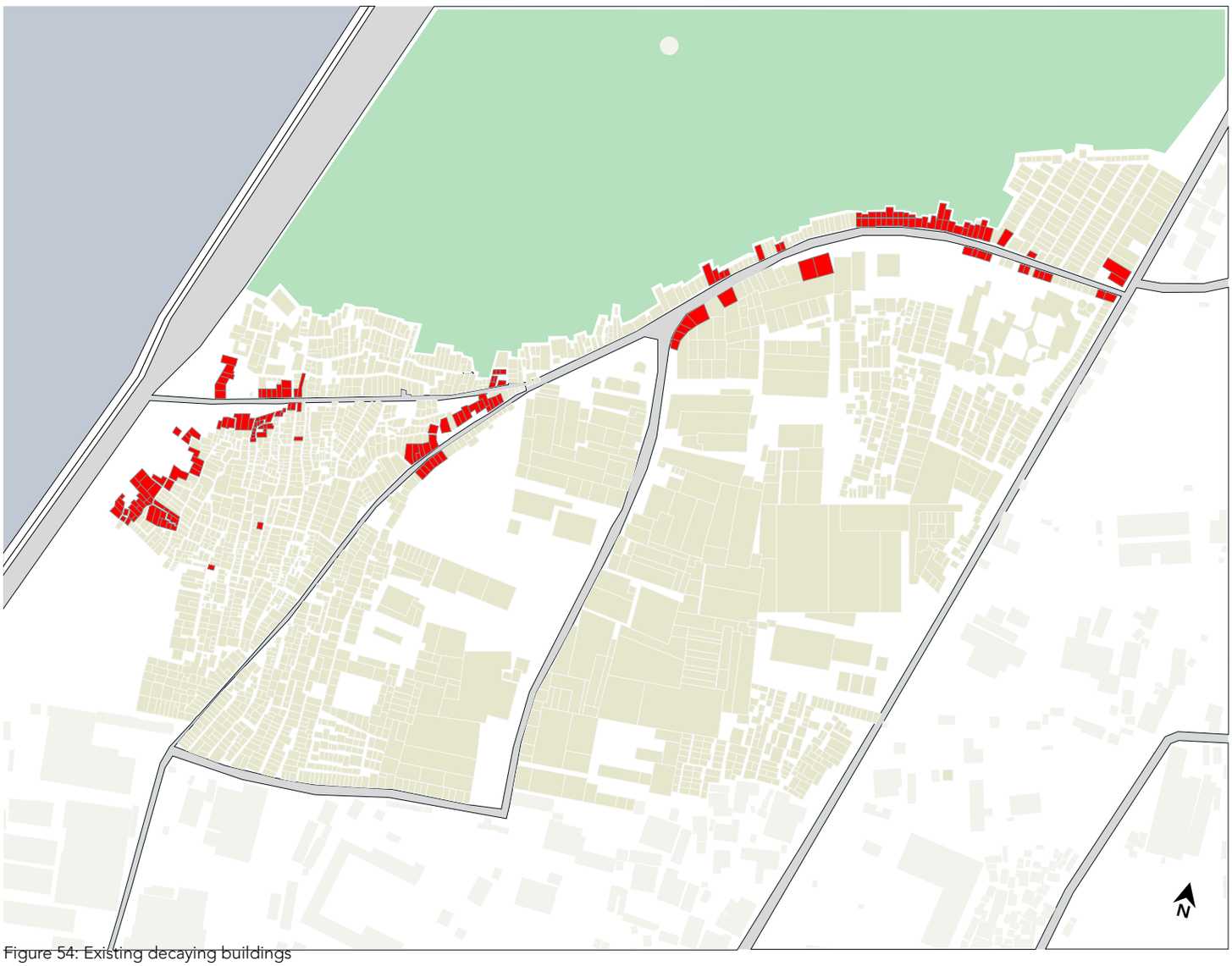



Figure 54: Existing decaying buildings

Decaying Buildings

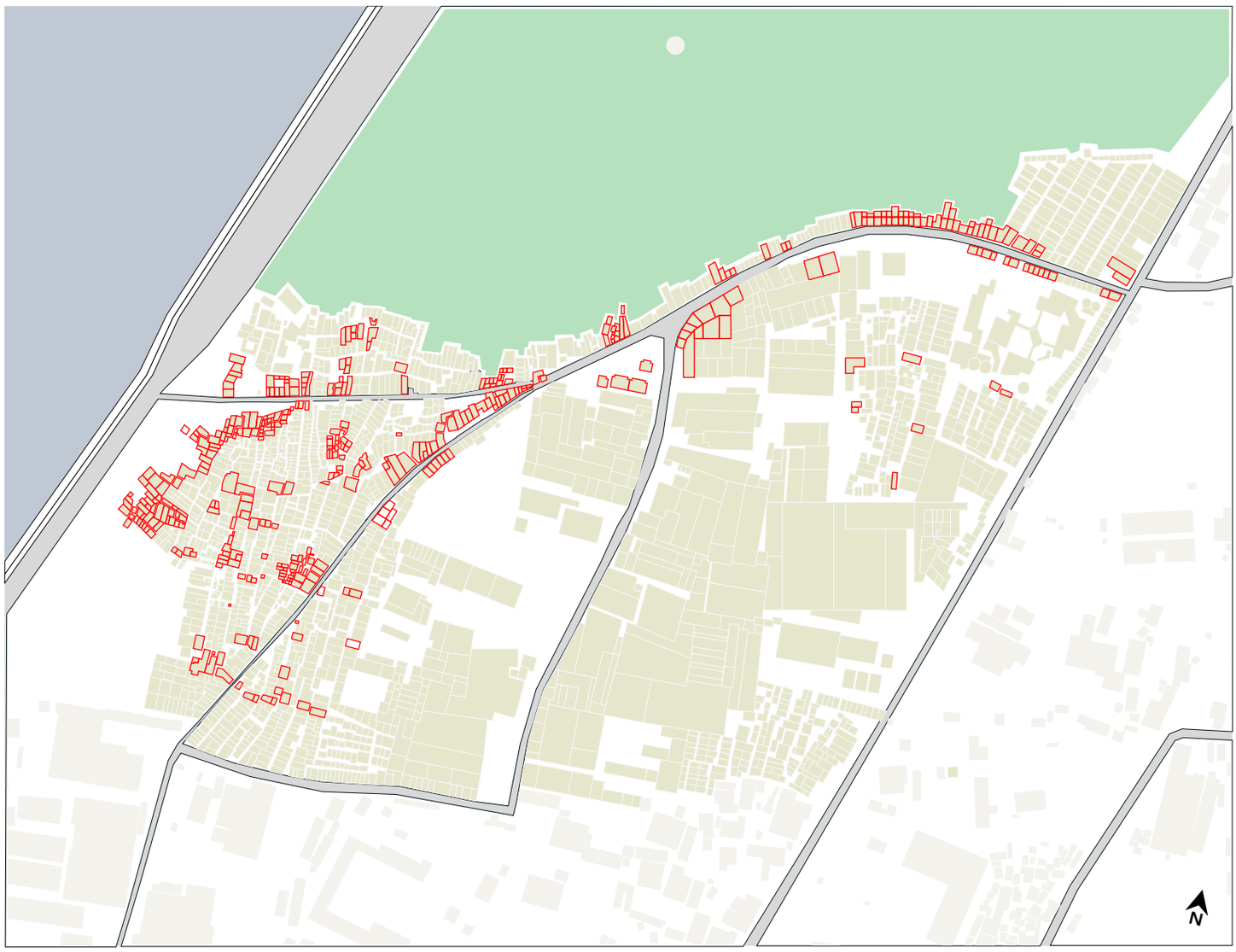



Figure 55: To be demolished for the new situation

Demolish

The buildings that will be demolished are the decaying buildings and the building that needs to be demolished for a better road connectivity in the Calico Mills.

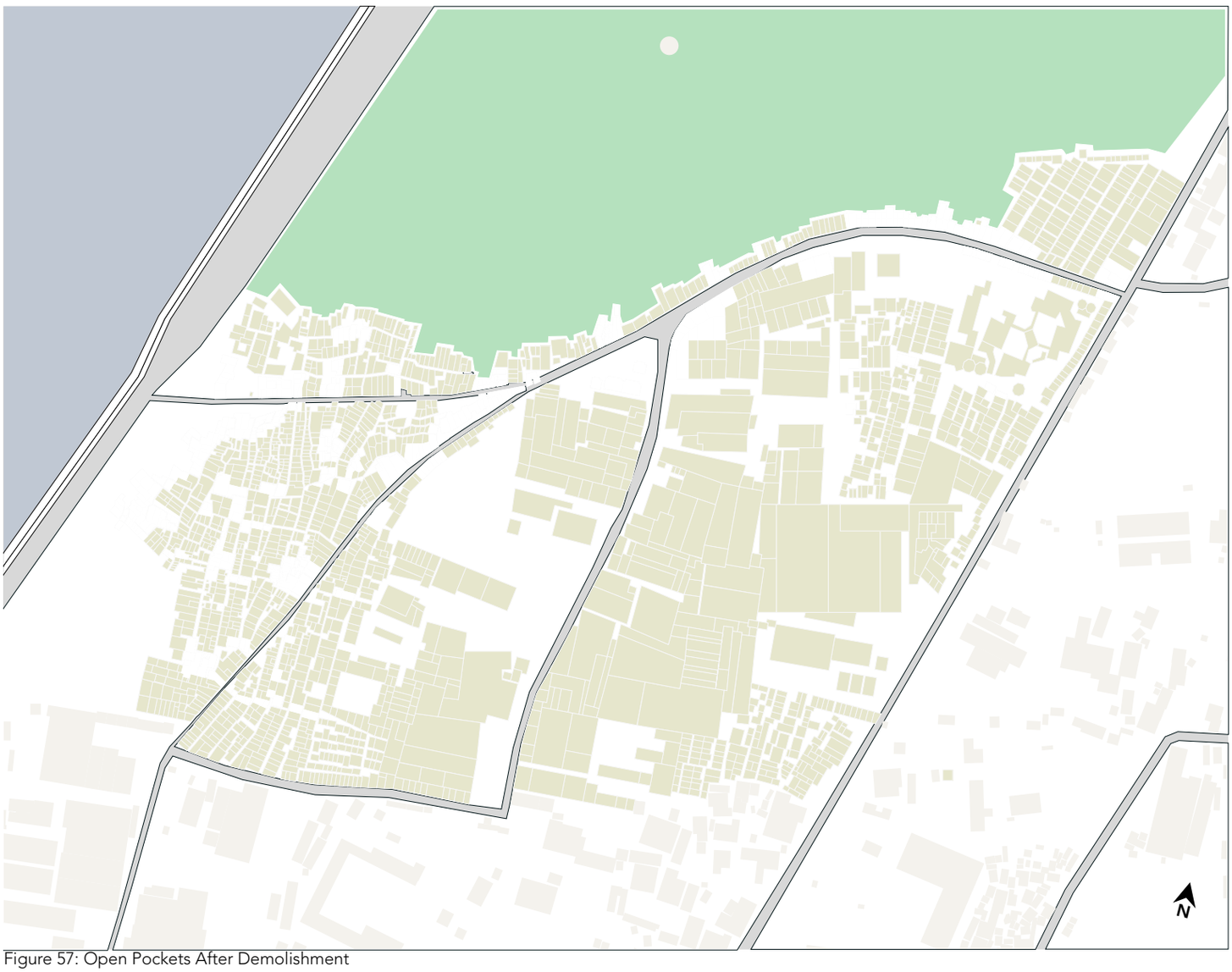



Figure 57: Open Pockets After Demolishment

Open Pockets After Demolishment

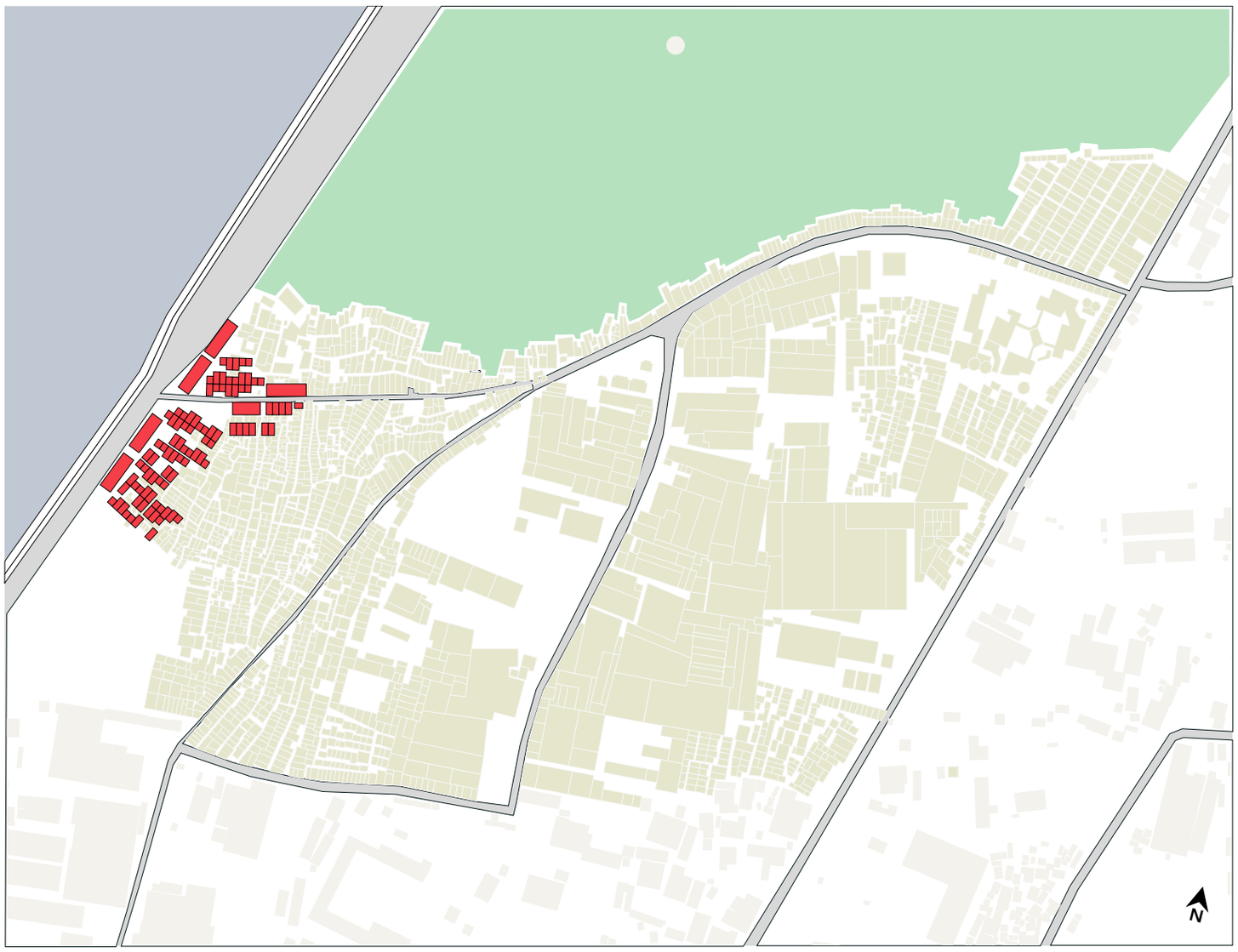



Figure 58: Phase One

New Buildings First Phase

The projects start with building in the open and cleared spaces on the riverside. These buildings initially will be used as transition dwellings, where residents can temporally live while their own dwelling are under construction.

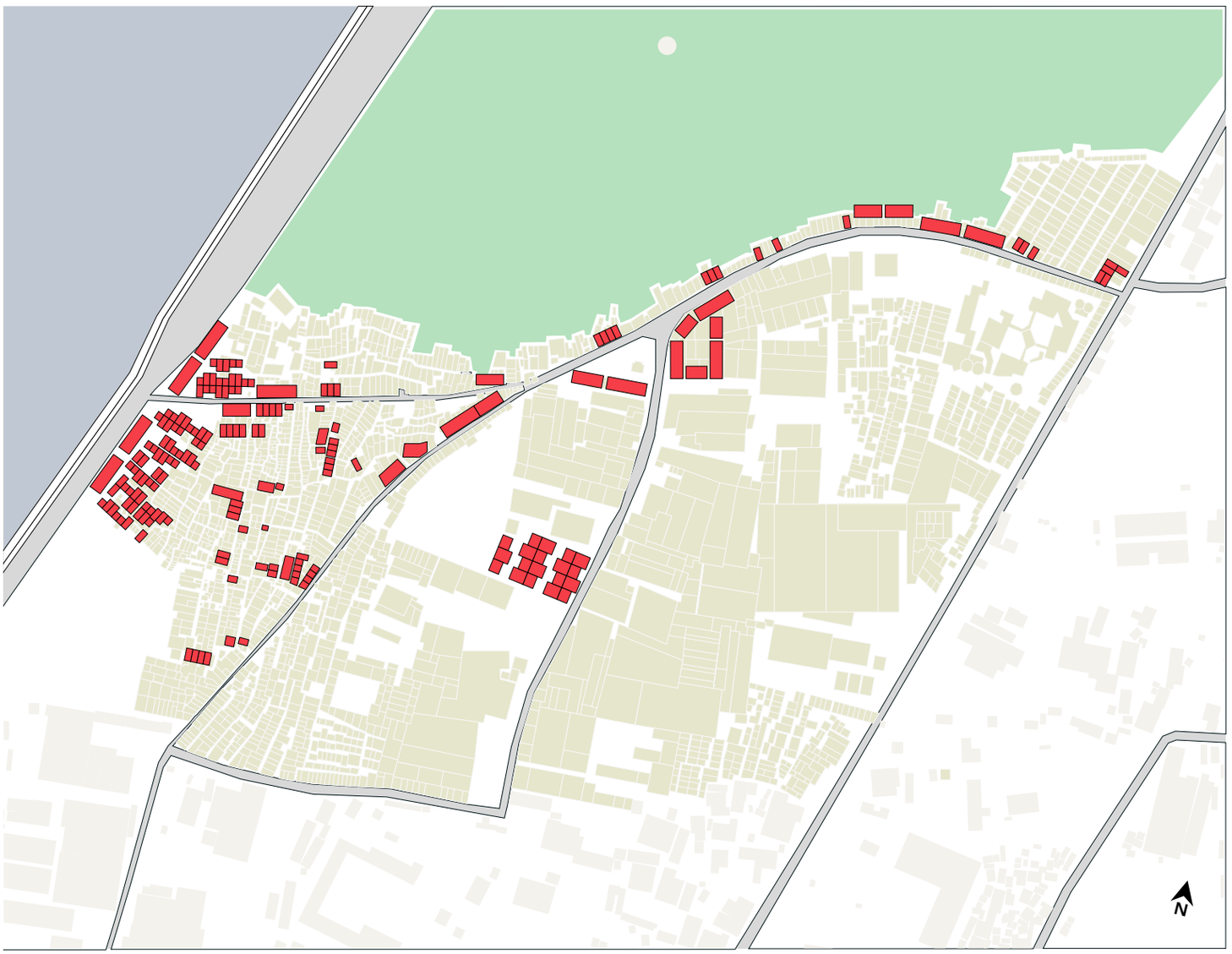



Figure 59: Masterplan

New Buildings Second Phase

The second phase exist from acupunctural intervening in the actual dens site. This can be continued over the years based on the wishes for redevelopment of the residents.

Figure 59: Masterplan

# DESIGN

As a result of the research conducted on home-based work and workers at the Calico Mills, a design phase been developed to address the main research question: "How can a low-cost housing design create a spatial mediate between domestic life and home-based work, allowing for flexible spatial use to balance economic productivity with privacy and social life?" One of the key elements of this project is to work within the existing context. To support this, a site analysis is executed and a catalogue of dwelling typologies has been developed as a guideline for interventions at specific sites. This catalogue shows spatial strategies such as plans, circulation, massing, and the potential integration of shared spaces. Furthermore, the design chapter elaborates on each typology in detail, floor plans, sections, elevation, details and visual impressions. Together, these elements transform the research findings into a architectural design that addresses to both the spatial and social conditions that is needed to create a dual home.

# Typology catalogue

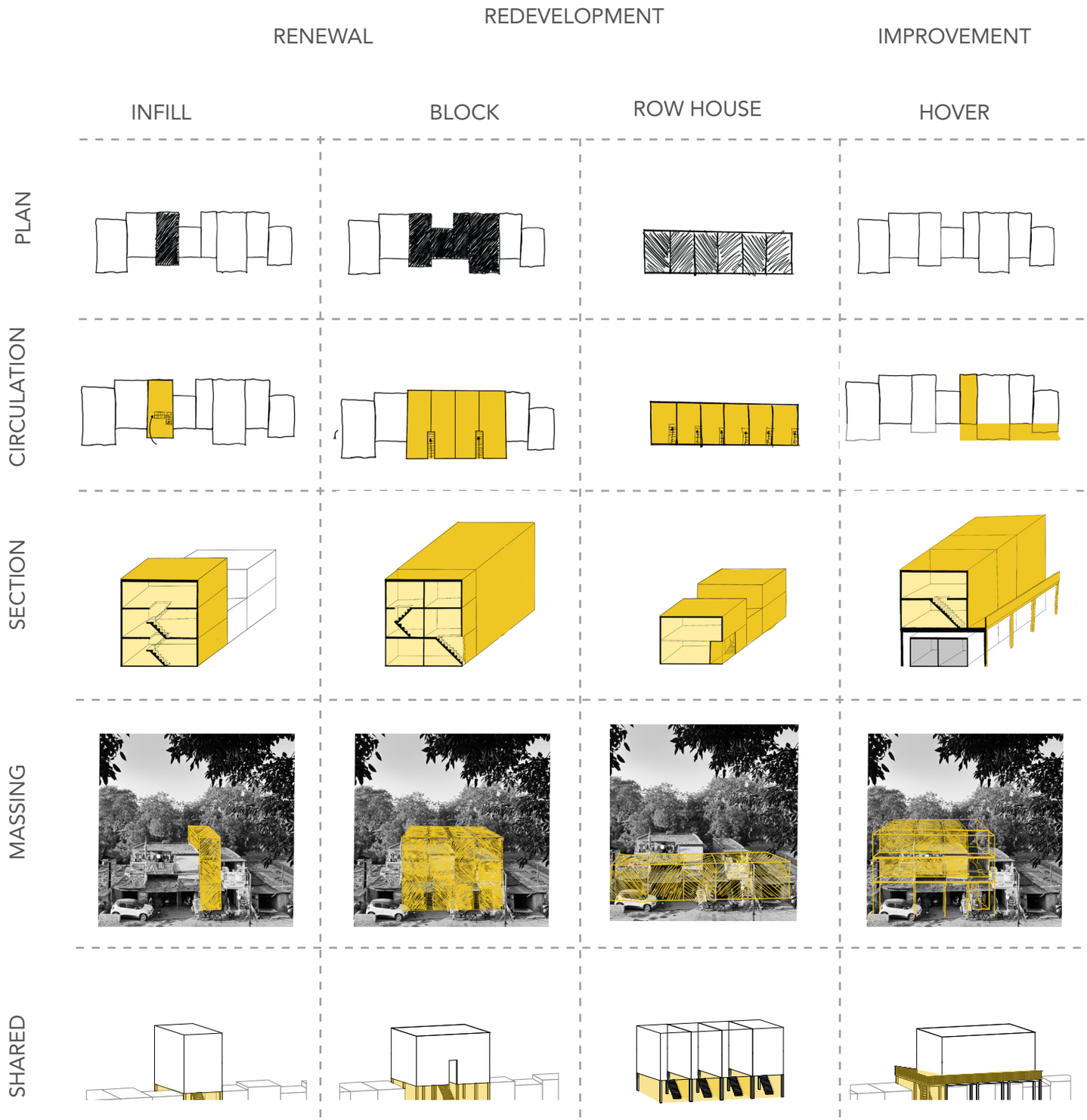
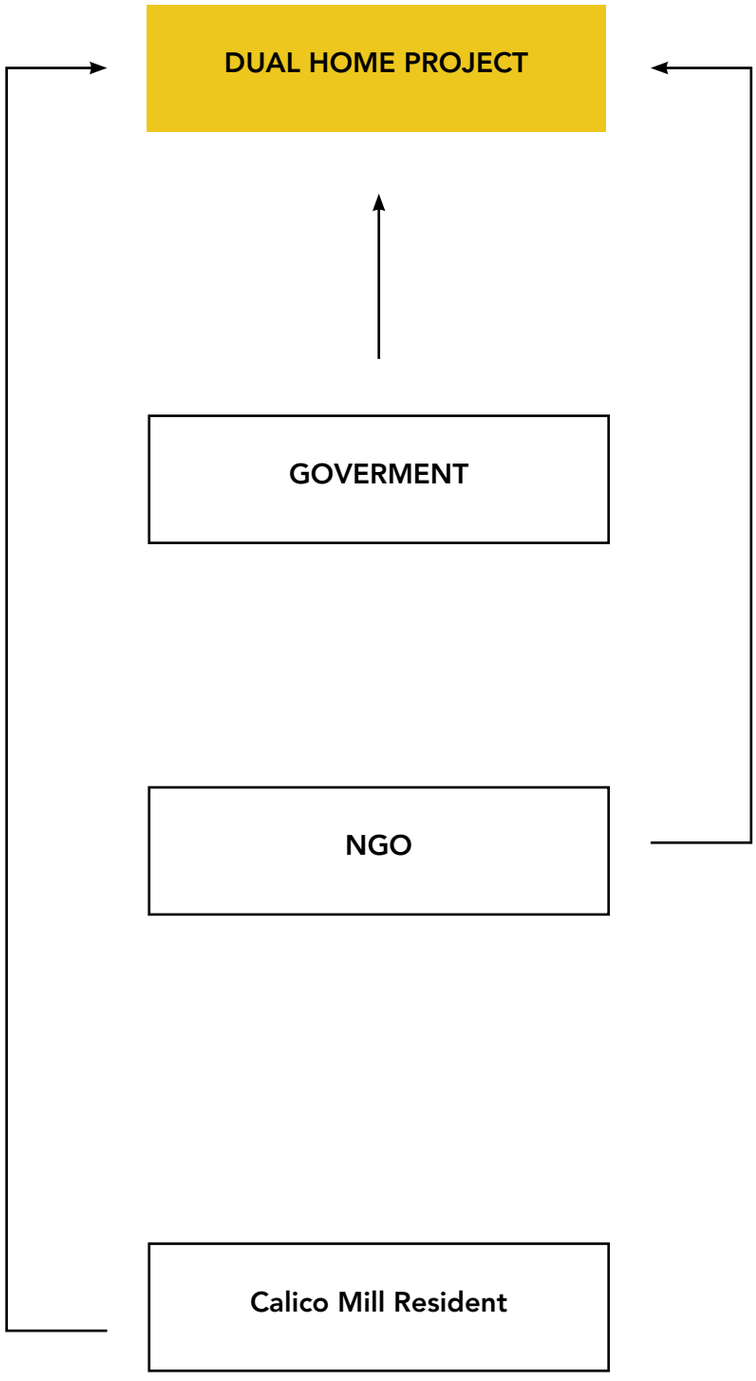



Figure 60: Catalogue Typologies

# Managerial Strategy




To ensure the financial viability of the project a tripartite cost sharing management model will be deployed, this means that the responsibilities of the cost will be divided between the government (local government), NGO and involved Calico Mill residents. A similar approach like the pune Yerawada Slum upgrading project in Pune. Where they had a cost division as follows: 50% Central gocerment, 20% State Government, 20% Local Government and lastly 10% the residence.

