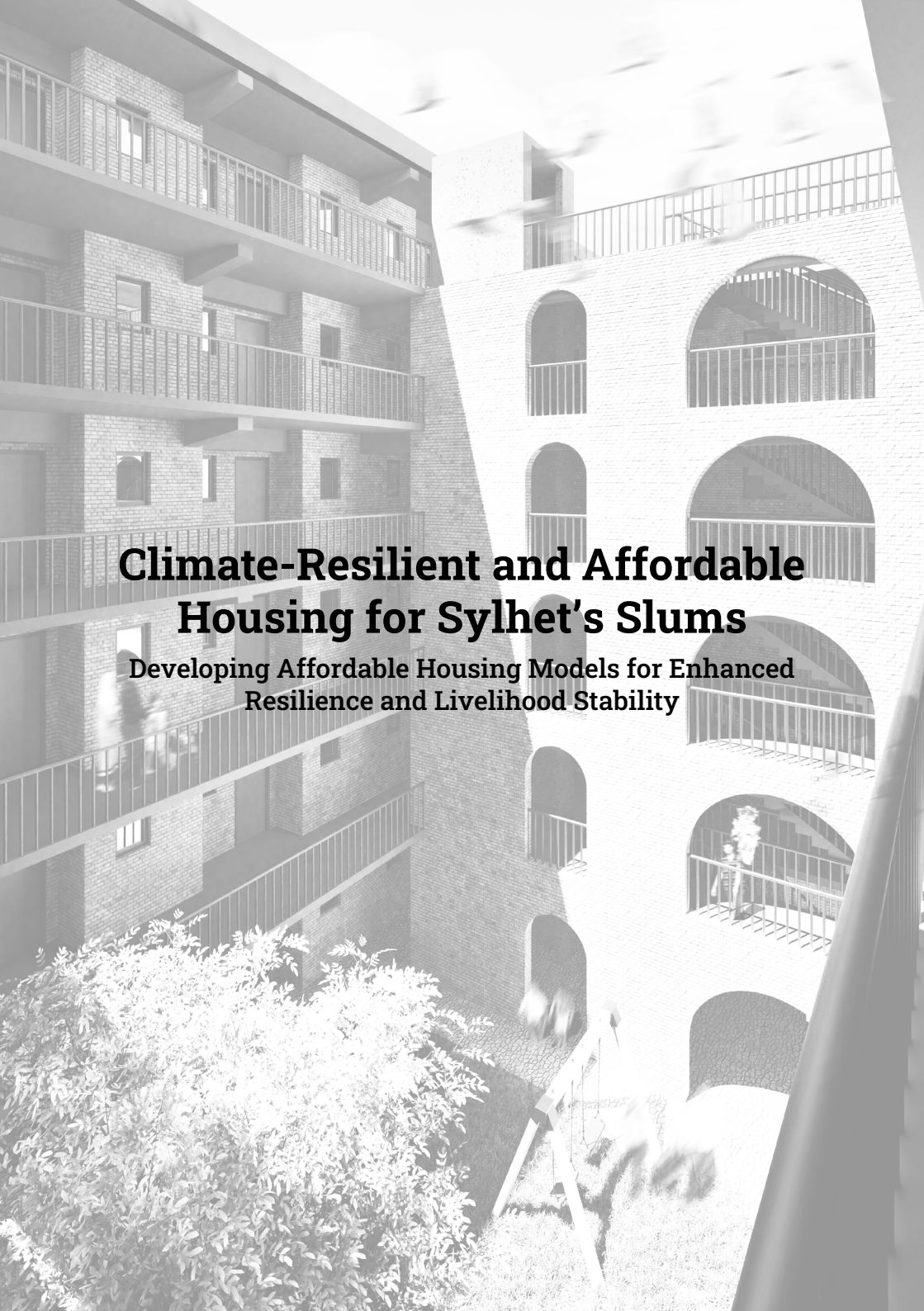

Climate-Resilient and Affordable Housing for Sylhet's Slums

Developing Affordable Housing Models for Enhanced Resilience and Livelihood Stability

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Architecture of Transition: In the Bangladesh Delta

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01

01 Problem & Research

- Literature review
- Problem statement
- Research question
- Hypothesis & Aim

01 Introduction

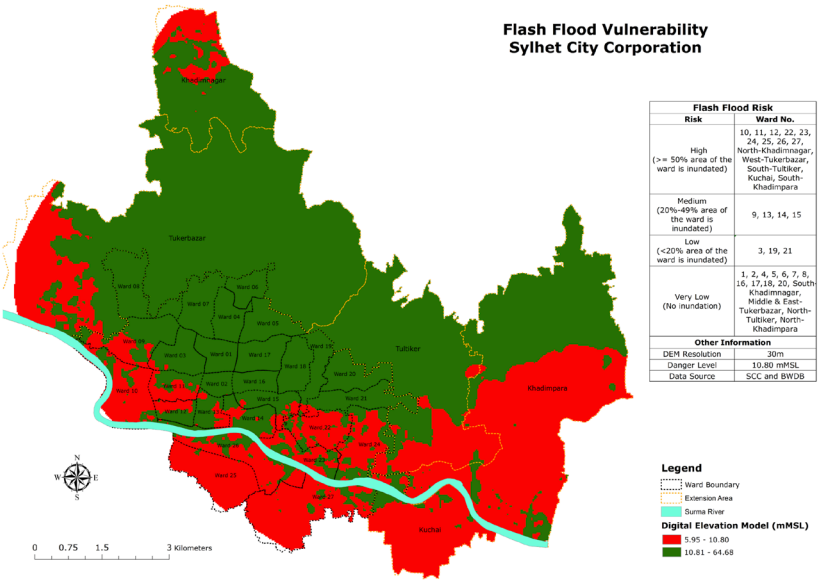
In cities worldwide, millions of people are In cities worldwide, millions of people are forced to live in slums, enduring extreme poverty, inadequate housing, and a lack of basic services, making them particularly vulnerable to the effects of rapid urbanization and climate change. Slums historically emerged during industrialization to house low-paid workers near factories, but today, slum dwellers face high rates of poverty, illiteracy, and poor health. Many are engaged in informal, low-paying, and unsafe jobs, and often lack access to basic services such as clean water, sanitation, and education. This increases their exposure to diseases, accidents, and climate-related risks. Overcrowding, substandard infrastructure, and the prevalence of one-room homes further exacerbate these conditions. Poor governance, corruption, and ineffective policies make it difficult for slum residents to attain even basic living standards (Kamruzzaman & Hakim, 2016).

Simultaneously, climate change has emerged as a major global concern, with the accumulation of greenhouse gases driving its progression. While climate change affects all nations, its impacts and responsibilities are unevenly distributed. Developing countries like Bangladesh, despite contributing minimally to global emissions, are disproportionately affected. In Bangladesh, the effects of climate change are increasingly evident through rising temperatures, fluctuating rainfall patterns, sea-level rise, and more frequent and intense cyclones. These changes have a particularly devastating impact on vulnerable populations, including slum dwellers, whose inadequate housing and poor access to infrastructure leave them highly exposed to climate- related disasters (Nishat & Mukherjee, 2013).

As climate change intensifies, extreme weather events, particularly floods and tropical cyclones, are becoming more frequent in Bangladesh. The monsoon season brings severe flooding, exacerbated by the lack of infrastructure and precarious housing in slum areas. Additionally, localized tornadoes with accompanying thunderstorms and hail threaten informal settlements during the pre-monsoon season. To protect the lives, livelihoods, and homes of slum dwellers, targeted interventions and policies focusing on climate resilience are urgently needed. Housing improvements, infrastructure upgrades, and sustainable urban development strategies are essential in reducing the vulnerability of these communities to future climate shocks (Awal, 2015).

Sunamganj, located in northeastern Bangladesh under the Sylhet Division, is one such area facing significant climate challenges. Its geographical features make it particularly susceptible to annual flooding, exacerbated by the Surma, Kushiyara, Dhamalia, and Jadukata rivers, which raise riverbeds and increase flood risks (Akter et al., 2023). River erosion displaces 60,000 people annually and threatens to create 35 million climate refugees in Bangladesh by 2050 as rural livelihoods deteriorate due to flooding and drought (S. F. Rashid et al., 2013).

The expansion of slums in Bangladesh has been fueled by rural-to-urban migration, as environmentalpressuresdrivepeopletocities in search of work (Chowdhury et al., 2012). As these populations face multiple layers of vulnerability, both economic and environmental, self-help housing has emerged as a potential solution for improving living conditions and resilience in these communities (Ward, 2019).



Flash Flood Risk	
Risk	**Ward No.**
High (>= 50% area of the ward is inundated)	10, 11, 12, 22, 23, 24, 25, 26, 27, North-Khadimnagar, West-Tukerbazar, South-Tultiker, Kuchai, South-Khadimpara
Medium (20%-49% area of the ward is inundated)	9, 13, 14, 15
Low (<20% area of the ward is inundated)	3, 19, 21
Very Low (No inundation)	1, 2, 4, 5, 6, 7, 8, 16, 17,18, 20, South-Khadimnagar, Middle & East-Tukerbazar, North-Tultiker, North-Khadimpara
Other Information	
DEM Resolution	30m
Danger Level	10.80 mMSL
Data Source	SCC and BWDB

Sylhet flash flood vulnerability mapping (SNV, 2023)

01 Literature review

A “slum” is defined as a densely populated urban area characterized by inadequate housing, poor infrastructure, and unsanitary living conditions. Key characteristics like overcrowding and limited access to basic services play a significant role in shaping how the public views slums and impact the policies designed to address the challenges faced by these communities. (UN- Habitat, 2004). Housing in slums ranges from makeshift structures to more permanent homes. Residents also often lack adequate water, sanitation, and waste disposal systems, making them vulnerable to disease and accidents.

Rural-to-urban Migration

In Bangladesh, rural-to-urban migration is frequently driven by environmental pressures, economic stagnation, and limited job opportunities in rural areas. For instance, in Sylhet, where agriculture has historically been a primary livelihood, erratic rainfall patterns and rising temperatures have significantly disrupted productivity, forcing families to migrate to urban centers in search of better opportunities (Chowdhury et al., 2012). However, many migrants arrive in the city without the skills needed for stable, well-paying jobs. As a result, they often find themselves stuck in the informal economy, where they face low wages and unsafe working conditions, which only deepens their struggle with poverty (Islam et al., 2023; Awal, 2015).

This migration has fueled rapid slum expansion, particularly in cities like Sylhet and Dhaka. Many former agricultural workers struggle to adapt to urban life, where decent housing and civic services are often out of reach. With limited resources, many migrants settle in overcrowded, poorly constructed housing, increasing their vulnerability to floods and other natural disasters (Islam et al., 2023). For example, flooding during the monsoon season often devastates slum homes, leaving families homeless and forcing them into unsanitary, overcrowded conditions.

Climate Change

Climate change further exacerbates the vulnerabilities of slum residents. In Sylhet, significant changes in rainfall and temperature patterns have been observed. Between 1986 and 2010, summer rainfall increased by 24.5%, while critical-period rainfall rose by 33.8%, and winter rainfall decreased by 35% (Chowdhury et al., 2012). These shifts disrupt traditional agricultural cycles, contribute to flooding, and place additional strain on slum infrastructure. The mean annual temperature has also been rising steadily, complicating agricultural production and increasing the frequency of extreme weather events (Chowdhury et al., 2012).

For slum residents, extreme weather events like floods and cyclones pose direct threats to their lives, homes, and livelihoods. Poorly constructed homes are often destroyed by flooding, making recovery nearly impossible for families with limited savings or social support networks. As many rely on informal jobs in urban markets, inadequate wages prevent them from improving their living conditions or implementing climate adaptation measures. As a result, residents contend with two layers of vulnerability: economic and environmental. They must navigate unstable job situations while also facing an increased risk of natural disasters. (Islam et al., 2023).

Challenges in Governance and Policy Implementation for Slum Upgrading

The rapid growth of slums in Bangladesh highlights gaps in governance, fragmented policies, and inadequate urban planning. Corruption and unclear policies regarding slum settlements hinder long-term planning that could improve living conditions (S. F. Rashid et al., 2013). While slum upgrading initiatives, such as investments in housing, infrastructure, and disaster risk reduction, have proven effective elsewhere (Collado & Wang, 2020), local governments in Bangladesh often hesitate to implement such measures due to limited financial resources, political disinterest, and a lack of coordination with slum communities (Shaw et al., 2013). Without proactive interventions, slum residents remain vulnerable to natural disasters, disease outbreaks, and food insecurity.

Research highlights the significance of slum upgrading as a vital economic and social solution. By improving housing, we can strengthen the resilience of slum residents to climate-related challenges and help reduce poverty and inequality. However, these efforts require effective governance and collaboration among government agencies, private-sector developers, and local communities (Udin, 2018). Unfortunately, many policy efforts remain fragmented and poorly implemented, leaving millions of slum residents without access to safe housing or essential services.

Although this research will not specifically focus on policies or government actions, understanding the reasons behind the lack of adequate interventions to improve slum residents' living conditions, particularly concerning climatic, social, and economic challenges, is crucial. The available literature underscores the necessity of investigating the housing circumstances and informal strategies employed by urban poor settlers to create targeted interventions that address their specific needs (Akinwande et al., 2023).

Climate Resilience

The concept of climate resilience in informal settlements has become increasingly importantinthecontextofclimatechange adaptation. It emphasizes the ability of communities to anticipate, cope with, and recover from climate-related hazards. Resilience encompasses not just individual adaptability but also the capacity of urban centers and their systems to manage hazardous events effectively (Satterthwaite et al., 2020).

Over the past 35 years, the Bangladeshi government has invested more than $10 billion in disaster resilience measures, including flood management, coastal protection, and the development of advanced warning systems (Islam et al., 2013). To further secure economic and social development, Bangladesh needs to scale up these investments, especially to support the most vulnerable populations, including women and children. The government is focused on eradicating poverty and enhancing well- being through a climate management strategy designed to benefit the poorest communities. This strategy prioritizes adaptation to climate change, disaster risk reduction, low-carbon development, technology transfer, and securing sufficient international financial support.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Community Engagement

The research of Dixit (2022) highlights the role of participatory design in empowering communities, promoting collaborative decision-making, and aligning architectural solutions with local needs and cultural contexts. This approach cultivates a sense of ownership and shared responsibility, which is essential for effective disaster preparedness and recovery (Dixit, 2022). Community engagement, as defined by Hotwani (n.d.), is a collaborative effort between a community and organizations, municipalities, or agencies to improve the quality of life at the local level. This partnership involves the identification, planning, and implementation of solutions to address local challenges, ensuring the active participation of all stakeholders in shaping their environment through participatory methods.

Hotwani (n.d.) identifies several forms of community participation:

Informative Participation: Residents are kept informed about upcoming procedures, decisions, and changes in their environment, helping to prevent misunderstandings or conflicts.

Participatory Planning: Residents provide feedback on ongoing projects. The combination of online tools and offline options helps engage a broader audience, including hard-to-reach groups. Early participation gathers valuable insights into residents' values and preferences, which are critical for effective planning.

Decision-Making Participation: In this model, residents propose and vote on decisions such as budgeting, urban planning, and policy development, enabling them to directly influence city funds allocation and policy implementation.

One other form Bovard and Loeffler (2012) would like to add, is co-production. User and community co-production has been recognized as a powerful way to improve public outcomes, though it has long been practiced informally. Residents are willing to engage meaningfully, but public agencies must ensure that their efforts are valued and directed effectively. Co-production excels in creating user value, though it can also support social, environmental, and preventive goals. While some risks are tied to resident involvement, embedding services in the community may improve quality (Bovaird & Loeffler, 2012).

According to Galarza (2017), the architecture profession, shaped by politics and finance, has distanced itself from real community needs. To be effective, architects must reconnect with communities by focusing on empowerment, practical experience, and addressing the specific needs of local people rather than relying solely on idealized, theoretical designs. Additionally, community engagement is essential for creating sustainable, healthy communities with long-lasting impacts. Though challenging, it fosters community ownership, which is crucial for the ongoing success, maintenance, and growth of local projects (Aboelata et al., 2011).

Working directly with residents on an individual level was challenging due to the limited opportunity for engagement, with only one site visit conducted. During this visit, the priority was to gather as much information as possible to understand their living conditions, needs, and aspirations.

01 Problem Statement

In June 2022, heavy upstream rainfall caused rivers in Sylhet to overflow, resulting in severe flooding. Approximately 7.2 million people in Sylhet and surrounding districts were affected, with 500,000 evacuated to emergency shelters and millions displaced. While Bangladesh regularly faces monsoon floods, recent events such as those in 1988, 1998, 2004, 2017, and 2020 have become increasingly destructive due to factors like climate change, deforestation, hill erosion, unregulated development in wetlands, and reduced river navigability (Zahid, n.d.). With 80% of Sylhet submerged, nearly 1.3 million homes were damaged, and many lives were lost.

What makes recovery increasingly difficult is the compounding effect of these floods, which strain both community resilience and government resources. Each disaster leaves lasting damage, eroding infrastructure, livelihoods, and savings, making it harder for residents to rebuild. As people continuously lose homes and belongings, they face deeper poverty, making subsequent floods even more devastating. With limited recovery time between floods and insufficient adaptation measures, affected populations are trapped in a cycle where each event worsens their vulnerability, pushing them further into crisis.

Sylhet's slum residents face compounded vulnerability due to recurring floods, climate change, and economic precarity, which render their homes increasingly uninhabitable and their livelihoods unstable. Existing housing solutions are often unaffordable and unsuitable for the region's environmental conditions, leaving residents in a cycle of poverty with few options to improve resilience or economic stability. Slum relocation schemes, intended to improve living conditions, have been largely unsuccessful, with issues such as loss of livelihood, overcrowding, disrupted education, limited job opportunities, and poor infrastructure in relocated areas (Kapse et al., 2012). Inefficiencies in government planning, including inadequate housing provisions and a lack of tenant security, have led to failures in resettlingresidents,forcingmanytoreturntotheir original locations or rent out their new homes.

01 Research Question

This research explores the urgent need for climate-resilient, affordable housing in Sylhet's slums, where residents face the dual challenges of urban poverty and climate change. The focus is on developing housing models that improve living conditions, support local economies, and enhance resilience to flooding and other climate impacts. The study aims to identify design strategies that are both practical and culturally appropriate for Sylhet's slum residents.

Research Question:
How can housing models be designed to enhance climate resilience and affordability for slum residents in Sylhet, Bangladesh, without requiring relocation?

Sub-Questions

1. Affordability and Livelihoods:
What is the definition of "affordable" housing in the context of Sylhet's slums, considering the income levels, livelihoods, and economic activities of the residents?

This sub-question examines the socio-economic realities of slum residents, focusing on income sources, livelihood patterns, and realistic housing costs. It also considers material costs and financial limitations to ensure proposed solutions are economically viable.

2. Housing Design and Resilience:
What design features can be integrated into housing models in Sylhet to enhance climate resilience?

This sub-question identifies specific design strategies that can improve resilience to frequent floods and other climate-related risks in Sylhet. It aims to define what makes a housing model climate-resilient in this context and assess the practical effectiveness of such features.

3. Building Materials and Techniques:
Which affordable, locally available building materials and construction techniques can be used to create durable housing that withstands climate challenges in Sylhet's slums?

This sub-question explores suitable materials and construction methods that are cost-effective, locally sourced, and capable of withstanding climate-related stress, ensuring solutions are practical and implementable in slum settings.

4. Design Adaptability:
How can housing design respond to the specific needs and daily activities of Sylhet's slum residents?

This sub-question investigates how housing design can reflect residents' day-to-day lives, including economic activities, spatial needs, and preferences, in a way that strengthens both housing functionality and local livelihoods.

5. Non-Relocation:
How can housing models be implemented in a way that avoids the need for relocation during construction?

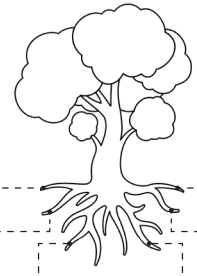
This sub-question addresses strategies to allow residents to remain in place throughout the construction process, including phased development, incremental building, and temporary accommodations to minimize disruption and displacement.

01 Hypothesis & Aim

The integration of affordable, culturally appropriate design features and locally available building materials will enhance climate resilience and improve living conditions for residents of Sylhet's slums. By ensuring that the construction of new housing does not require relocation, these models will support long-term social and economic stability while protecting communities from the impacts of climate change and flooding.

This research aims to develop new, climate-resilient and affordable housing models for slum residents in Sylhet. The focus is on creating practical and culturally appropriate solutions that can be implemented without displacing current residents. A key objective is to design housing that can be built on-site in a phased manner, ensuring continuity of daily life during construction. By assessing the effectiveness and feasibility of these models, the research will provide valuable insights to inform policymakers, urban planners, and housing agencies working to address urban poverty and climate vulnerability.

Vulnerability of Slum Residents in Sylhet, Bangladesh



Climate Change
Increased flooding and erratic rainfall

Inadequate Housing
Poor construction exacerbates disaster impact

Economic Instability
Low-wage jobs and low capability limit recovery options

Governance Issues
Fragmented policies hinder effective solutions

Rural-to-Urban Migration
Displacement leads to overcrowded living conditions

Lack of Resources
Insufficient funding for housing solutions

How can housing models be designed to enhance climate resilience and affordability for slum residents in Sylhet, Bangladesh, without requiring relocation?

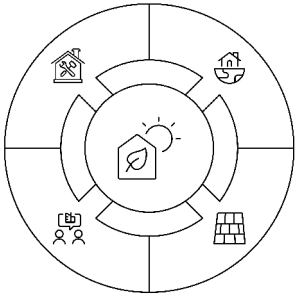
- Housing Design and Resilience
- Affordability and Livelihoods
- Building Materials and Techniques
- Community Insights
- Non-Relocation

- Engaging Conversations with Residents
- Photographing Housing Conditions
- Site Visits and Observations
- Material Data Collection

- Literature Review
- Case Studies

Designing Climate Resilient and Affordable Housing Models

On site
Residents to stay in their homes while constructing



Design Features
Integrating cultural, climate resilience and affordability in housing design

Resident Insights
Understanding community needs and preferences

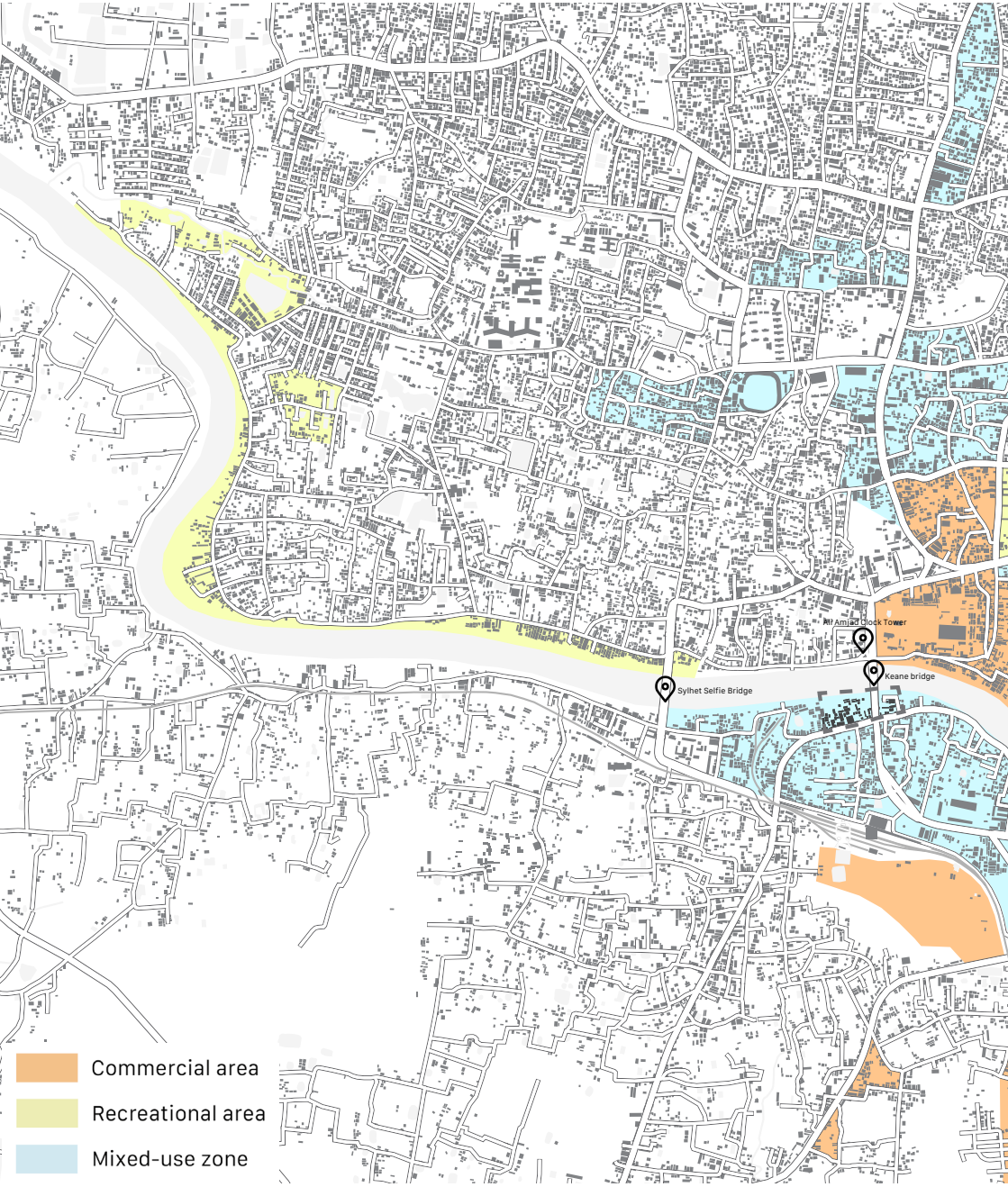
Building Materials
Identifying durable and affordable (local) construction materials