Under this framework the local government will secure baseline capital subsidies and ahdle infrastructural essentials to the building site. To bridge the remaining gap the project will partner with a NGO like Saath, SEWA where they had a similar role in the Slum Networking Project: the Sanjay Nagar Pilot project.  In that project the NGO acted the bridge, they organized collective micro saving so residents could accumulate the finances until required contribution to the project and micro lend money. They served as financial trustees.

# MATERIAL

Ahmedabad is shaped by a diverse architecture from traditional pol houses to modern brutalist using different. As The Global Housing studio a material research was conducted focusing on the material that was found in the buildings of the researched case studies.

For this project brick, steel and concrete are used for the materialization.

Steel is used structurally in the project. The primary reason for choosing this is because of its high strength to weight characteristics and easy transportability. This was a critical factor when navigating through a dense area like the Calico Mills with narrow streets Furthermore because of its high strength, the thinner structural element can be used for the project that builds for different scenario's and also where there is minimal space wasting less scarce are in the dwelling.

The facade of this project is made out of brick with plaster and paint and glazed tiles.

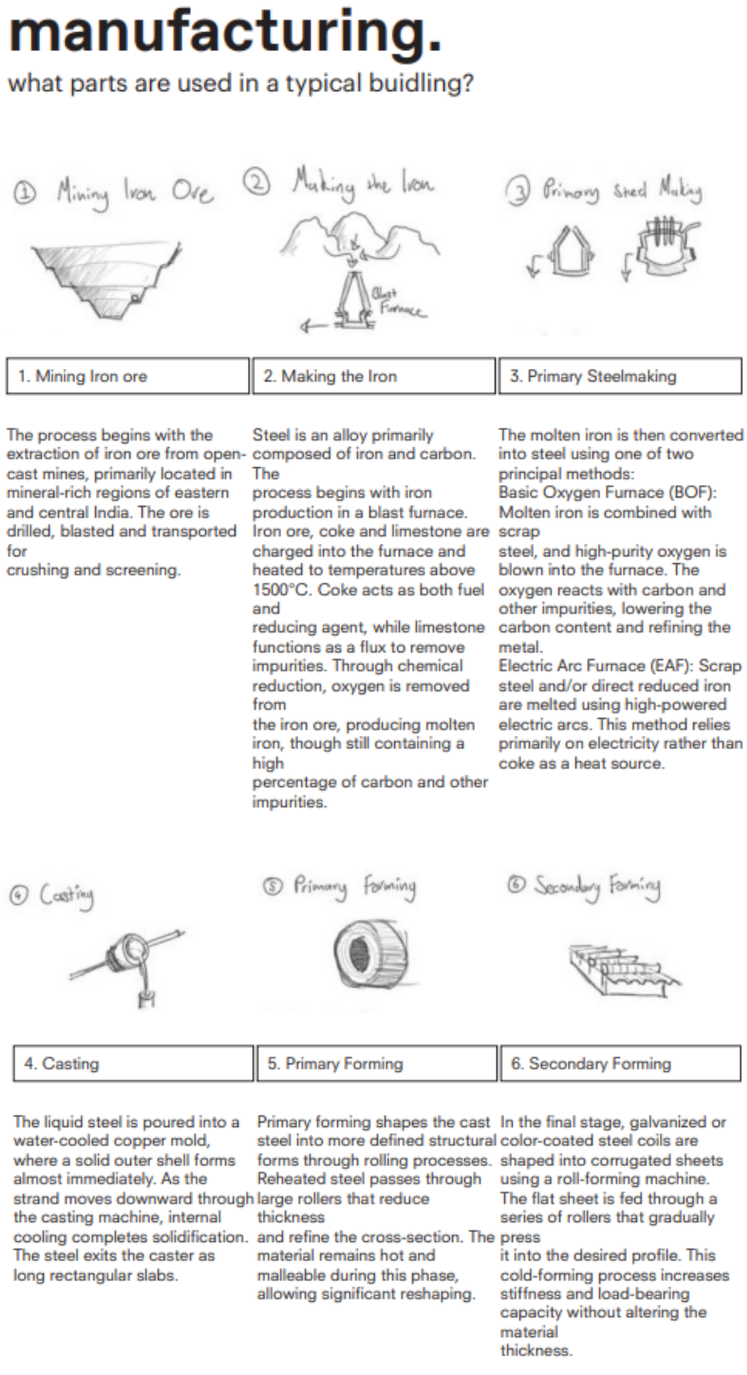



Figure 61: Steel Manufacturing, Global Housing Materials

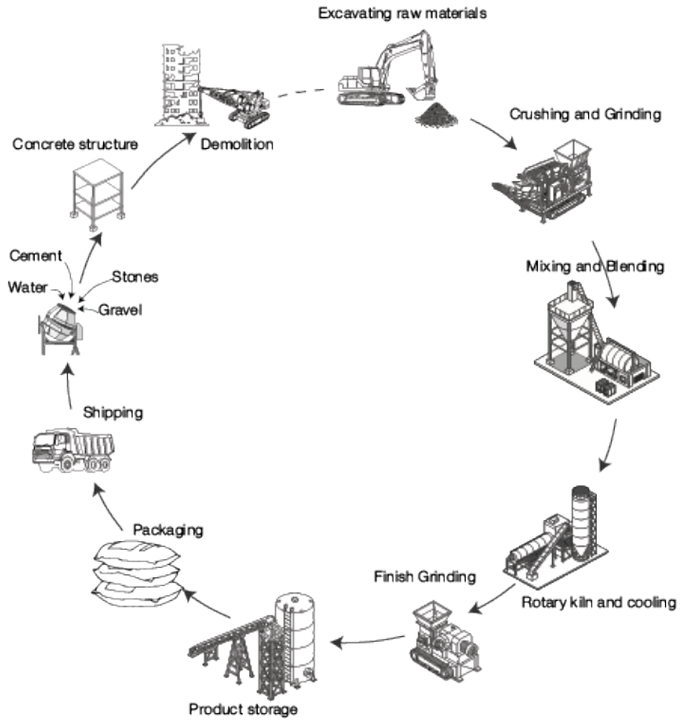



Figure 62: Cement Chain Structure, Global Housing Materials

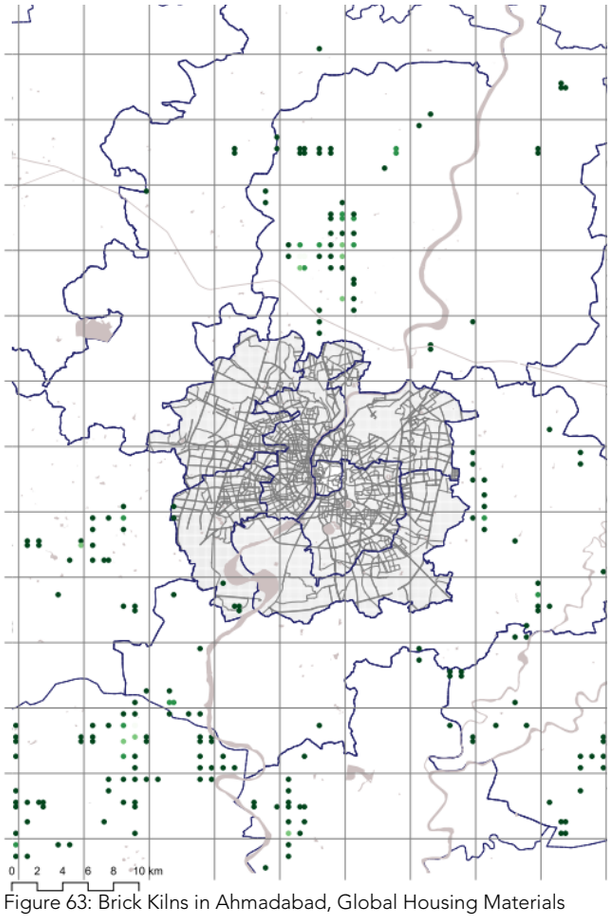


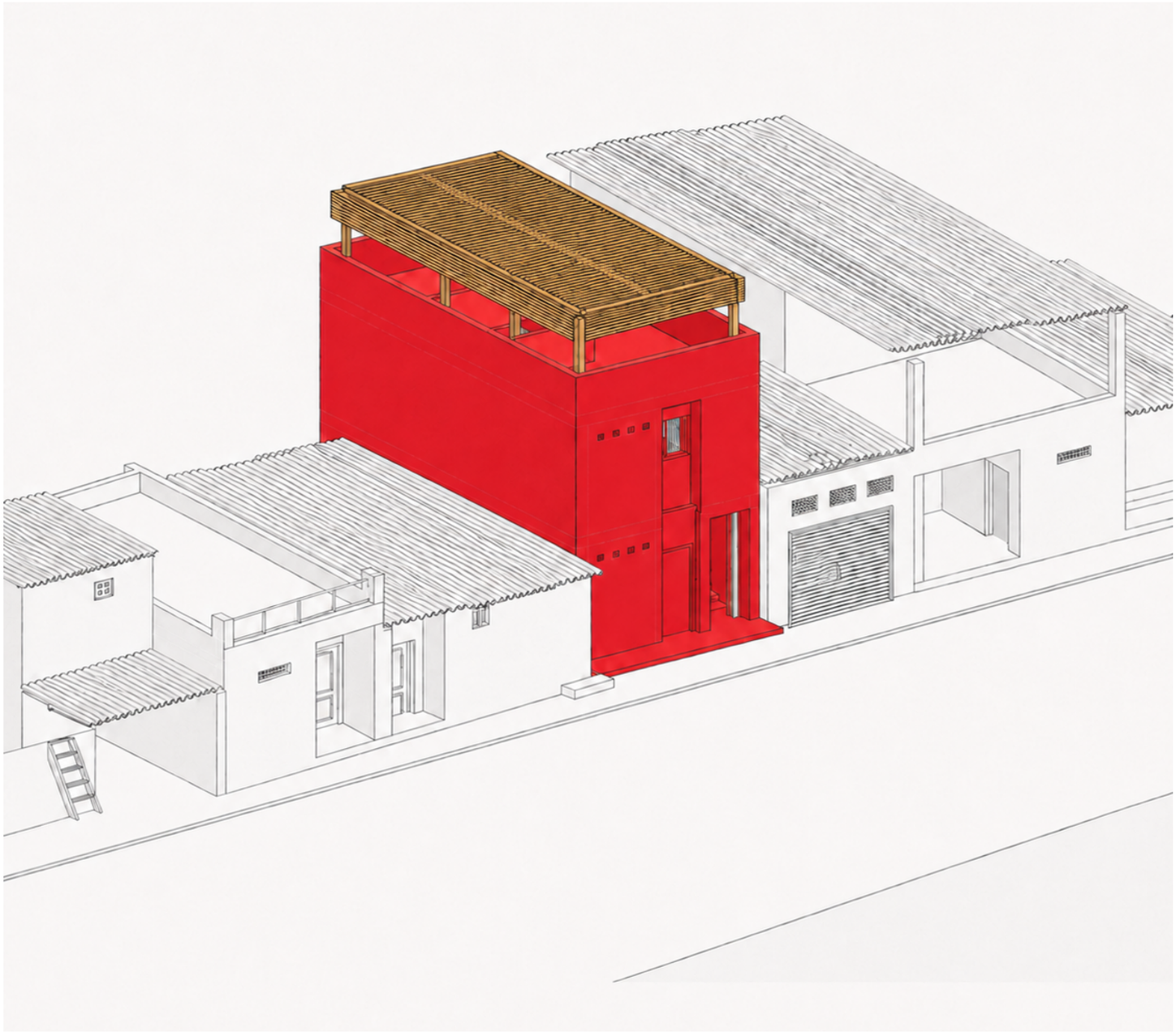

Figure 63: Brick Kilns in Ahmadabad, Global Housing Materials

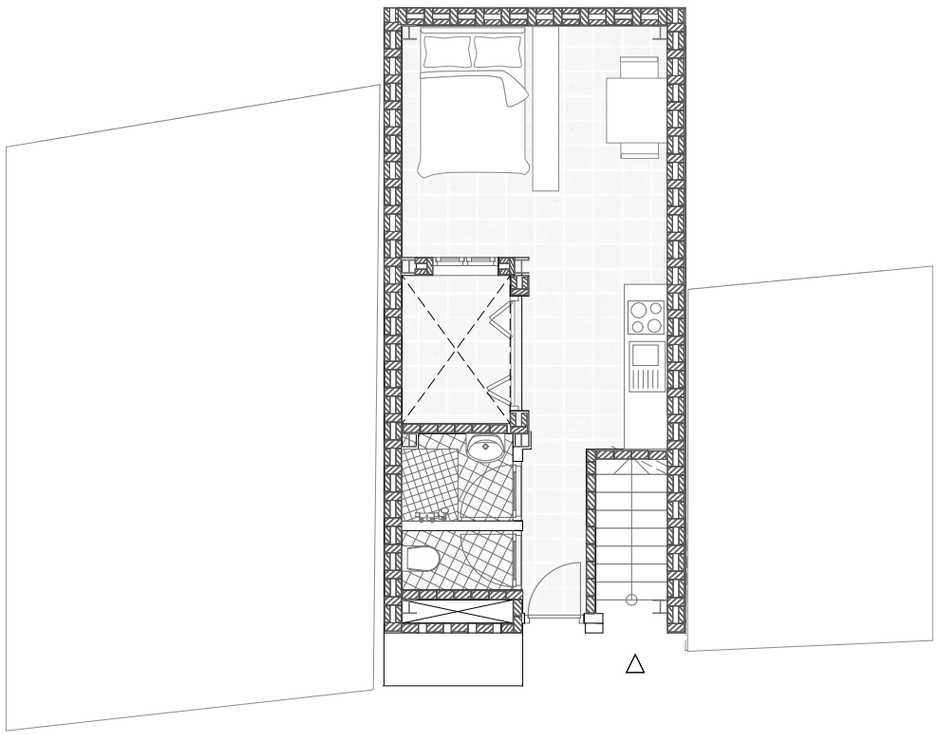
Next to steel as structural material, concrete is used for the project in the form of stairs and slabs. Concrete slabs are selected to create a solid and continuous surface. The mass of the concrete slabs dampens noises between floors, providing a more comfortable acoustic environment especially with the homebased work during the day.

Brick is primarily used as walling in this project. Brick is a local, available and low in cost compared to other partition materials. The Project has a rat trap bound, the reasoning for this bound is because you need to use less material and is provides more thermal comfort because of the void that can be found. The project maintains an exterior wall 230 mm (one full brick length) and a interior wall of 115mm (half brick length)

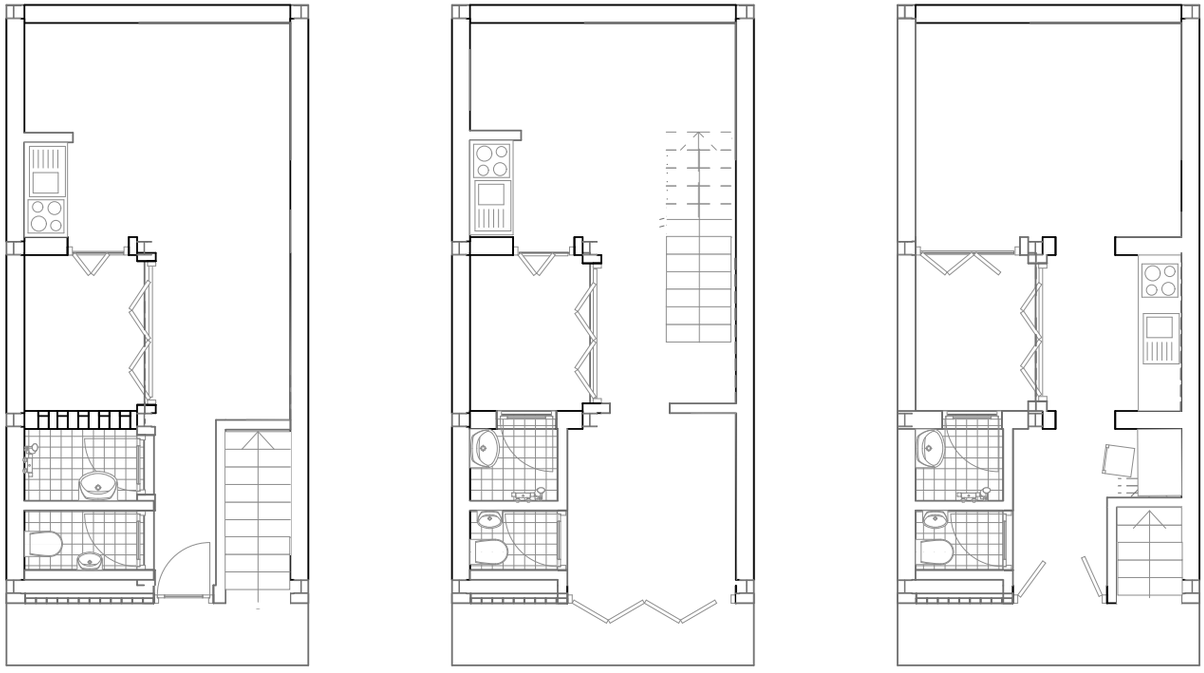
# INFILL

The infill typology applies to situations where only a single house is being renewed. This approach allows individual families to upgrade their homes. The standard infill house features a footprint of 32 square meters, with opportunity for future vertical expansion.

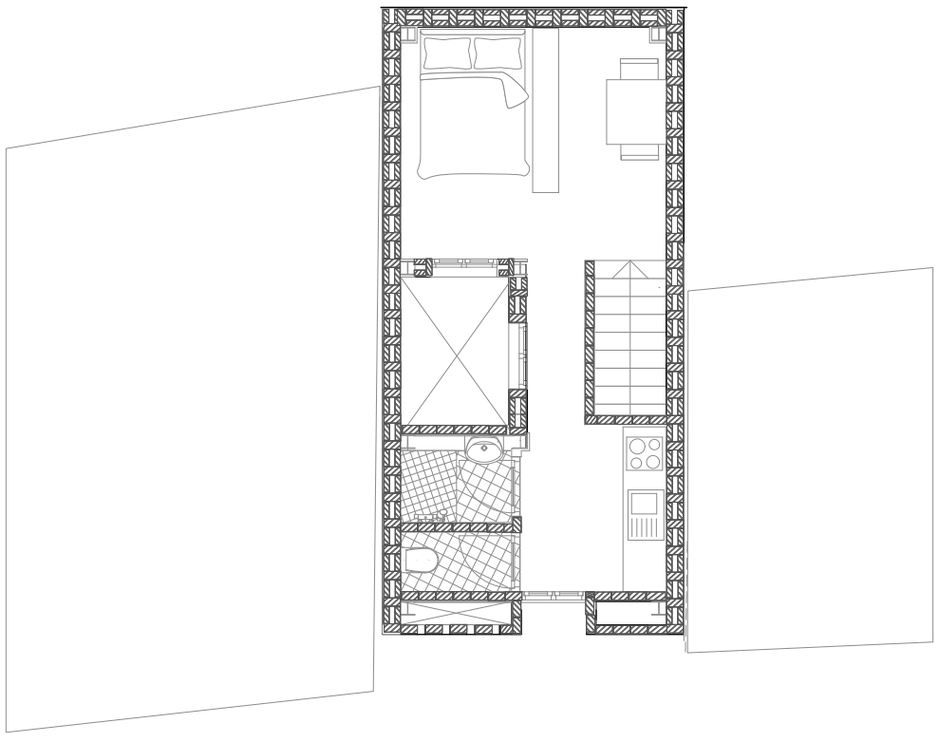




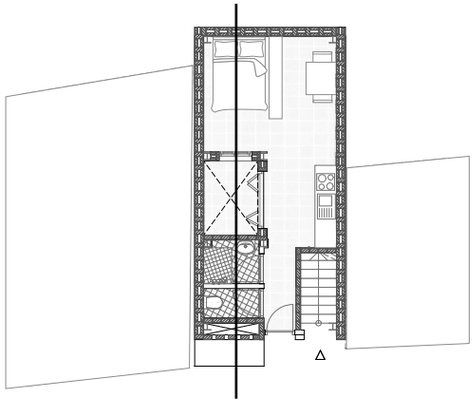
INFILL Ground Floor 1:100



INFILL Ground Floor Options 1:100



INFILL First Floor 1:100



SECTION 1:100

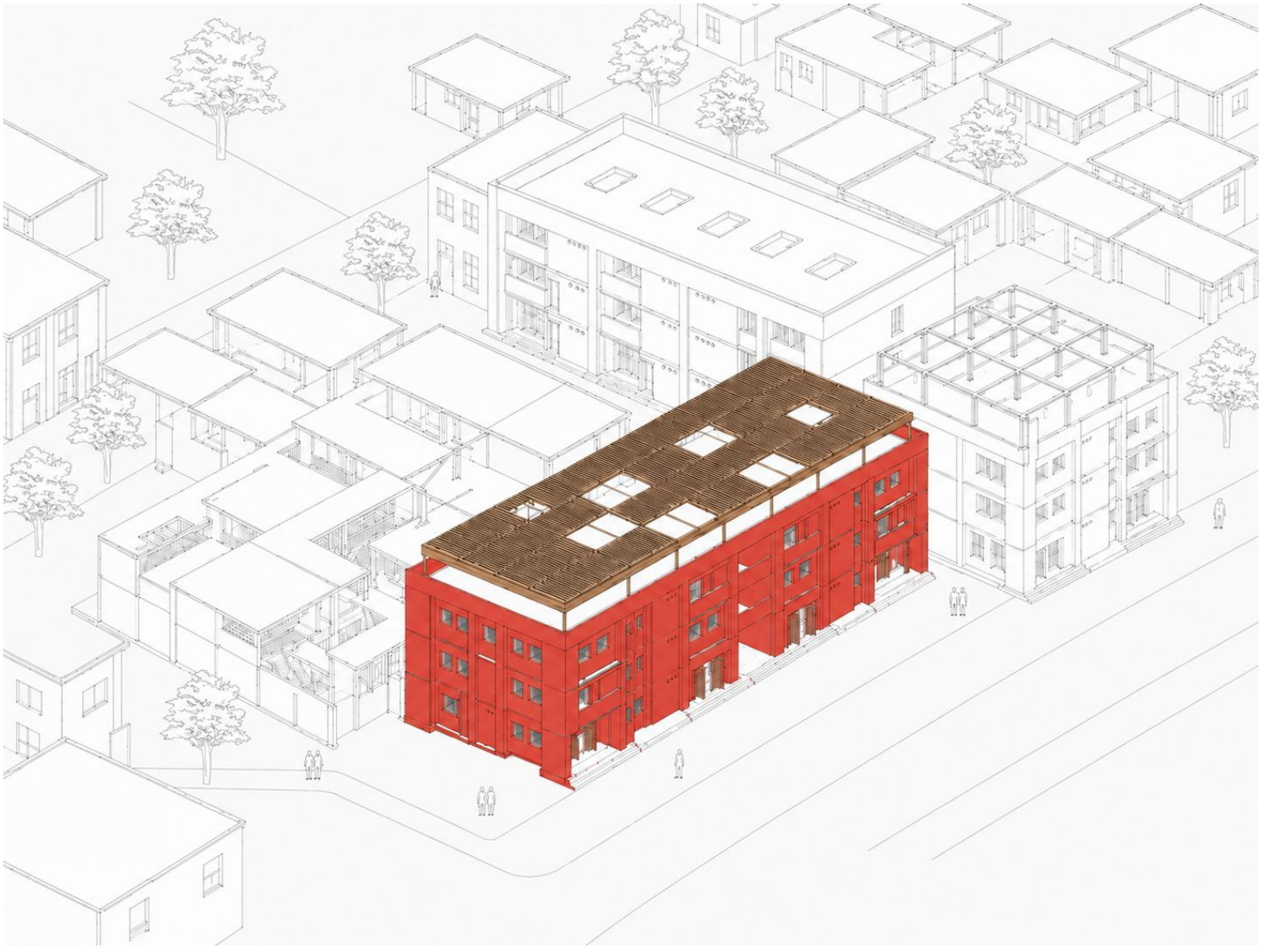
Front Facade

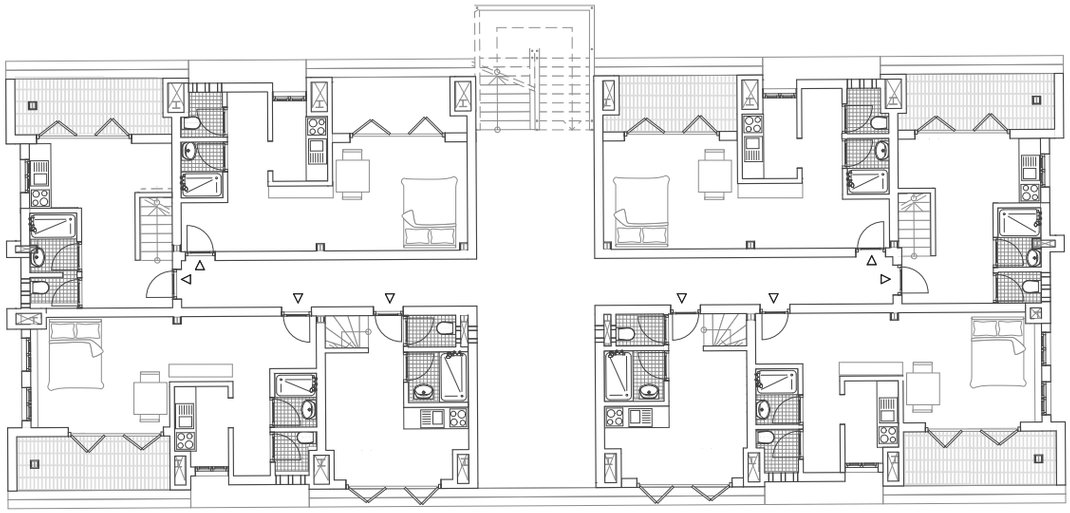
SIde Facade With Courtyard

# BLOCK A

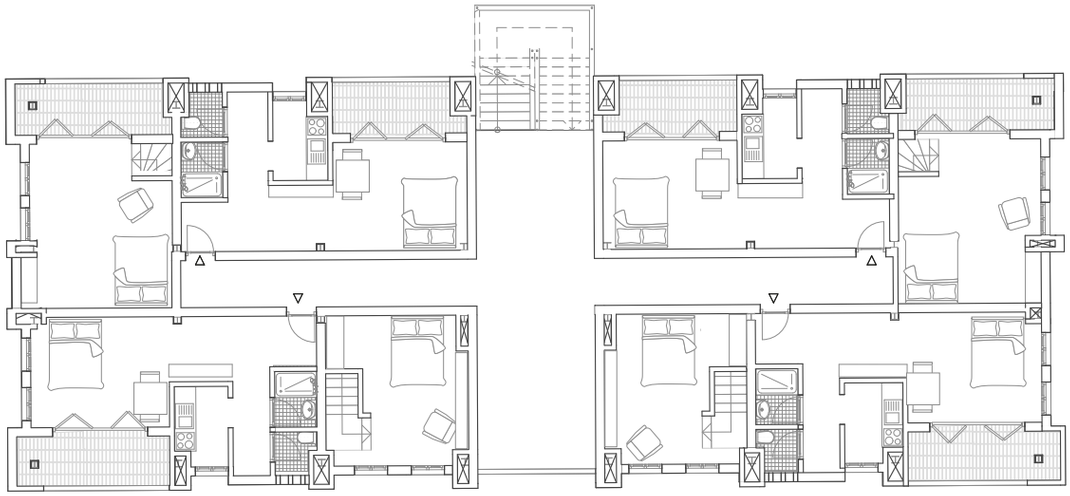
Block A is a typology designed for open, unused spaces or for scenarios where multiple families decide to renovate collectively. It features a footprint of 360 square meters, making it the largest of the six designed types.