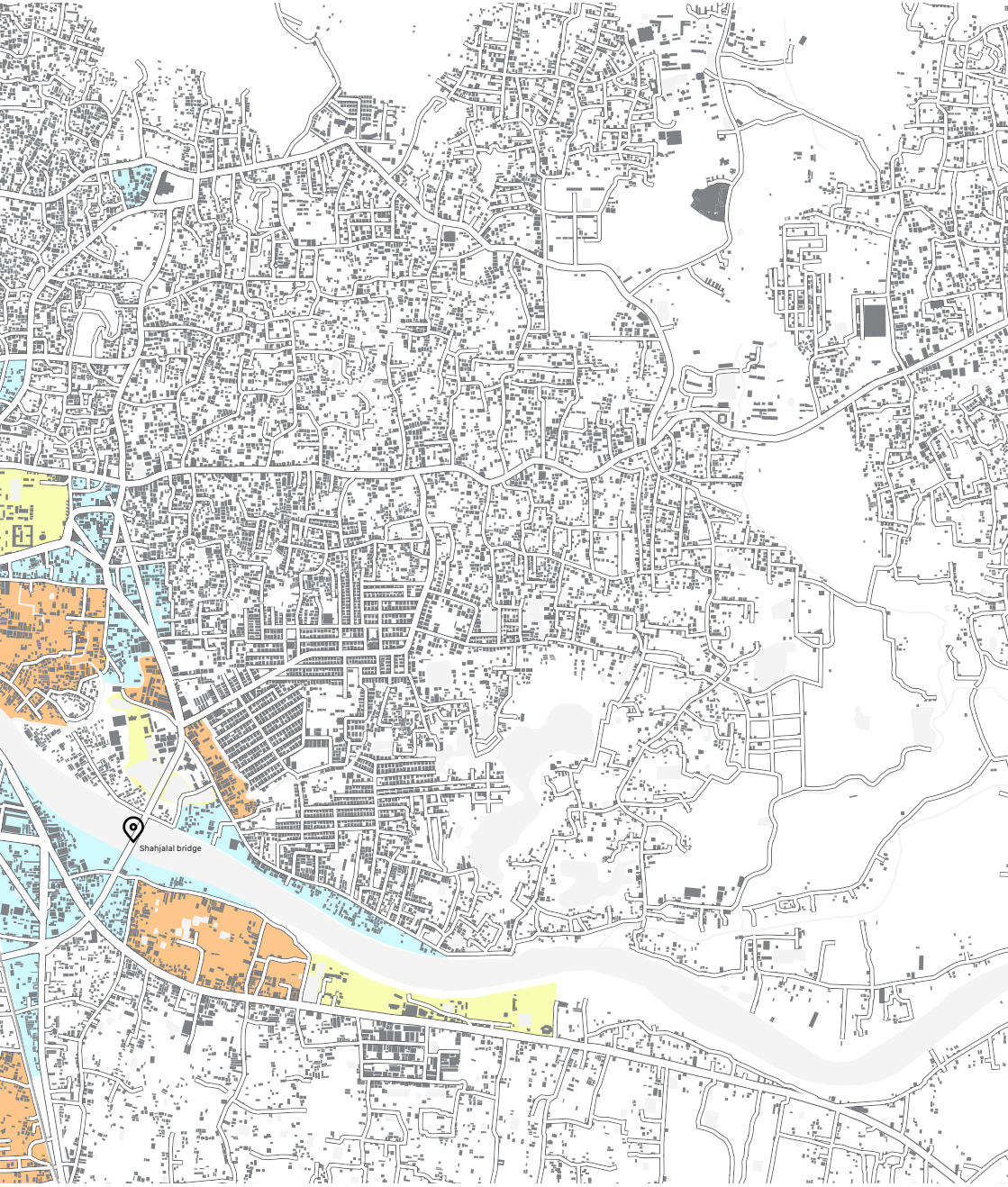
02

02 Site Analysis

- Situation
- Flood map
- Sections
- Floorplans
- Materials

02 Situation Sylhet



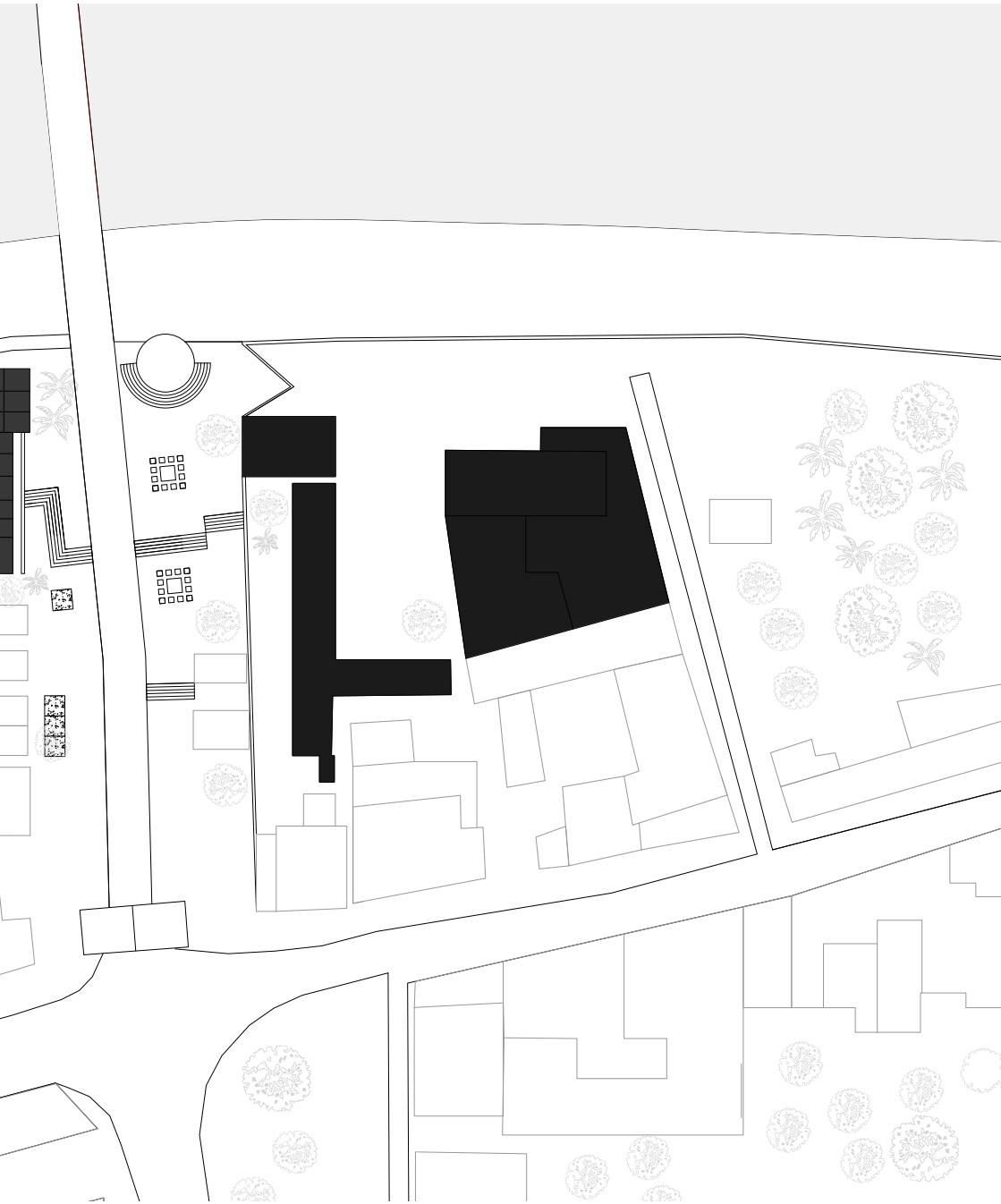

Shahjalal bridge

As shown on the map of Sylhet, the city has a noticeable shortage of commercial and recreational spaces. With a population of over 700,000, the demand for public amenities, social gathering areas, and economic activity zones is high, yet the city offers few such opportunities. The area surrounding the Keane Bridge presents an ideal location to address this gap. As a central and historic landmark connecting the north and south of the city, the Keane Bridge is already a key pedestrian route with high foot traffic. Its proximity to the riverfront and potential for scenic, walkable public space makes it a strategic spot for developing vibrant commercial and recreational zones that can serve both locals and visitors, boosting urban livability and economic vitality.

Underneath the Keane Bridge

02 Situation Site

- Hindu Community
- Muslim Community
- Mosque
- Fish market
- Madrasah (Muslim school)
- Shops / Bazar
- Sawmill & Wood workshops



Madrasah (Muslim school)

Sawmill & Wood workshops

View on Sweepers Colony from Keane Bridge

The Keane Bridge is one of Sylhet's most historically and functionally significant landmarks. Built in 1934 during British colonial rule, it was the first bridge to span the Surma River, physically linking the north and south sides of the city. Its construction marked a major step in establishing reliable land-based routes connecting Sylhet to the rest of the Bengal delta, which had previously relied heavily on river-based transportation (Chowdhury & Elahi, 2017).

At the time, the Surma River was losing its navigability, especially from the mid-1850s, which contributed to significant population shifts—with many river-dependent communities moving toward better-connected areas. The Keane Bridge was thus a key infrastructural response to changing economic and environmental realities (Chowdhury & Elahi, 2017).

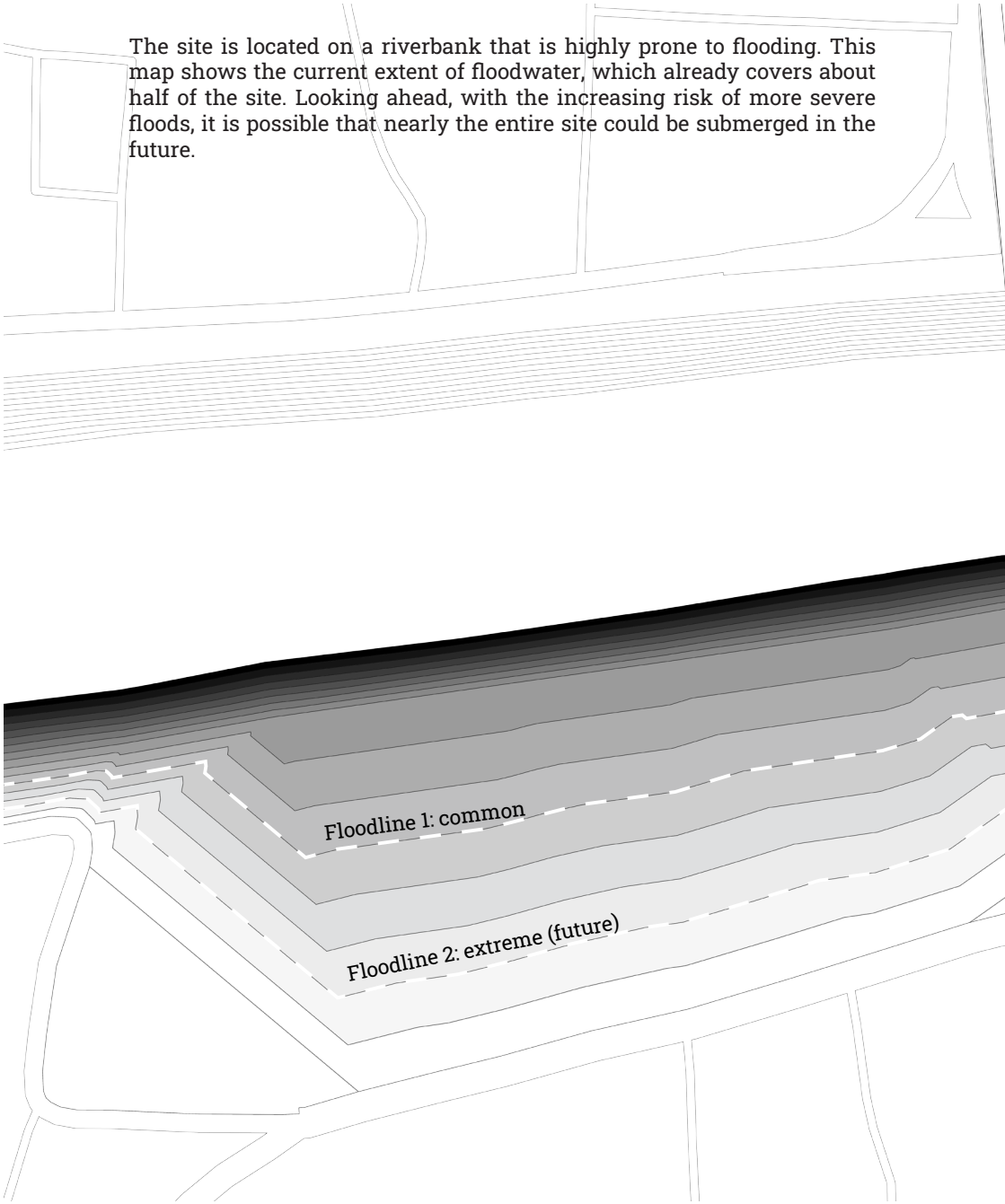
The bridge was constructed as part of broader efforts to modernize Sylhet, which included developments such as electrical connections (1931) and the growth of commercial infrastructure following the introduction of tea plantations in the late 19th century (Chowdhury & Elahi, 2017).

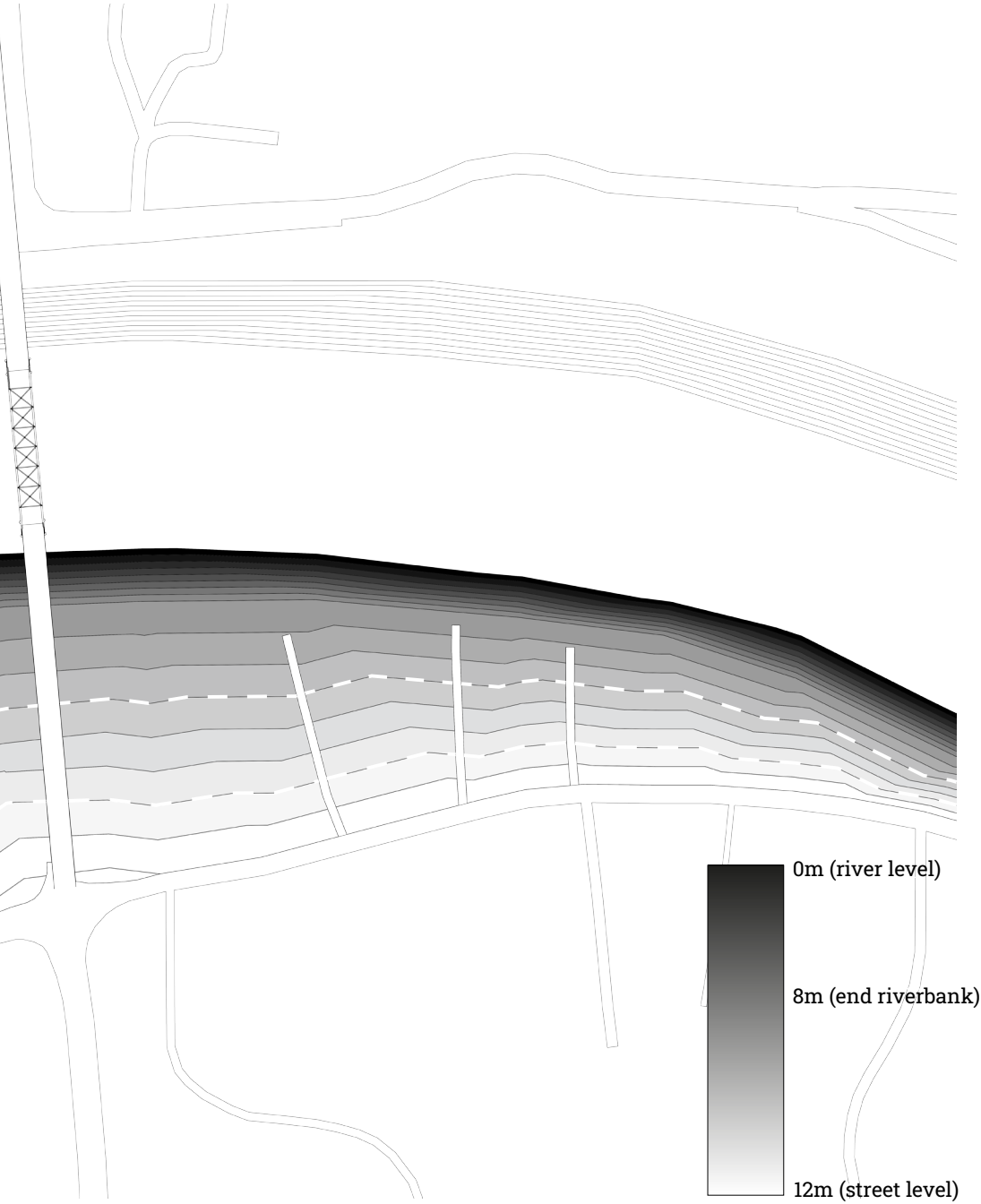
Today, the Keane Bridge is a pedestrian-only structure, and while it remains a vital thoroughfare, it also serves as an informal marketplace, with limited space for street vendors. Its proximity to the Sweeper Colony underscores the tension between heritage, informal urban life, and modern redevelopment needs.

Keane Bridge with water level marks on structure

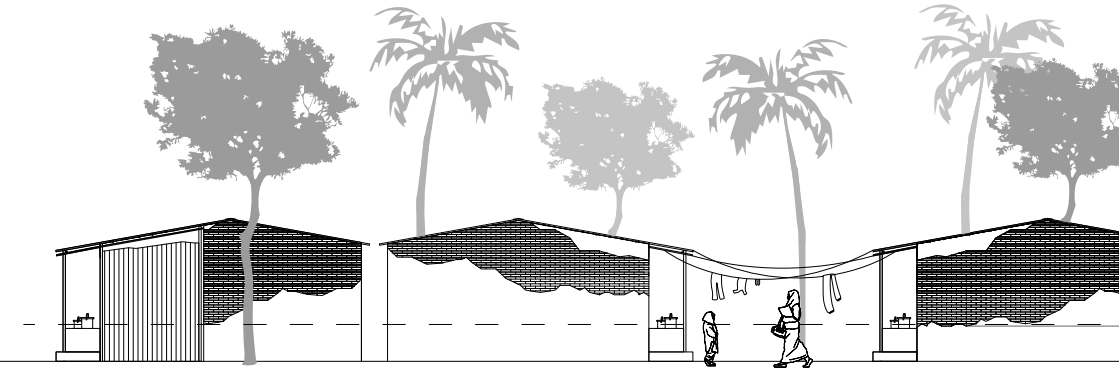
02 Flood map

The site is located on a riverbank that is highly prone to flooding. This map shows the current extent of floodwater, which already covers about half of the site. Looking ahead, with the increasing risk of more severe floods, it is possible that nearly the entire site could be submerged in the future.

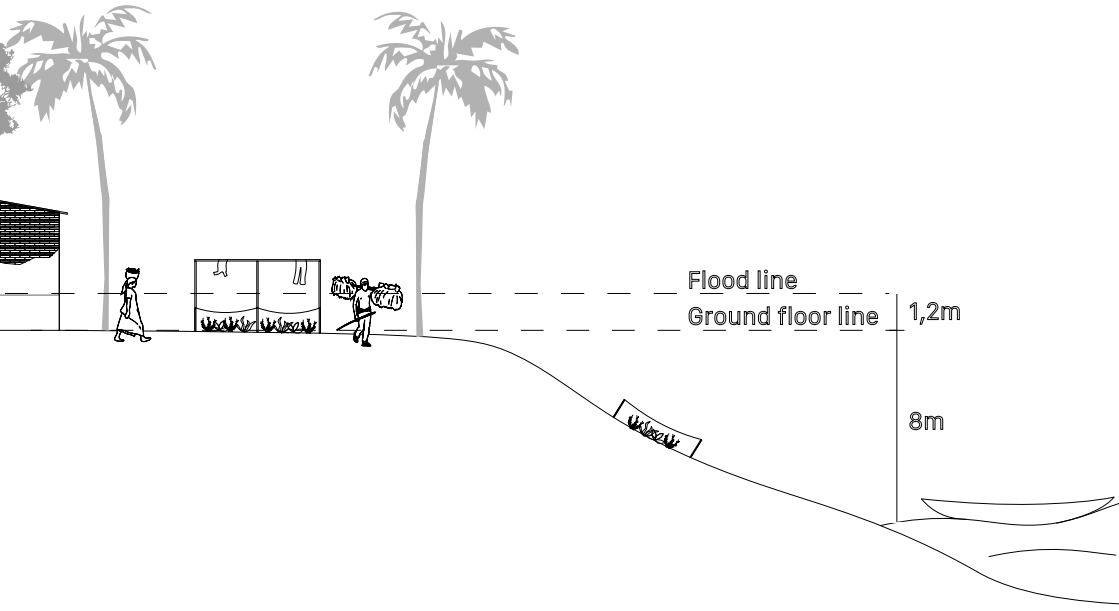



0m (river level)
8m (end riverbank)
12m (street level)

02 Section Slope of Riverbank & Waterlevel



This section clearly illustrates the water level in relation to the houses during flooding. It shows that the homes become uninhabitable, forcing residents to leave and take shelter on the street until the water recedes. Repeated flooding also damages the structures, making them increasingly difficult and costly to repair over time.



(M, Gerritsen, 2024)

Visable floodlines on the wall

Measuring visable floodline on the wall

02 Sweepers Colony

Muslim community

- 40 families
- 240 people

Hindu community

- 20 families
- 120 people

Sweeper communities in Bangladesh endure serious socio-economic and health challenges. Primarily employed in sanitation work, such as street sweeping and maintaining public toilets, their jobs are physically demanding and socially undervalued. These communities typically live in overcrowded, unsanitary colonies, with limited access to education, healthcare, and basic services. Women face additional burdens due to gender-based discrimination and the dual responsibilities of sanitation work and domestic duties.

Housing conditions differ notably between the Muslim and Hindu sweeper communities. The Muslim section, home to around 40 families, lives in overcrowded, makeshift shelters constructed from corrugated metal, bamboo, and wood. These structures offer poor insulation and lack safe cooking facilities, with open-fire cooking posing significant fire hazards. In contrast, the Hindu community of about 20 families resides in more durable brick-and-concrete homes with better ventilation and separate kitchens. Their municipal employment has granted them more stable housing, as well as greater political visibility and support.

These stark contrasts reveal deep-rooted inequalities and underscore the urgent need for inclusive, equitable housing and social policies that uplift all members of sweeper communities, particularly those most at risk.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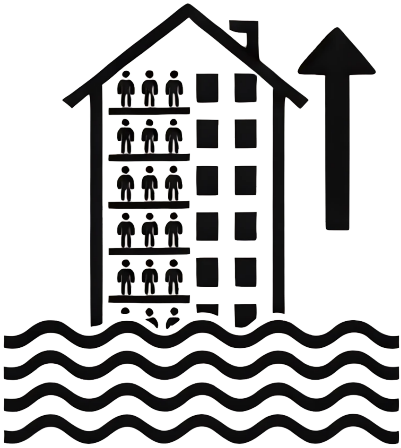
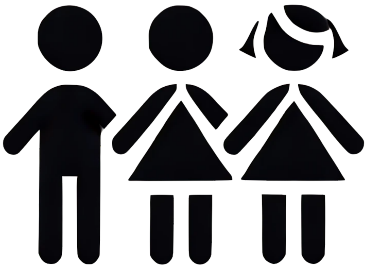


Live on higher ground

Community space



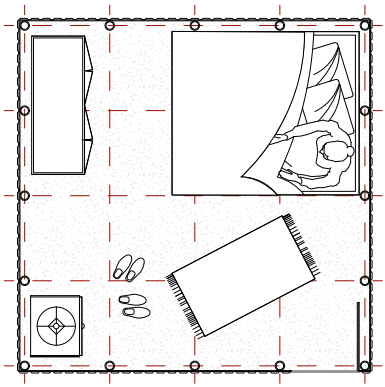
“Children are the most important.
They need to be happy”

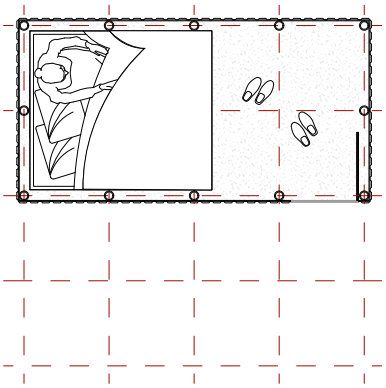
No relocation

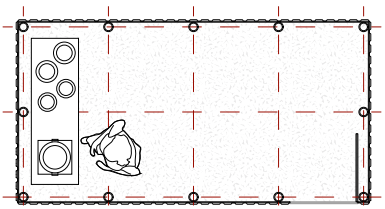
Children drawing their dream house

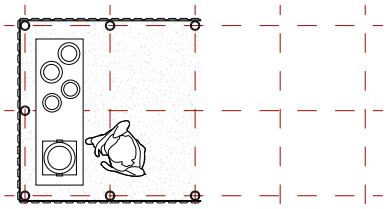
Children drawing their dream house

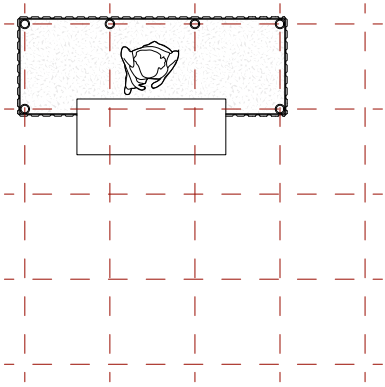
02 Floorplans Muslim Community



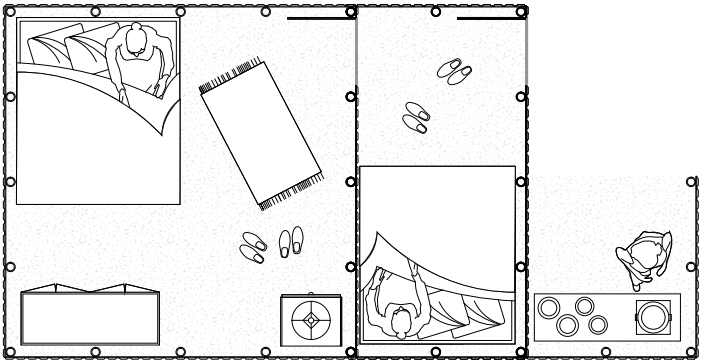


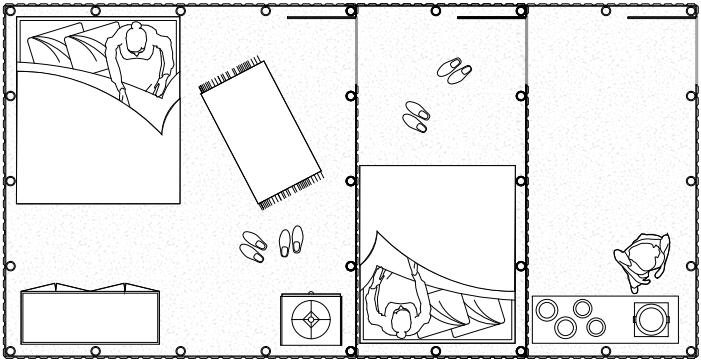


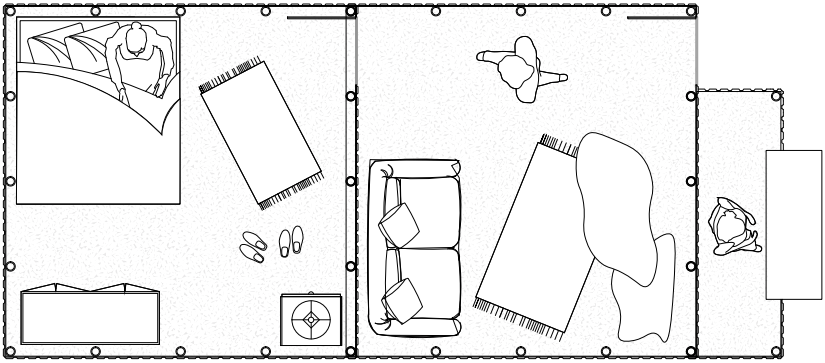


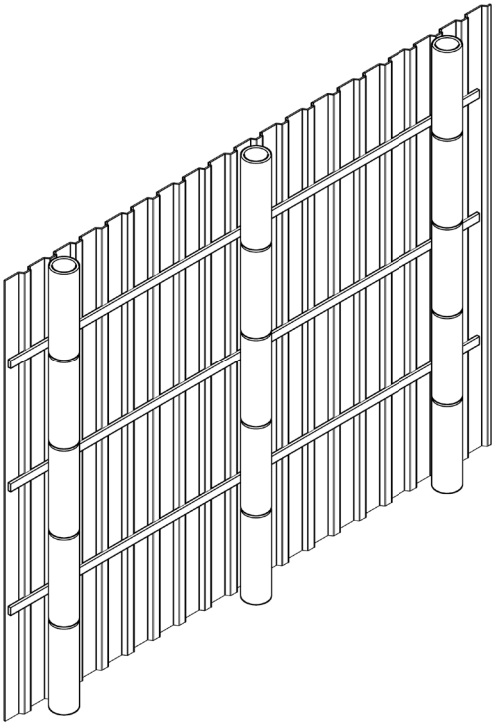


Both communities live in housing layouts that are mostly open but can be partially divided by walls. These flexible configurations are adapted to meet the specific needs of each family, allowing for variations in privacy, function, and household size. In the Muslim community, some homes have small storefronts at the front, enabling families to generate a modest income. Cooking typically takes place inside the homes, often in shared or multifunctional spaces.

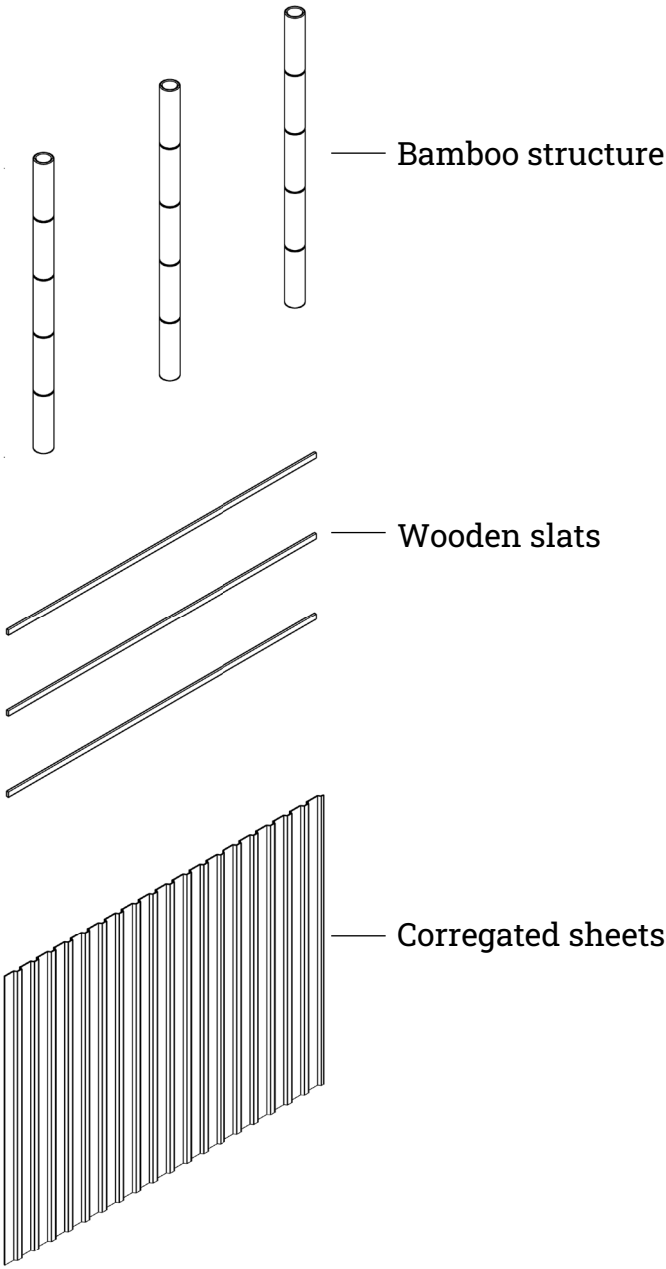




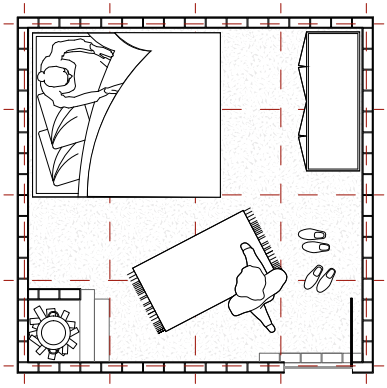


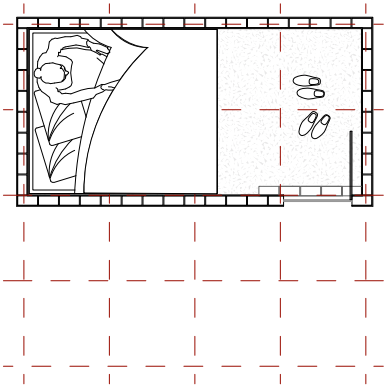


The hous lt with bamboo, wood, and corru ffer limited resistance to the frec residents face constant uncertaint f damage. This leads to repeated r ncial strain for already vulnerable

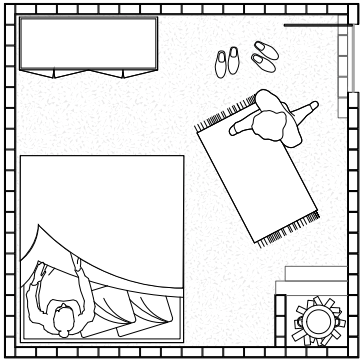

Bamboo structure
Wooden slats
Corregated sheets

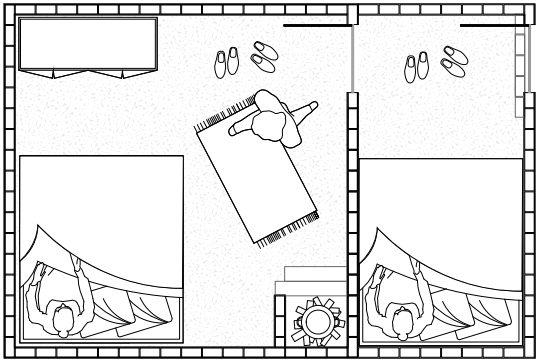
02 Floorplan Hindu Houses

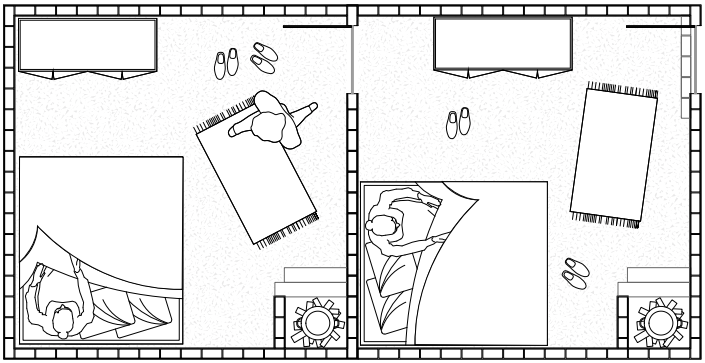




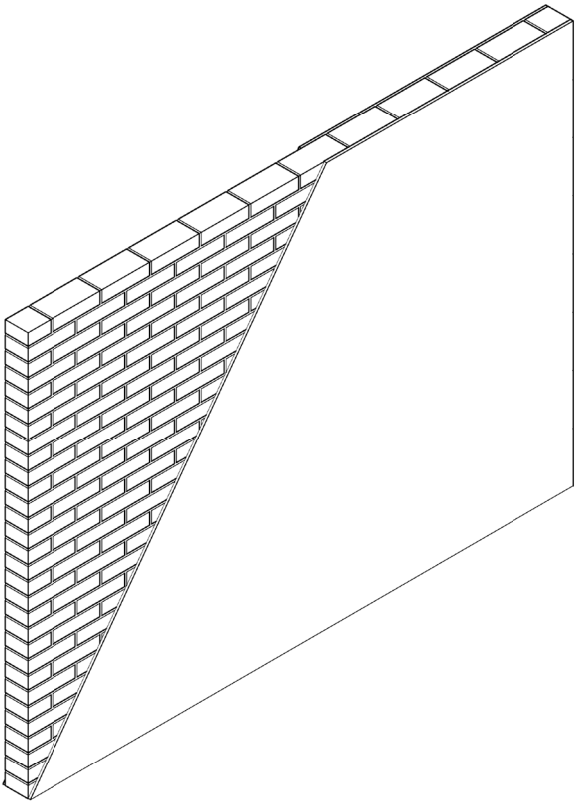
The Muslim houses are owned by the railway company and are significantly more robust in construction. They offer greater structural stability and include built-in indoor cooking areas, providing residents with safer and more functional living conditions.



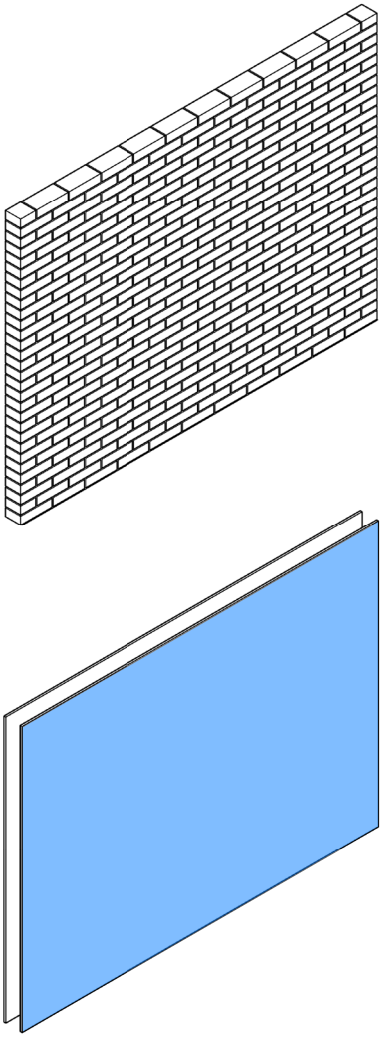




02 Materials Muslim Houses



The houses are constructed with brick, providing strength and durability, and finished with a layer of concrete plaster for added protection. To give each home a sense of individuality, residents are free to paint their houses in their own style, adding personality and identity to the uniform structure. Compared to bamboo structures, these brick houses suffer significantly less damage during floods, reducing the need for frequent repairs and offering a greater sense of stability.



Brick structure

Concrete plaster
(Painted in colour of choice)

03

03 Design: Urban

- Concept masterplan
- Masterplan
- Functions
- Parking
- Circulation
- Section
- Elevation

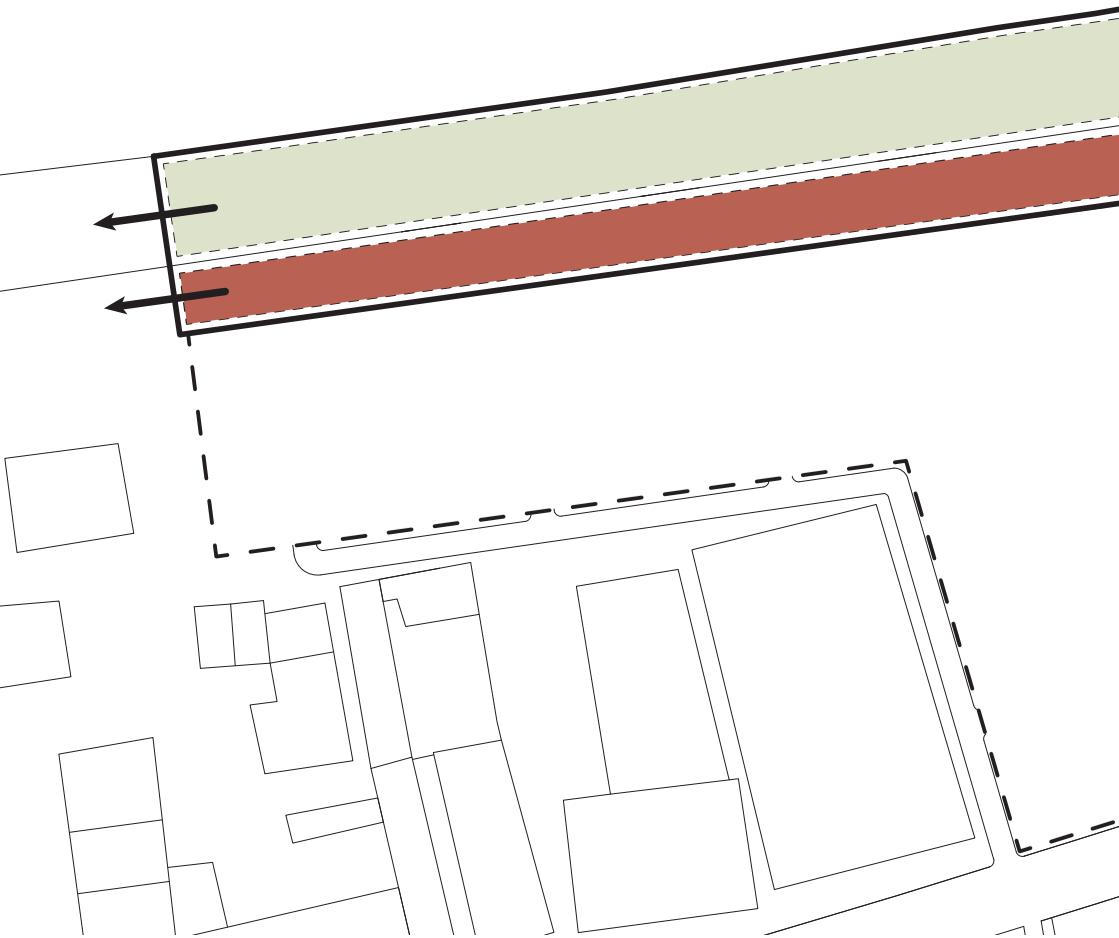
04 Masterplan - Concept

Build area on raised ground

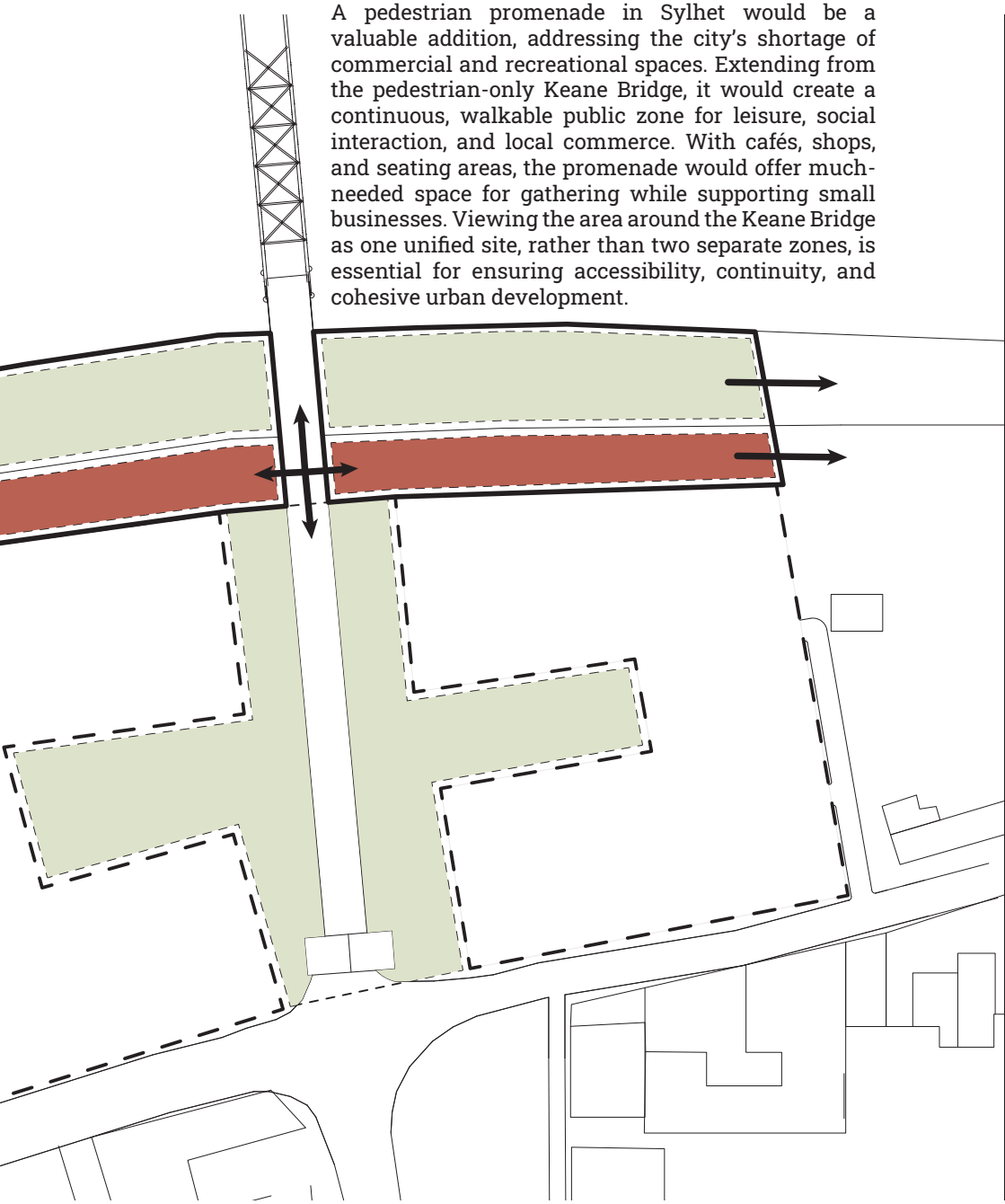
Green area, connects both sides of the bridge (public)

Pedestrian promenade (public)

Activated public space for the city. Directly accessible from the bridge (public)



A pedestrian promenade in Sylhet would be a valuable addition, addressing the city's shortage of commercial and recreational spaces. Extending from the pedestrian-only Keane Bridge, it would create a continuous, walkable public zone for leisure, social interaction, and local commerce. With cafés, shops, and seating areas, the promenade would offer much-needed space for gathering while supporting small businesses. Viewing the area around the Keane Bridge as one unified site, rather than two separate zones, is essential for ensuring accessibility, continuity, and cohesive urban development.



04 Masterplan - Functions

1-6	Residential cluster: mid- and high-income	7-9 floors	(70 - 115,9 m2)
7-11	Residential cluster: low-income	6 floors	(34,7 - 37,8 m2)
12	Community centre	2 floors, commercial and social activities	
13	Gravel court	Space dedicated for playing cricket or other sports	
14	Temple	Dedicated for the Hindu community	
15	Central park	Connecting both sides of the bridge, social gathering	


8
15
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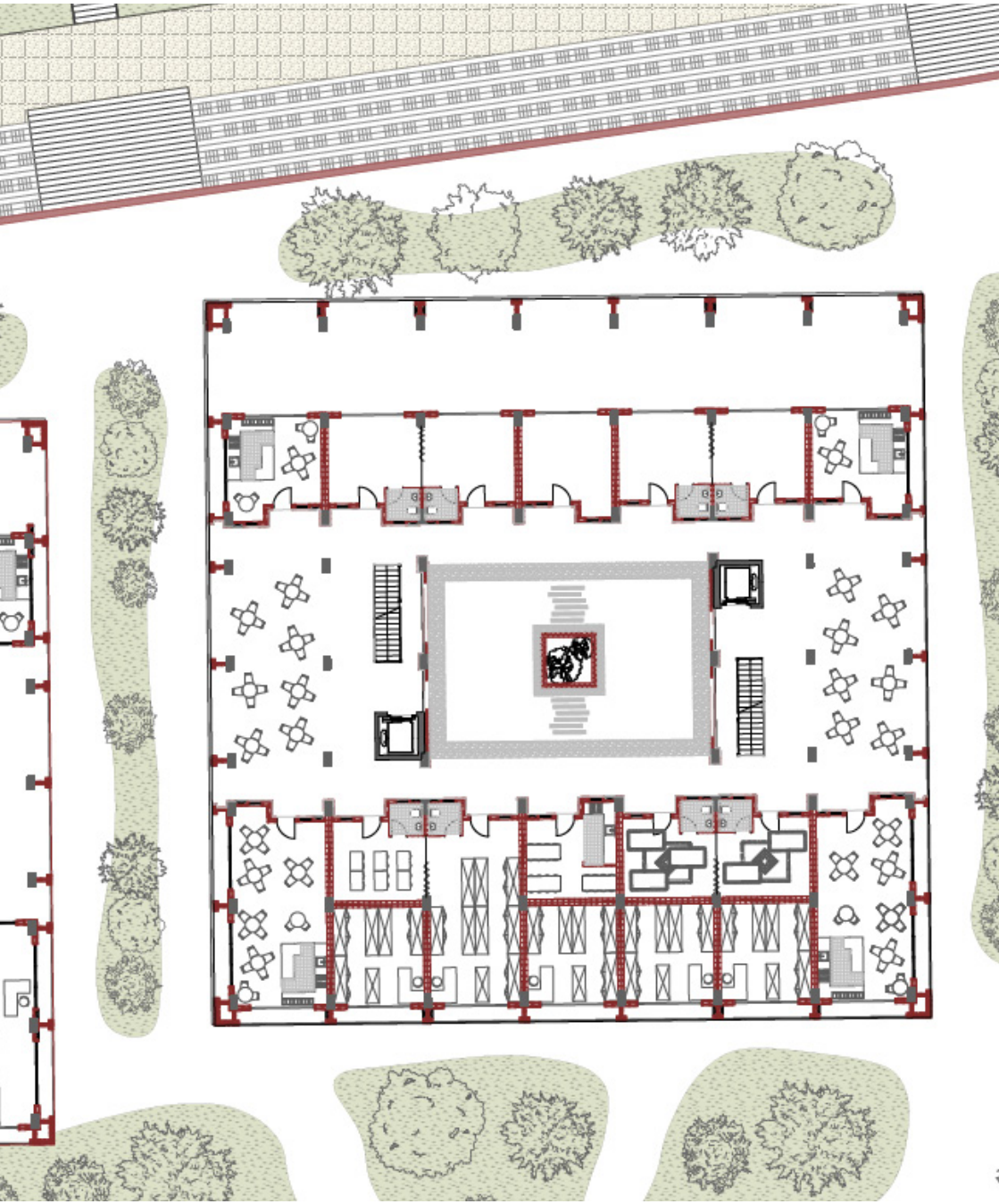
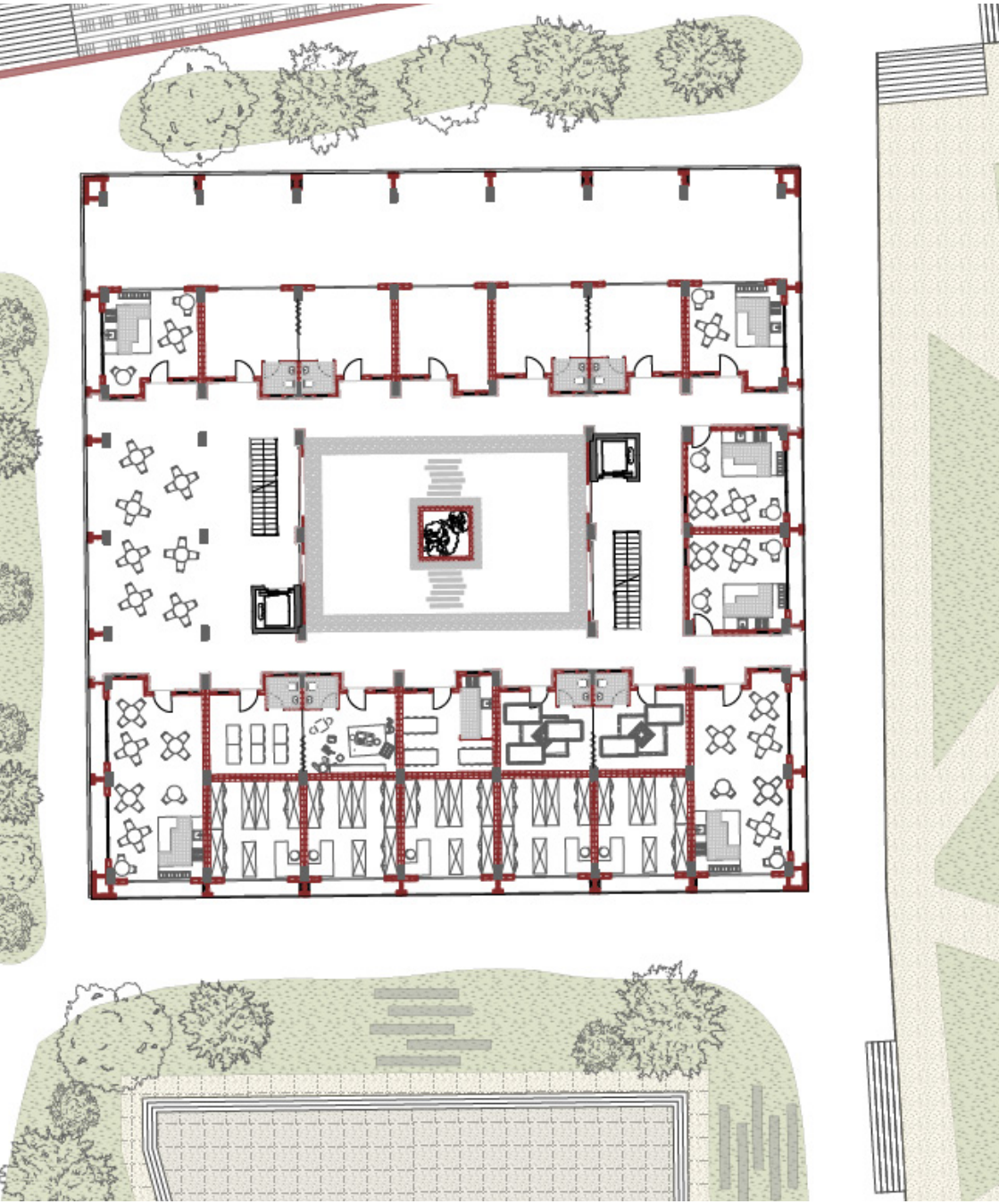
6
11
9