This block accommodates three different unit types, ranging in size from 32 to 60 square meters, and includes a shared roof terrace.

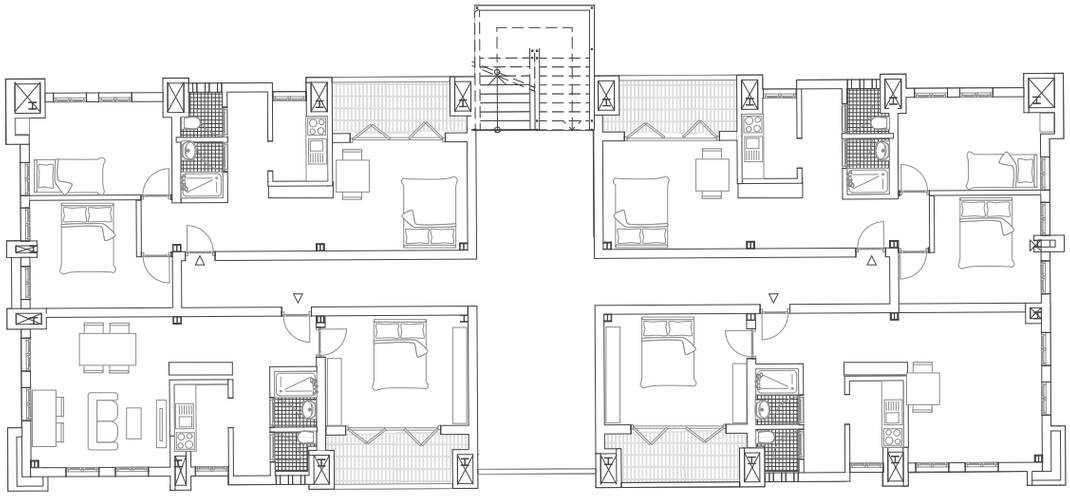




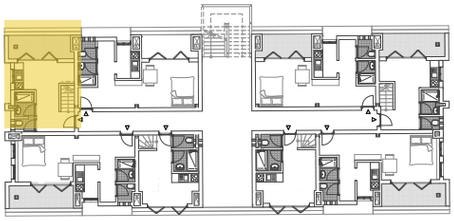
BLOCK A Ground Floor 1:200

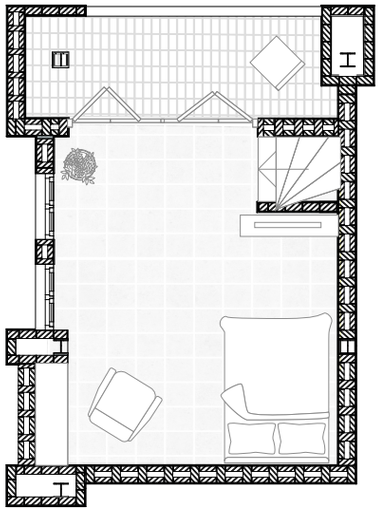


BLOCK A First Floor 1:200

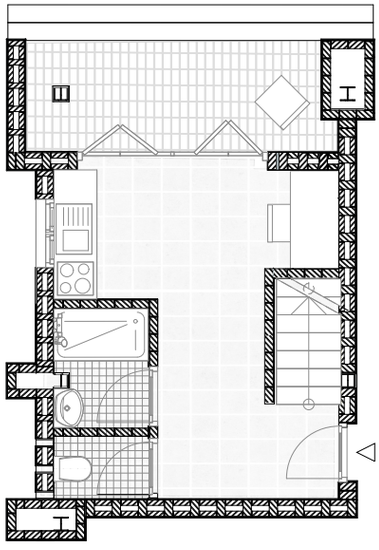


BLOCK A Second Floor 1:200



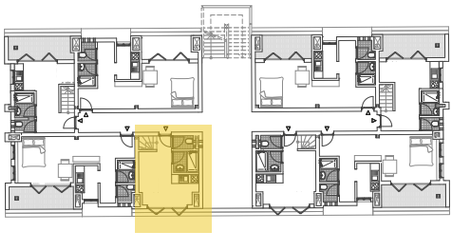


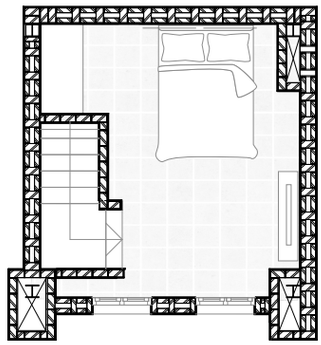
Unit A First Floor 1:100



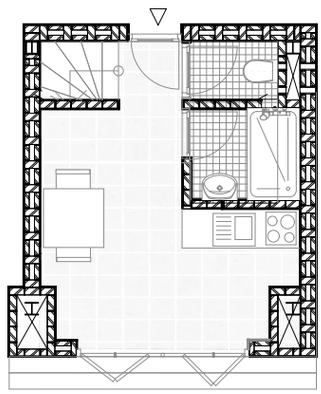
Unit A Ground Floor 1:100

Unit A 60m2 1:100



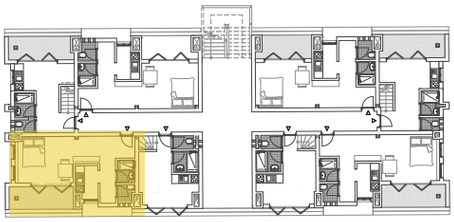


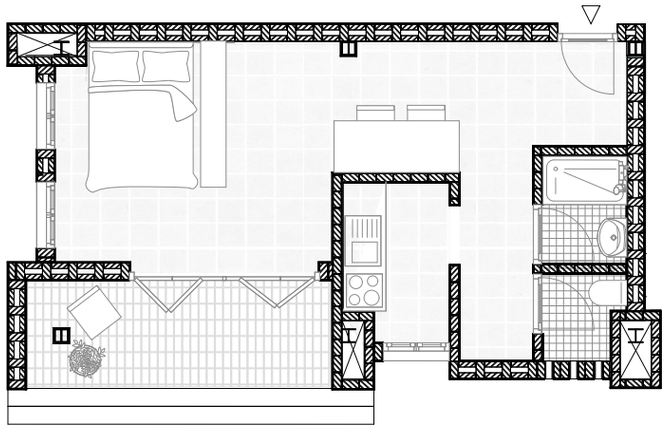
Unit B First Floor 1:100



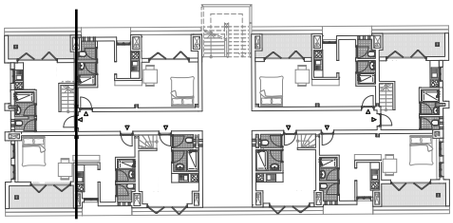
Unit B Ground Floor 1:100

Unit A 36m2 1:100



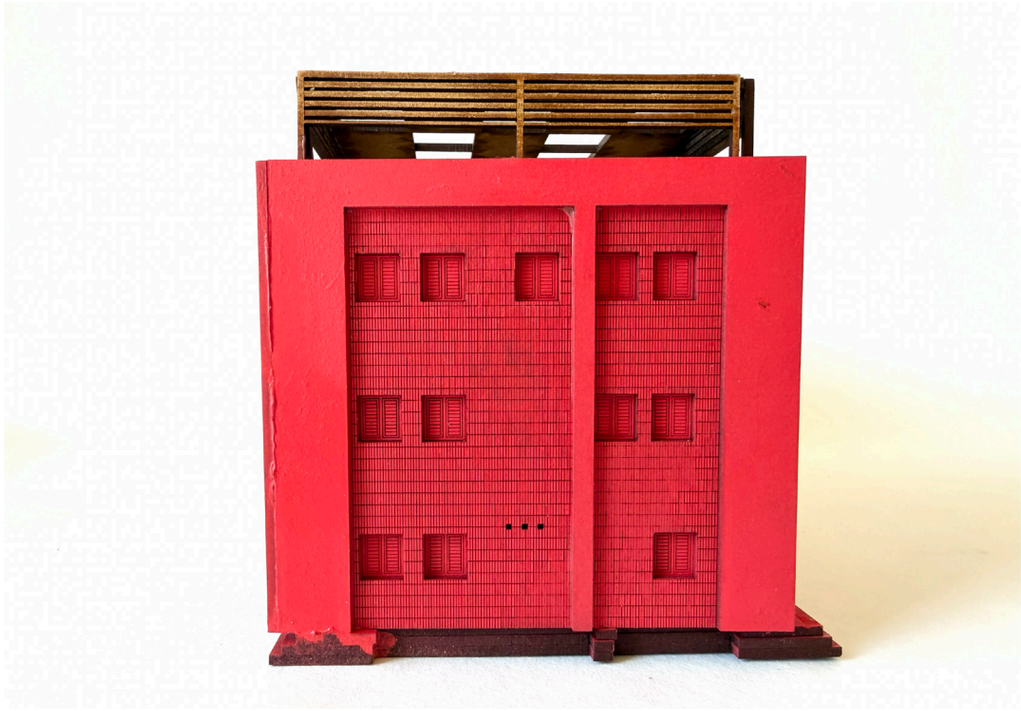


Unit C 40m2 1:100

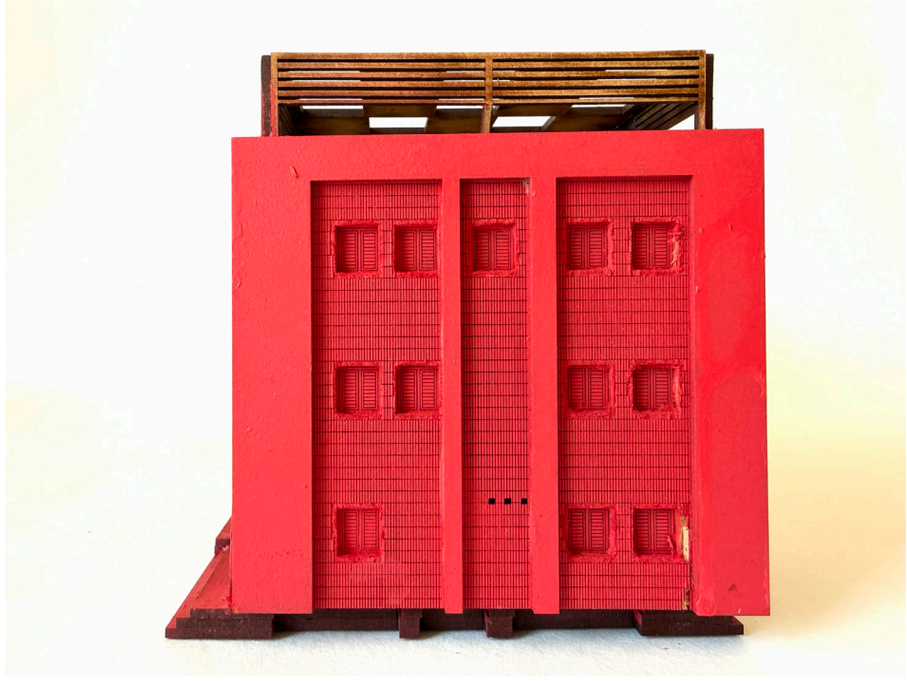


Section 1:100

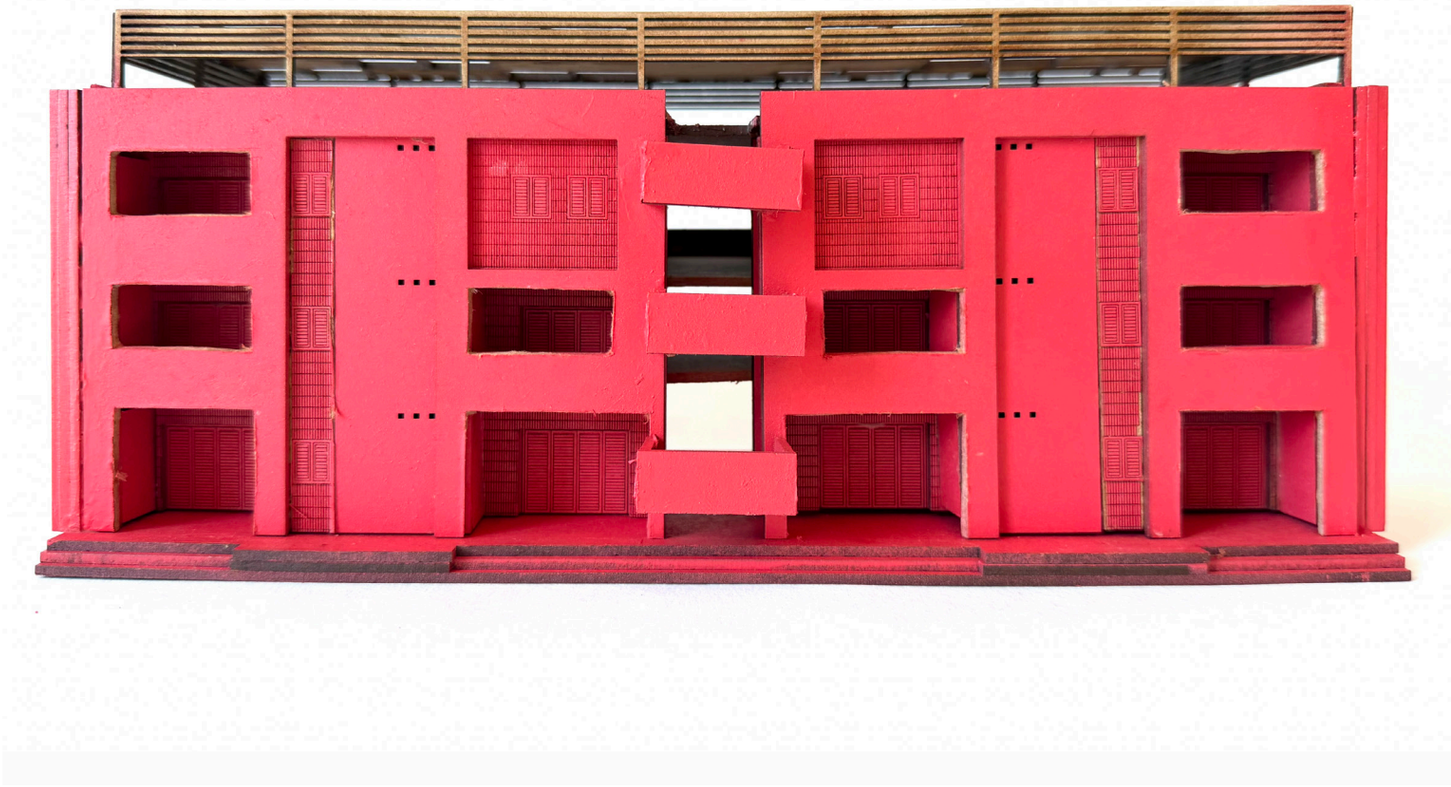
Front Facade



Side Facade



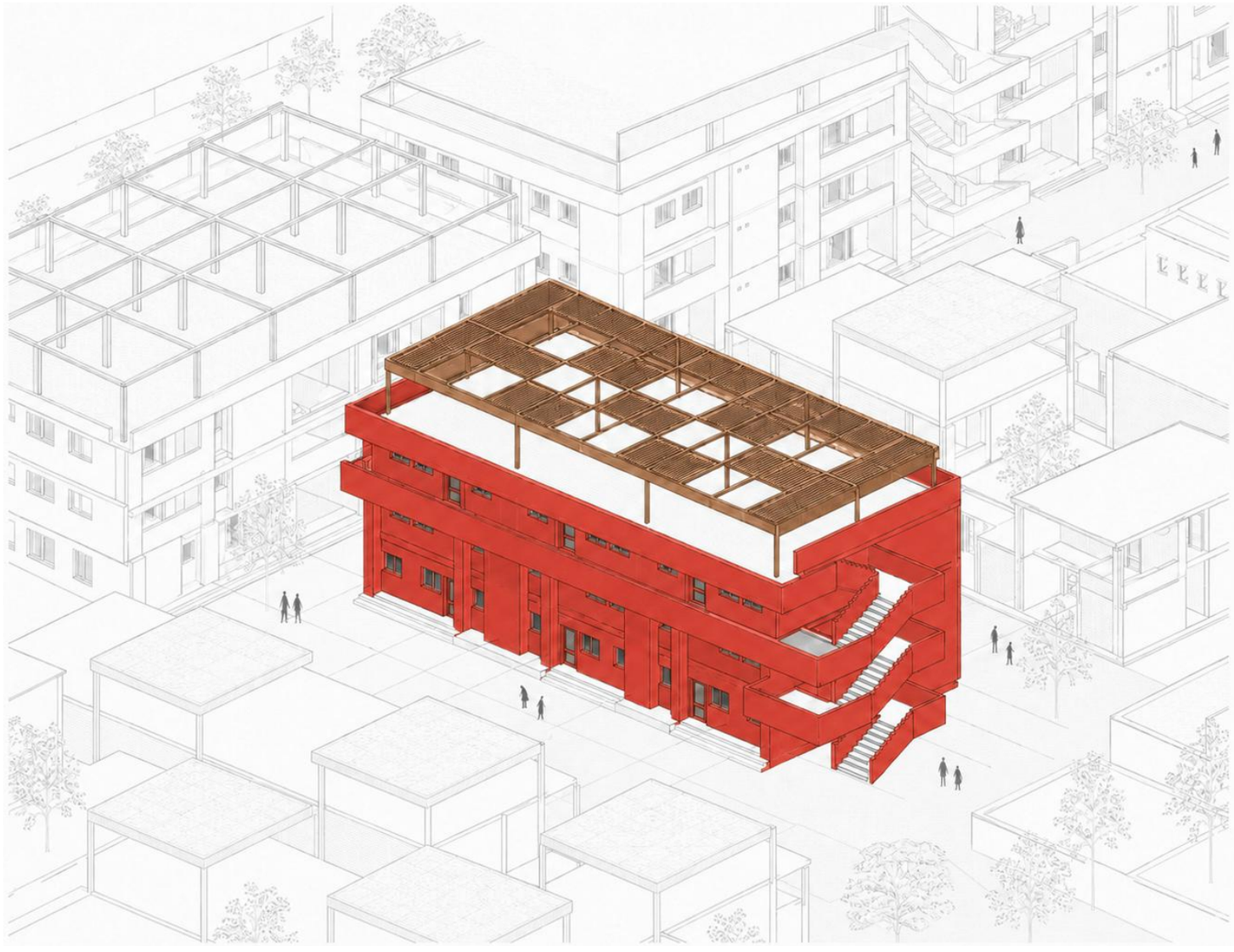
Side Facade



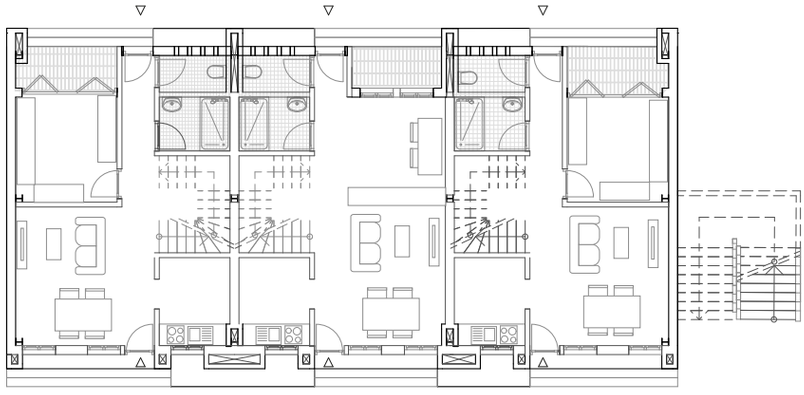
Back Facade

# BLOCK B

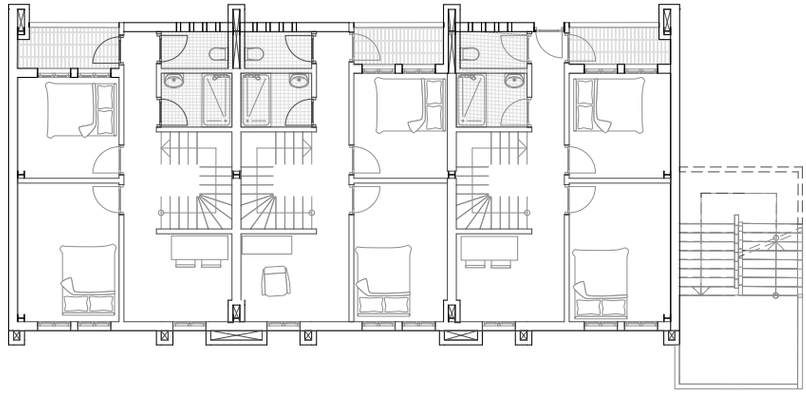
Block B features a more compact design with a footprint of 200 square meters. The distinction of this typology is its external circulation route. Additionally, the ground floor consists of maisonette units, providing residents with the flexibility to use the ground floor for economic activities while maintaining a separate, private floor for living space. This block contains two unit types, ranging from 50 to 100 square meters.



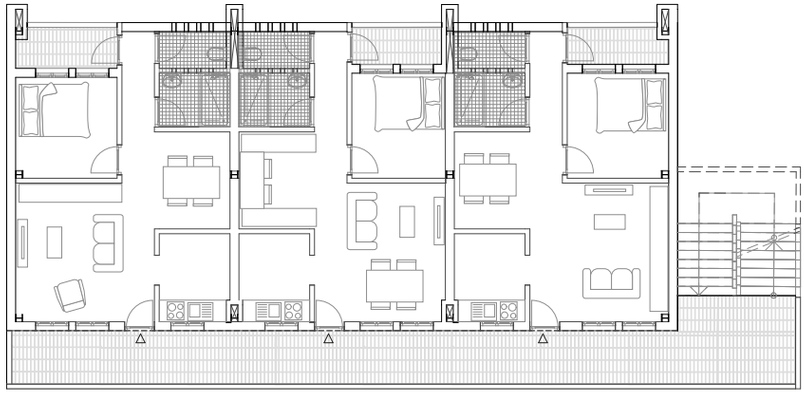
*This visualization was created by the author using ArchiCAD and Illustrator. The final rendering was then enhanced using ChatGPT



BLOCK B Ground Floor 1:200

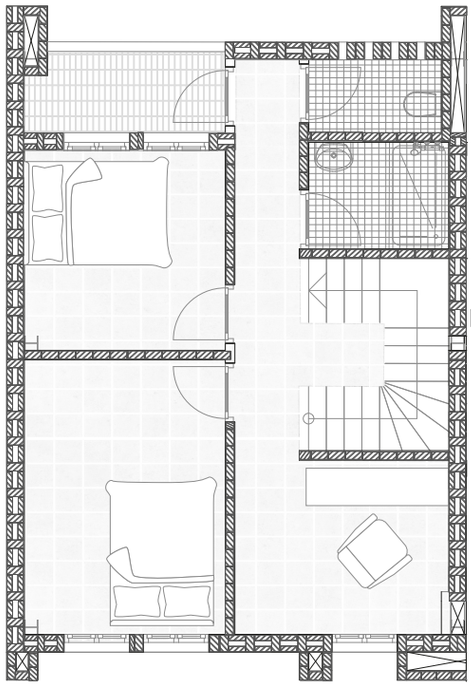


BLOCK B First Floor 1:200

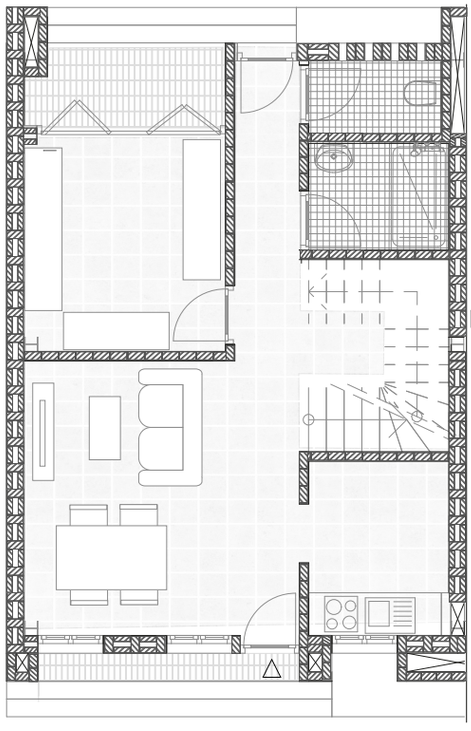


BLOCK B Second Floor 1:200

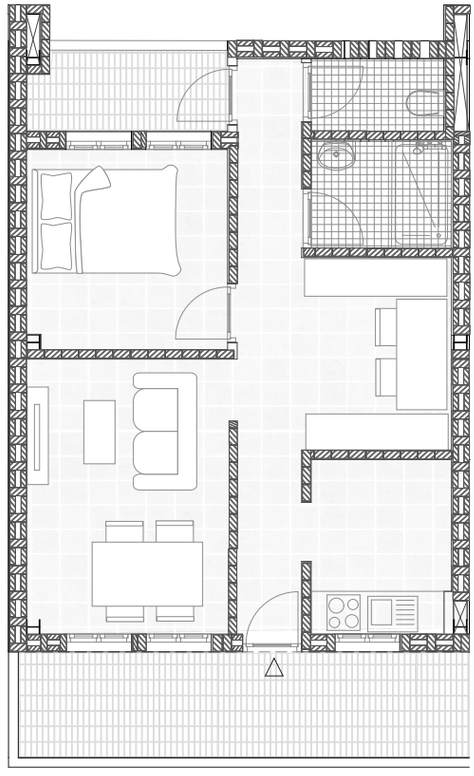
BLOCK B Unit A 100m2 1:100



BLOCK B Unit A First Floor 1:100

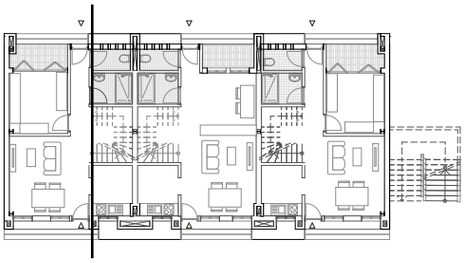


BLOCK B Unit A Ground Floor 1:100



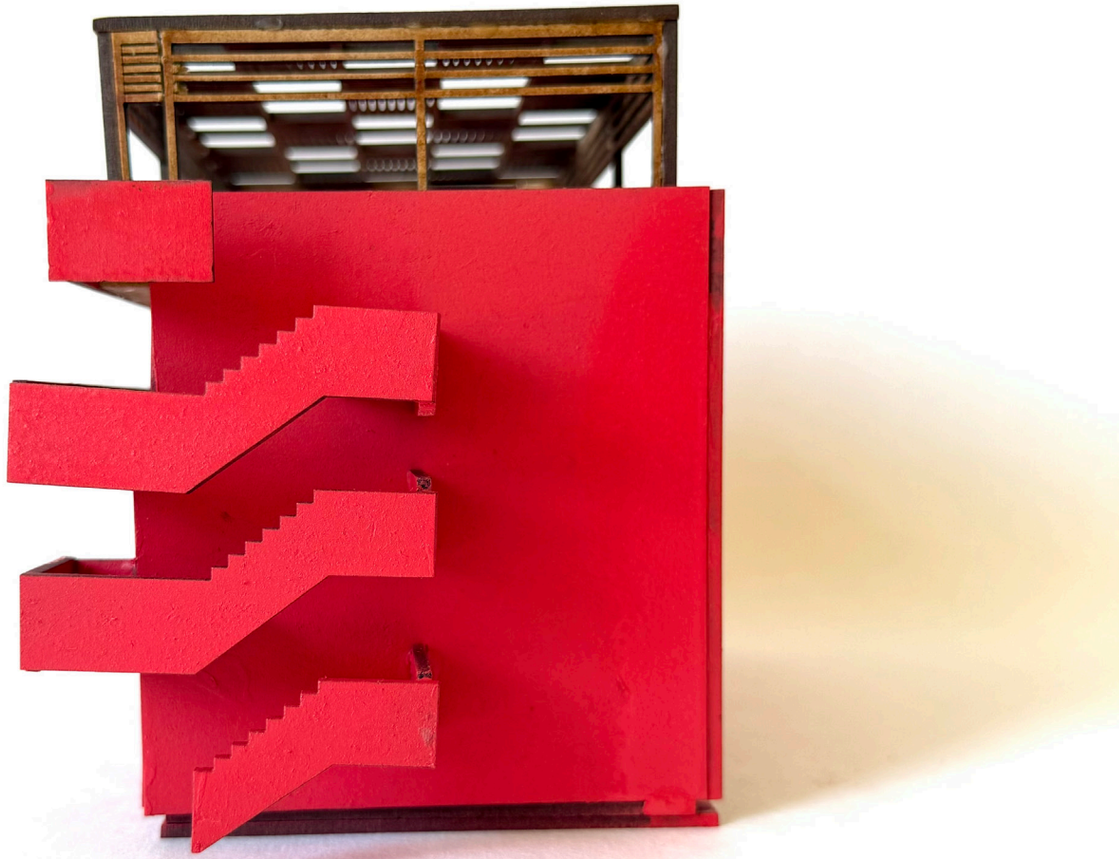
BLOCK B Unit B 1:100

BLOCK B Unit B 50m2 1:100

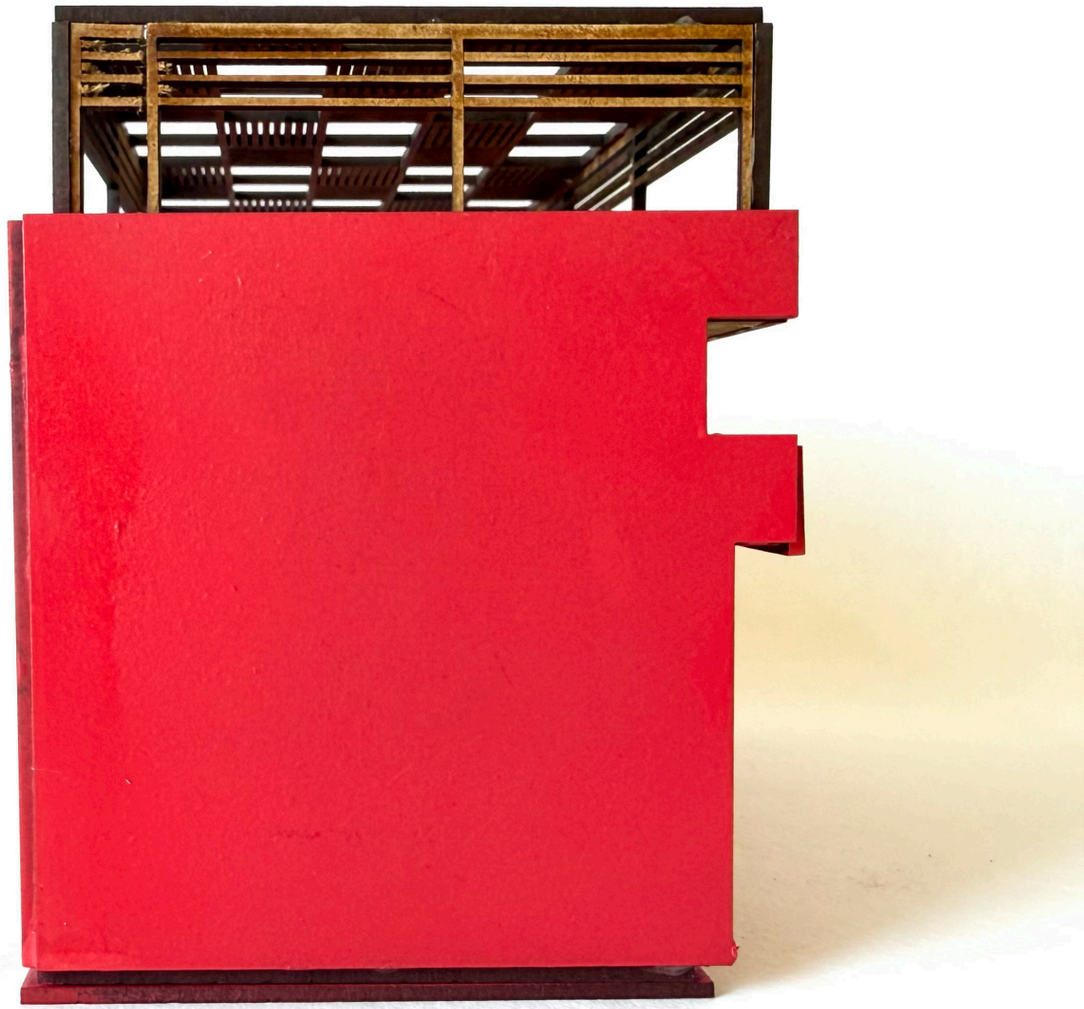


BLOCK B Section 1:100

Front Facade



Side Facade



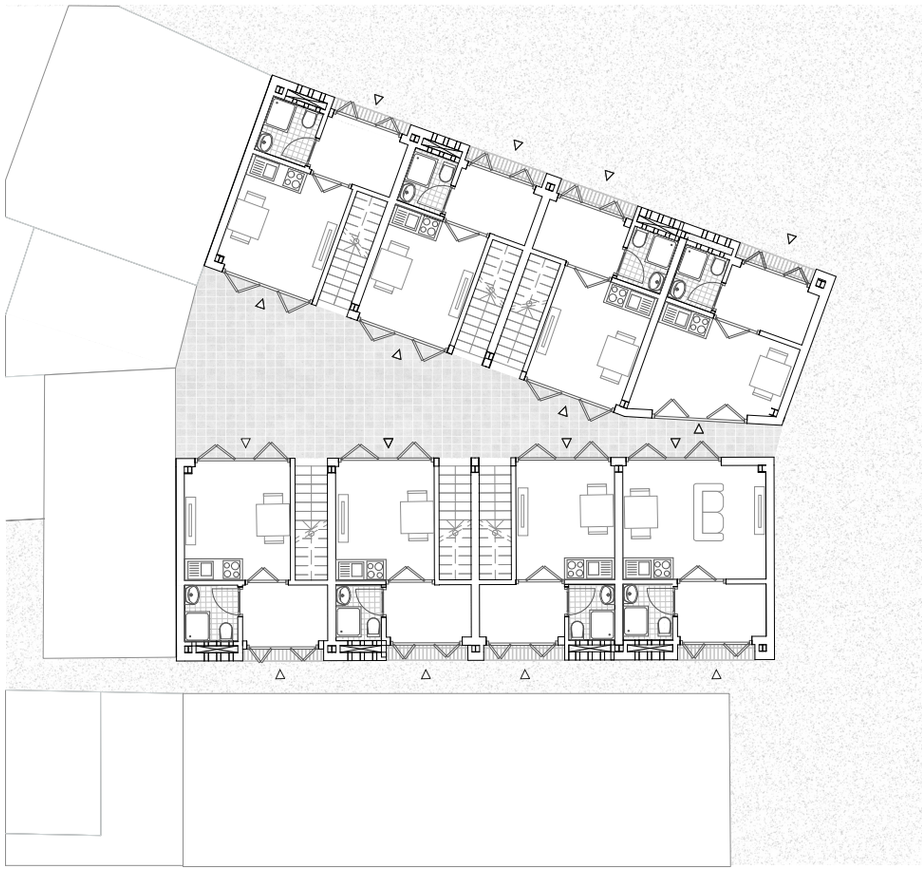
Side Facade

Back Facade

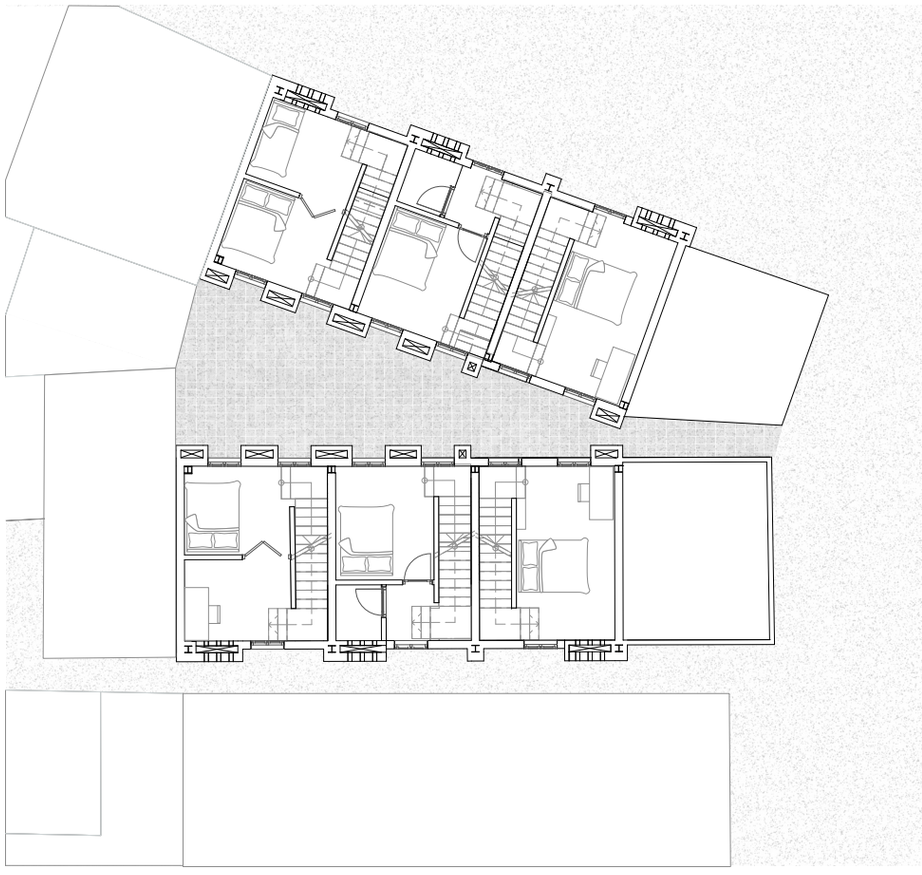
# Row House A

Row house A features both a front and a back yard, offering the opportunity to create a private courtyard or connection with neighboring houses. This typology contains the smallest base unit of 25 square meters, with the capacity for further vertical expansion.

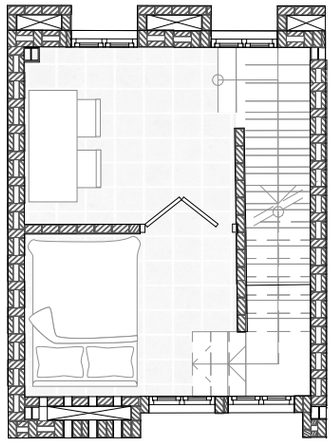
*This visualization was created by the author using ArchiCAD and Illustrator. The final rendering was then enhanced using ChatGPT



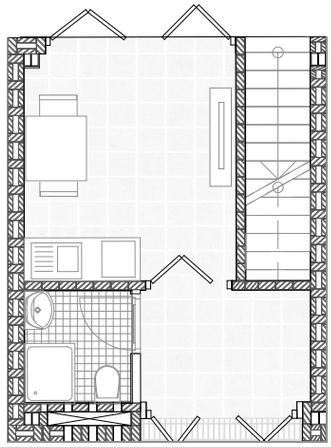
Row House A Ground Floor 1:200



Row House A First Floor 1:200

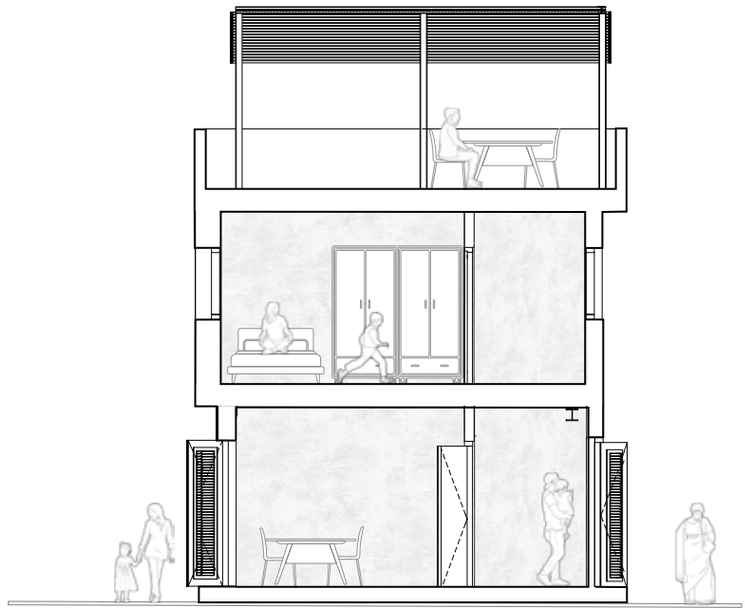


Row House A First Floor



Row House A Ground Floor

Row House A 50 m2  Unit 1:100



Row House A Section 1:100

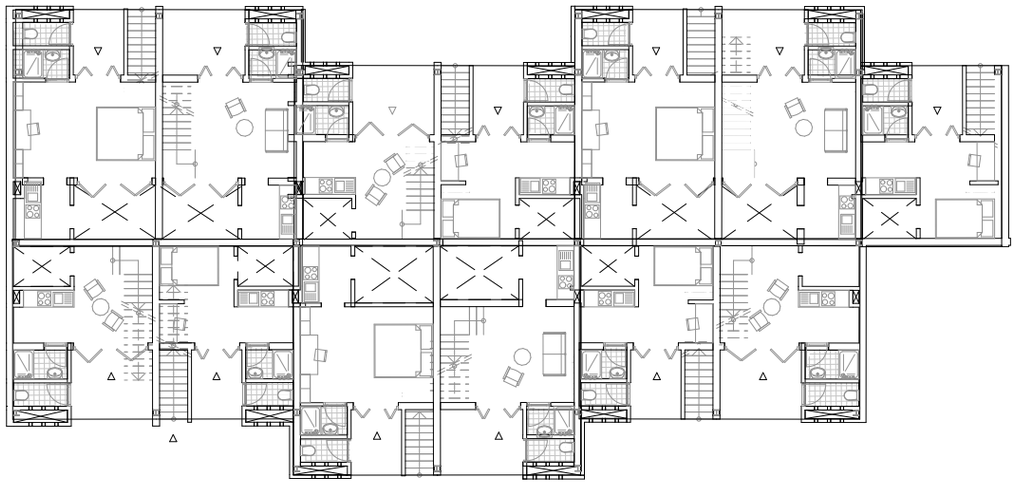
Front Facade

Back Facade

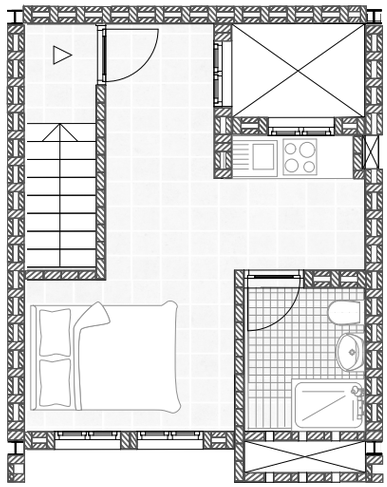
# Row House B

Row house B is an alternative variant that features access to the dwelling exclusively from the front, allowing for a back-to-back configuration. This typology contains two units ranging from 30 to 40 square meters, with the potential for future vertical expansion.

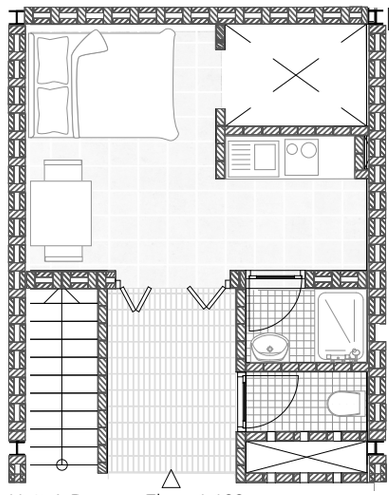
*This visualization was created by the author using ArchiCAD and Illustrator. The final rendering was then enhanced using ChatGPT



Row House B Unit 1:200

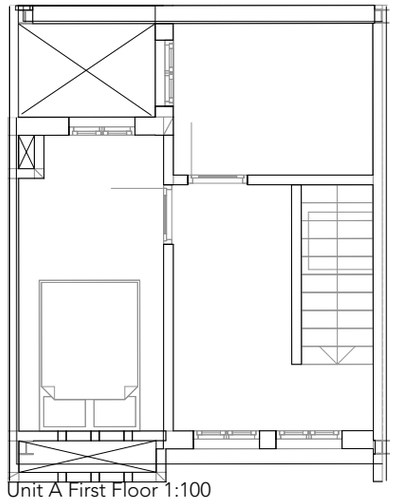


Unit A First Floor 1:100

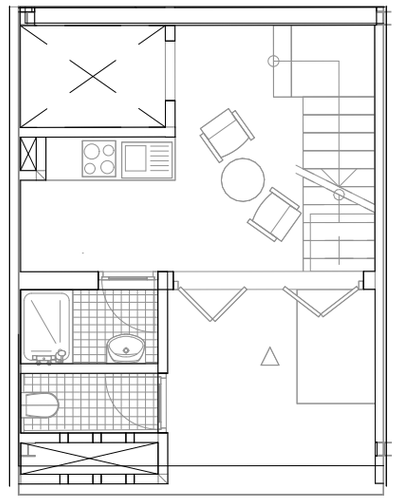


Unit A Begane Floor 1:100

Row House B Unit A 30m2 1:100

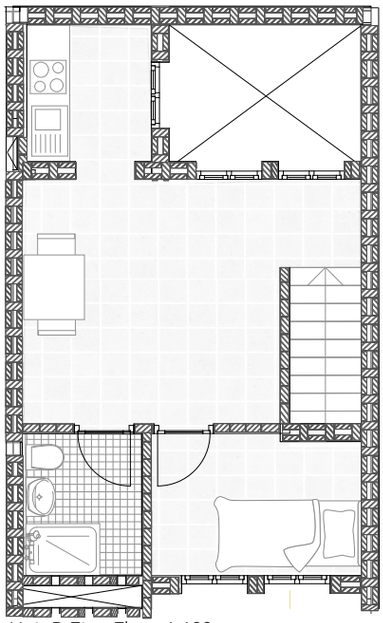


Unit A First Floor 1:100



Unit A Begane Floor 1:100

Row House B Unit A Variants 1:100



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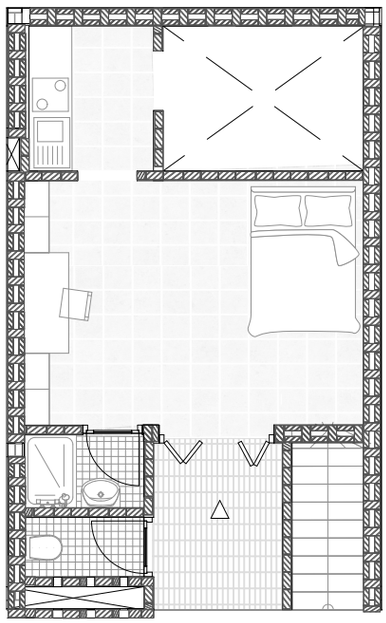
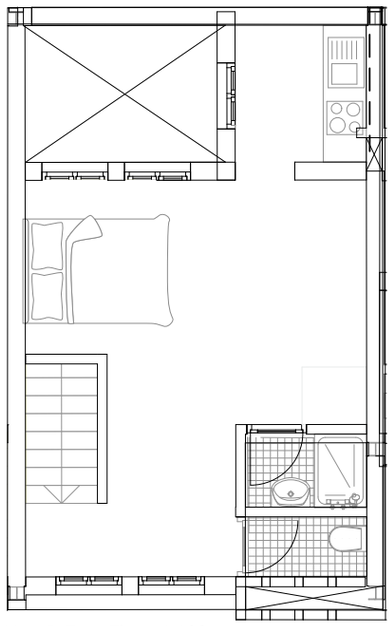


Unit B Ground Floor 1:100

Row House B Unit B 40m2 :100



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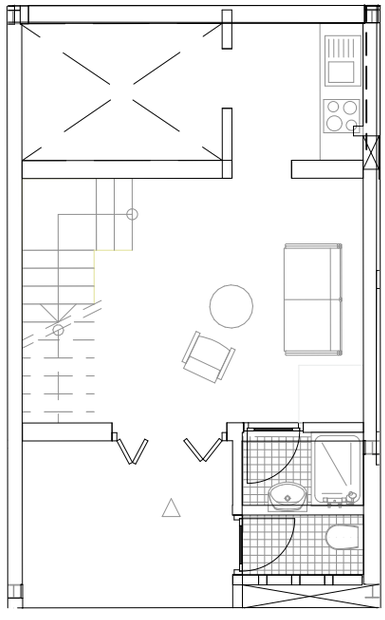


Unit B Ground Floor 1:100

Row House B Unit B Variants 1:100

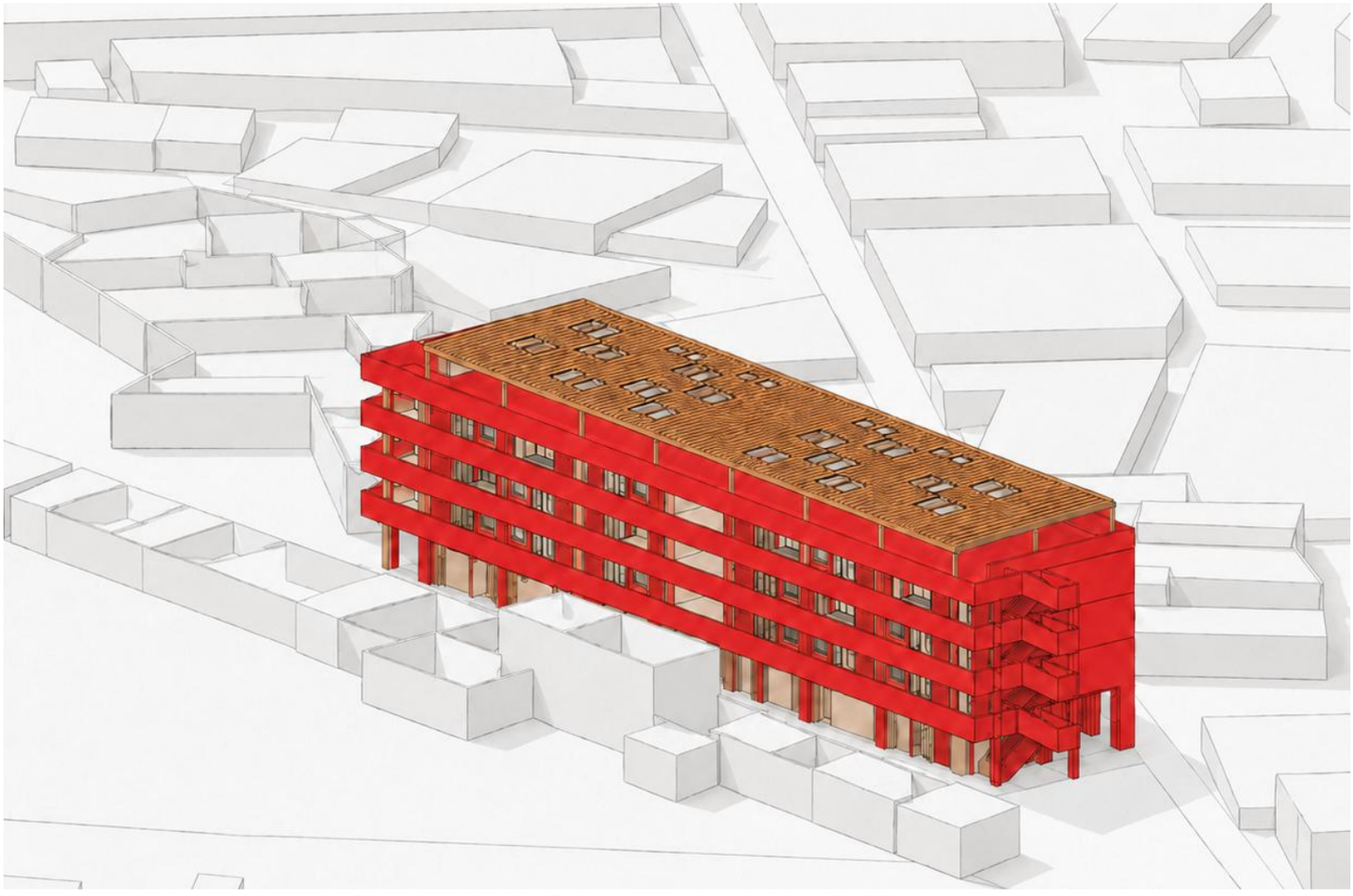
Row House B Unit Section 1:200

Front Facade

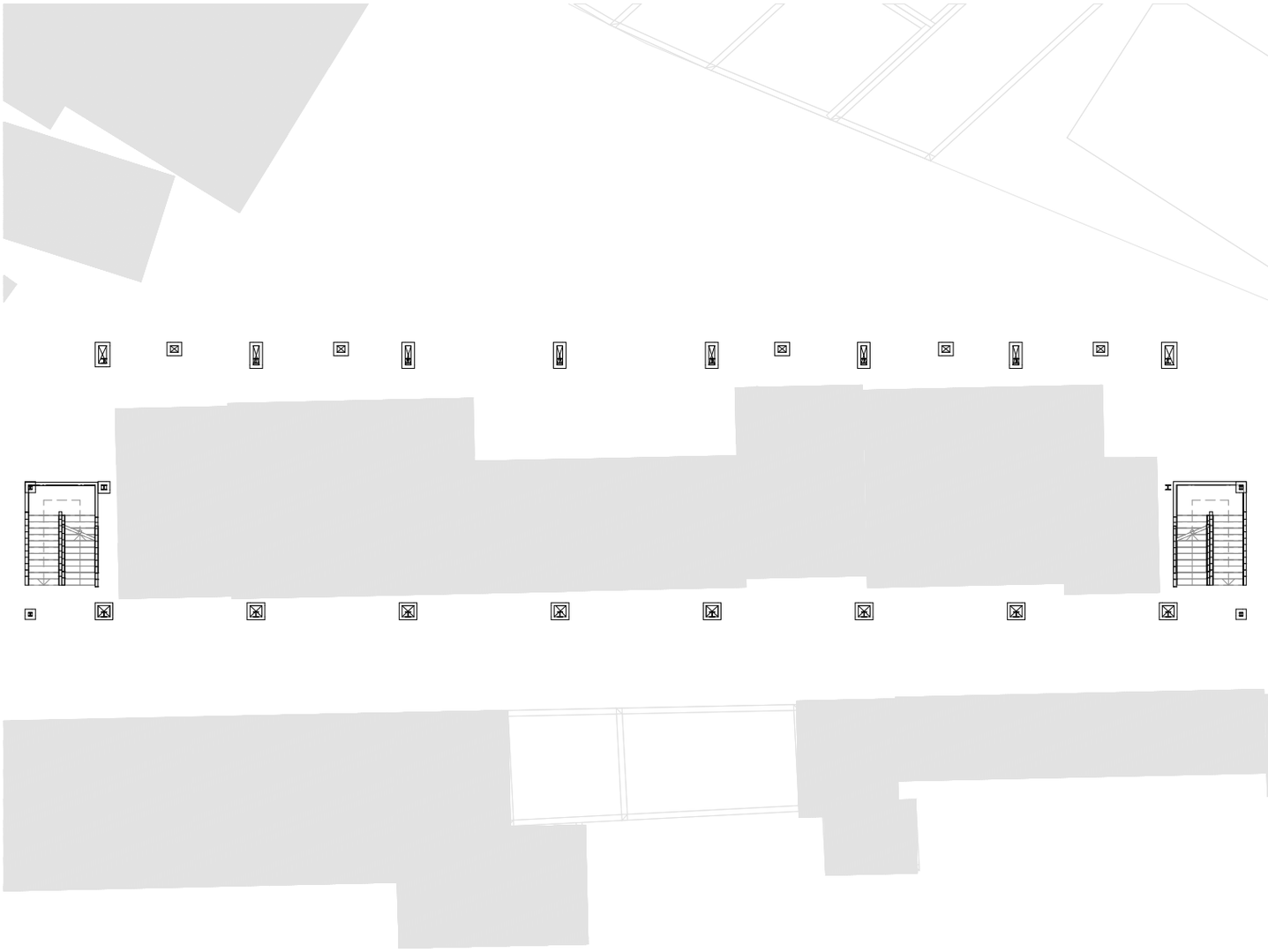
# HOVER

The Hover typology involves building over existing structures, allowing residents to remain in their homes while new dwellings are created above. Over time, residents from the existing lower level can gradually transition into the hover building, freeing up the ground floor to be repurposed for other uses.