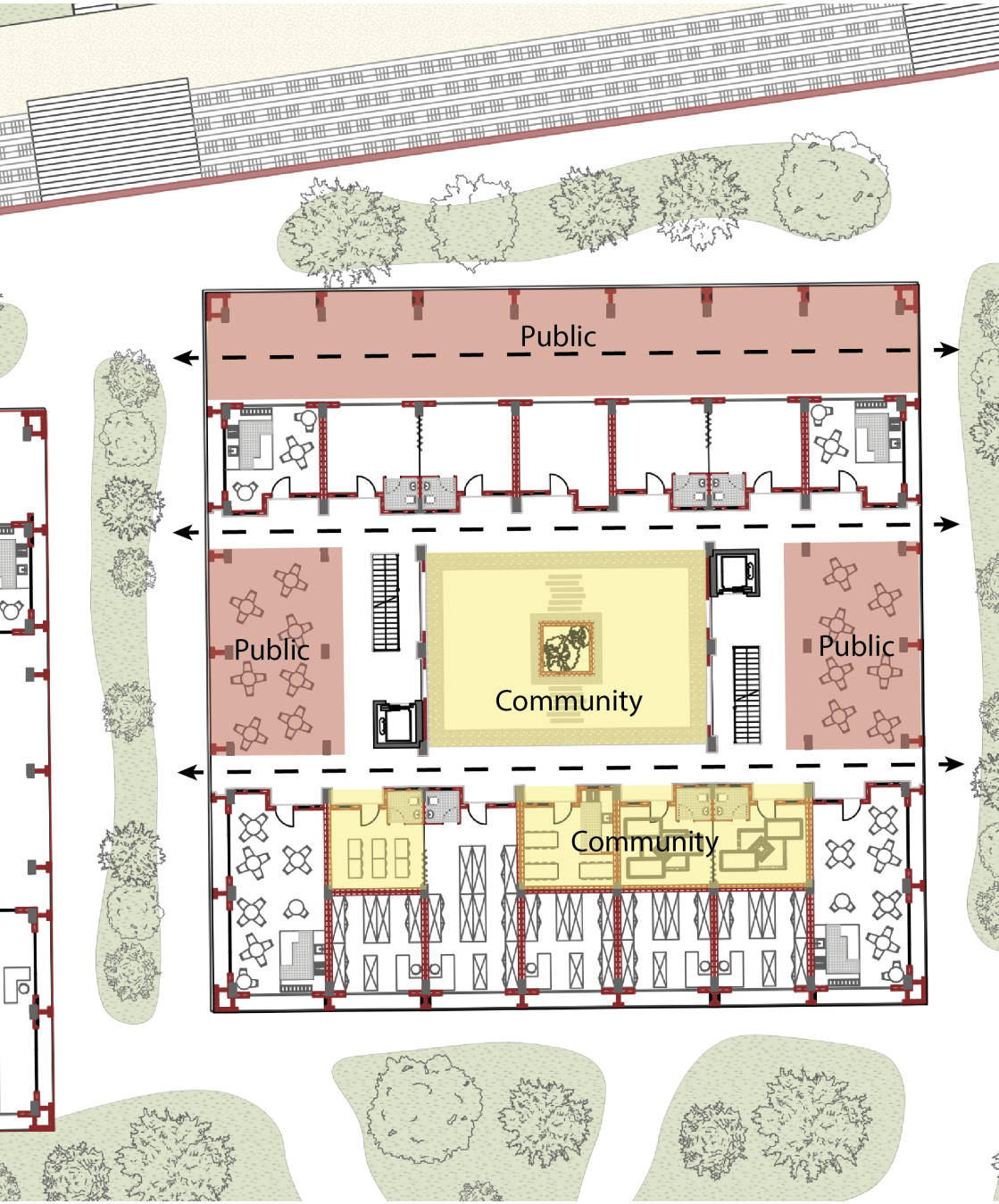
04 Masterplan - Ground floor

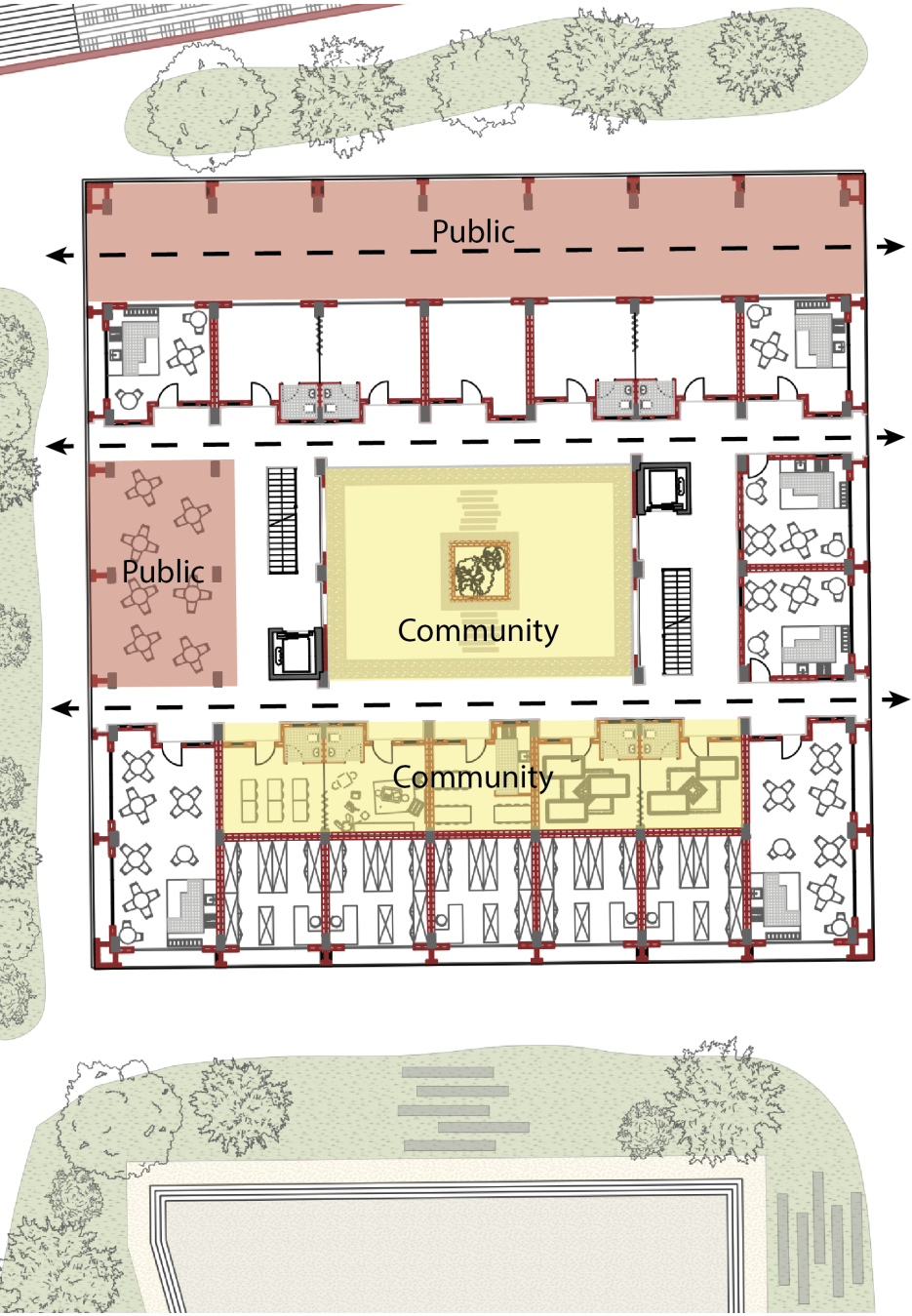
04 Masterplan - Ground floor zoom in



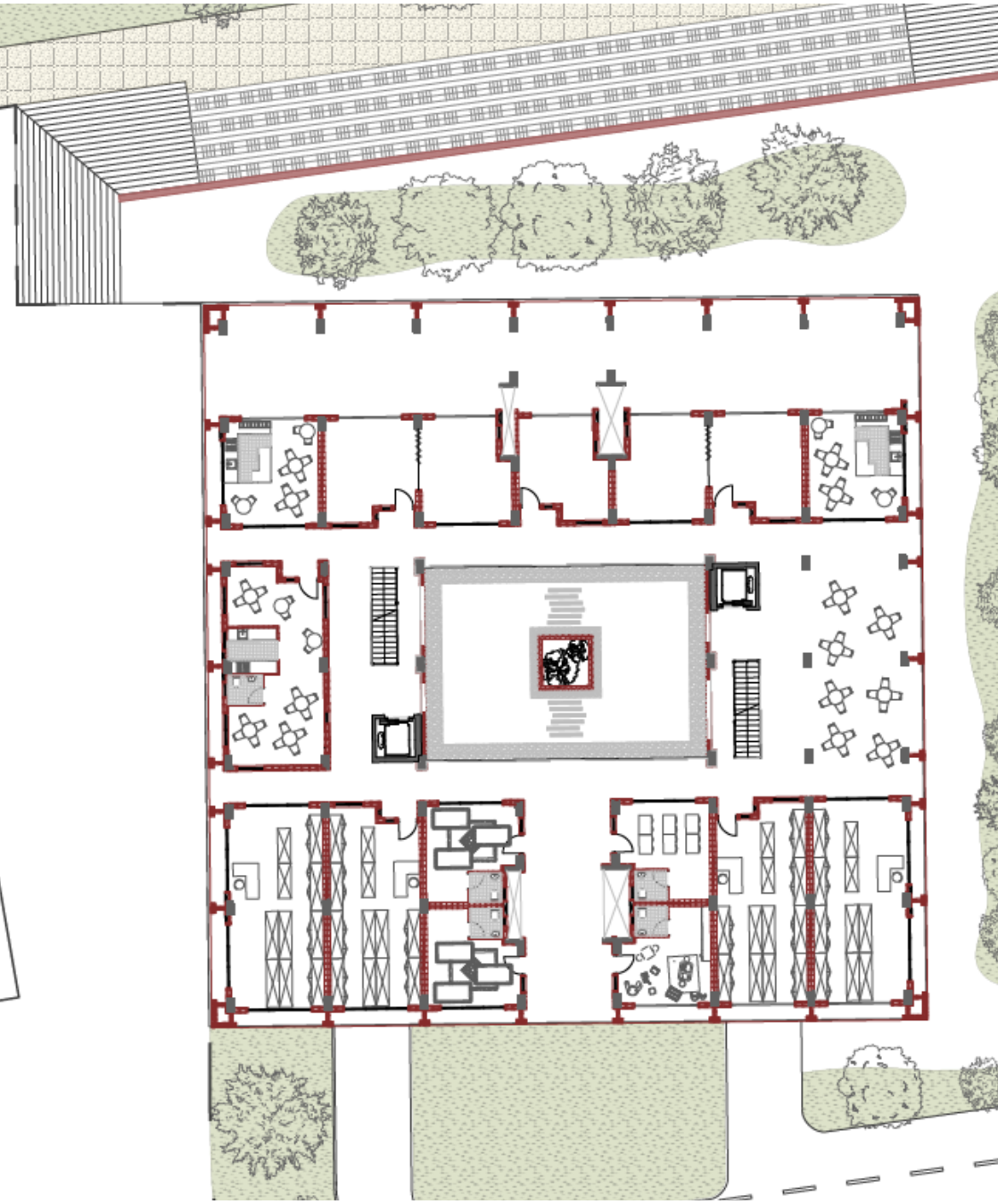


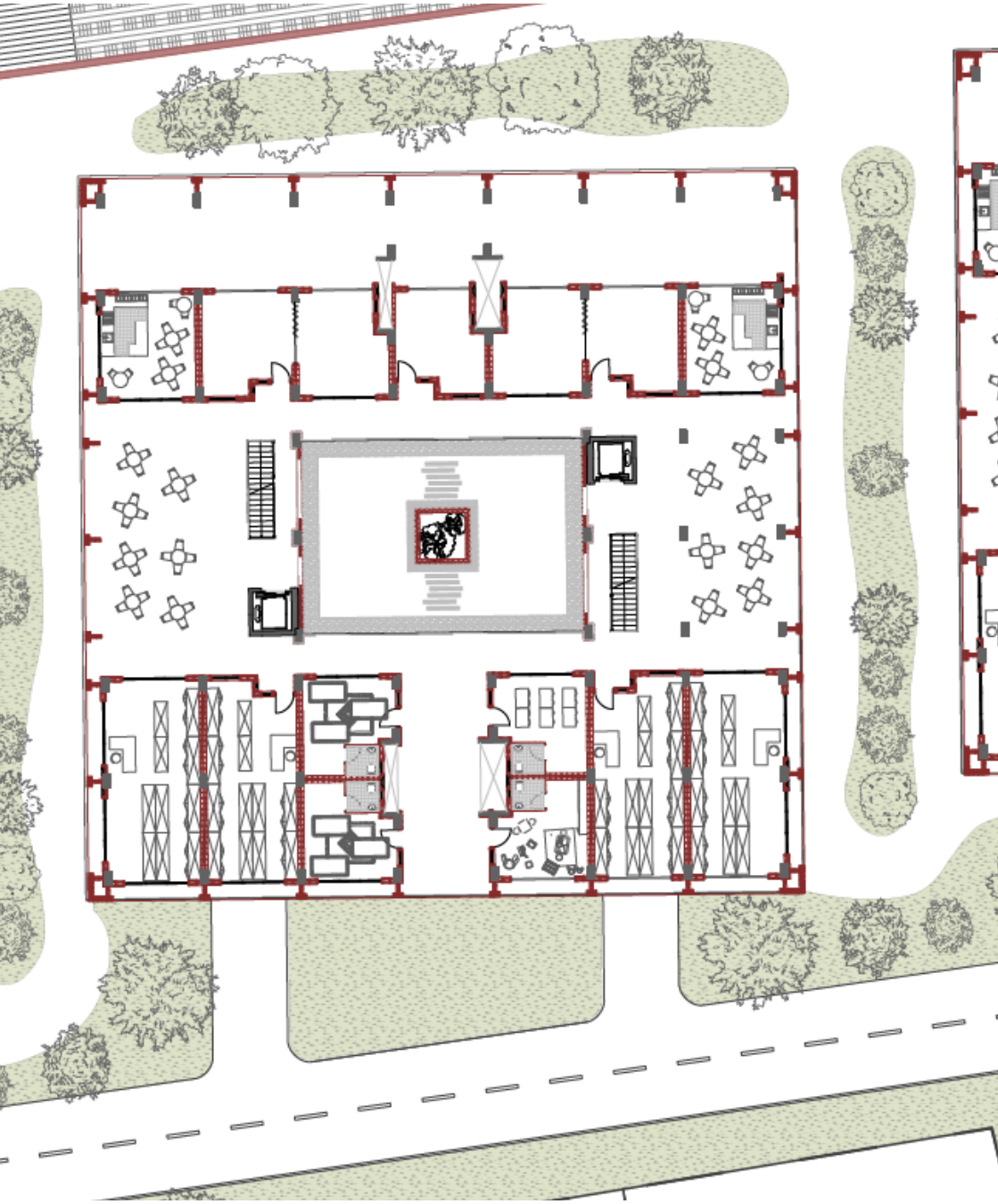
04 Masterplan - Ground floor functions



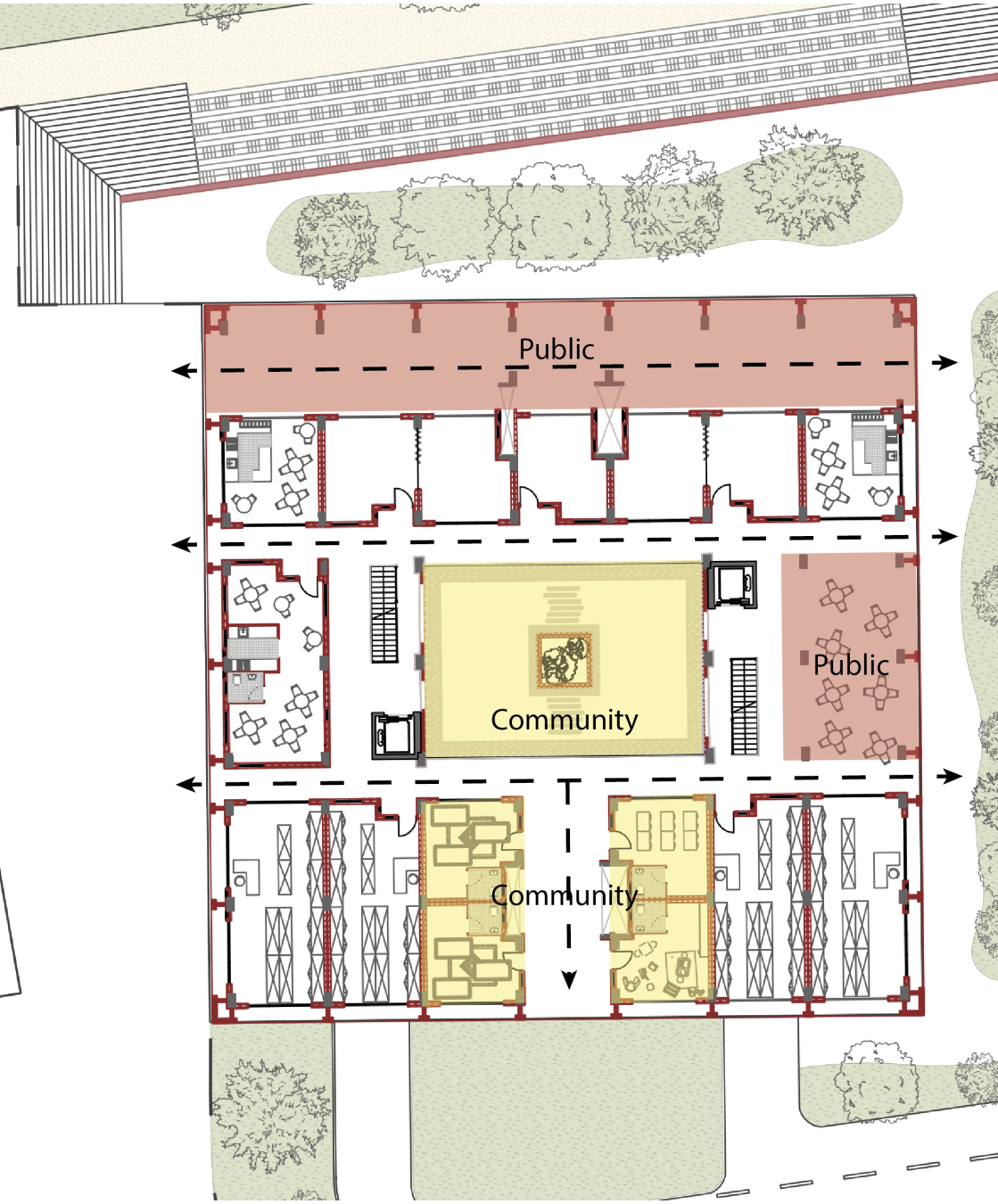

Public
Public
Community
Community

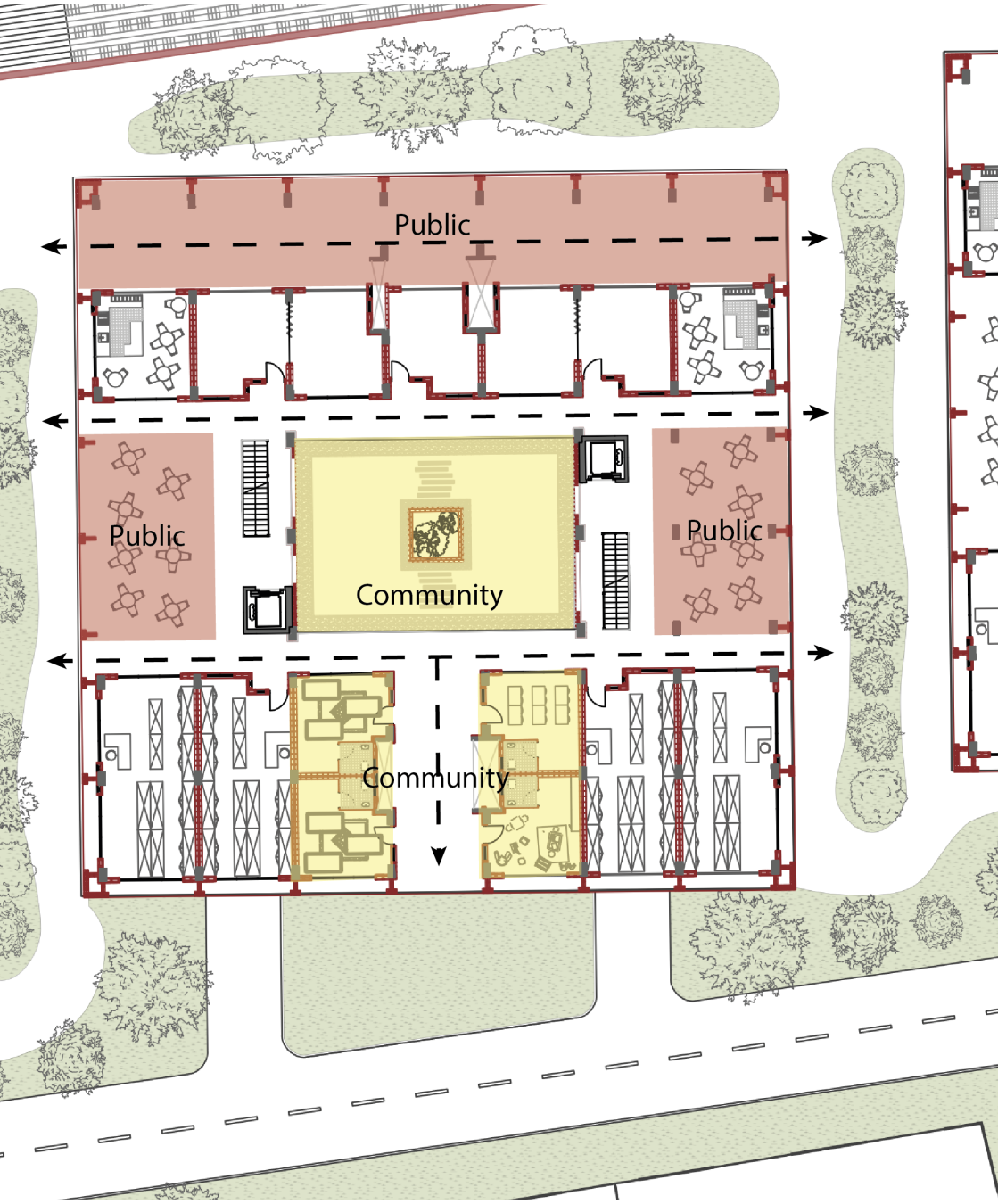
04 Masterplan - Ground floor zoom in





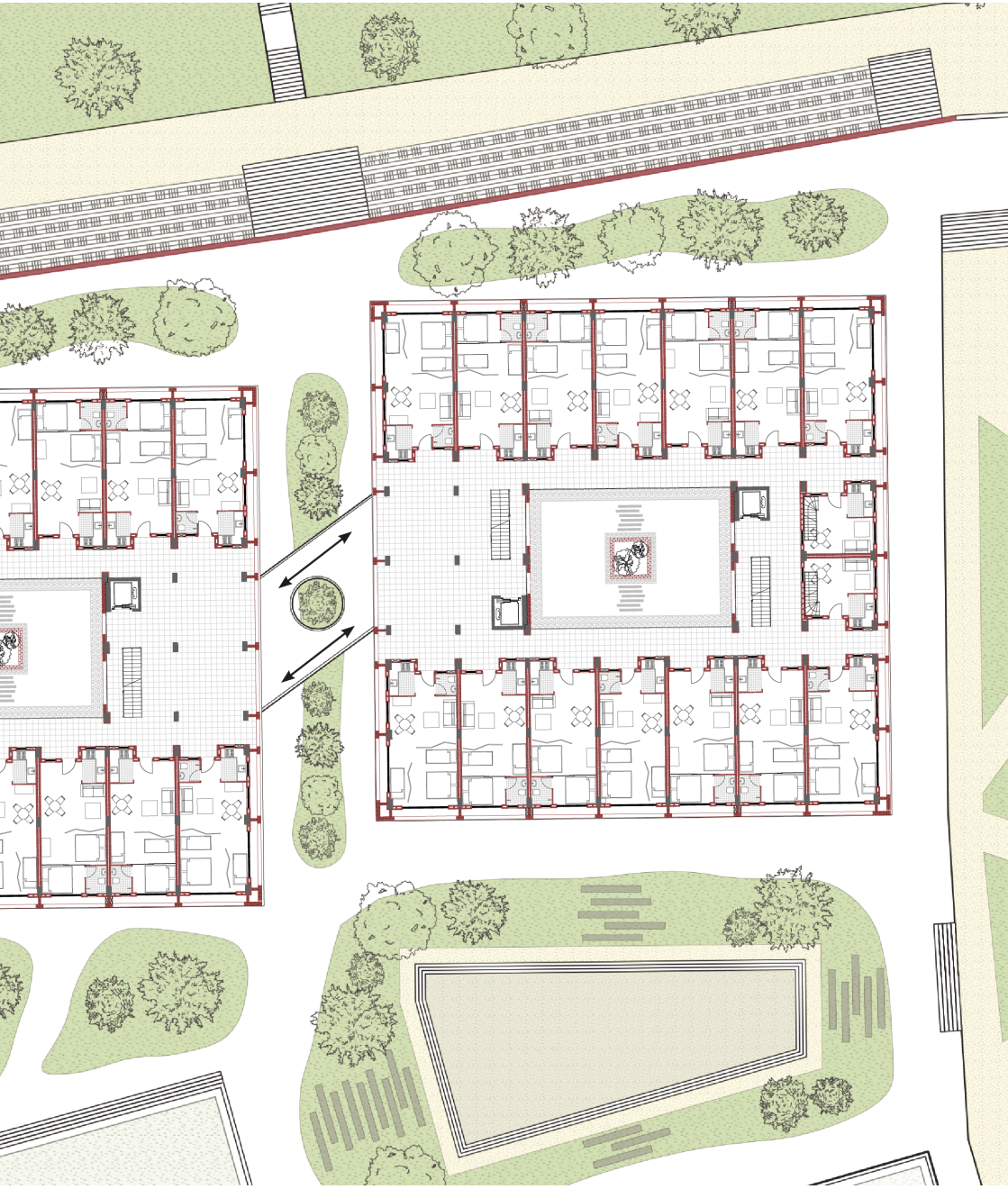
04 Masterplan - Ground floor functions




Public
Public
Public
Community
Community

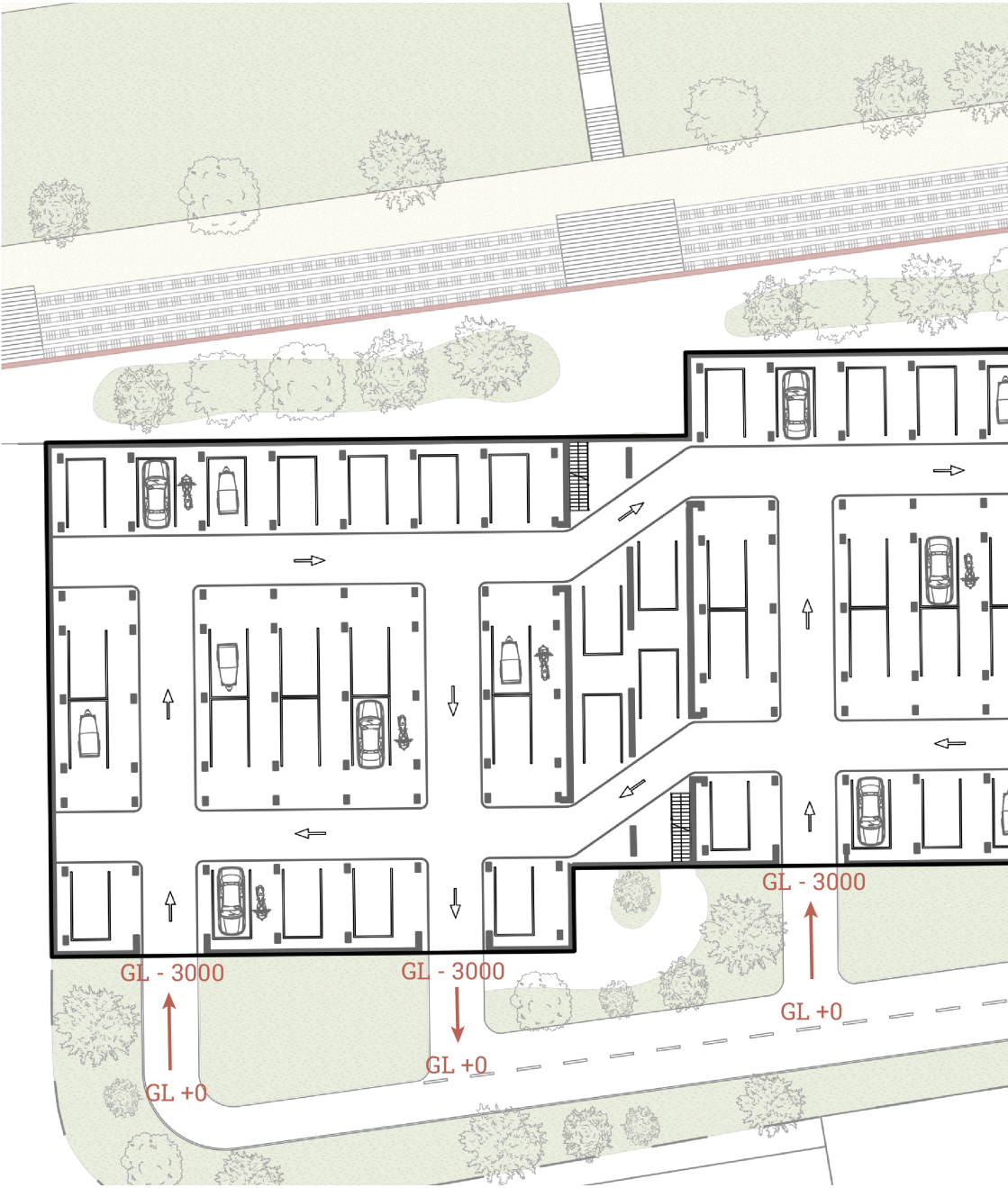
04 Circulation

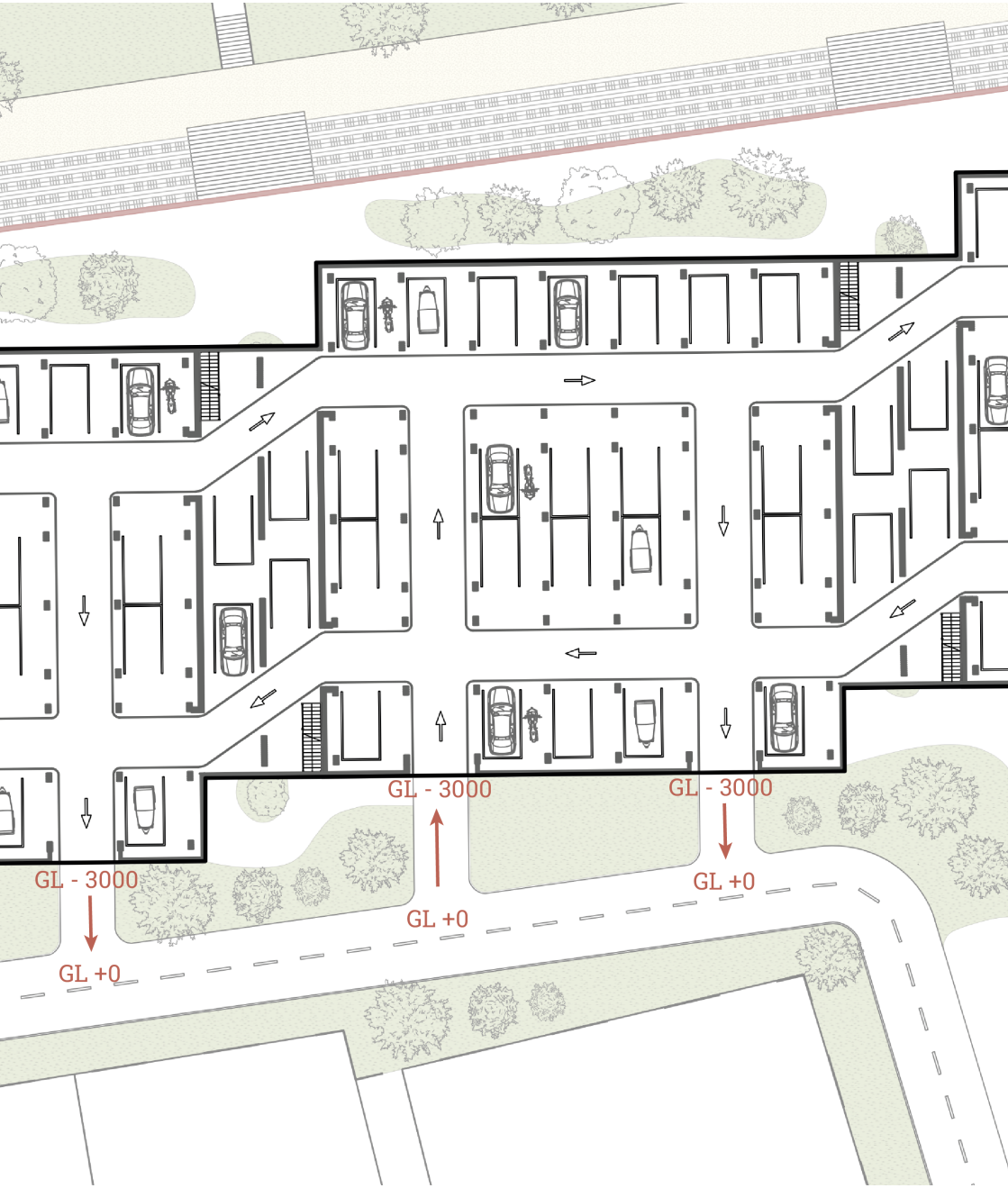
04 First floor connections



04 Parking - Basement

04 Ground levels & Lay-out

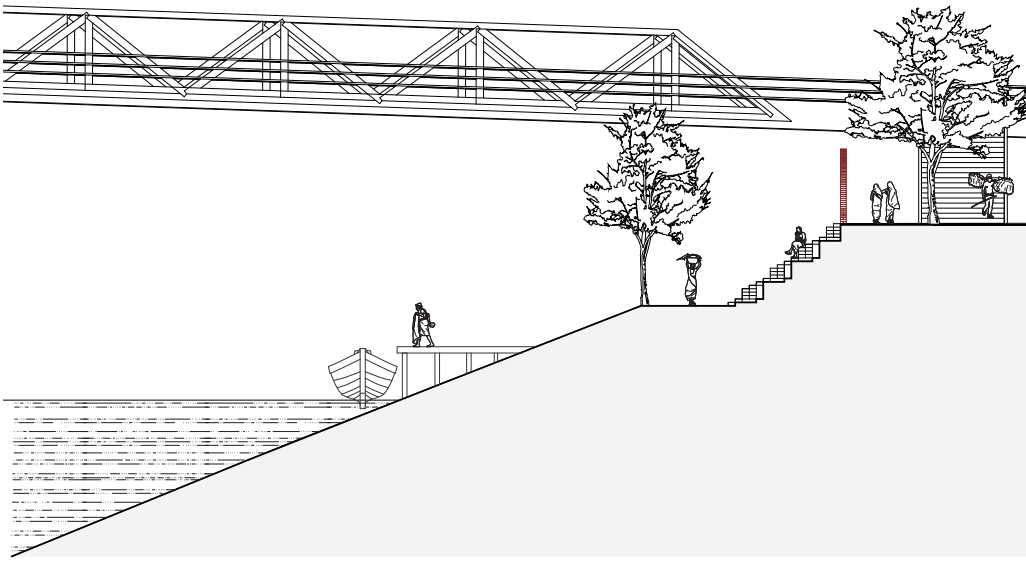


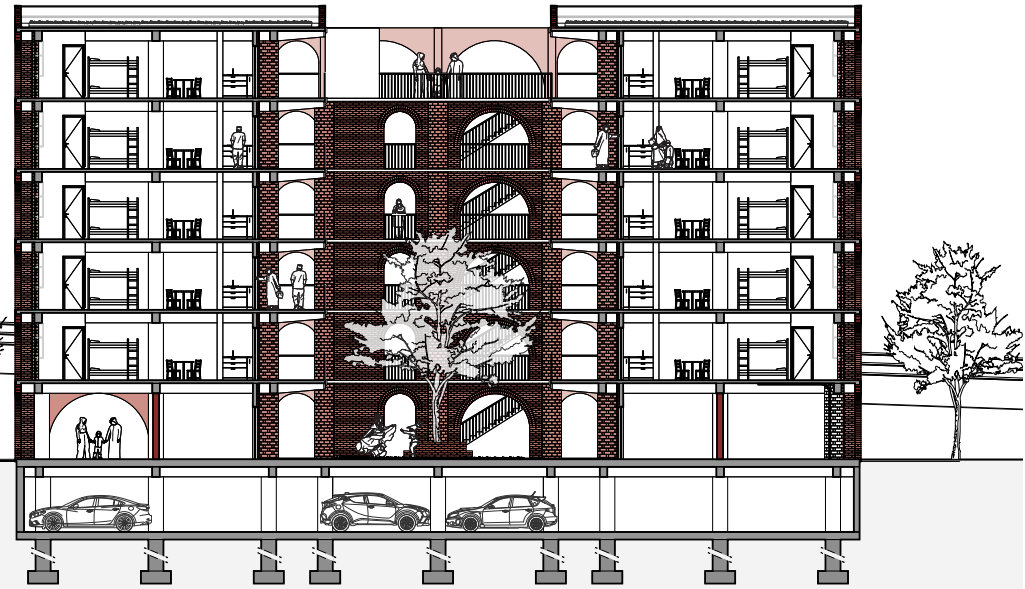

GL - 3000
GL +0
GL - 3000
GL +0
GL - 3000
GL +0

04 Masterplan - Ground levels


GL -11500
GL -3500
GL -3500
GL -3500
GL +0
GL -500
GL -1000

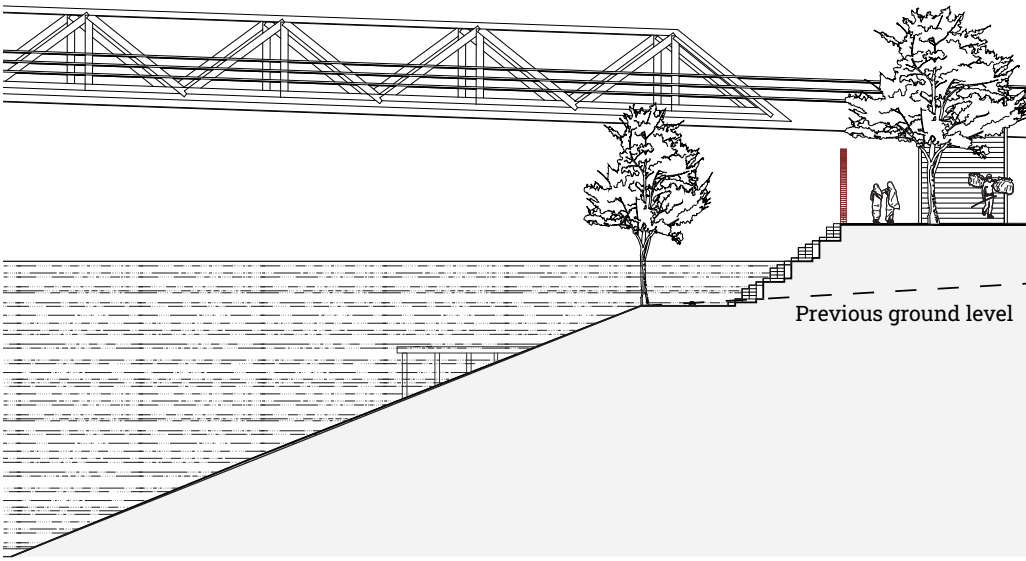
04 Section through the site





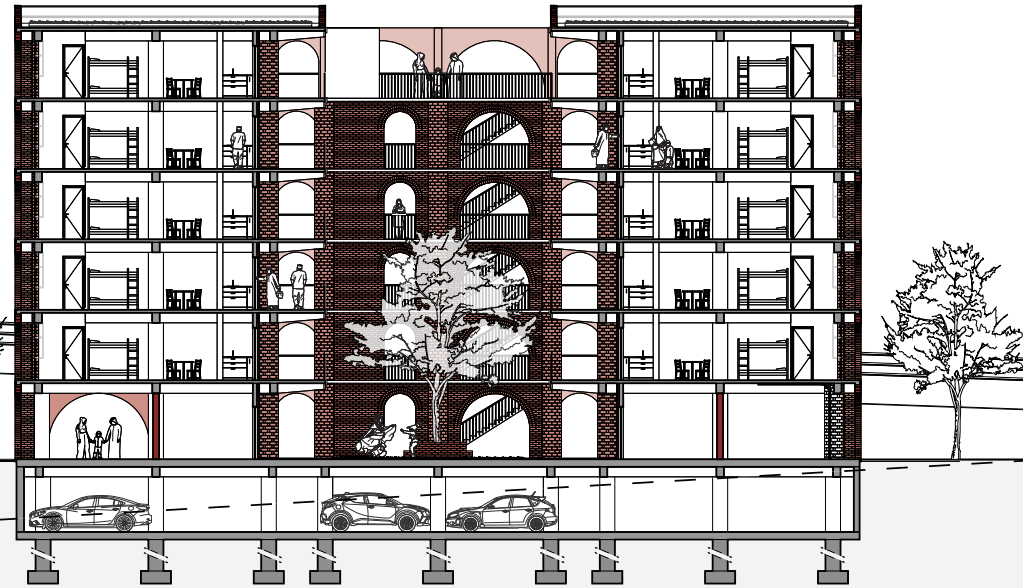
04 Section through the site - High water & Ground level

This section illustrates the change in the riverbank's slope, comparing its original state to the current, elevated condition. The raised ground level has been achieved using soil excavated from the basement parking area. This added elevation helps prevent floodwaters from reaching the pedestrian promenade and nearby homes, creating a safer and more livable environment. By reducing flood risk, the intervention significantly enhances the site's climate resilience.