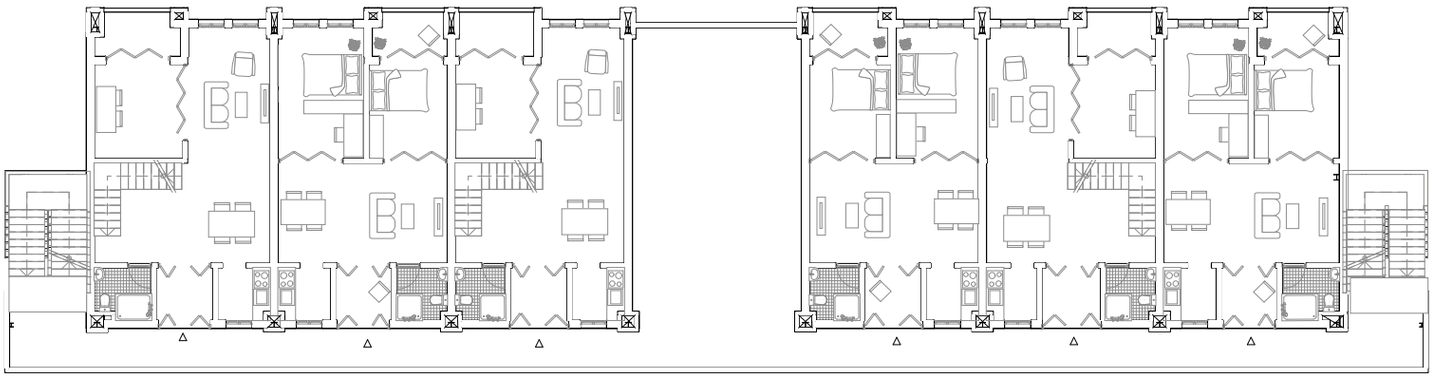
This typology features a variety of unit types, ranging from a single-floor unit of 60 square meters to a 120-square-meter maisonette, and includes a shared roof terrace.



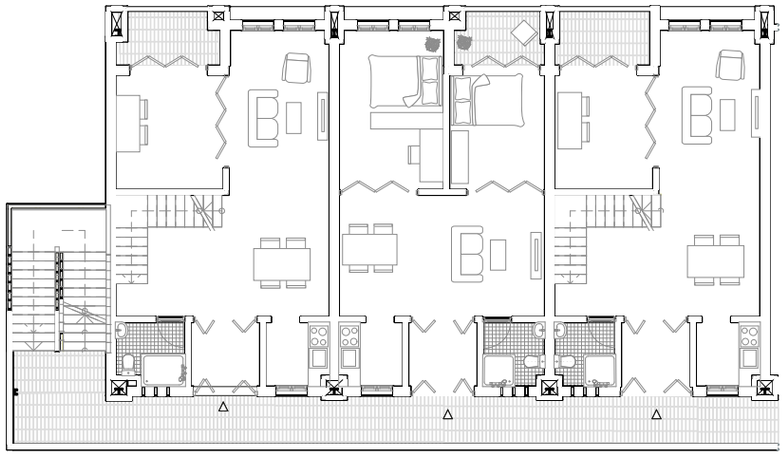
*This visualization was created by the author using ArchiCAD and IllustratorPhotoshop. The final rendering was then enhanced using ChatGPT



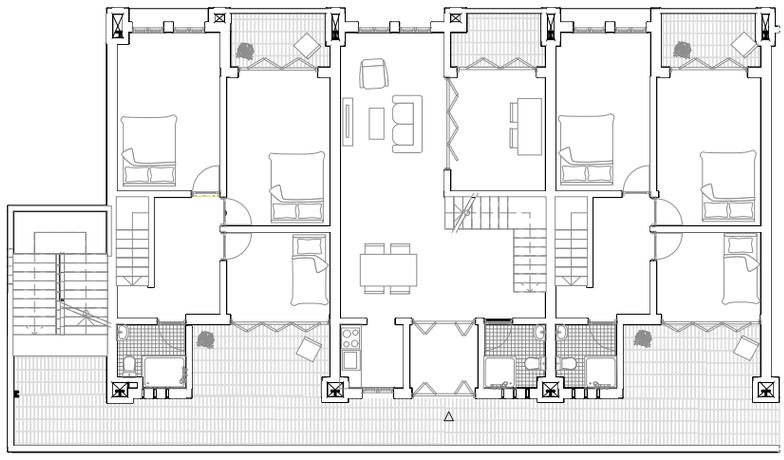
Row House B Ground Floor 1:250 Two building merged



Row House B First Floor 1:250 Two building merged

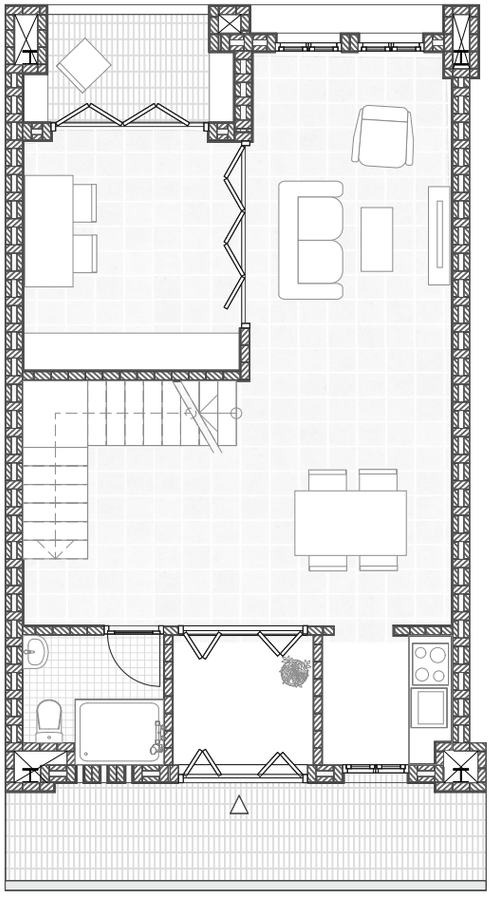


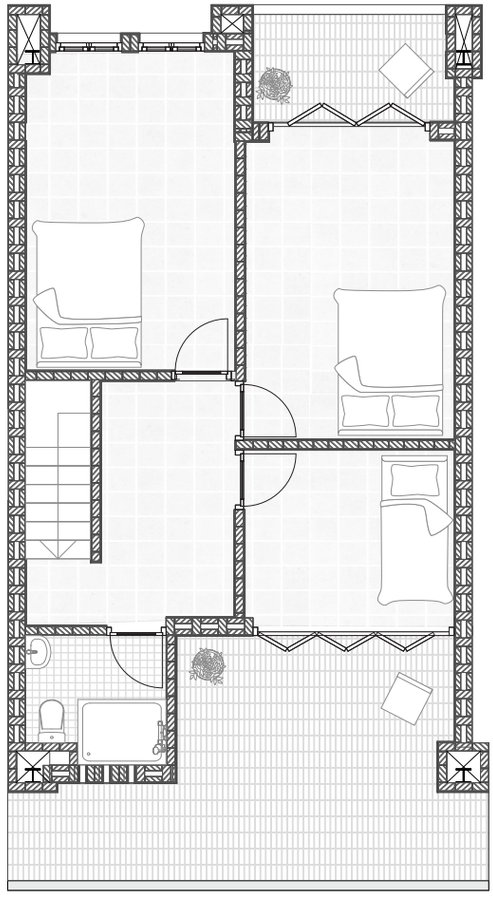
Row House B First Floor 1:200



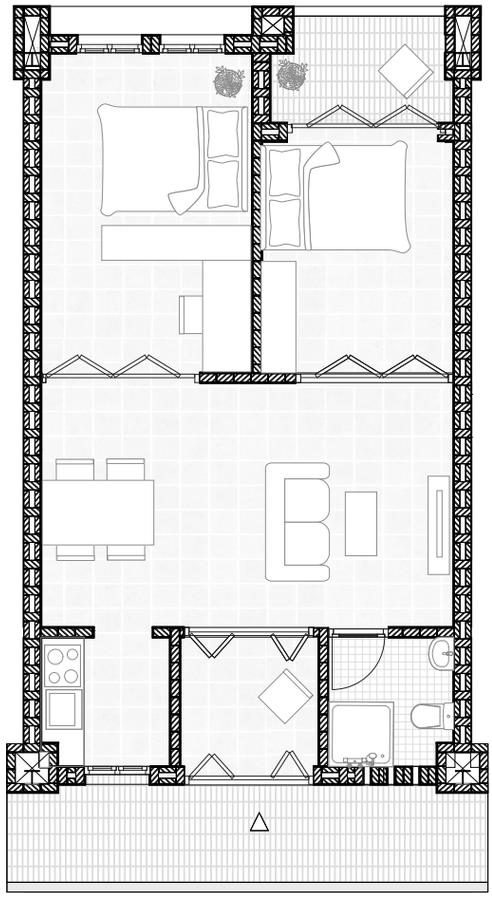
Row House B Second Floor 1:200

Row House B Third Floor 1:200

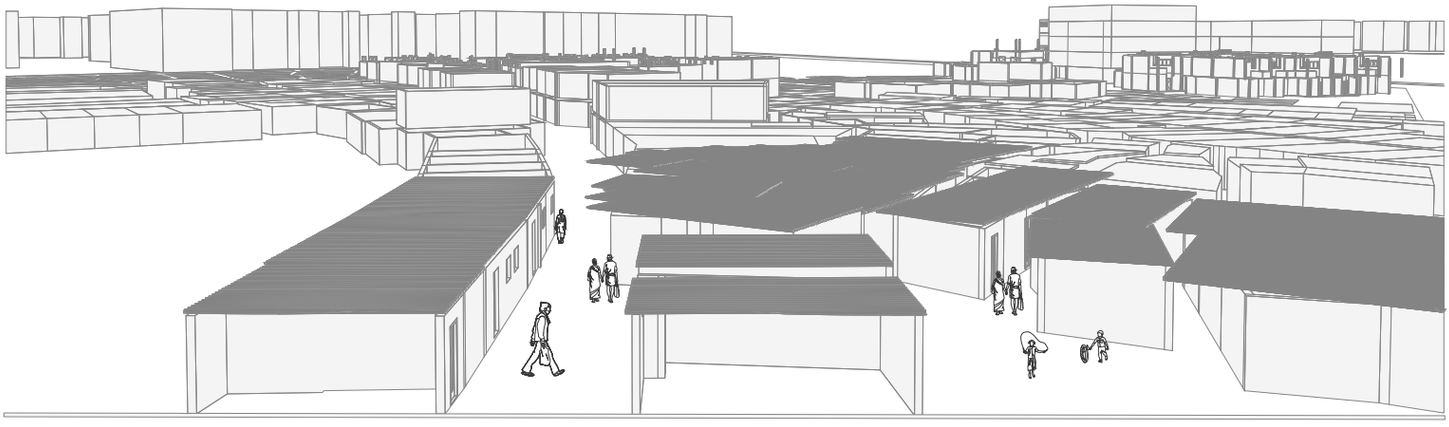




Row House B Unit A 1:100

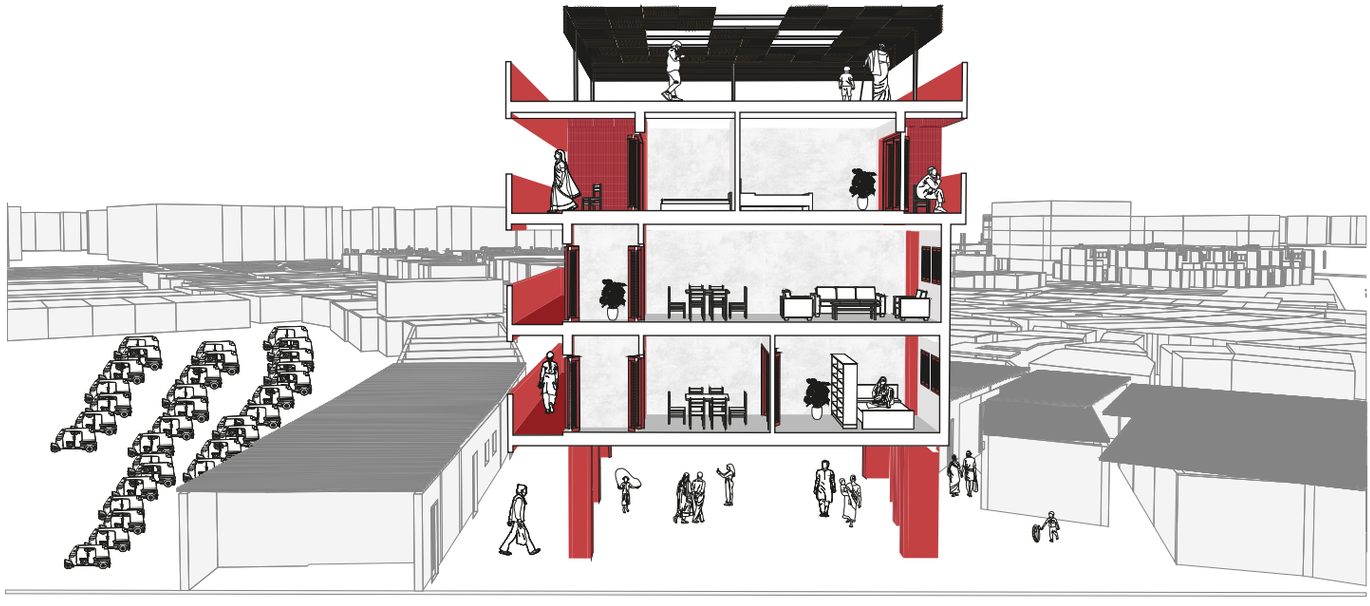


Row House B Unit B 1:100



Section Current 1:200

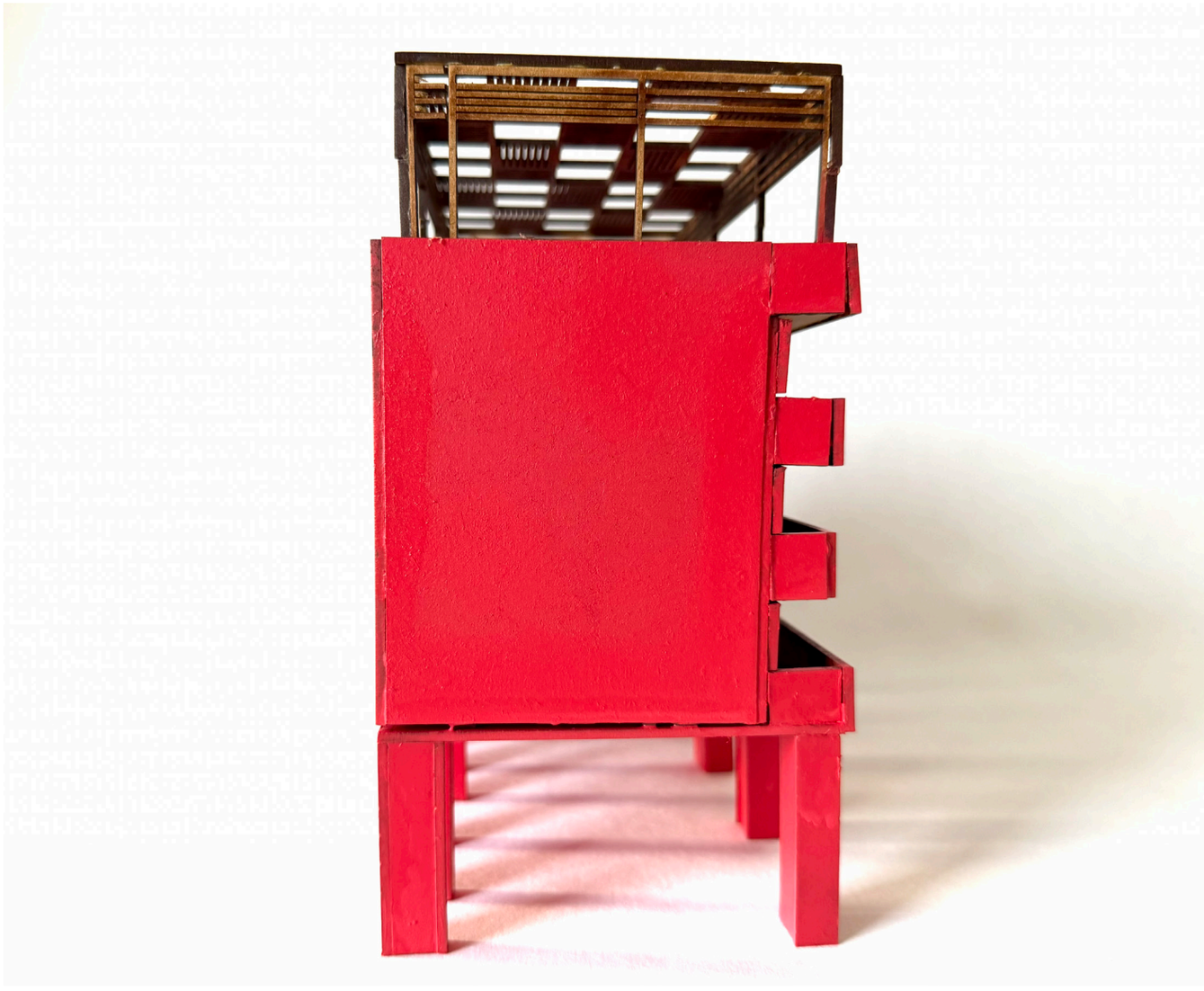
Section After Interven1:200



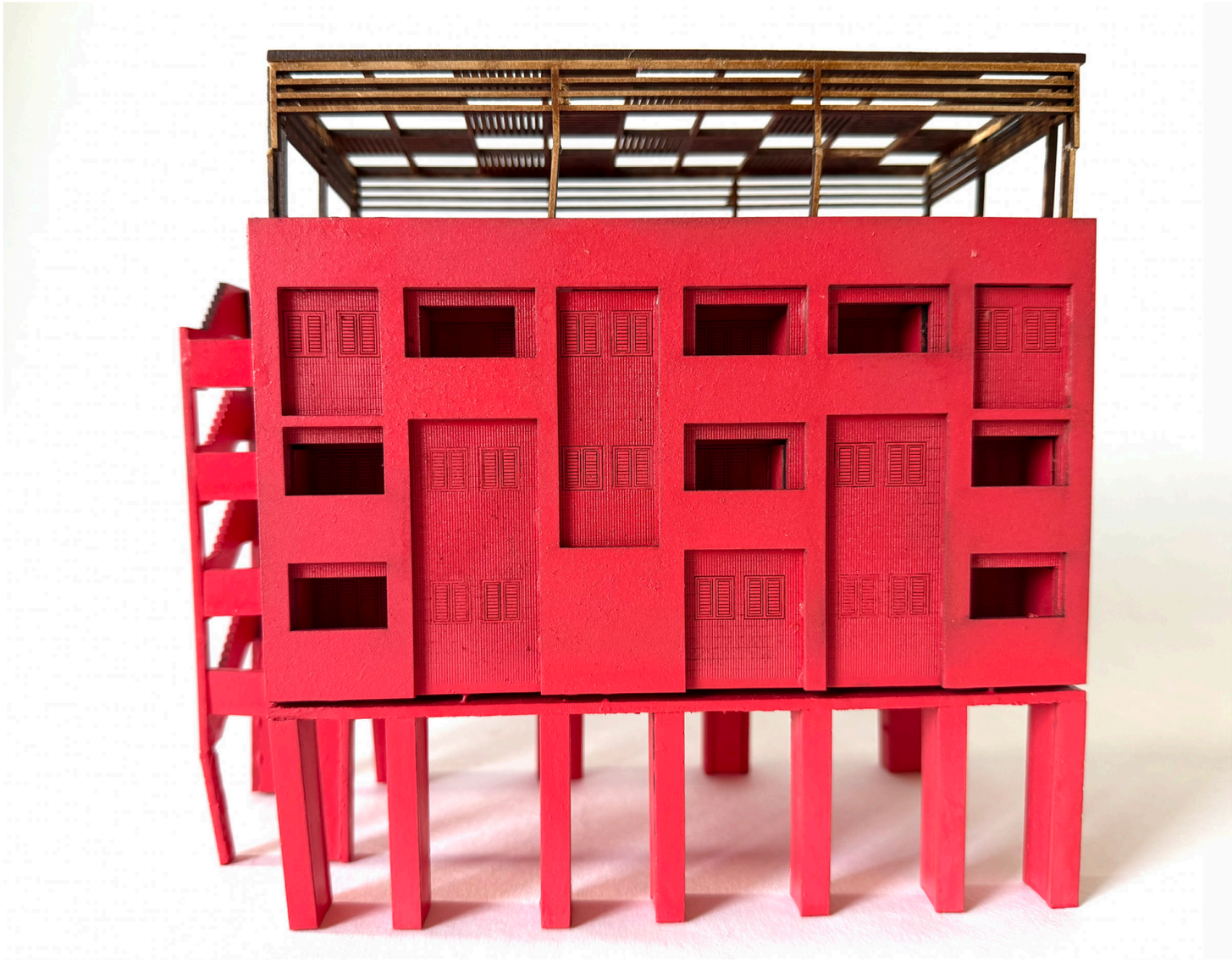
Section After Interven1:200

Front Facade

Side Facade

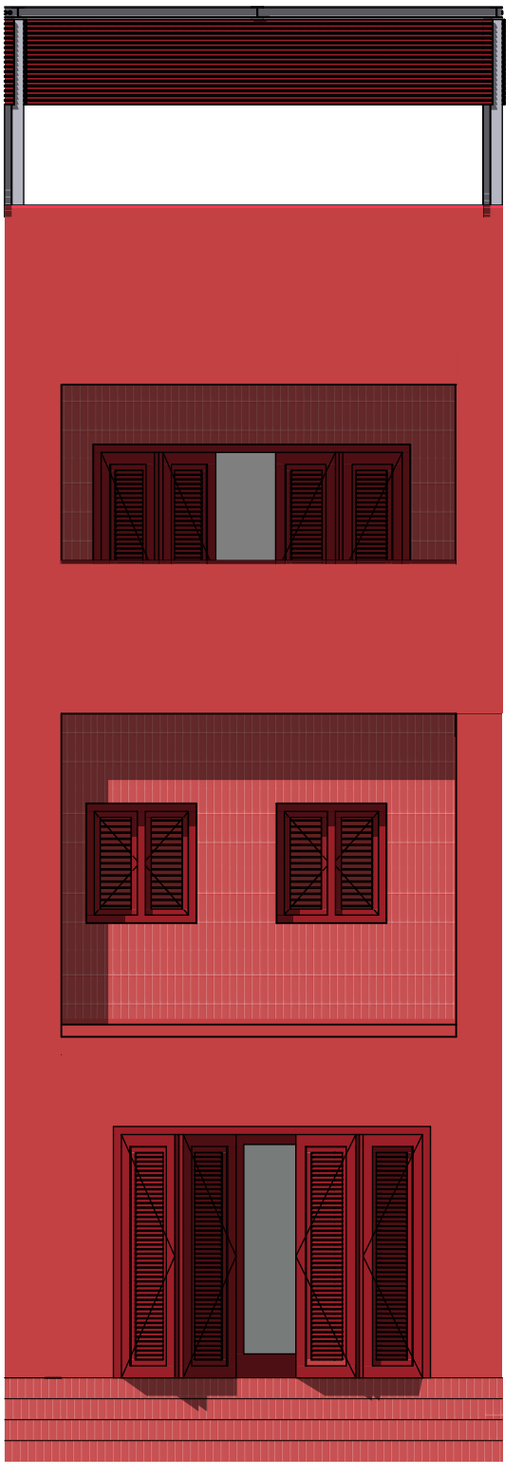


Side Facade



Back Facade

# FRAGMENT



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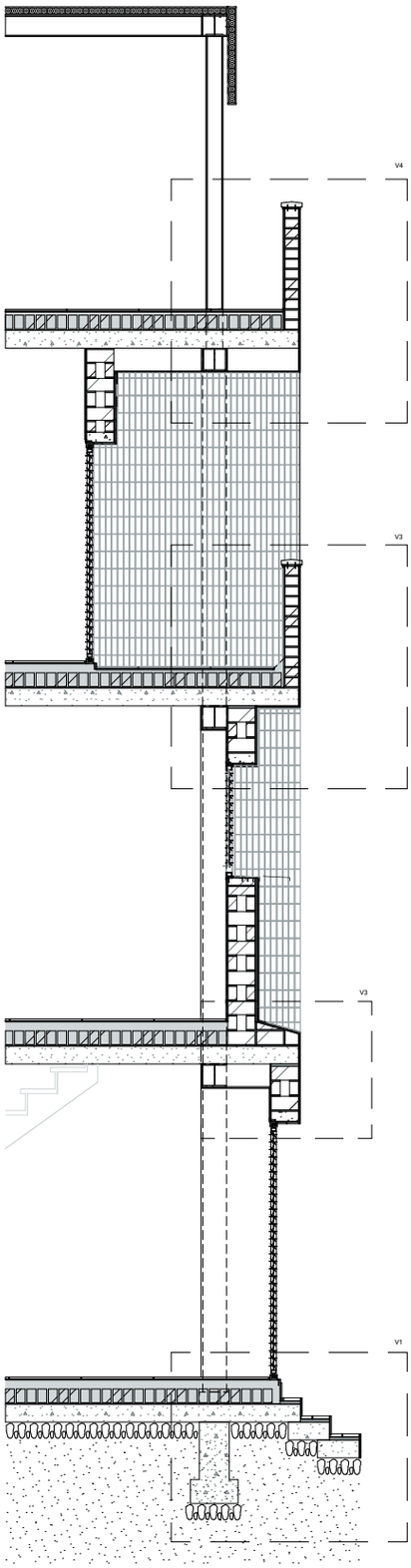


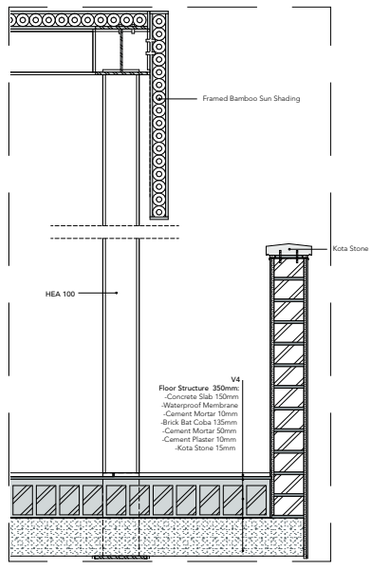


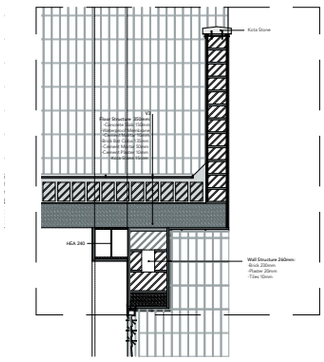


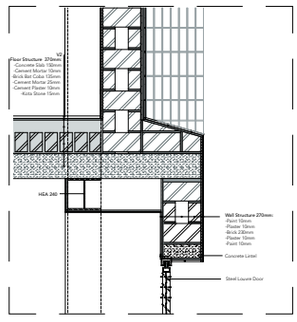


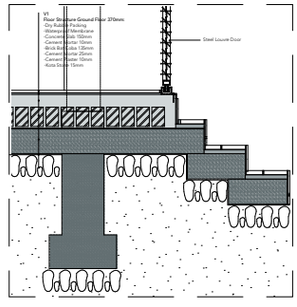

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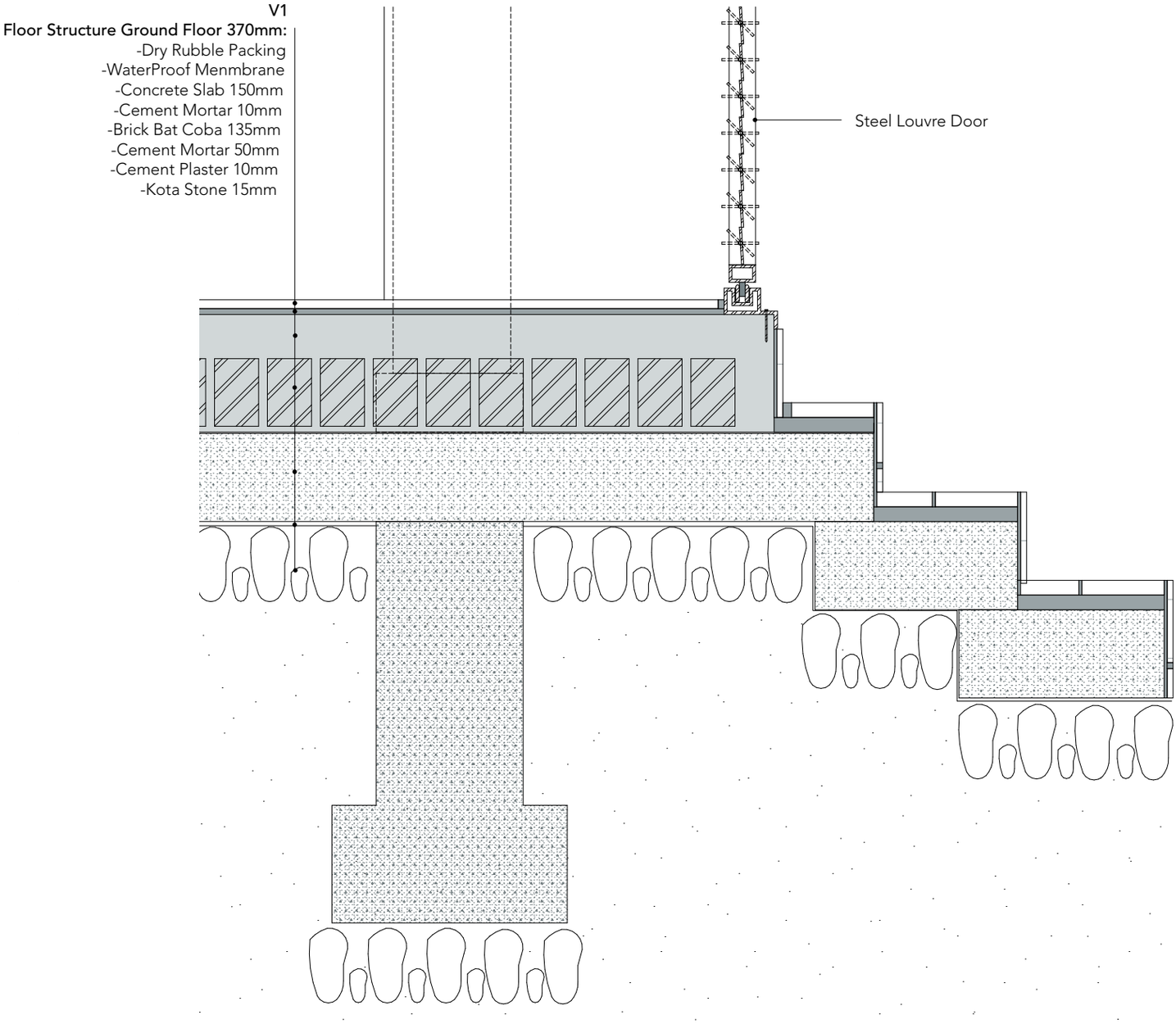
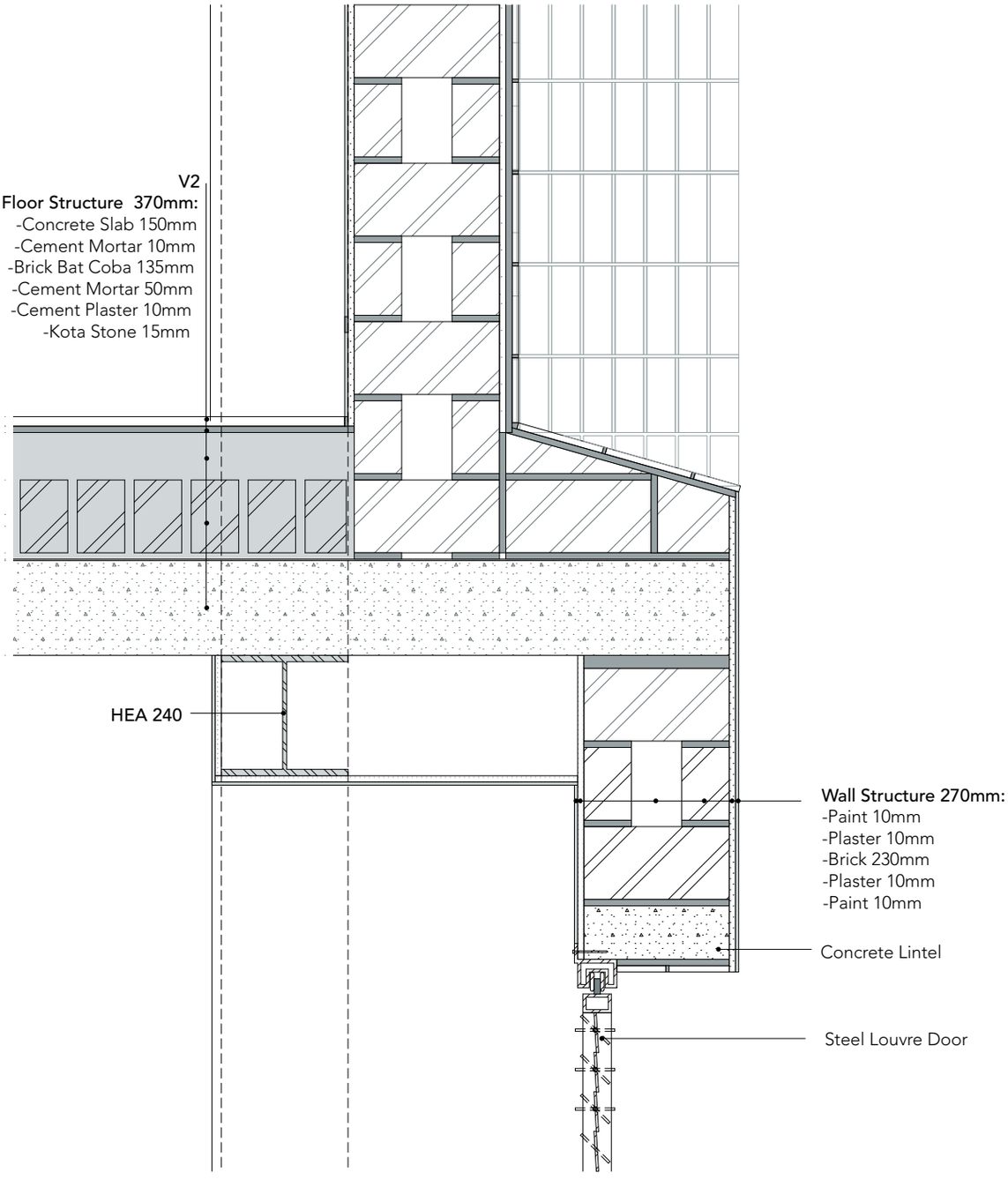



Detail 1:10

# DOOR FRAME DETAIL

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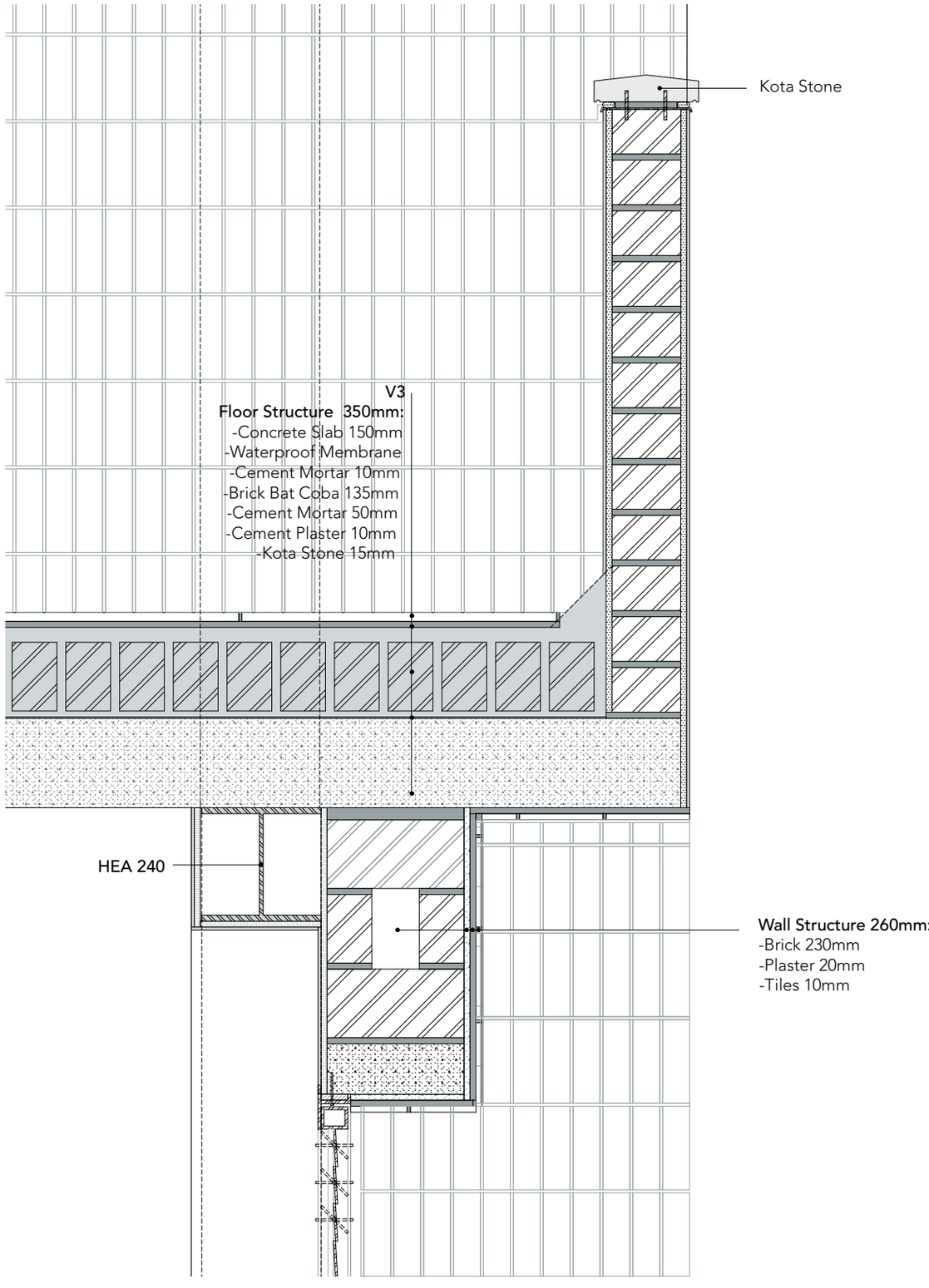


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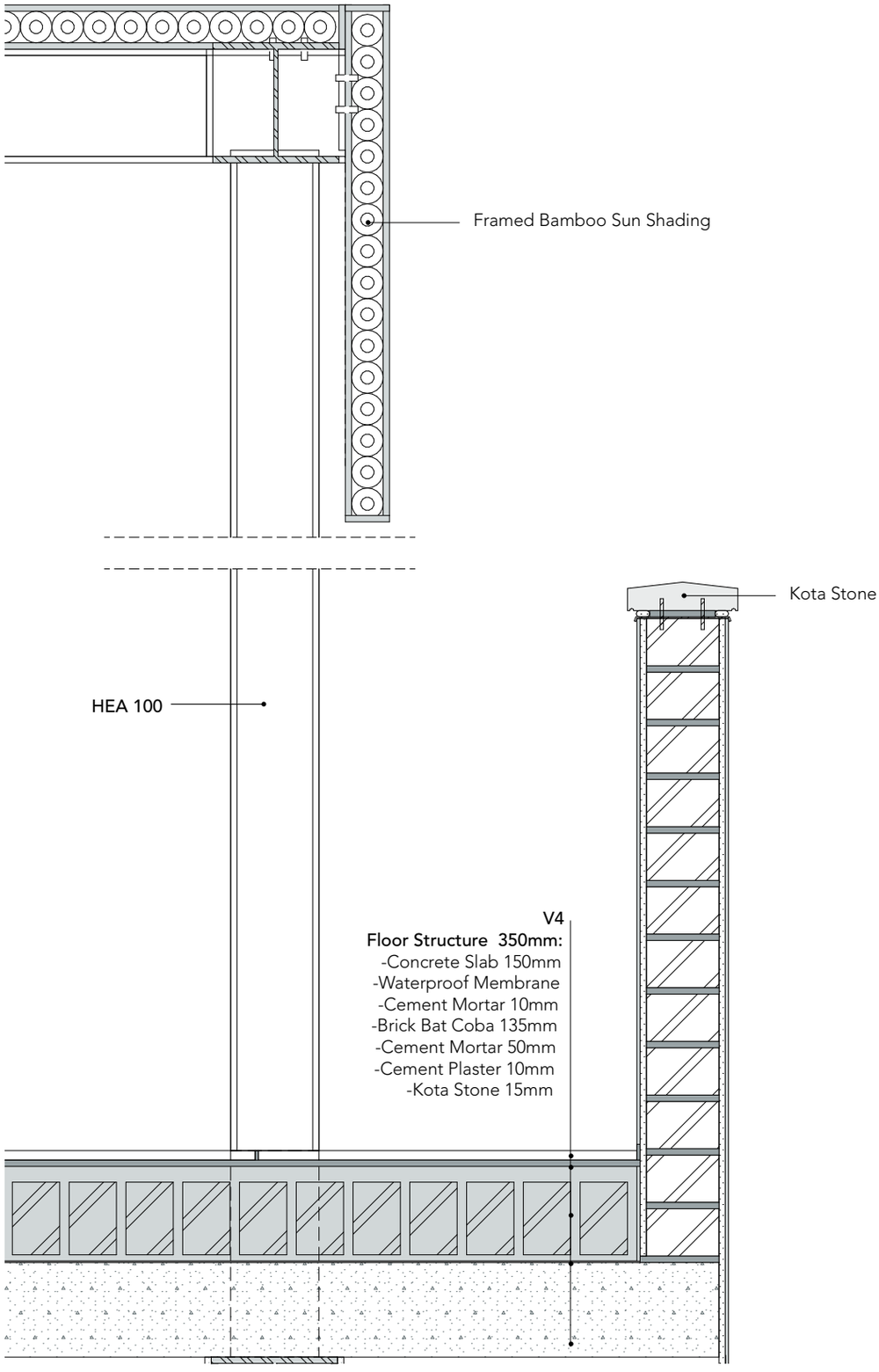


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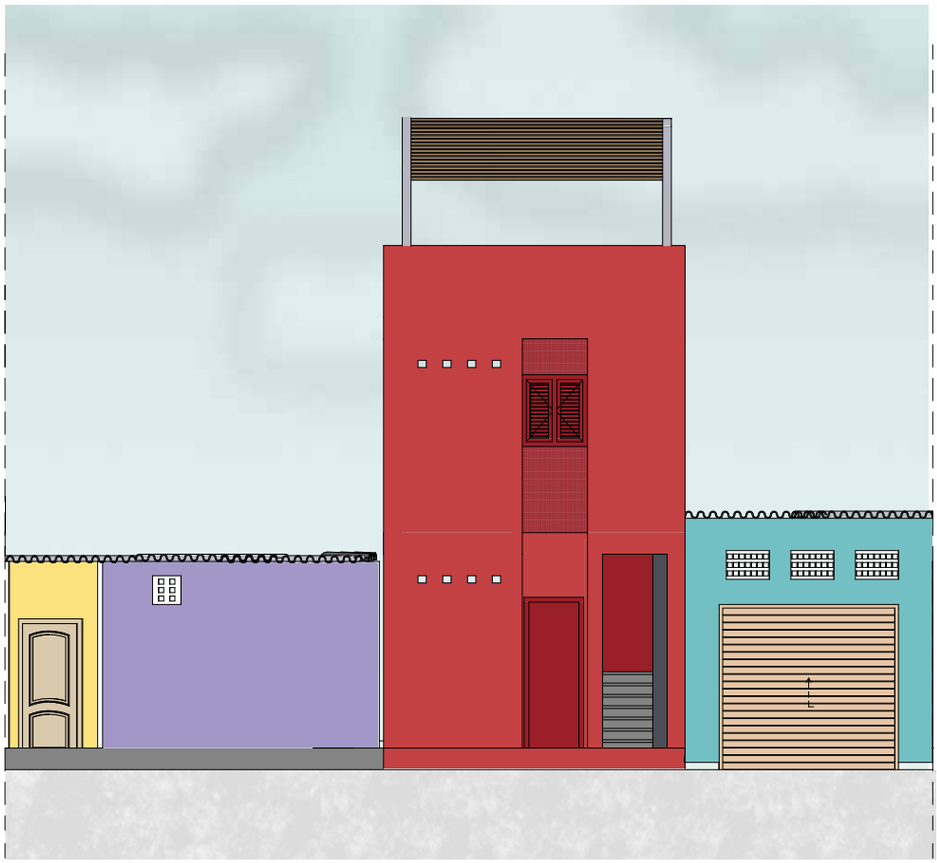
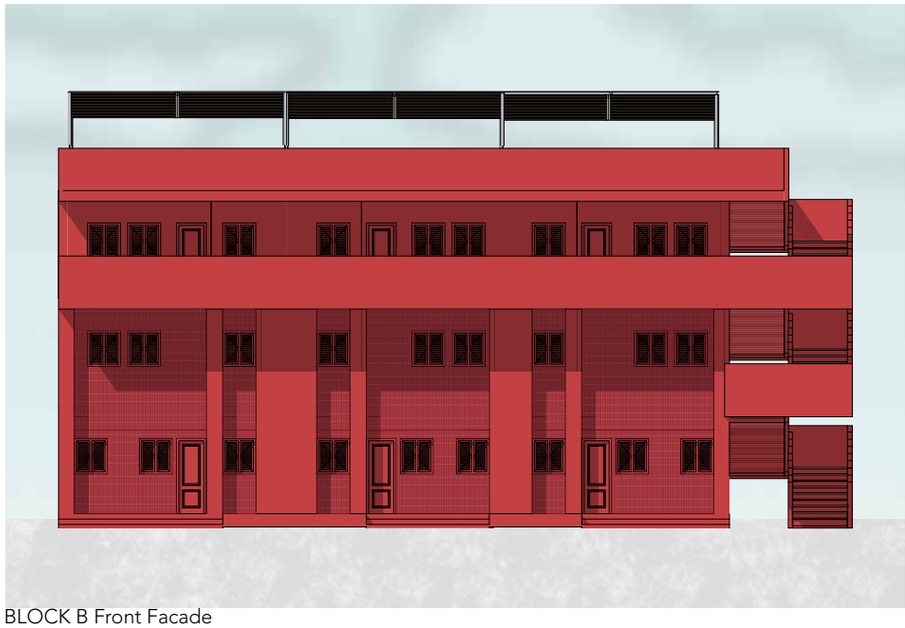
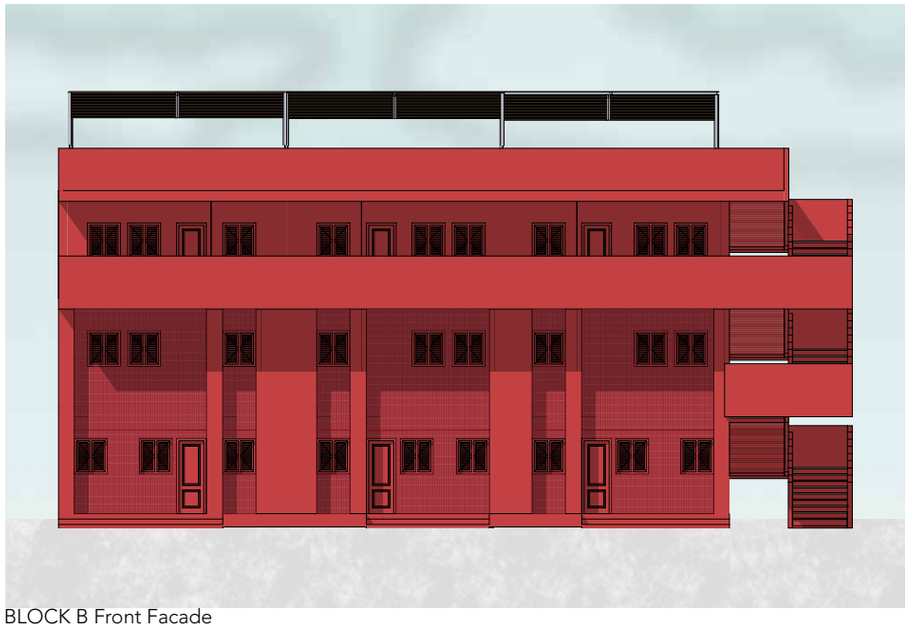