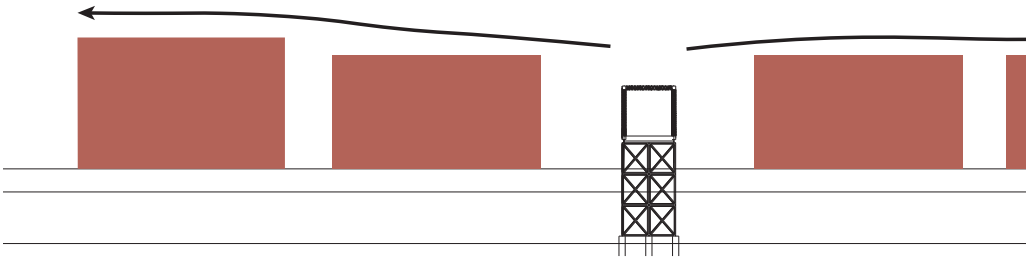
Excavation:

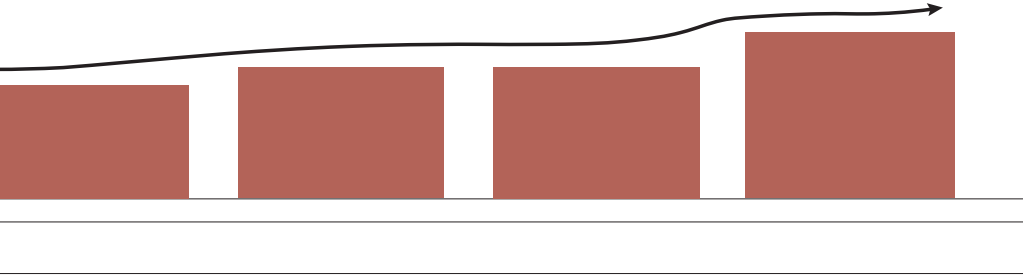
Left side bridge parking:	9670 m2
Right side bridge parking:	3678 m2
Park:	2120 m2
Total:	15468 m2
Amount of soil needed:	15738 m2
Amount of soil shortage:	**270 m2** ≈ 18 trucks full of soil



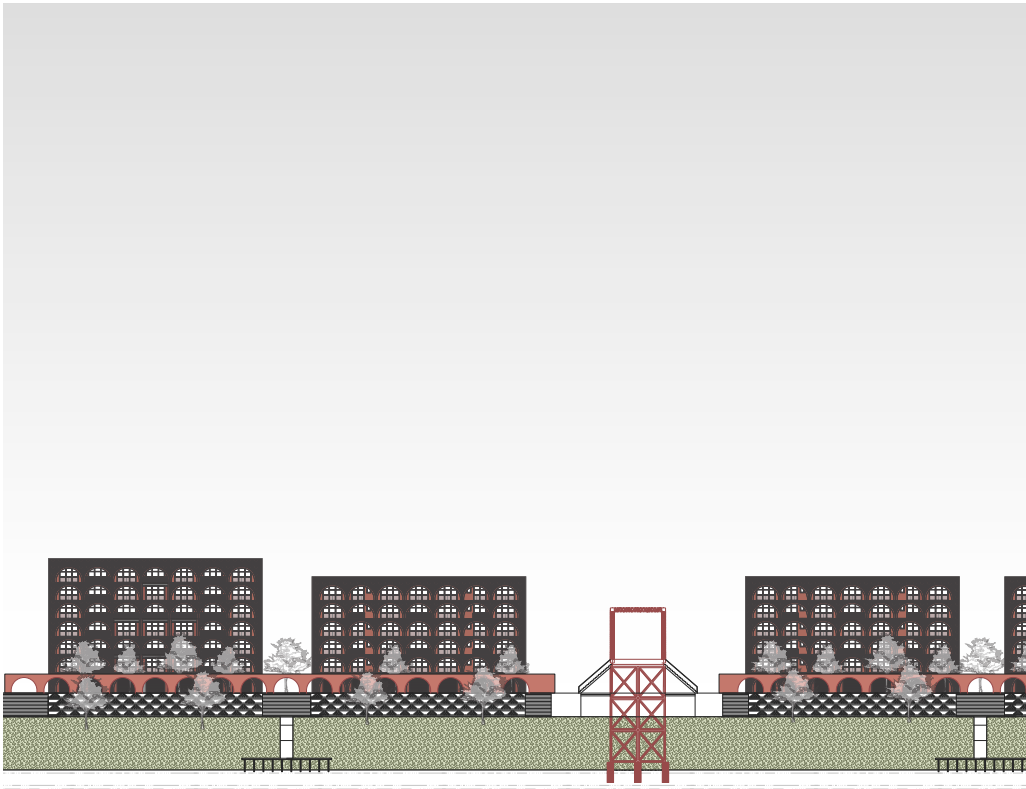
04 Concept Building Heights

The building heights are gradually scaled up, with the Keane Bridge serving as the central reference point. As one of Sylhet's most iconic landmarks, the structures closest to the bridge are kept at a similar height to avoid drawing attention away from it. This respectful height distribution preserves the visual prominence of the bridge. Additionally, the bridge is seamlessly connected to the pedestrian promenade, enhancing its role as both a functional and symbolic anchor within the urban landscape.



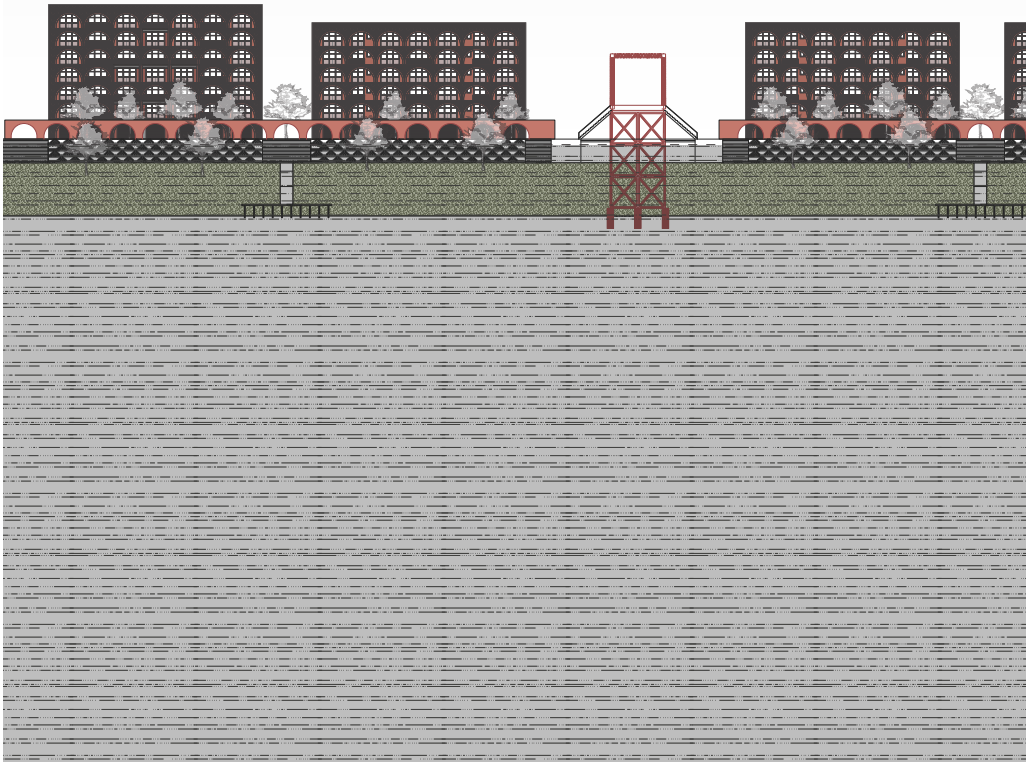


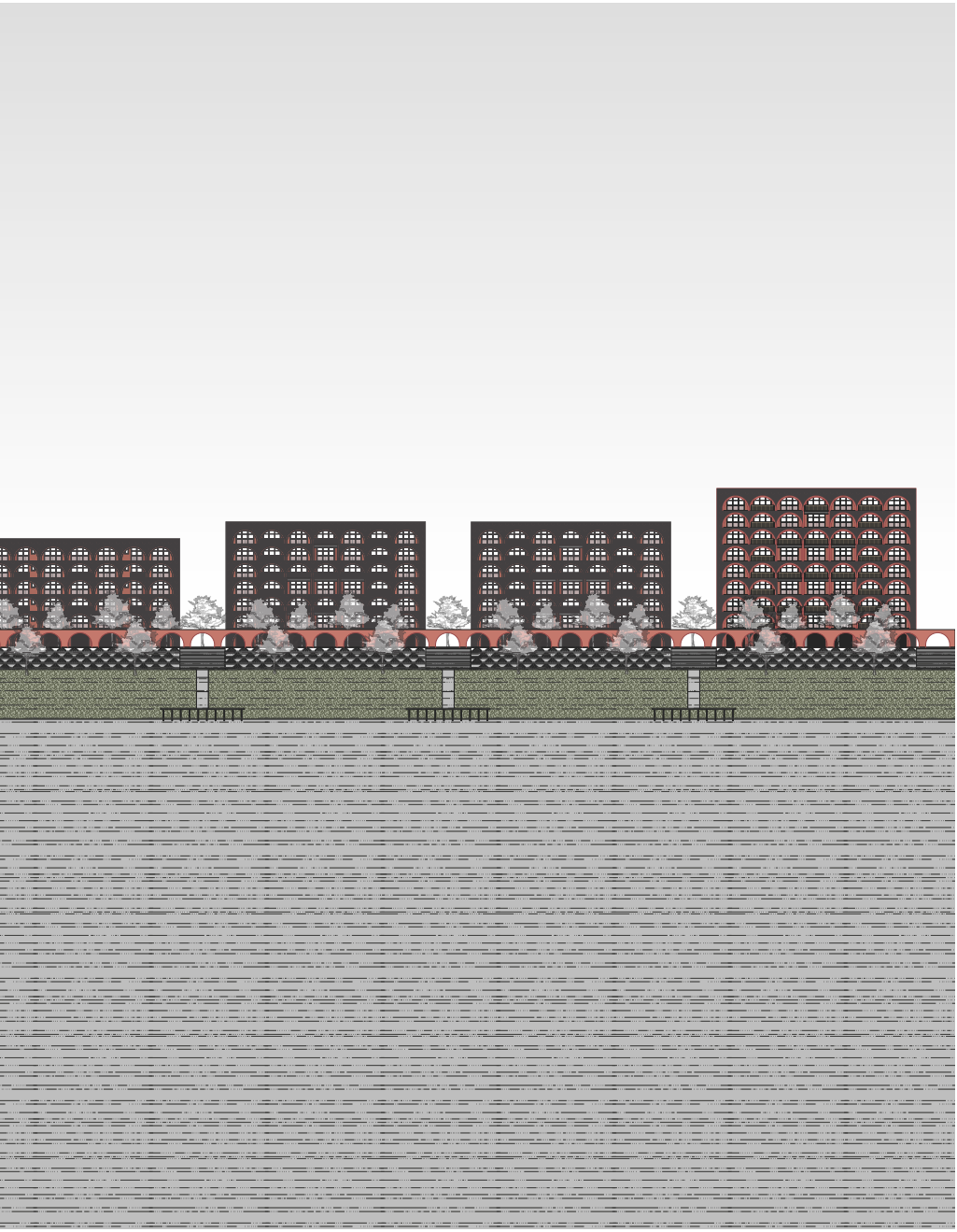
04 Elevation river view (North)



04 Elevation river view (North) - High water level

This section illustrates that even with a raised water level, the floodwaters do not reach the residential buildings. The only area affected is the Central Park located beneath the Keane Bridge, which is designed to accommodate occasional flooding. Since no essential functions are located there and it is not required for access to the buildings or the pedestrian promenade, the flooding poses no disruption to daily use or circulation.