INFILL Facade



BLOCK B Front Facade

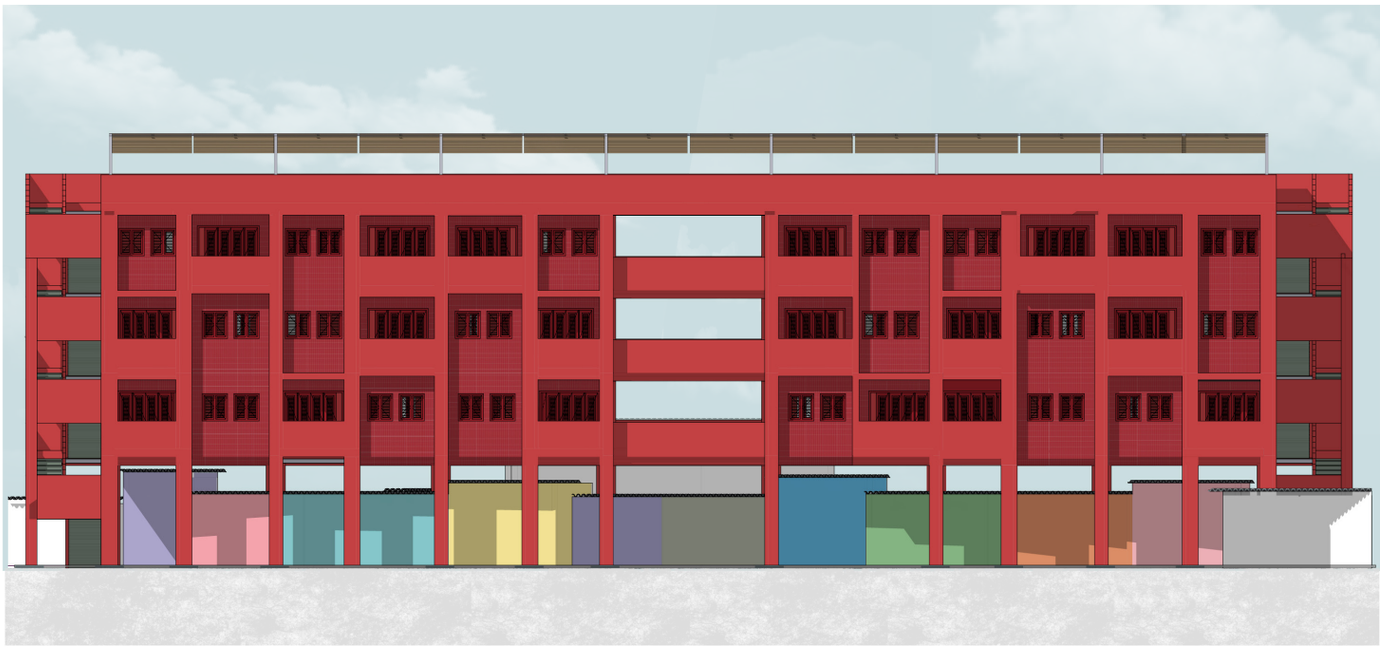
BLOCK B Back Facade



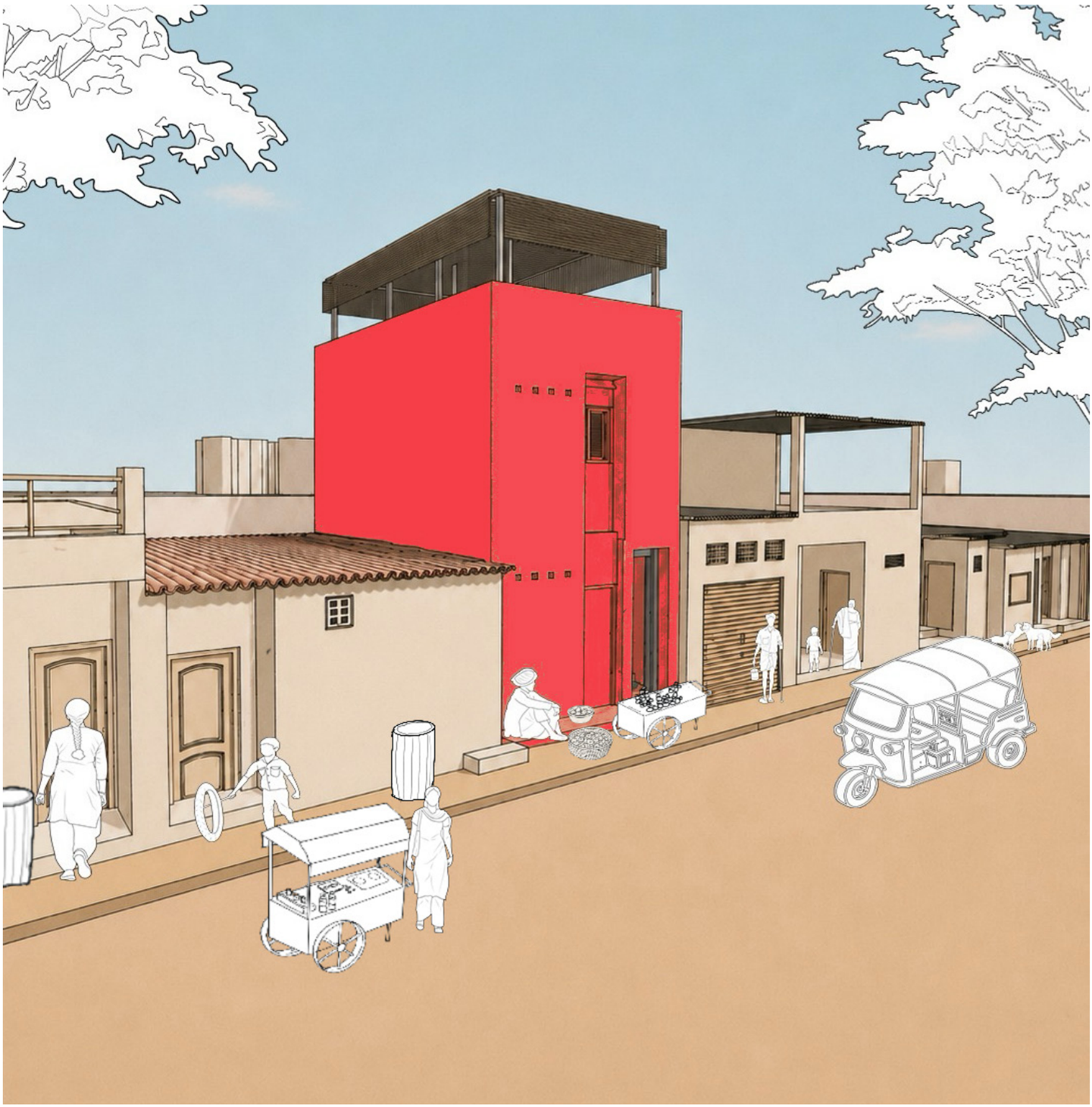
BLOCK B Front Facade

BLOCK B Back Facade

Hover Front Facade



Hover Back Facade



*This visualization was created by the author using ArchiCAD andIllustrator. The final rendering was then enhanced using ChatGPT

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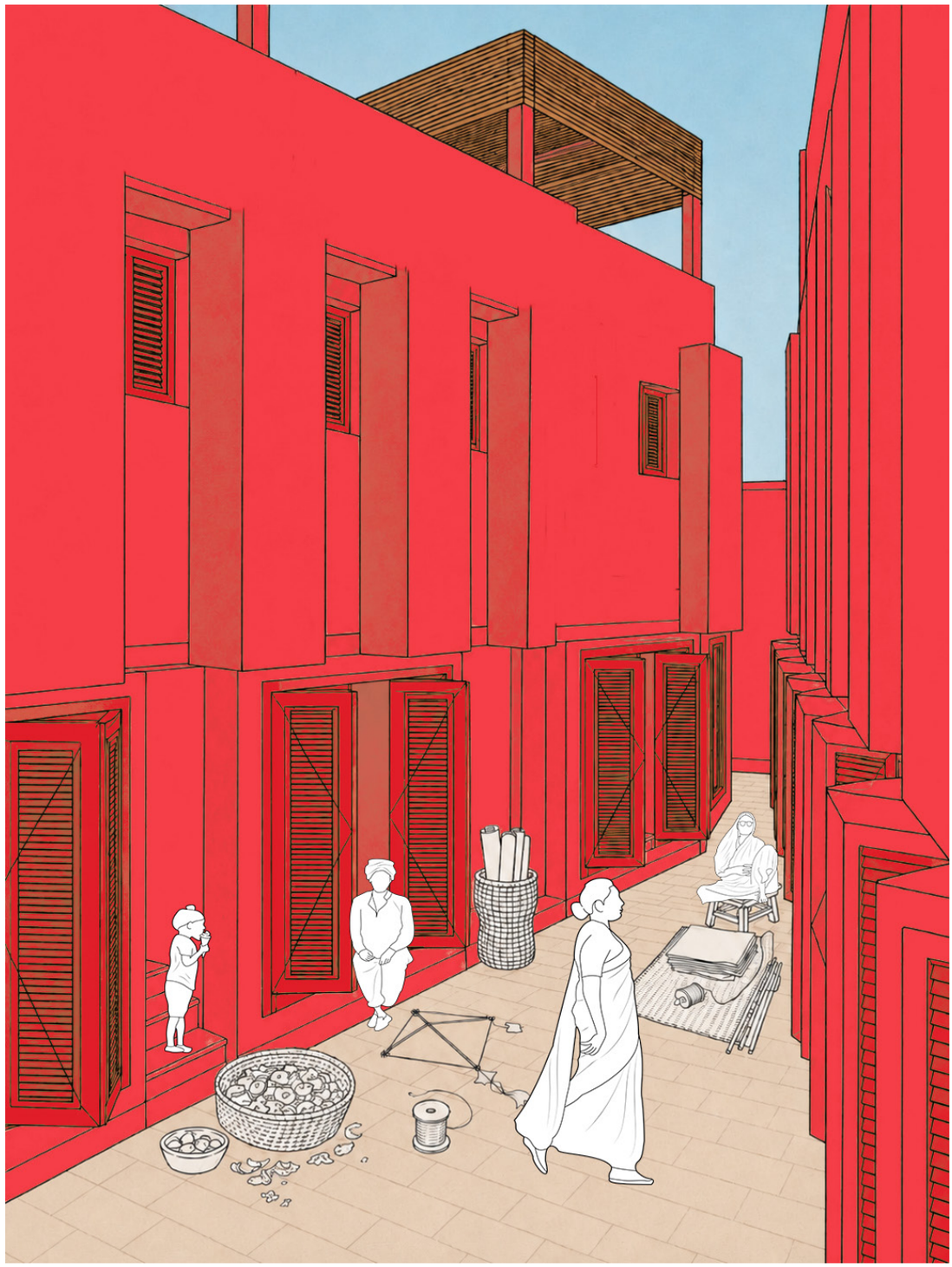
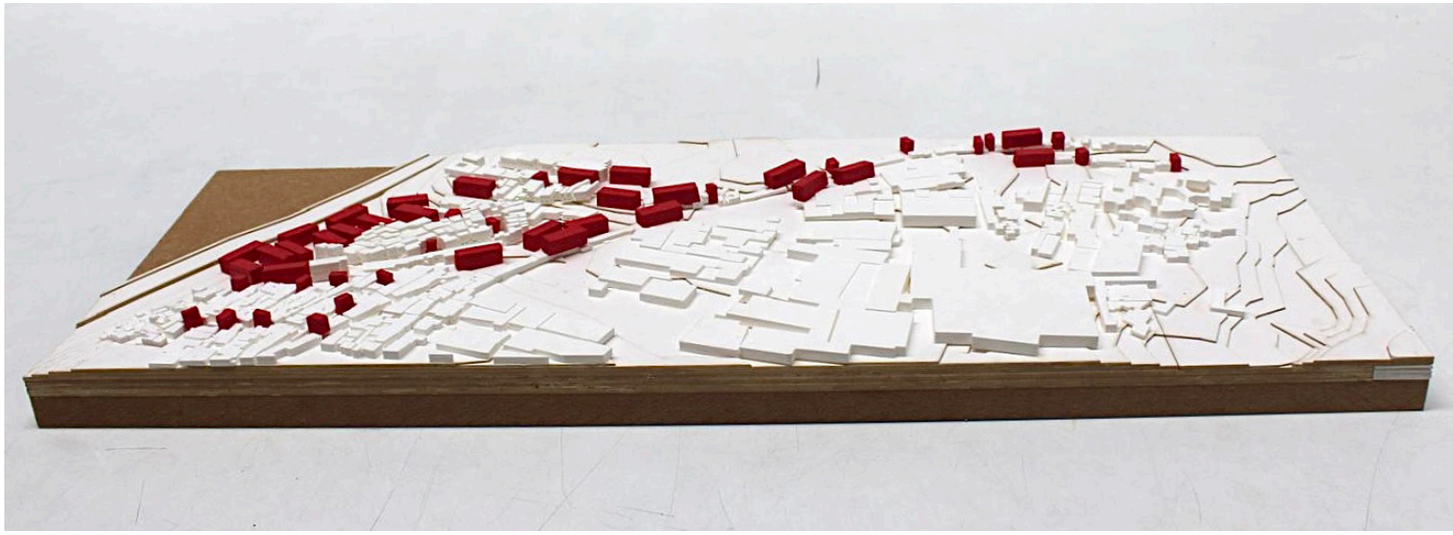
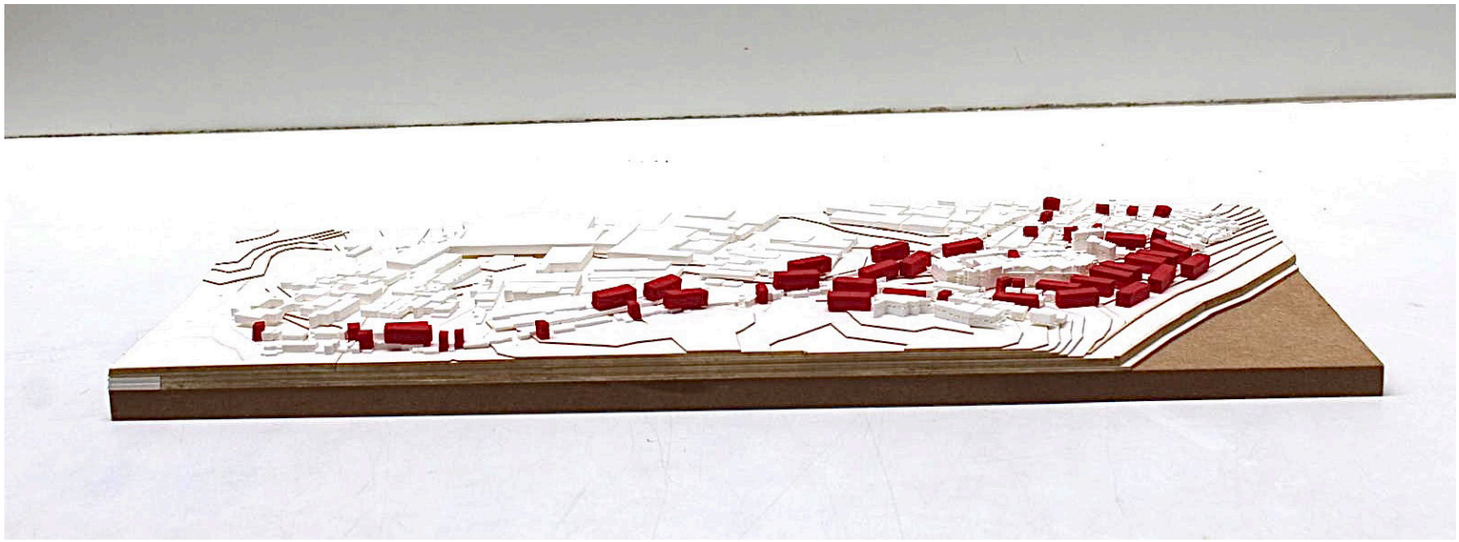


*This visualization was created by the author using ArchiCAD and Illustrator Photoshop. The final rendering was then enhanced using ChatGPT

Impression Row house A Courtyard



Site Model



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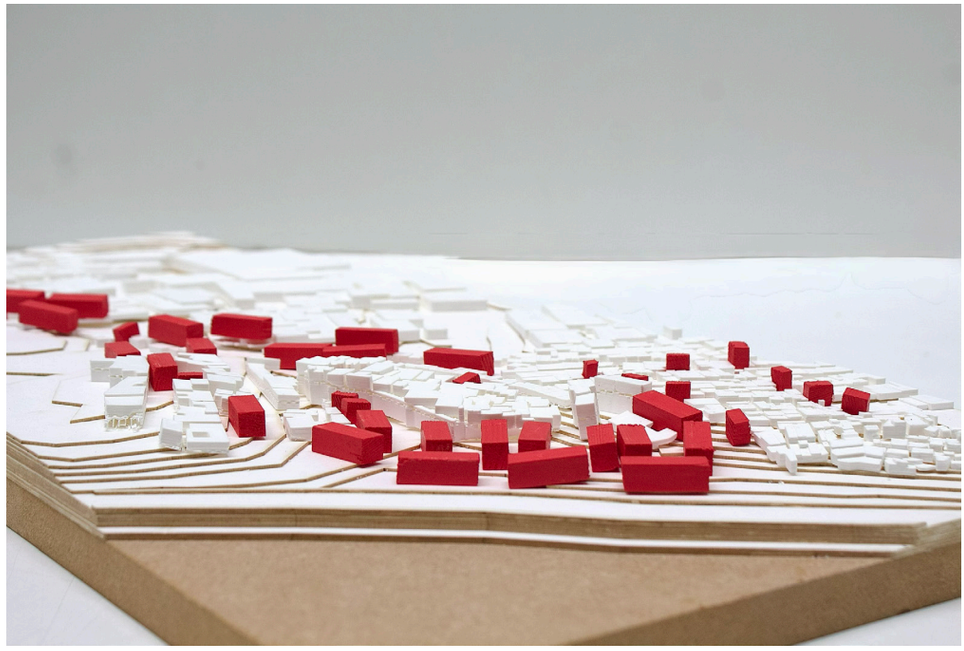
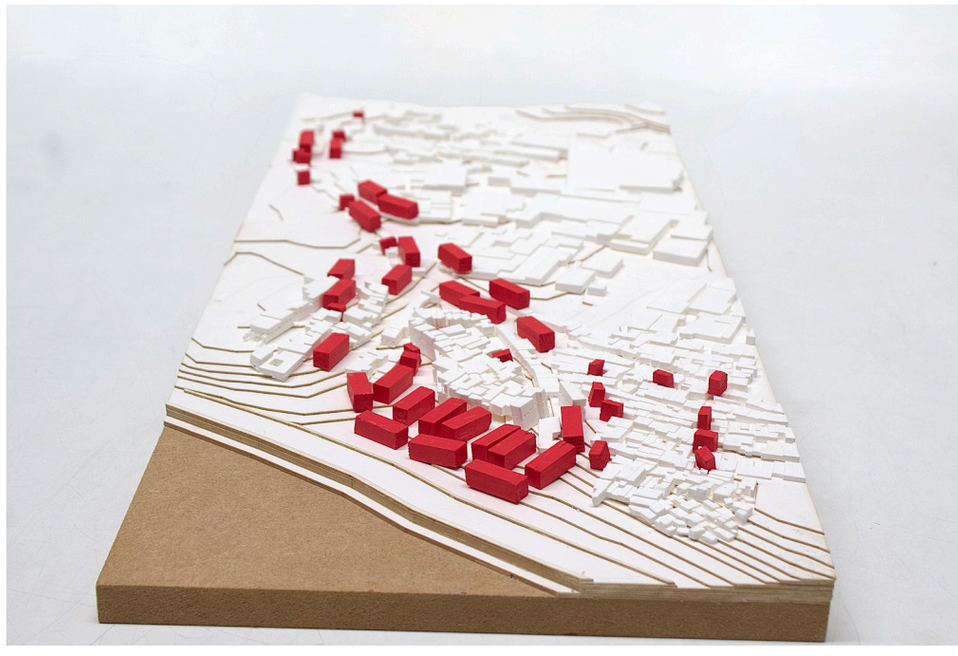