04

04 Designing Climate Resilient & Affordable Housing

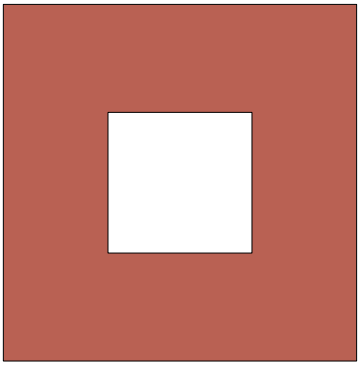
- Concept Cluster
- Low-income housing
- Mid-income housing
- High-income housing
- Section
- Elevations

05 Concept Cluster

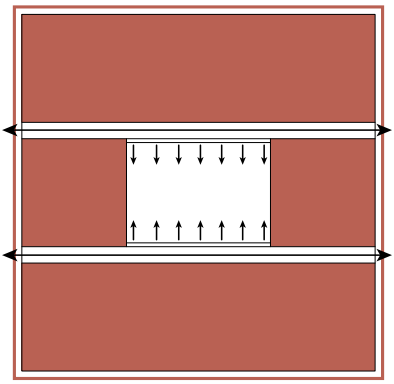
The cluster concept is based on a compact and efficient arrangement of housing units around a shared courtyard. The design begins with a solid building mass organized around an inner courtyard, which brings natural light and ventilation into the center of the cluster. A gallery is then added to serve as a circulation path and a ventilation corridor, while a secondary façade offers additional shading and privacy.

Each housing unit is given a little front space, creating a buffer zone between the home and the shared areas. This enhances the sense of ownership and provides opportunities for personalization or small-scale gardening. Vertical circulation elements, such as staircases, are strategically placed to connect the different levels and maintain easy access throughout the cluster.

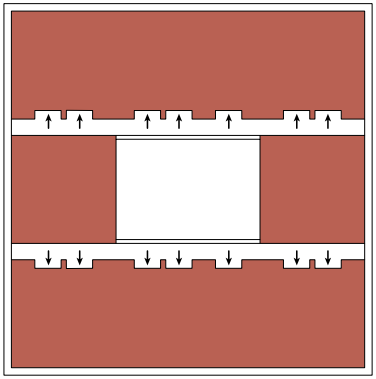
Together, these elements form a socially inclusive, climatically responsive, and space-efficient housing model that encourages community interaction while respecting privacy.



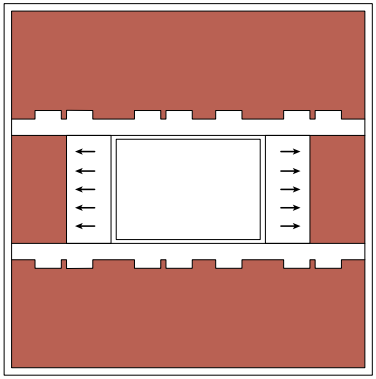
Building mass with a courtyard



Adding a gallery for circulation and ventilation and introducing second facade

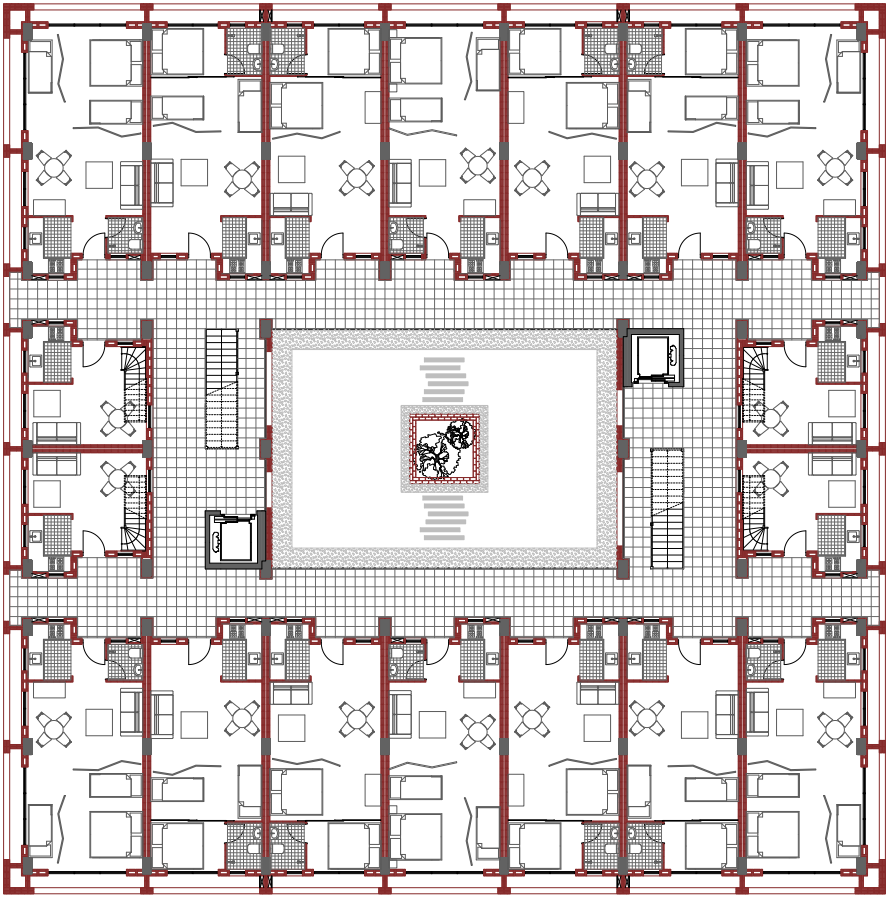


Create private front space per unit

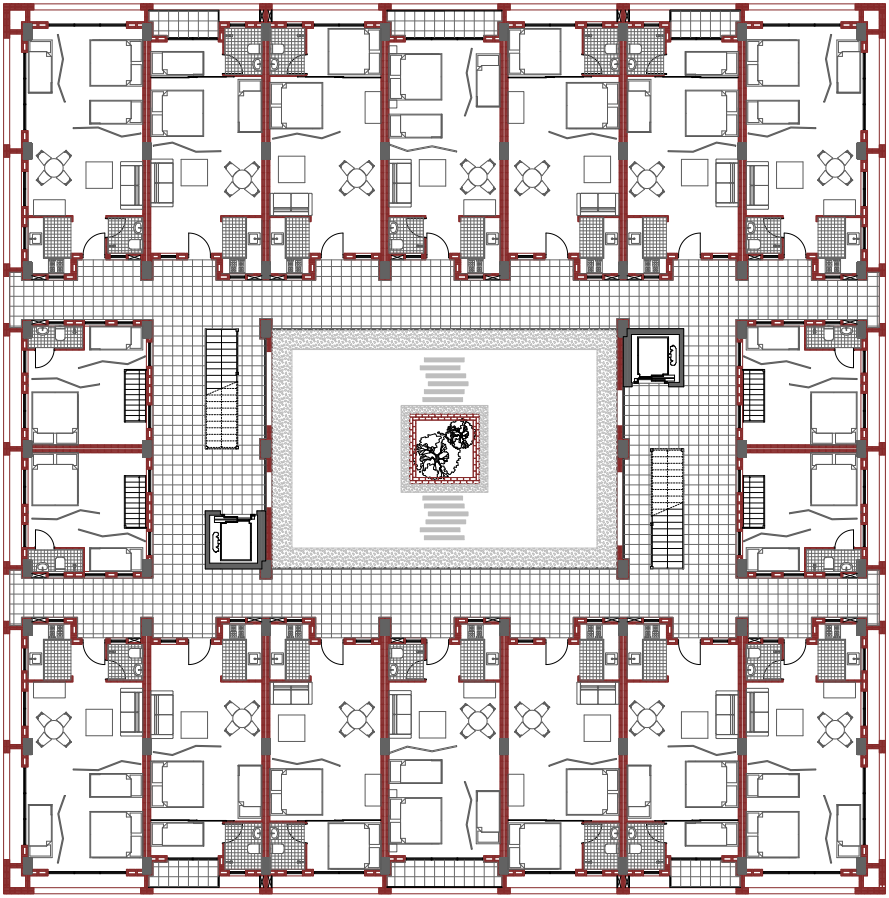


Create vertical circulation space

05 Low-income Housing Cluster - Type A & B

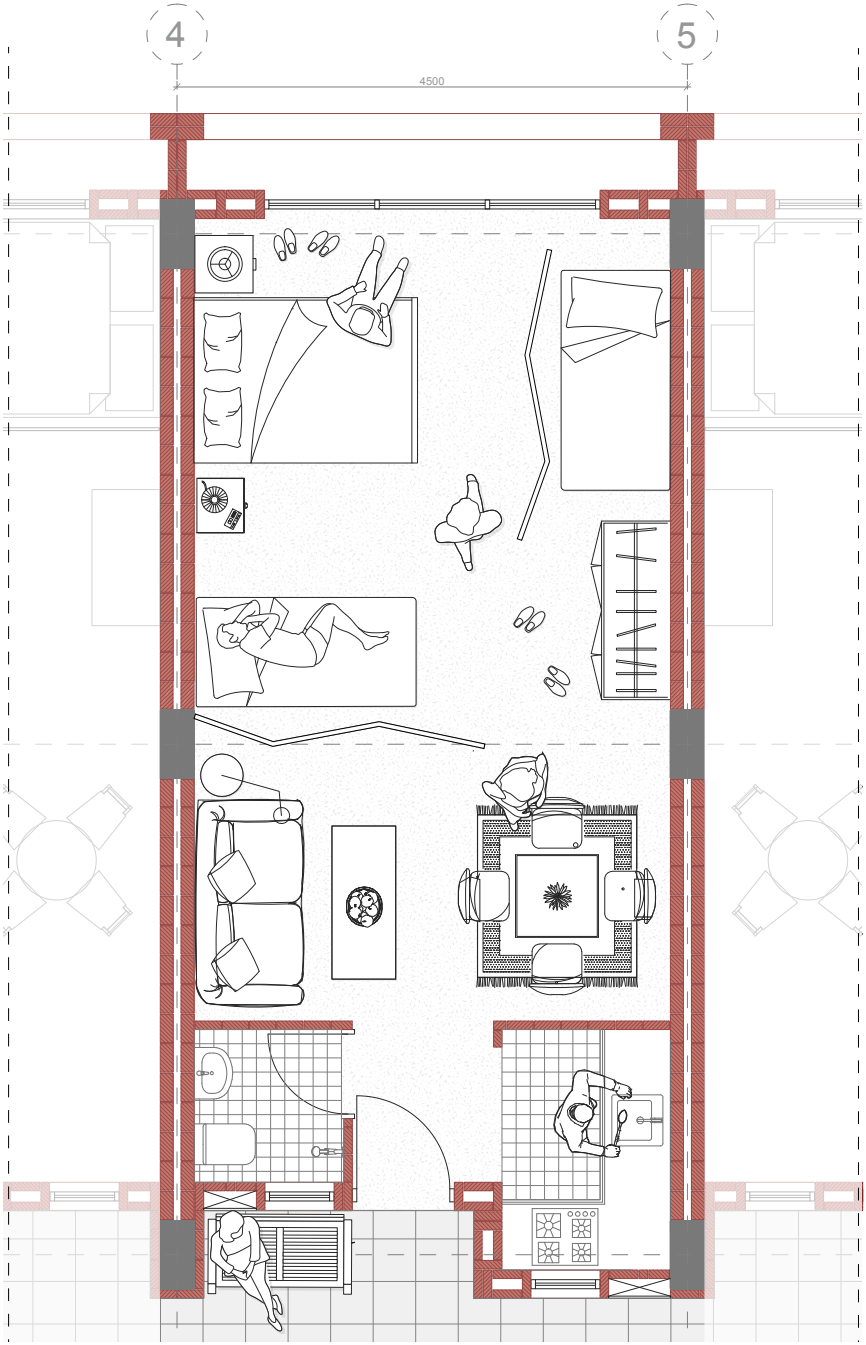


The low-income cluster consists of 14 single-storey units per floor with varying layouts, along with 4 double-storey units. Varying open layouts are ideal for low-income housing as they offer flexibility, efficiency, and adaptability. They allow families to arrange spaces based on their needs, reduce construction costs by minimizing partitions, and support future changes or expansions.



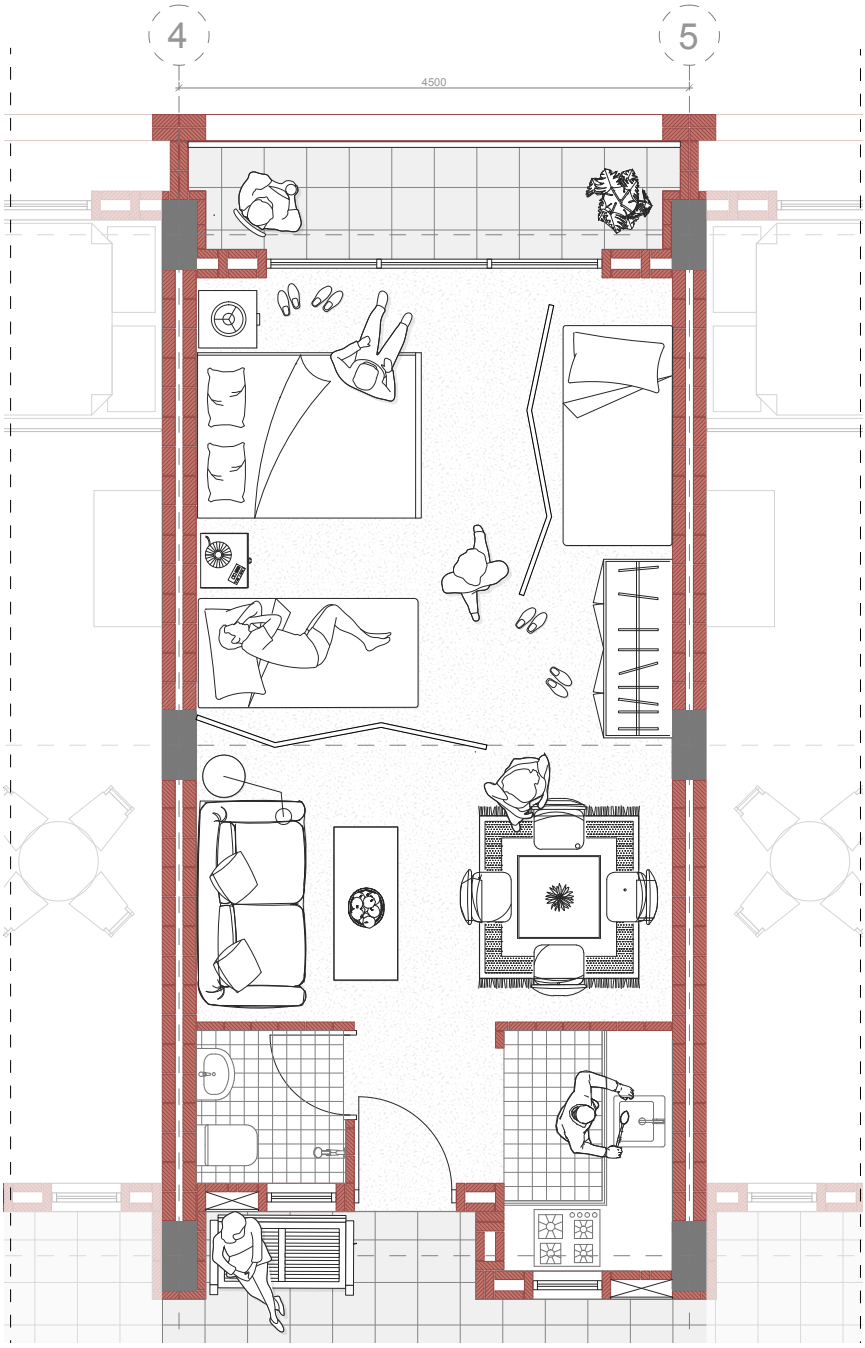
The units offer varied outdoor spaces, with some featuring loggias ranging from 2.5 to 4.1 m². These compact, private areas provide valuable outdoor access without significantly reducing the essential indoor living space.

05 Low-income Housing Units - Type A & B



Inside area
36,8 m2

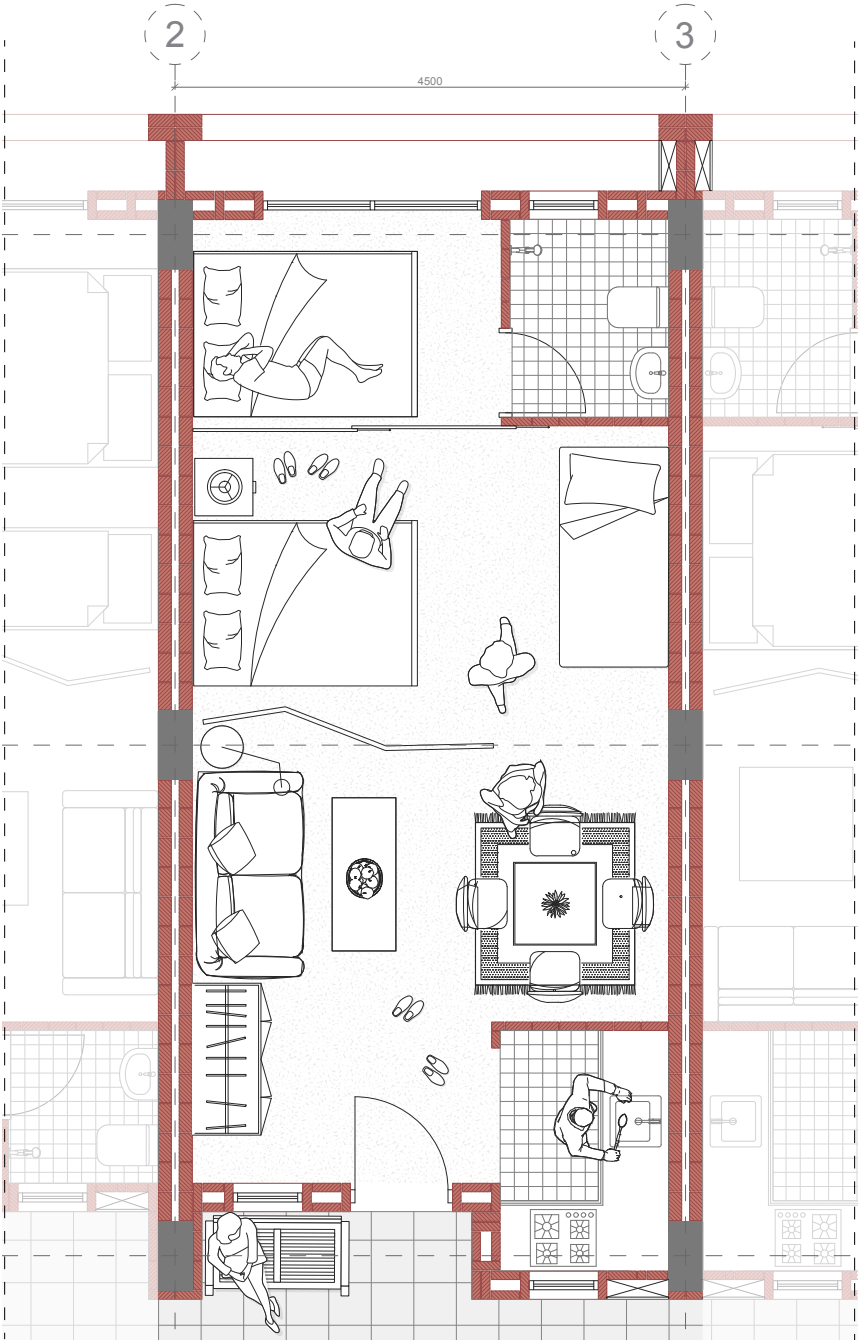
Loggia
-



Inside area
34,7 m2

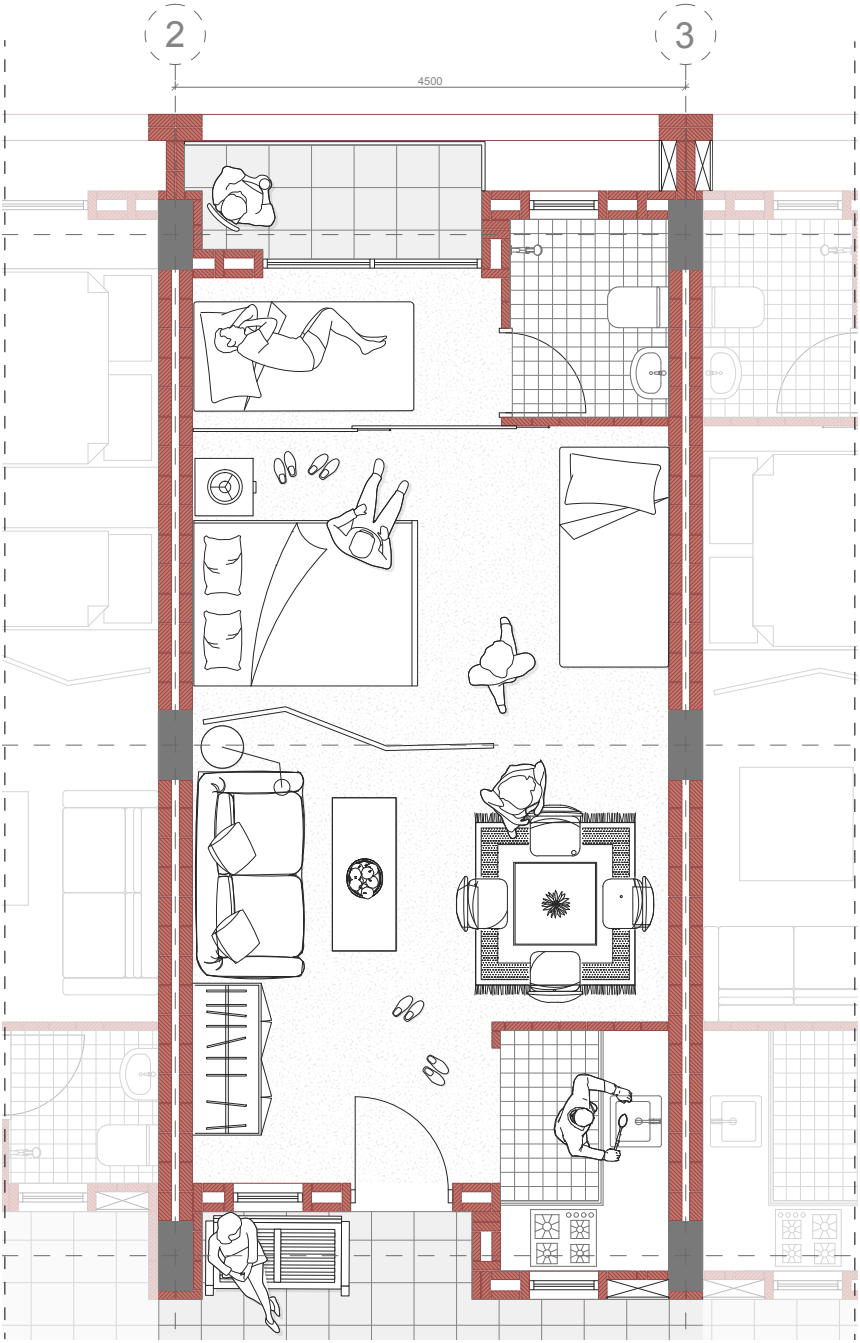
Loggia
4,1 m2

05 Low-income Housing Units - Type C & D



Inside area
36,8 m2

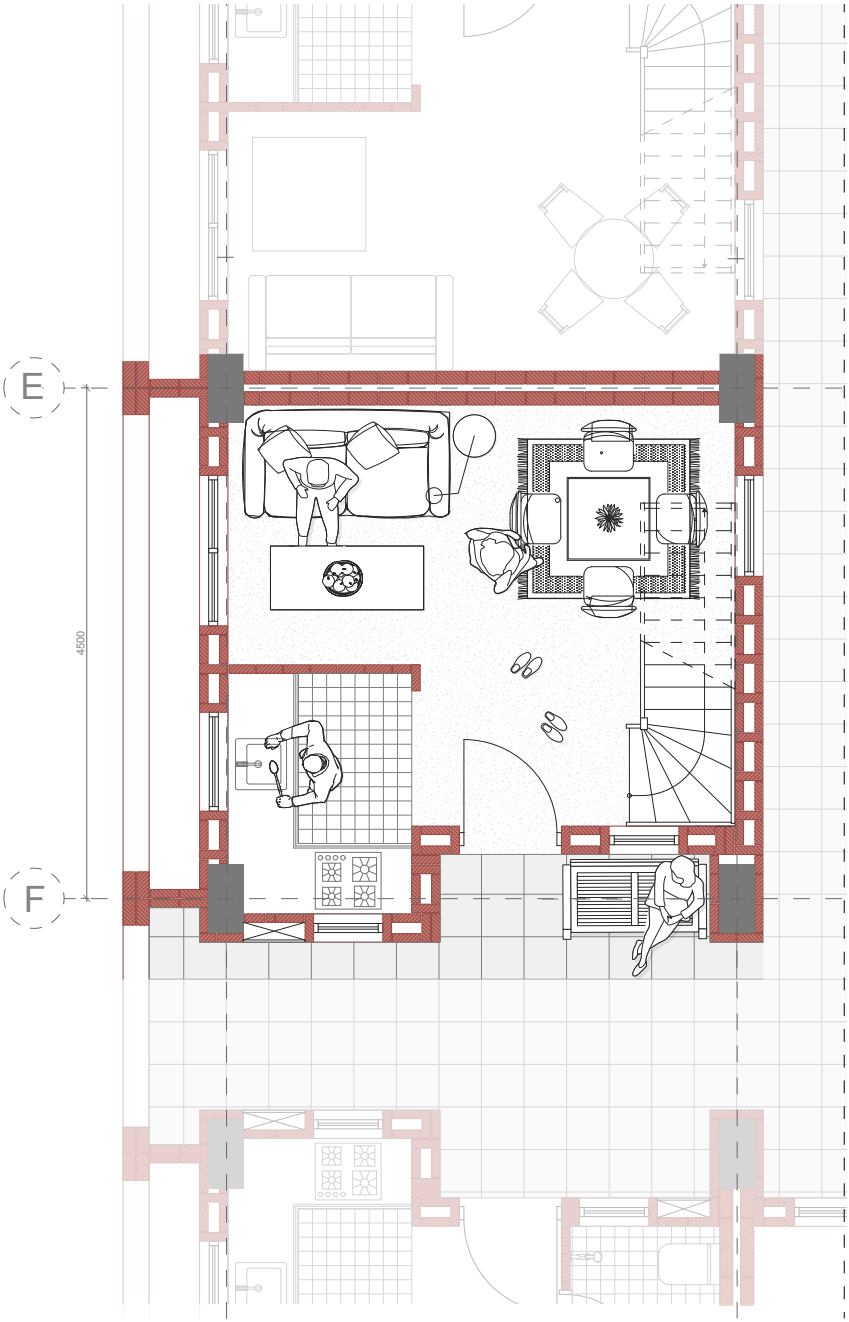
Loggia
-

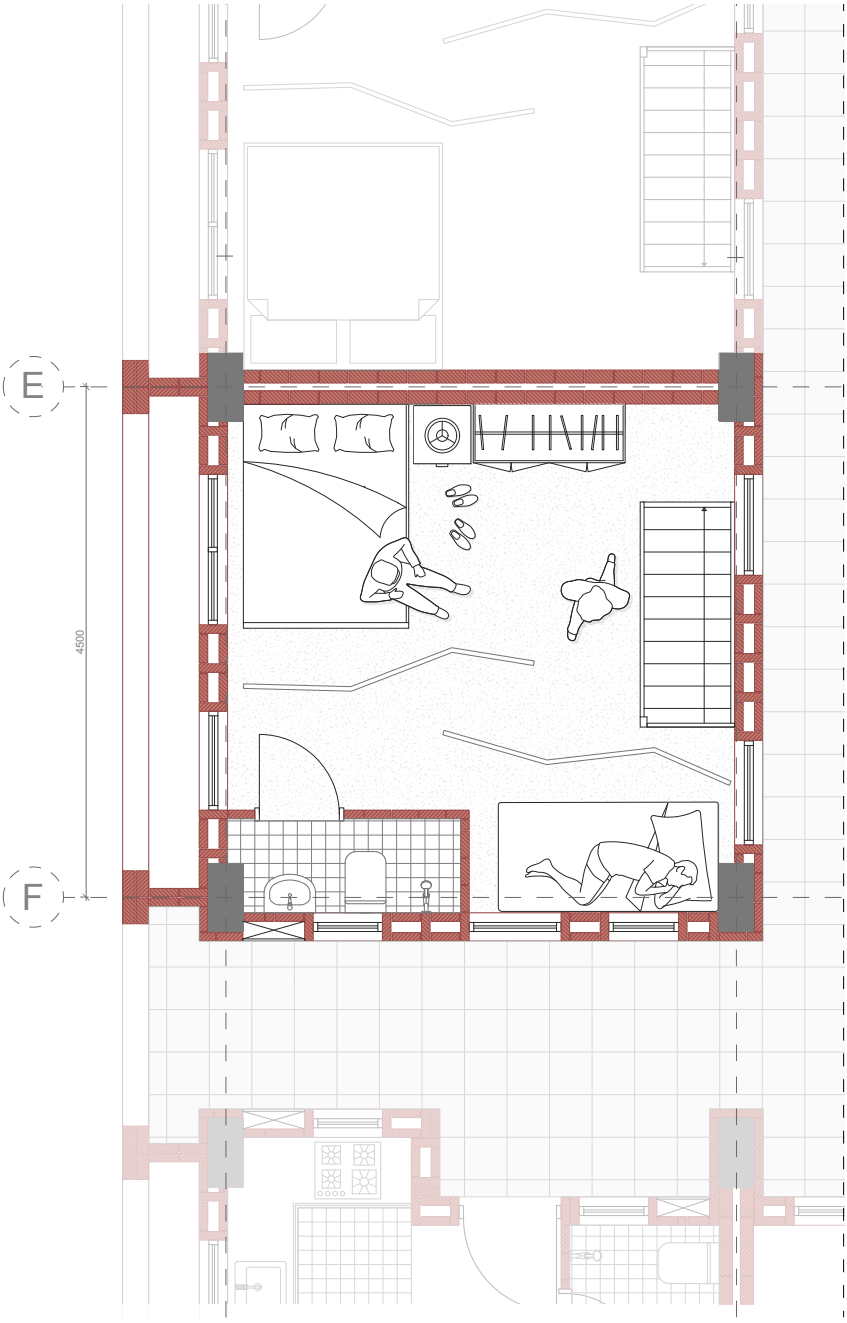


Inside area
35,6 m2

Loggia
2,5 m2

05 Low-income Housing Units - Type E





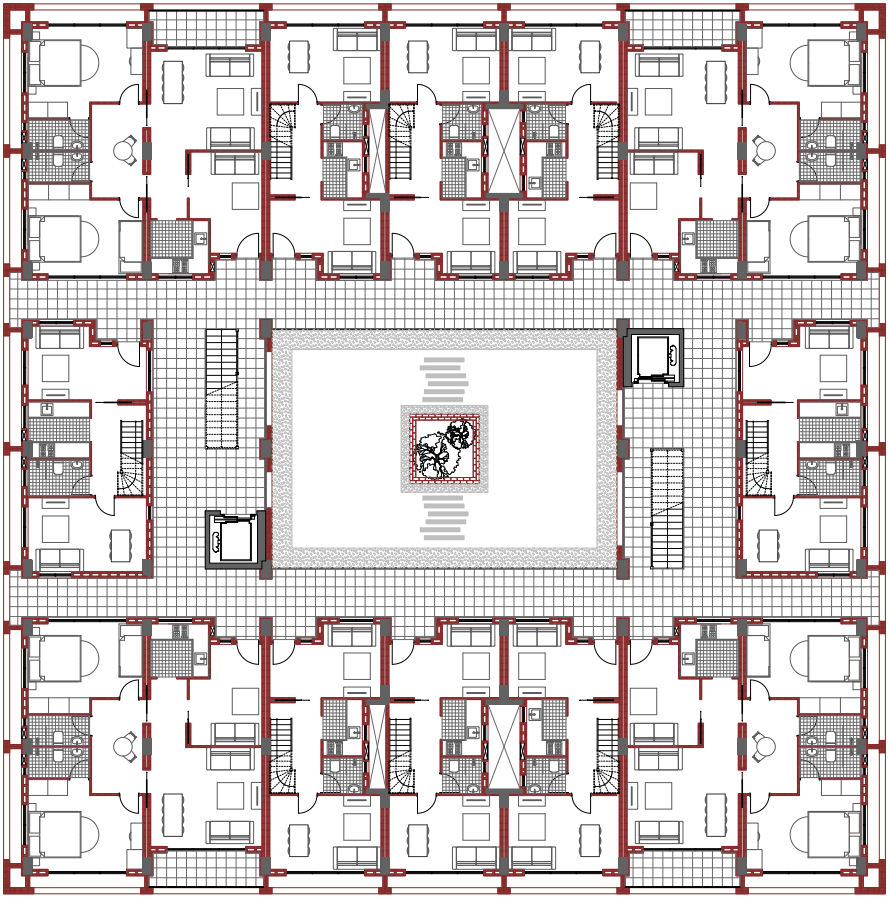
Inside area
37,8 m2

Loggia
-

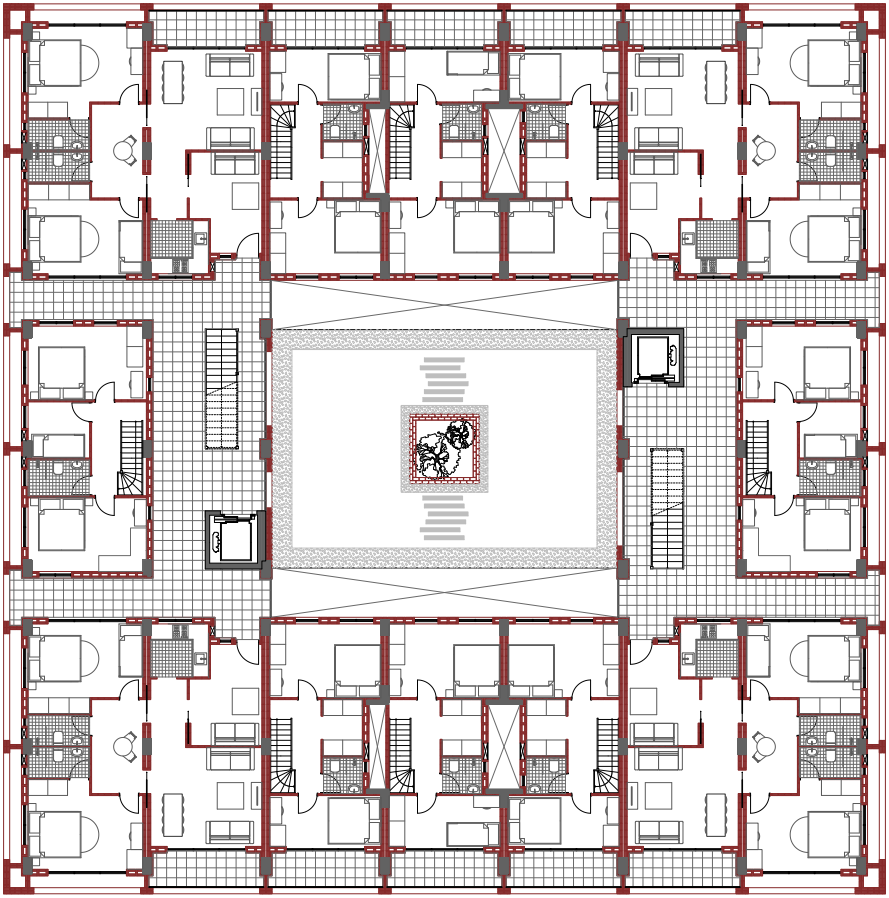
Courtyard from third floor

Courtyard from ground floor

05 Mid-income Housing Cluster - Type A & B

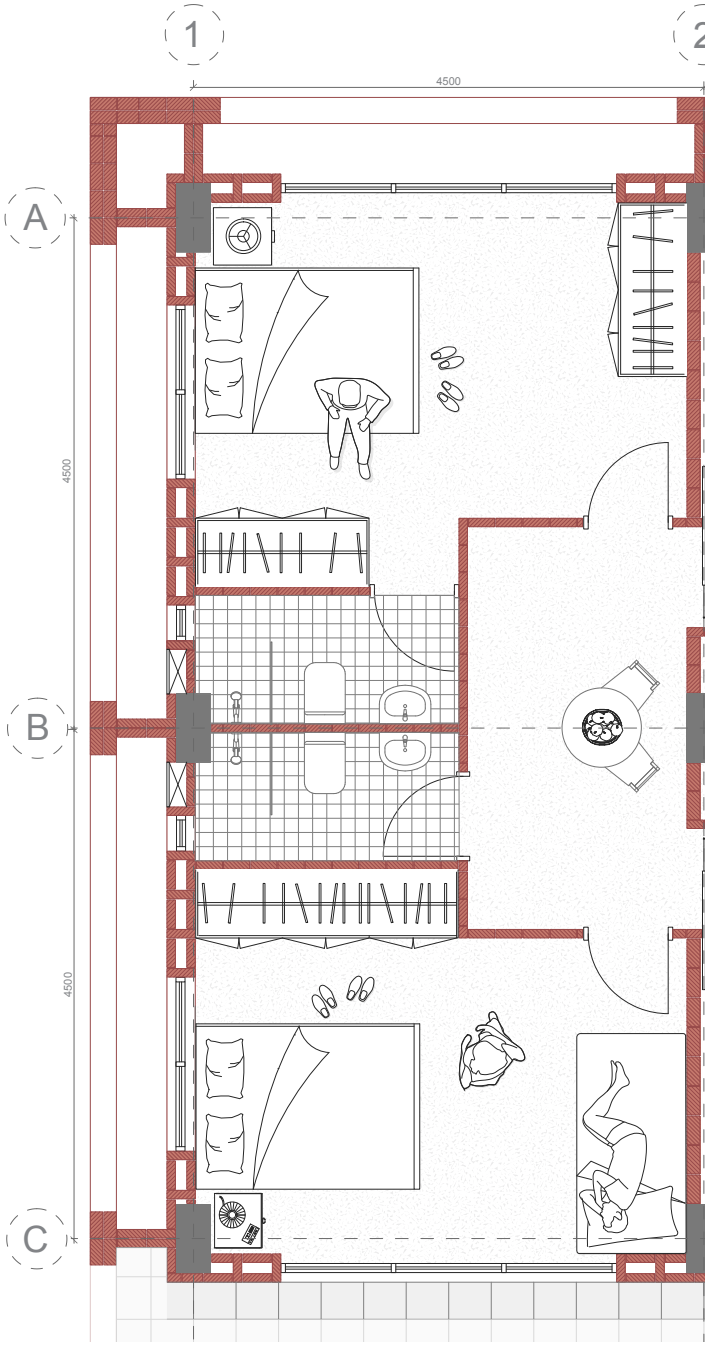


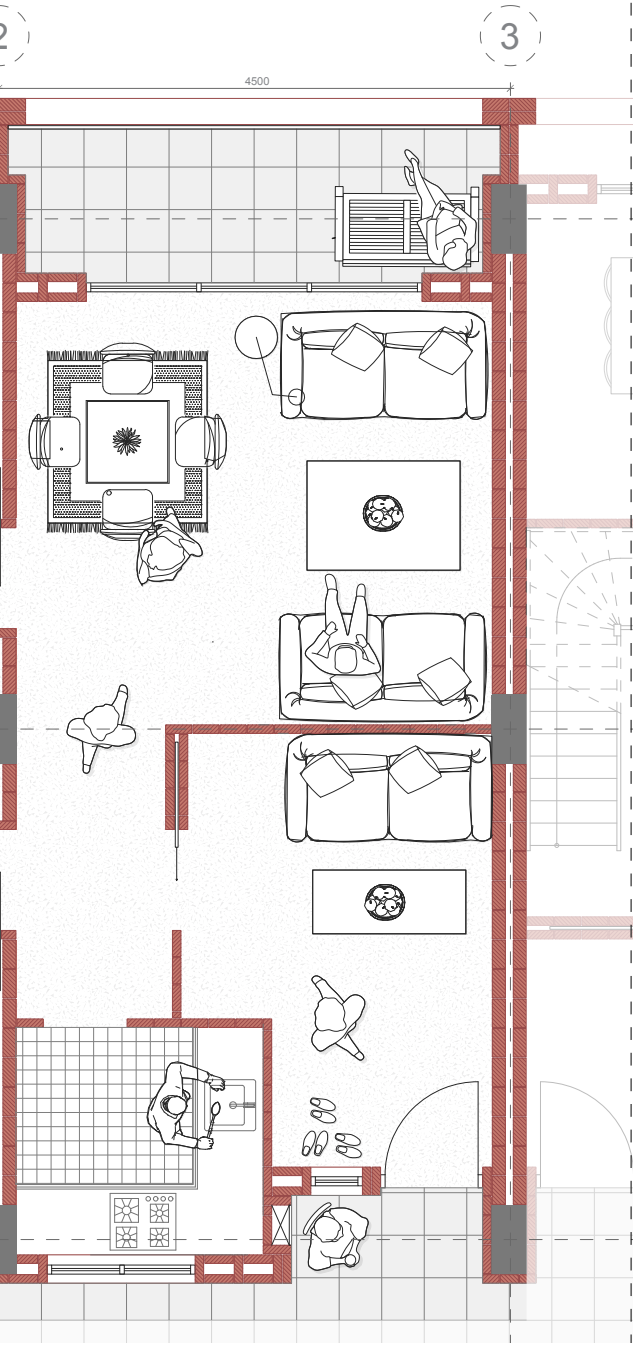
There are a few key differences in the design. Ventilation atriums are integrated into the layout, allowing spaces like kitchens and bathrooms to be placed at the center of the units while still receiving natural ventilation. Mid-income units are twice the size of low-income units, resulting in four single-storey units and eight double-storey units per floor. Reflecting Bangladeshi cultural norms, each mid- and high-income unit includes a dedicated guest room, thoughtfully positioned to remain separate from the home's private living areas.



The double-storey units create openings in the gallery, allowing more natural light to penetrate the shared circulation space and enhancing the overall brightness and openness of the building.