Site Model

Facade Model

Facade Model

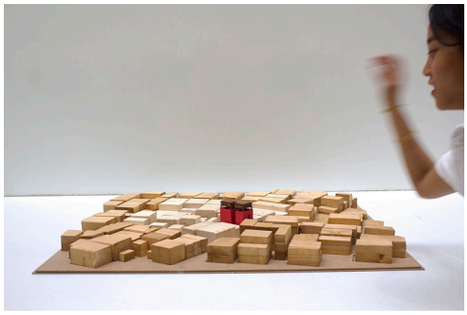
Facade Model

Facade Model

Facade Model

Neighbourhood Model

Neighbourhood Model



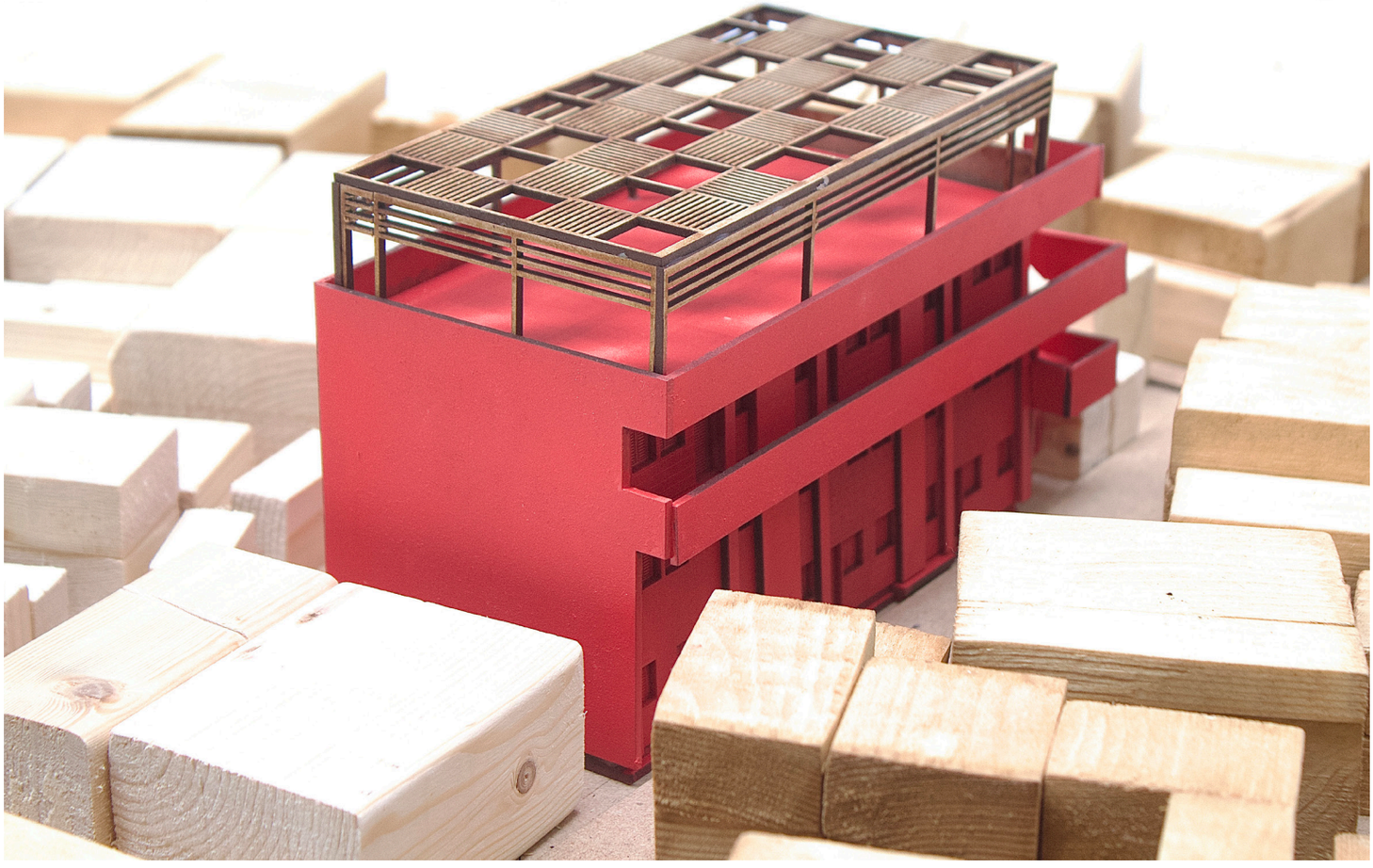
Infill Model

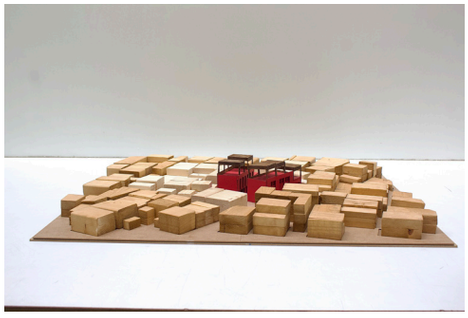
Infill Model

Block A Model

Block A  Model

Block B Model



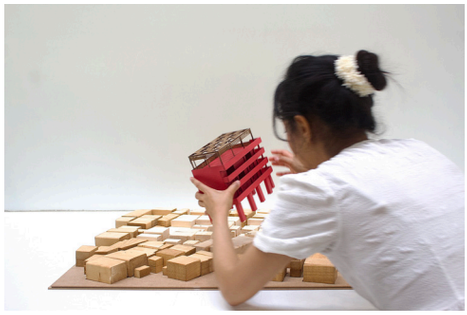


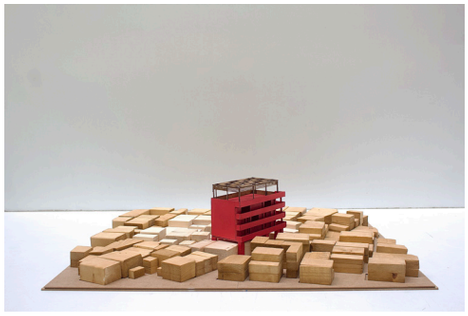
Row House A Model

Row House A Model

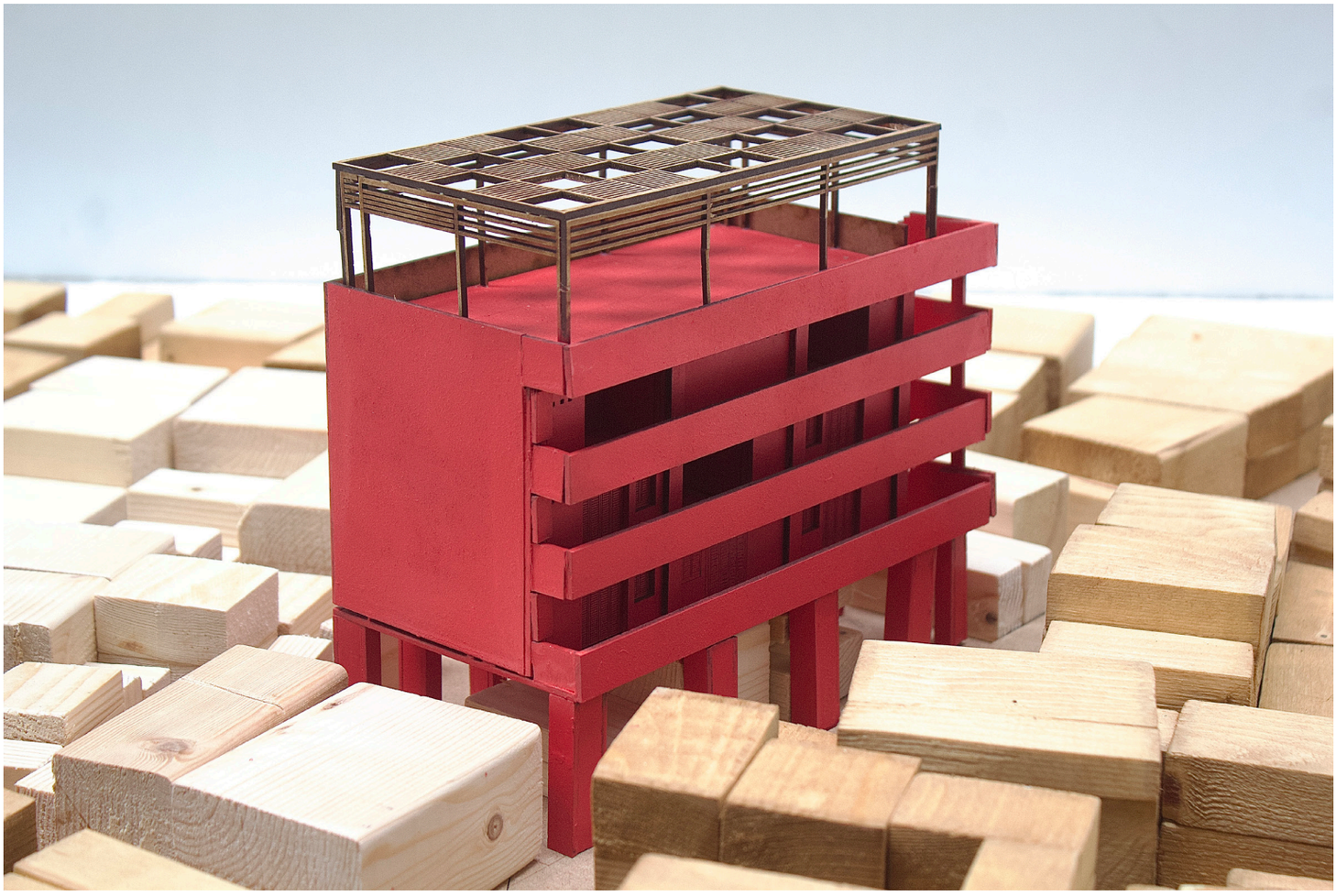
Row House B Model

Row House B Model



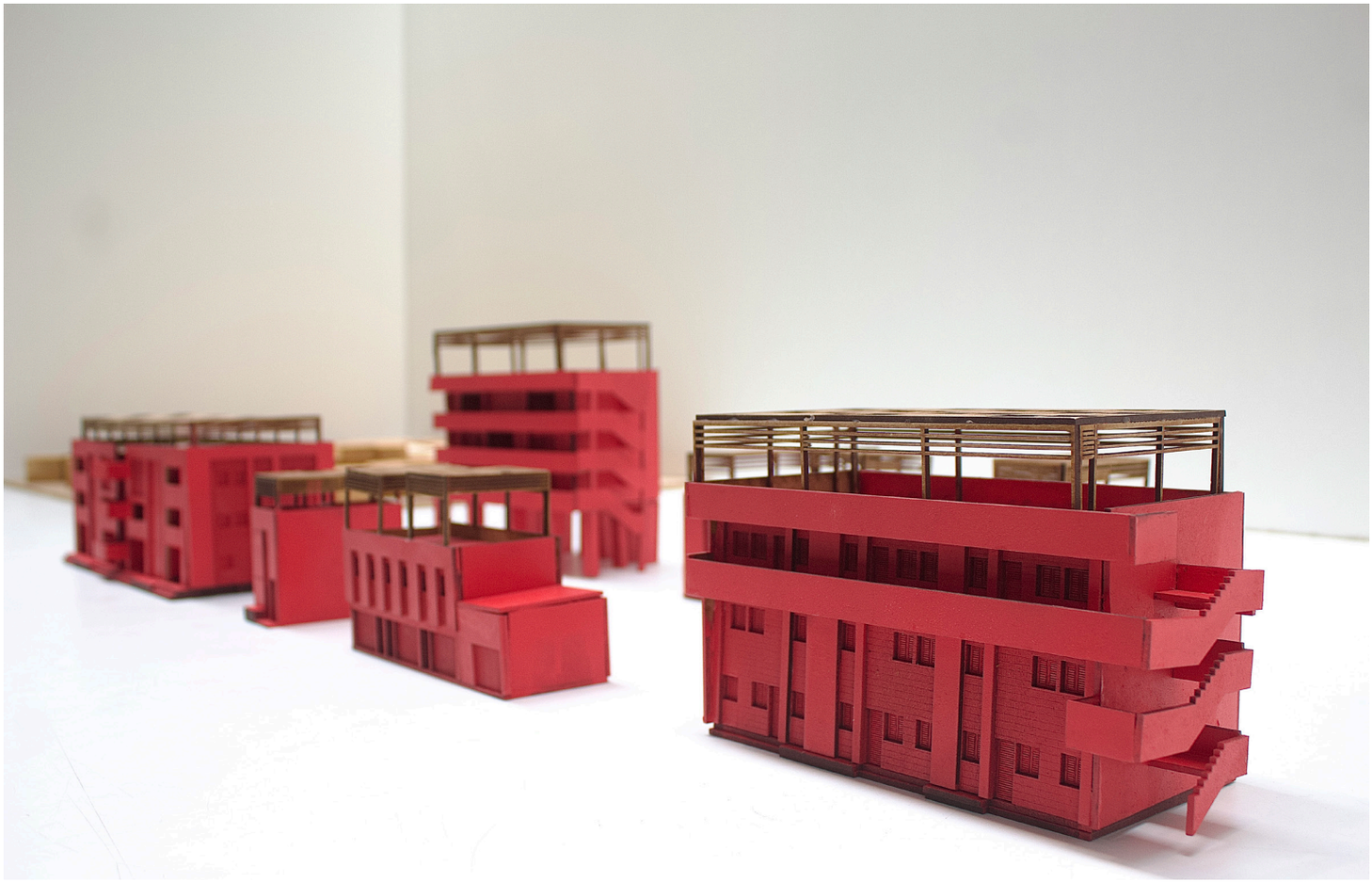


Hover Model



Hover Model

Typology Models



Typology Models

# IMPLICATION/RECOMMENDATION

This research challenges large scale clearance projects of informal settlements and their replacement with modern apartment blocks. Instead, it works directly with the existing context, demonstrating that the spatial conflation of life and work is an asset rather than an urban shortfall. This research shifts the perception of informality from a spatial shortfall to an active form of design. Interventions, like textile curtain and furniture zoning are tactics for negotiating extreme spatial scarcity. Implying the architect's role goes beyond interior walls and rigid layouts and learning from the existing way of living.

Building upon this insight, few recommendations can be offered for future design. At dwelling scale, future low-cost housing models should facilitate adaptivity within a dwelling for seamless multiple transitions in 24hours, along side enough storage. This ensures work can be physically hidden away after work hours and residents can completely detach themselves form their work

Scaled up to the neighbourhood level, municipal authorities must transition from complete clearance models to infrastructure-led upgrades. This includes embedding communal pockets within districts to create work zones, alongside expanding the existing road network work better connection and wider road for potential otlas. Ultimately, by shifting the design focus from private square footage to a strategy of a multi scala network architecture can successfully sustain local livelihoods while safeguarding privacy and social life within homes.

# REFLECTION

Reflecting on this graduation project, the greatest challenge was not inventing entirely new architectural forms, but learning how to deeply listen to, observe, respect, and design with an intense existing context. The research process exposed the truth that capturing a neighbourhood dynamic and rich like the Calico Mills required tools beyond traditional research. Moving from theories about urban space and architecture to a shift to on site reality approach. The process demanded a research through design methodology where drawing, mapping, and matrix synthesis operated not merely as element of final representation, but as primary tools of discovery. The fieldwork forced me to realize that true architecture in densely populated area's lies in the fluidity and ongoing negotiation of space by the residents themselves. Even after concluding the field phase, a thought kept lingering in my mind: "If only I could go back and systematically map Calico one more time." This urge stemmed from an acute awareness that such dense neighbourhood hold infinite layers of hidden information, leaving me with a continuous desire to uncover the micro layers I might have missed during my fieldtrip.

The tools for the research allowed me to explore the allowed me to visually translate invisible, sensory qualities such as acoustics from sewing workshops and occupations of the street and safety into more rigid and tangible data. Yet, even as I explored these urban systems to construct a shared network, I felt the need for an even deeper layer of site analysis to ground the project.

This anxiety directly translated into a period of design paralysis. Early in the design phase, I felt completely lost, terrified of intervening too heavily. I was constantly haunted by the question: "If my architectural interventions alter this fabric too aggressively, what truly separates my project from the large-scale clearance project that I am critiquing?" The project only found its footing once I accepted that strategic, surgical intervention was necessary to upgrade the site. This resulted in the development of the catalogue strategy, a framework consisting from 4 building typologies than can be placed based on different situations.

The catalogue system is a system that Coming up with the 4 typology and related floorplans and size was not an easy task as their is simple not enough space. Working with small footprints, lack of direct ventilation and light and making a cohesive project that is scattered throughout the site was the biggest challenge. After cases study on case study eventually everything started to roll and it began to look like one project instead of 4 different building placed in the site. Designing these 4 typologies into a cohesive and functional plan was a demanding task due to lack of physical space on site. Navigating extremely restricted footprints, resolving severe scarcity in direct natural light and ventilation, and ensuring that a project scattered across the site felt unified was my ultimate test as a designer. It required looping though case studies repeatedly. Through this cycle of precedent analysis, the separate puzzle pieces finally piece together, transforming four different building typology into a single, unified neighbourhood framework.

Ultimately, this journey highlighted the value of working directly within an existing contextual fabric. It proved to me that architects do not always need to start with a clean slat and invent entirely new forms rather. Instead our responsibility is to observe, decode, and formalize the existing brilliance already designed by communities themselves. In the end, the Calico Mills taught me that the role of a designer is not always to act as the author, but act sometimes as a translator and that the most powerful architectural interventions are not those that enforce an idealized future, but those that honour the complex realities of the present.

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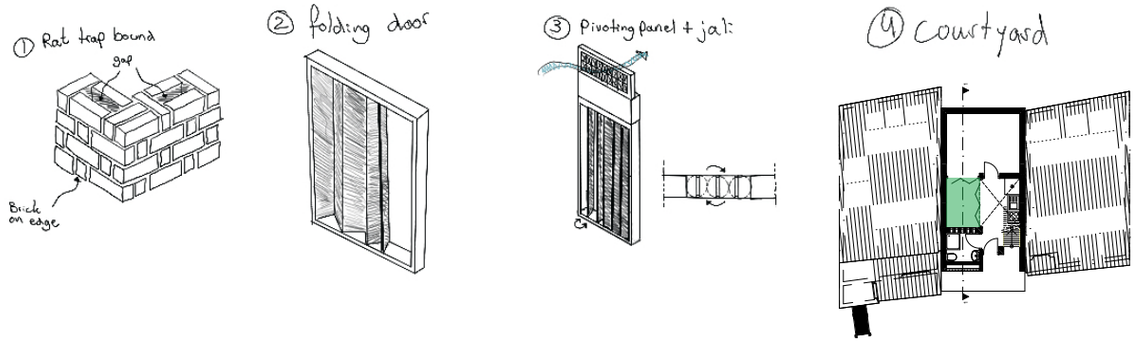
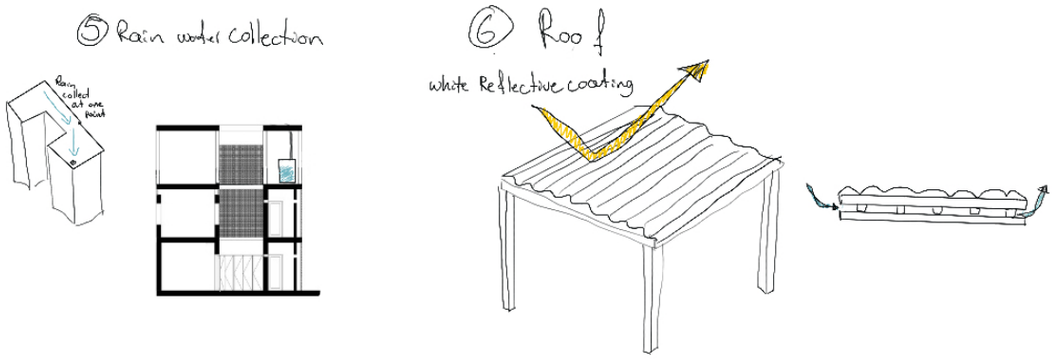
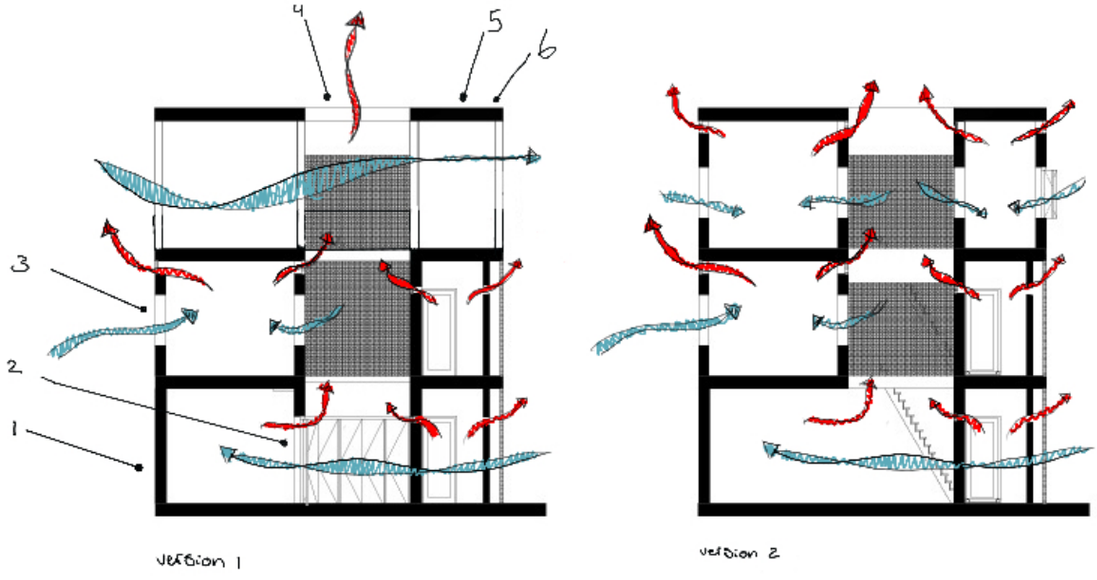
# APPENDIX

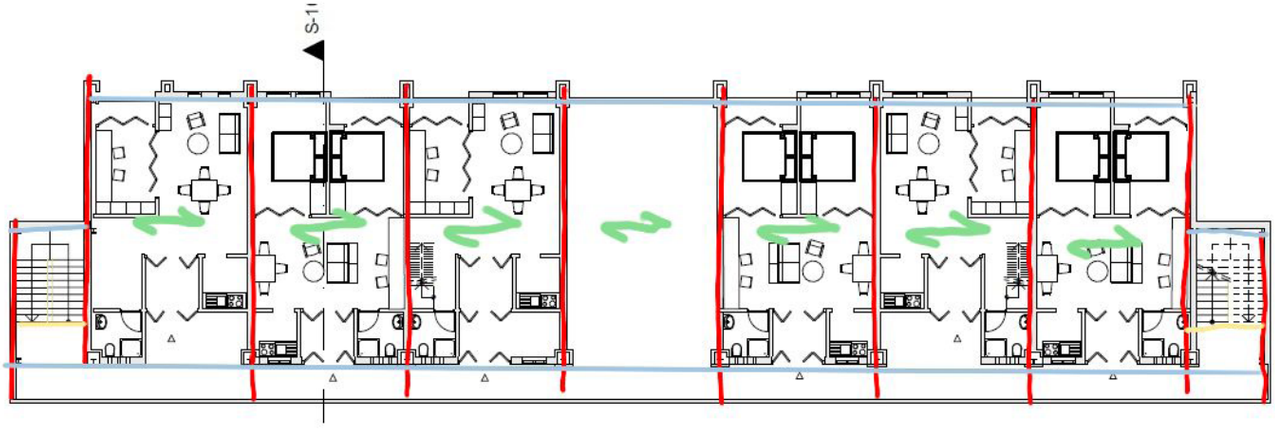
# CLIMATE


① Rat trap bound
gap
Brick on edge
② folding door
③ Pivoting panel + jali
④ courtyard


⑤ Rain water collection
Rain collect at one point
⑥ Roof
white Reflective coating


4
5
6
3
2
1
version 1
version 2

# CONSTRUCTION HOVER



# CONSTRUCTION INFILL

INFILL

**Bepaling dimensies stalen kolom (globaal)**

*- de groene cellen dienen ingevuld te worden op basis van het eigen ontwerp -*

Bepaling belasting in kolom:

| afdragend vloeroppervlak | lengte | | breedte | | rekenwaarde | | |
|---|---|---|---|---|---|---|---|
| opp.vl dak | 3.5 [m] | x | 4.2 [m] | x | 14 [kN/m²] | = | 205.8 [kN] |
| opp.vl 4e verd | 0 [m] | x | 0 [m] | x | 10.5 [kN/m²] | = | 0 [kN] |
| opp.vl 3e verd | 0 [m] | x | 0 [m] | x | 10.5 [kN/m²] | = | 0 [kN] |
| opp.vl 2e verd | 3.5 [m] | x | 4.2 [m] | x | 10.5 [kN/m²] | = | 154.35 [kN] |
| opp.vl 1e verd | 3.5 [m] | x | 4.2 [m] | x | 10.5 [kN/m²] | = | 154.35 [kN] + |
| | | | | | **kolombelasting:** | $F_{cd}$ = | **514.5 [kN]** |

| | | | |
|---|---|---|---|
| *kniklengte* | $l_{cr}$ = 3 [m] | Minimaal benodigde afmetingen: | |
| | | $A_{ben} = F_{cd}/f_{cd}$ = | 1449 [mm²] |
| | | $I_{z\ ben}$ = | 1.12E+07 [mm⁴] |

Profieleigenschappen van gekozen profiel:

HEA 200 — *gebruik bijvoorbeeld de app 'Staalprofielen'*

| | | | |
|---|---|---|---|
| *oppervlakte* | A = | 5383 [mm²] | |
| *traagheidsmoment* | $I_z$ = | 1.336E+07 [mm⁴] | *let op sterke/zwakke richting* |
| *rek. waarde druksterkte* | $f_{cd}$ = | 355 [N/mm²] | |
| *elasticiteitsmodulus* | E = | 210000 [N/mm²] | |

**Controle op druk:**

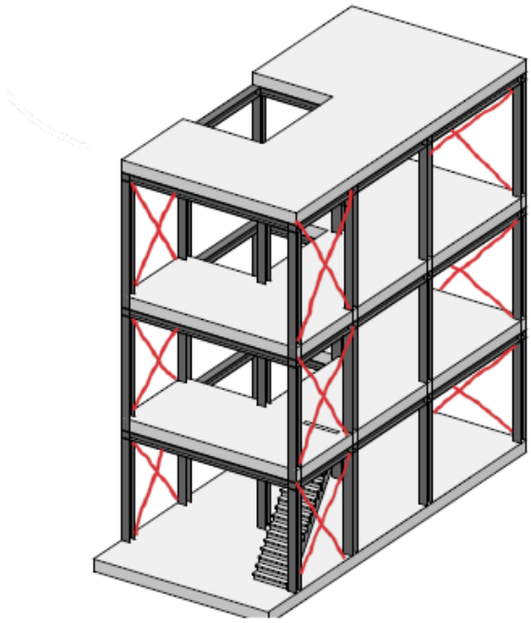
UC = 0.27 Voldoet

**Controle op knik:**

$F_{cr}$ = 3077 [kN]

UC = 0.84 Voldoet

Column: HEA 200



The construction of the infill typology is the main construction concept for the rowhouse and block 3 typology, as these three typologies have similar smaller spans and load in the structure.

**Bepaling dimensies stalen vloerligger (globaal)**

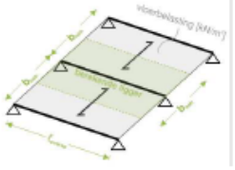
*- de groene cellen dienen ingevuld te worden op basis van het eigen ontwerp -*

HEA 140

| | | | |
|---|---|---|---|
| | $l_{overspan}$ = | 3.5 | [m] |
| | $b_{belast}$ = | 3.34 | [m] |
| | $q_{d;vast}$ = | 10.5 | [kN/m²] |
| *op ligger* | $q_{UGT}$ = | 35.07 | [kN/m] |
| | $q_{d;var}$ = | 2 | [kN/m²] |
| *op ligger* | $q_{BGT}$ = | 6.68 | [kN/m] |

Profieleigenschappen van gekozen profiel:

| | | | | |
|---|---|---|---|---|
| *weerstandsmoment* | $W_y$ = | 155000 | [mm³] | *gebruik bijvoorbeeld de app 'Staalprofielen'* |
| *traagheidsmoment* | $I_y$ = | 10330000 | [mm⁴] | |
| *vloeigrens* | $f_y$ = | 355 | [N/mm²] | |
| *elasticiteitsmodulus* | E = | 210000 | [N/mm²] | |




**Controle sterkte:**

UGT

| | | | | | | |
|---|---|---|---|---|---|---|
| $M_{max}$ | 53700937.5 | [Nmm] | $\sigma_{max}$ = | 346.5 | [N/mm²] | |
| UC = | 0.98 | Voldoet | $W_{y;benodigd}$ = | 151270 | [mm³] | |

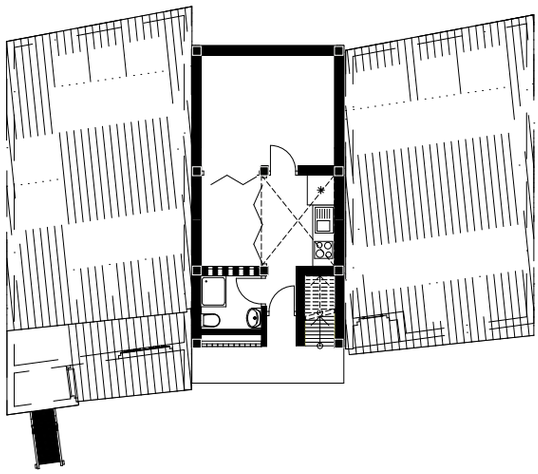
**Controle stijfheid:**

BGT

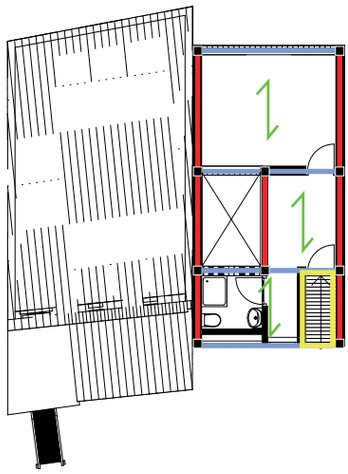
| | | | | | | |
|---|---|---|---|---|---|---|
| $w_{BGT}$ = | 6.02 | [mm] | $w_{BGT;norm\ vloer}$ = | 10.5 | [mm] | 0,003 x L |
| | | | $w_{BGT;norm\ vl.wand}$ = | 7.0 | [mm] | 0,002 x L |
| UC vloer = | 0.57 | Voldoet | $I_{y;benodigd}$ = | 5919416 | [mm⁴] | |
| ( UC vl.wand = | 0.86 | | $I_{z;benodigd}$ = | 8879123 | [mm⁴] ) | |

Beam: HEA 140

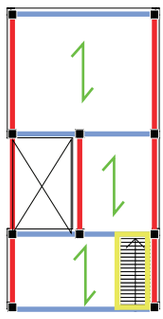
# CONSTRUCTION INFILL



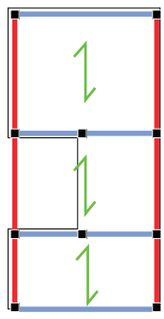
G



G +1



G +2



G +3

- Column
- Span direction
- Stair Trimmer
- Beam
- Beam

# CONSTRUCTION HOVER

## HOVER

**Bepaling dimensies stalen kolom (globaal)**

*- de groene cellen dienen ingevuld te worden op basis van het eigen ontwerp -*

Bepaling belasting in kolom:

| afdragend vloeropp. | lengte | | | breedte | | | rekenwaarde | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| opp.vl dak | 4 | [m] | x | 6 | [m] | x | 14 | [kN/m²] | = | 336 [ |
| opp.vl 4e verd | 0 | [m] | x | 0 | [m] | x | 10.5 | [kN/m²] | = | 0 [ |
| opp.vl 3e verd | 0 | [m] | x | 0 | [m] | x | 10.5 | [kN/m²] | = | 0 [ |
| opp.vl 2e verd | 4 | [m] | x | 6 | [m] | x | 10.5 | [kN/m²] | = | 252 [ |
| opp.vl 1e verd | 4 | [m] | x | 6 | [m] | x | 10.5 | [kN/m²] | = | 252 [ |
| | | | | | | | **kolombelasting:** | | $F_{cd}$ = | **840 [** |

kniklengte $l_{cr}$ = 3 [m]

Minimaal benodigde afme

$A_{ben} = F_{cd}/f_{cd}$ = 2366 [

$I_{z\ ben}$ = 1.82E+07 [

Profieleigenschappen van gekozen profiel:

HEA 240 *gebruik bijvoorbeeld de app 'Staalprofielen'*

oppervlakte A = 7684 [mm²]

traagheidsmoment $I_z$ = 2.769E+07 [mm⁴] *let op sterke/zwakke richting*

rek. waarde druksterkte $f_{cd}$ = 355 [N/mm²]

elasticiteitsmodulus E = 210000 [N/mm²]

**Controle op druk:**

UC = **0.31** Voldoet

**Controle op knik:**

$F_{cr}$ = 6377 [kN]

UC = **0.66** Voldoet

Column: HEA 240

**Bepaling dimensies stalen vloerligger (globaal)**

*- de groene cellen dienen ingevuld te worden op basis van het eigen ontwerp -*

HEA 300

$l_{oversp}$ = 8 [m]

$b_{hoh}$ = 3 [m]

$q_{d;vst}$ = 10.5 [kN/m²]

op ligger $q_{d;GT}$ = 31.5 [kN/m]

$q_{d;var}$ = 2 [kN/m²]

op ligger $q_{d;GT}$ = 6 [kN/m]

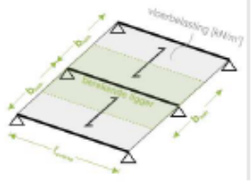
Profieleigenschappen van gekozen profiel:

weerstandsmoment $W_y$ = 1260000 [mm³] *gebruik bijv*

traagheidsmoment $I_y$ = 182630000 [mm⁴]

vloeigrens $f_y$ = 355 [N/mm²]

elasticiteitsmodulus E = 210000 [N/mm²]




**Controle sterkte:**

UGT $M_{ed}$ = 25200000 [Nmm]

UC = **0.06** Voldoet

$\sigma_{max}$ = 20.0 [N/mm²]

$W_{y;benodigd}$ = 709859 [mm³]

**Controle stijfheid:**

BGT $w_{GT}$ = 8.34 [mm]

$w_{GT;norm\ vloer}$ = 24.0 [mm] 0,003 x L

$w_{GT;norm\ vl.wand}$ = 16.0 [mm] 0,002 x L

UC vloer = 0.35 Voldoet

( UC vl.wand = 0.52

$I_{y;benodigd}$ = 63492063 [mm⁴]

$I_{y;benodigd}$ = 95238095 [mm⁴] )

Beam: HEA 160