05 Mid-income Housing Units - Type A

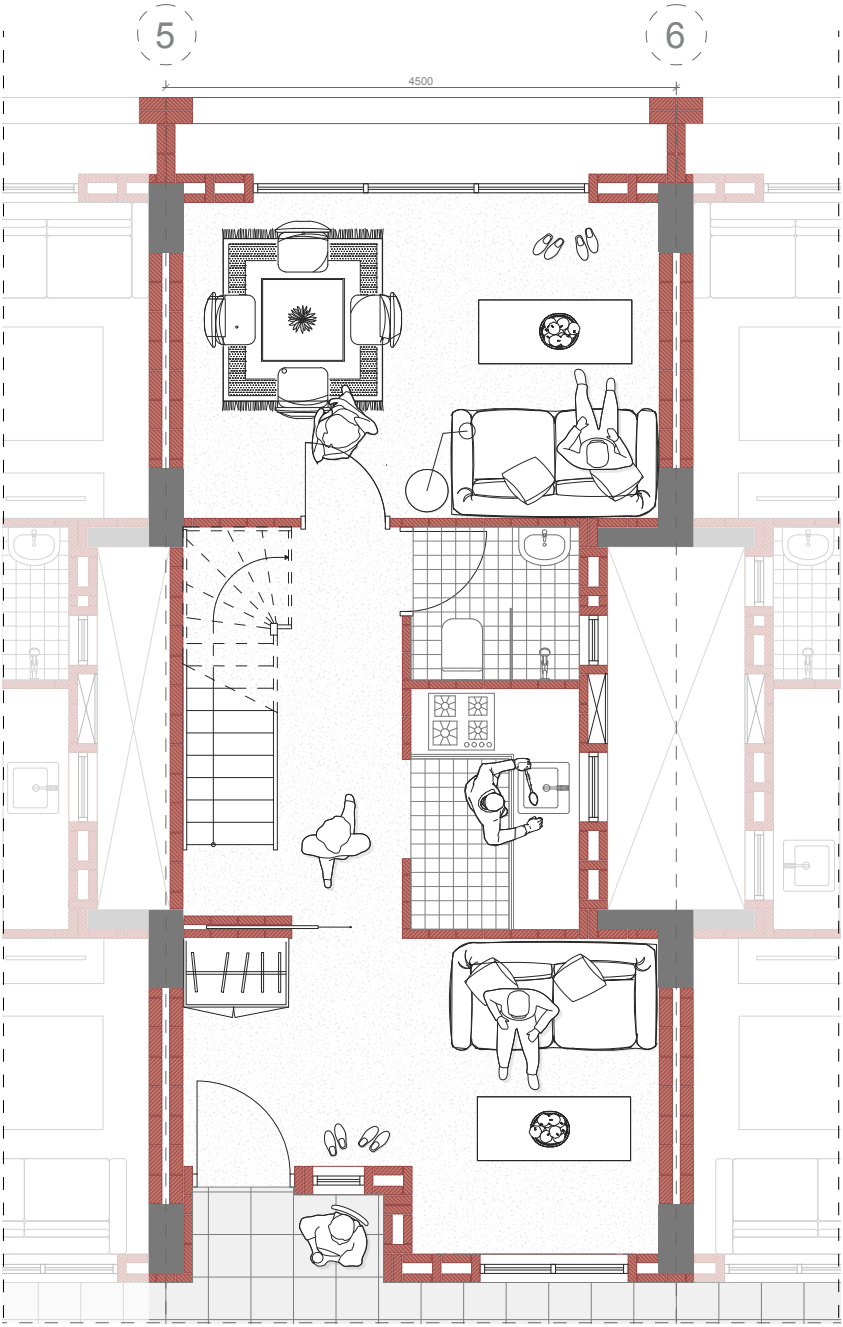


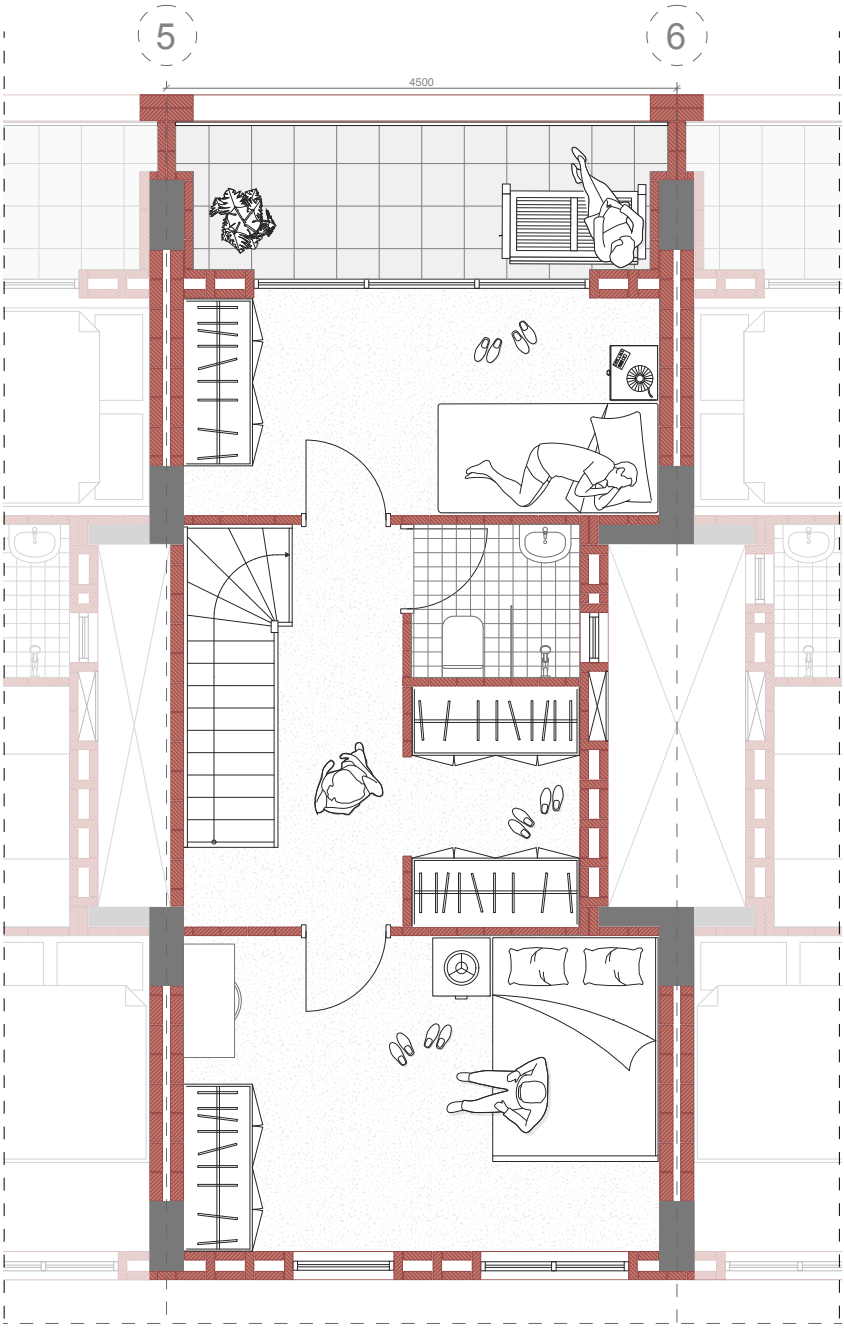


Inside area
70 m2

Loggia
5,5 m2

05 Mid-income Housing Unit - Type B

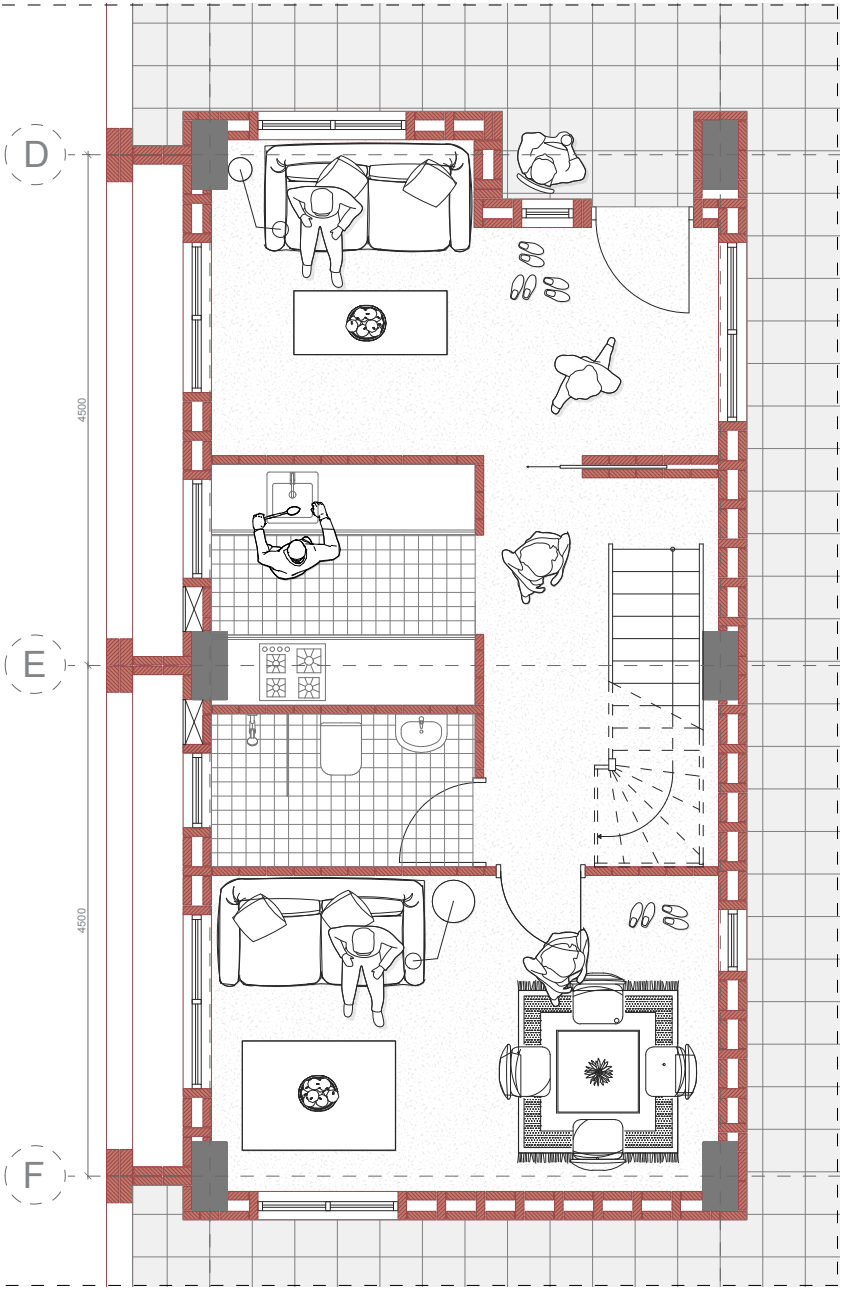


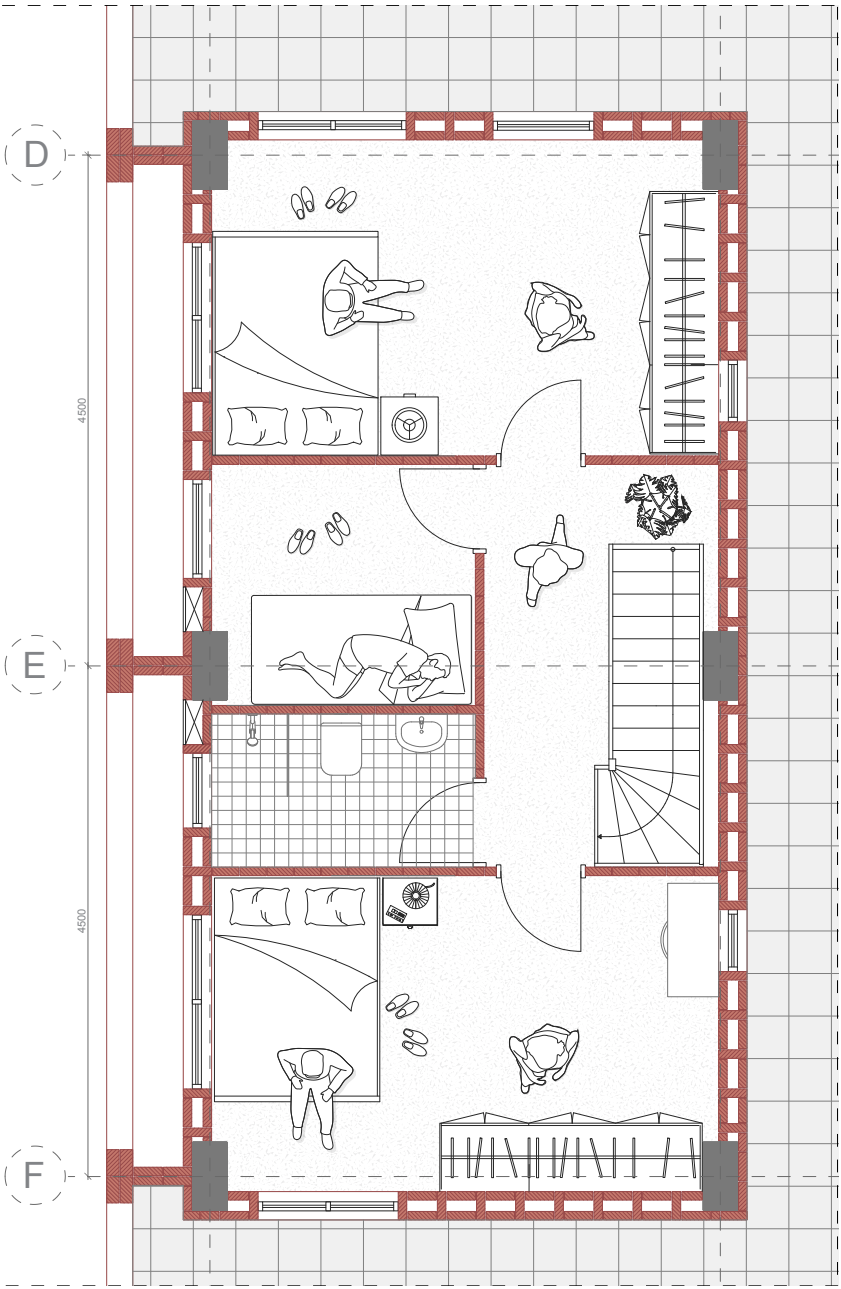


Inside area
71,5 m2

Loggia
5,5 m2

05 Mid-income Housing Unit - Type C

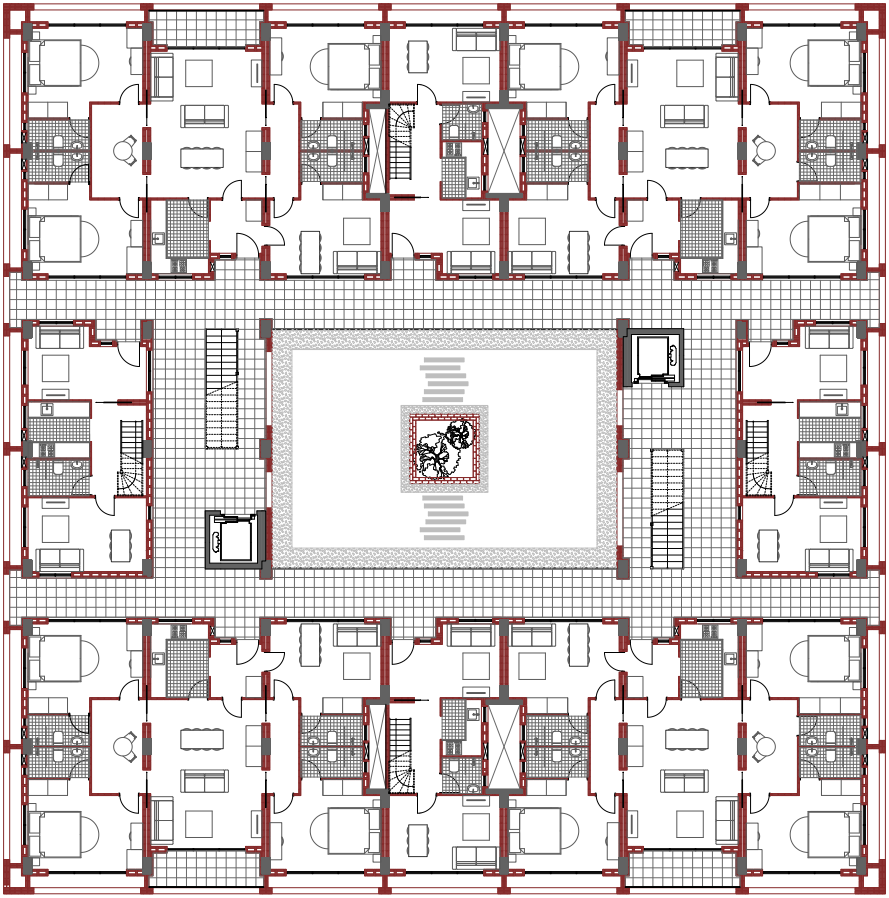




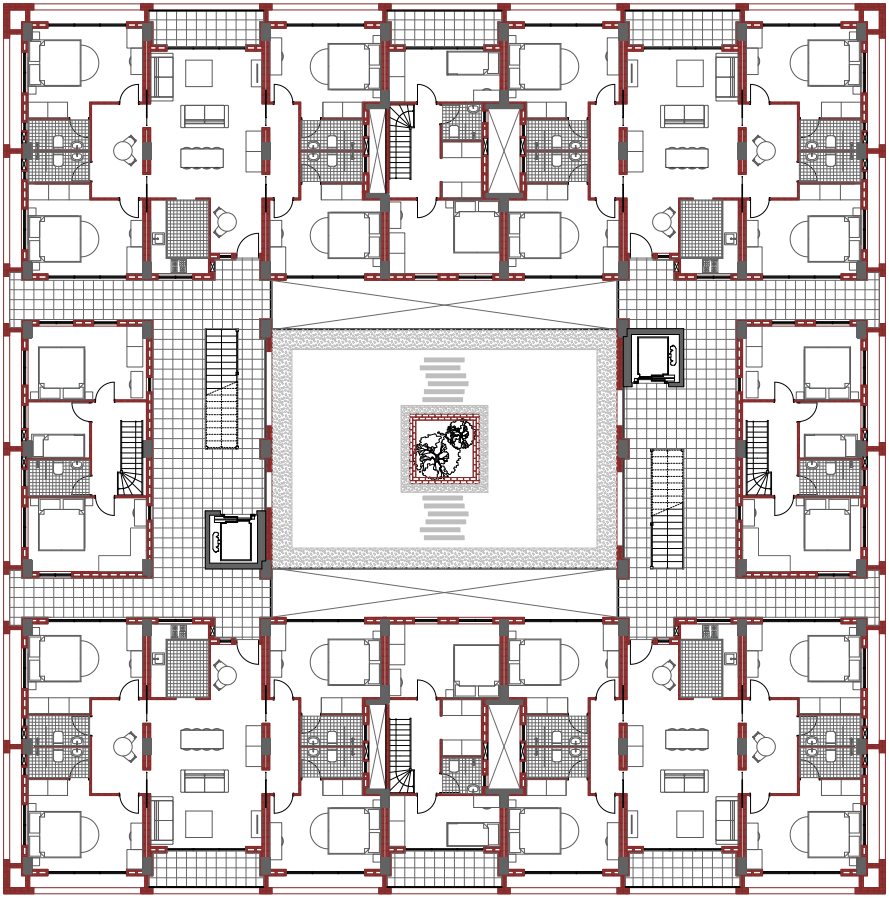
Inside area
80,4 m2

Loggia
-

05 Mid- & High-income Housing Cluster - Type A & B

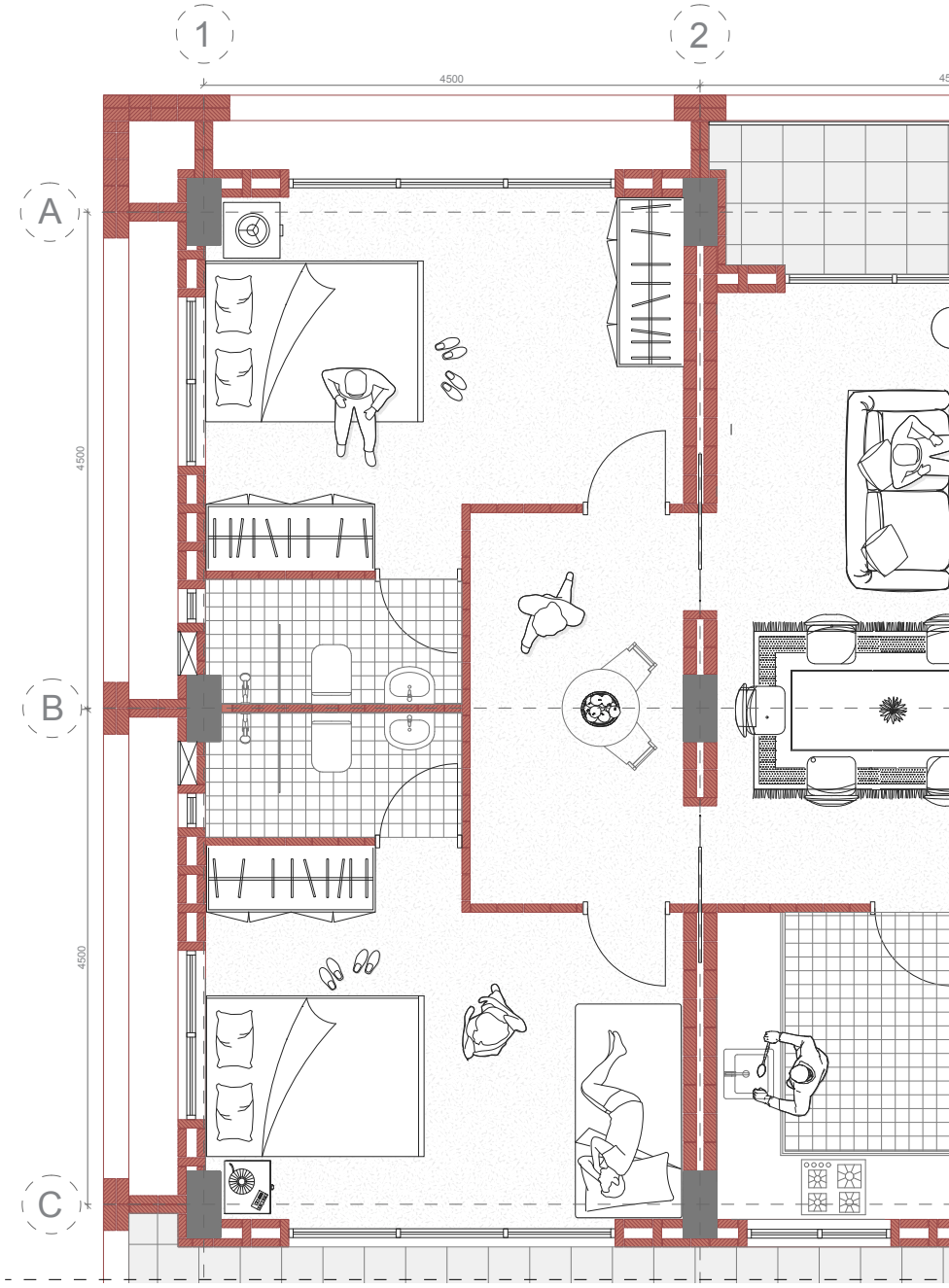


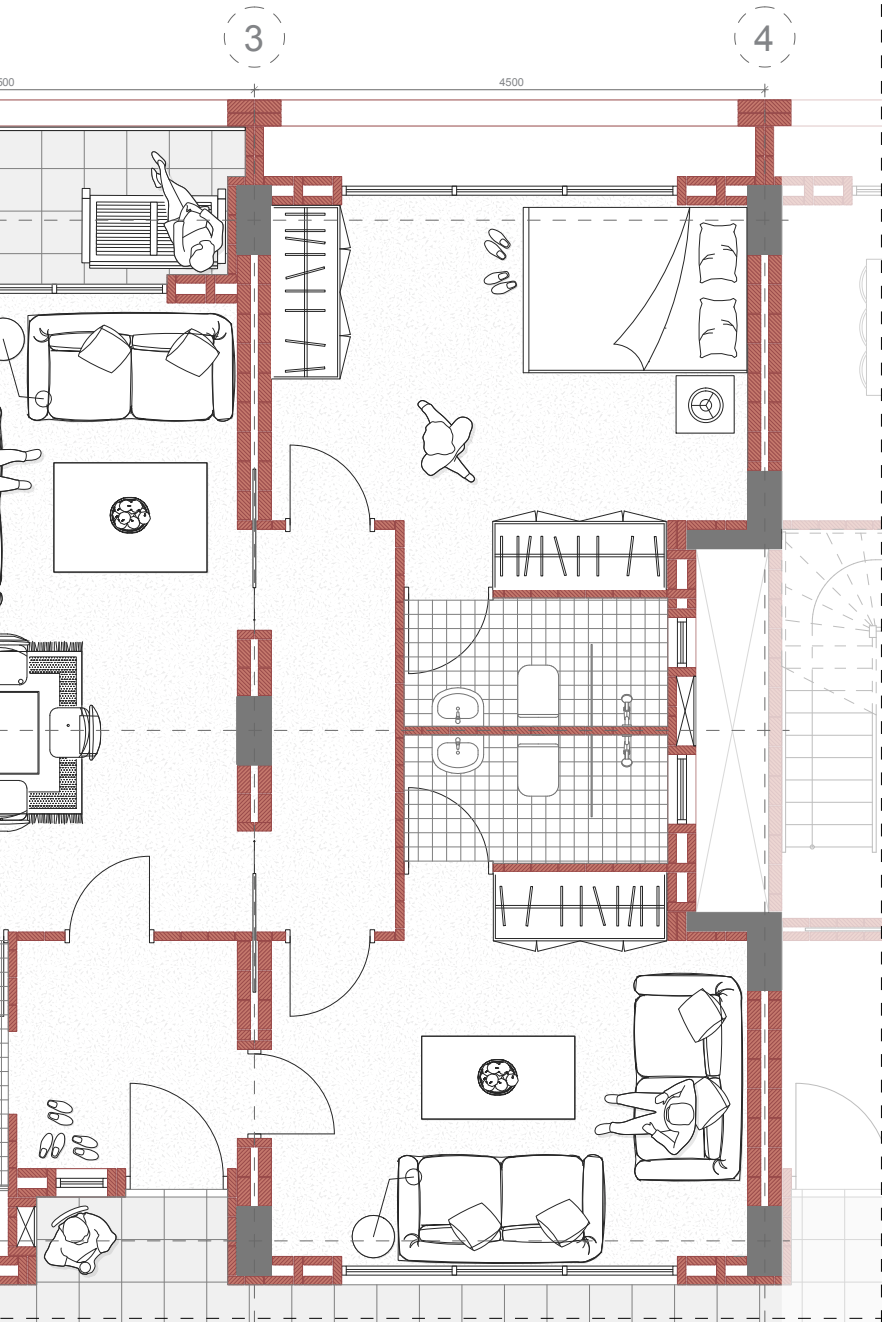
This cluster includes both mid- and high-income units. The high-income units are three times larger than the low-income units, offering significantly more space and comfort. On this floor, there are four high-income units alongside four double-storey mid-income units, creating a balanced mix of housing types within the same structure.



The high-income units are located exclusively on the upper two to four floors of the mid- and high-income clusters, ensuring greater privacy, better views, and improved access to natural light and ventilation. This vertical distribution also helps create a clear spatial hierarchy within the building while maintaining a diverse and integrated housing model.

05 Mid- & High-income Housing Unit - Type A





Inside area
115,9 m2

Loggia
5,5 m2

05 Section


A
B
C
D
4500
4500
2250
4500
P + 15290
P + 14390
P + 11580
P + 8770
P + 5960
P + 3150
P + 3150
P + 0
P - 2900
P - 3200


E
F
G
H
I
4500
2250
4500
4500

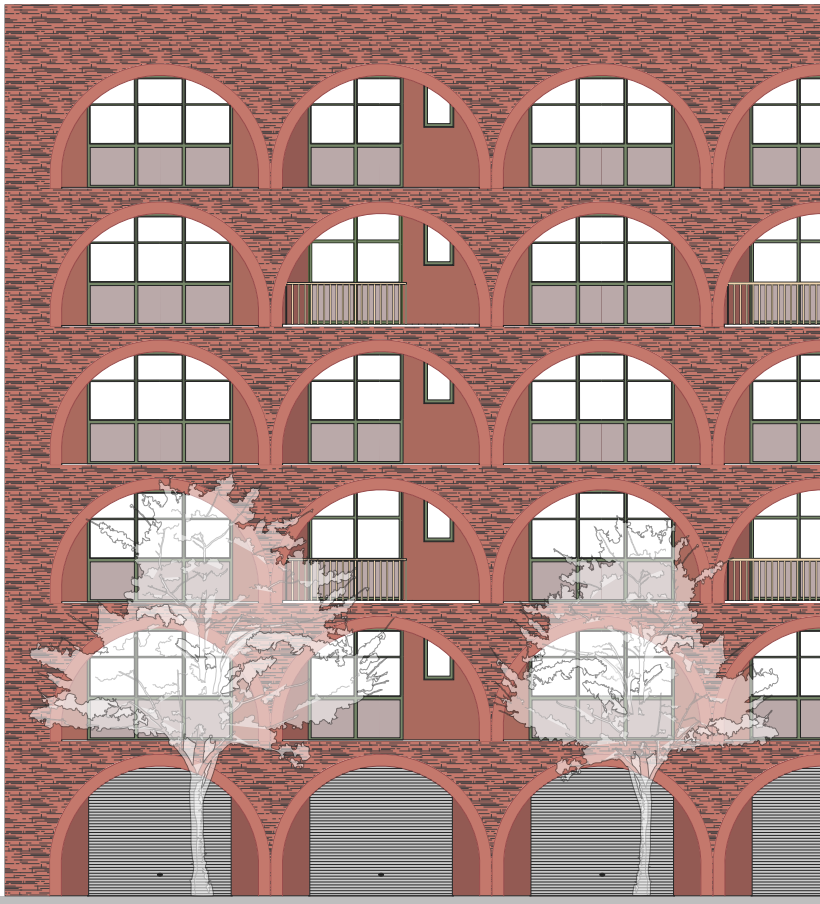
05 References Facade

Ayub National Hospital in Dhaka, Bangladesh by Louis I. Kahn

Capitol Complex in Dhaka, Bangladesh by Louis I. Kahn

05 Elevations Low-income Cluster

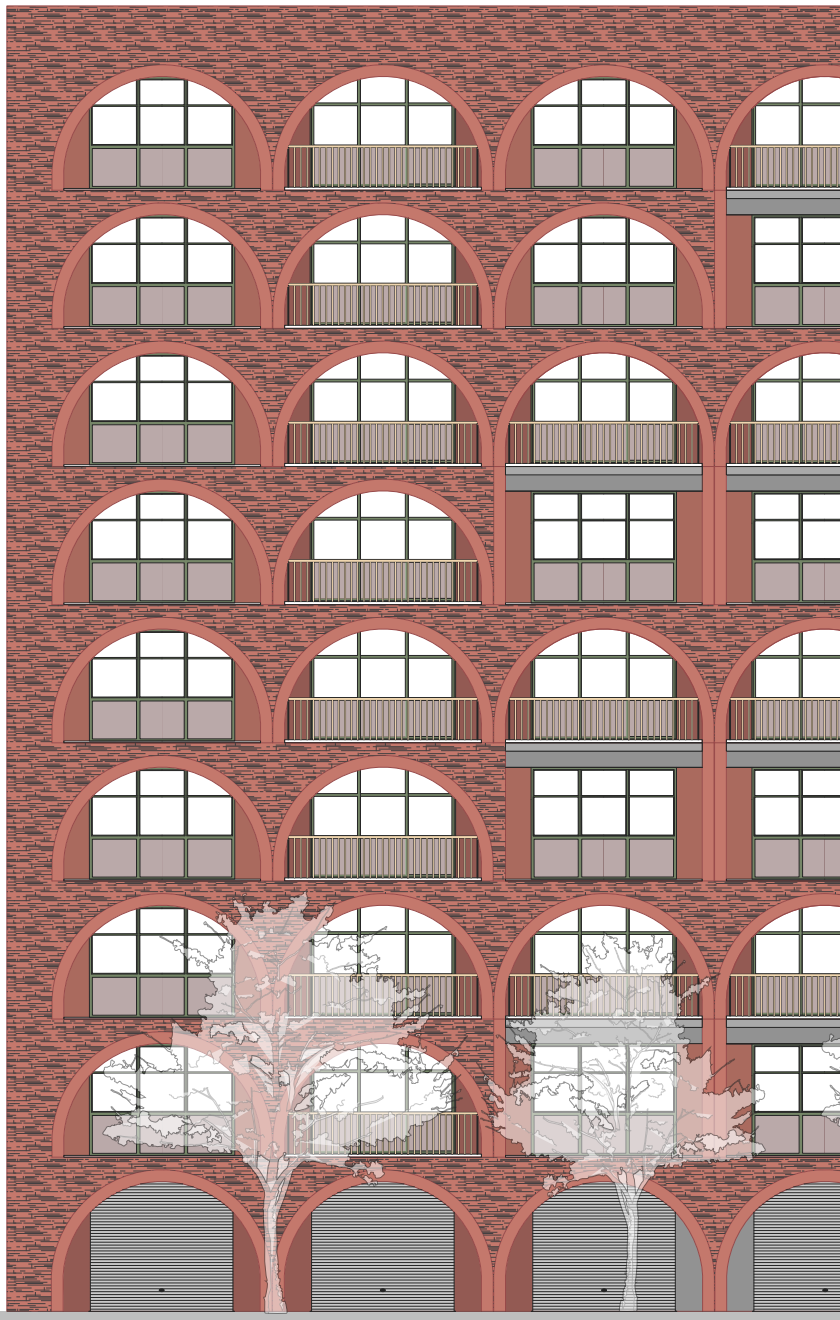
The arches in the façade reflect the height of the units behind them, visually revealing the building's internal layout. An arch in front of a single-storey unit spans one level, while those in front of double-storey units extend across both floors. This design approach creates a clear and expressive connection between the exterior and interior, allowing the building's structure and spatial organization to be read from the outside.

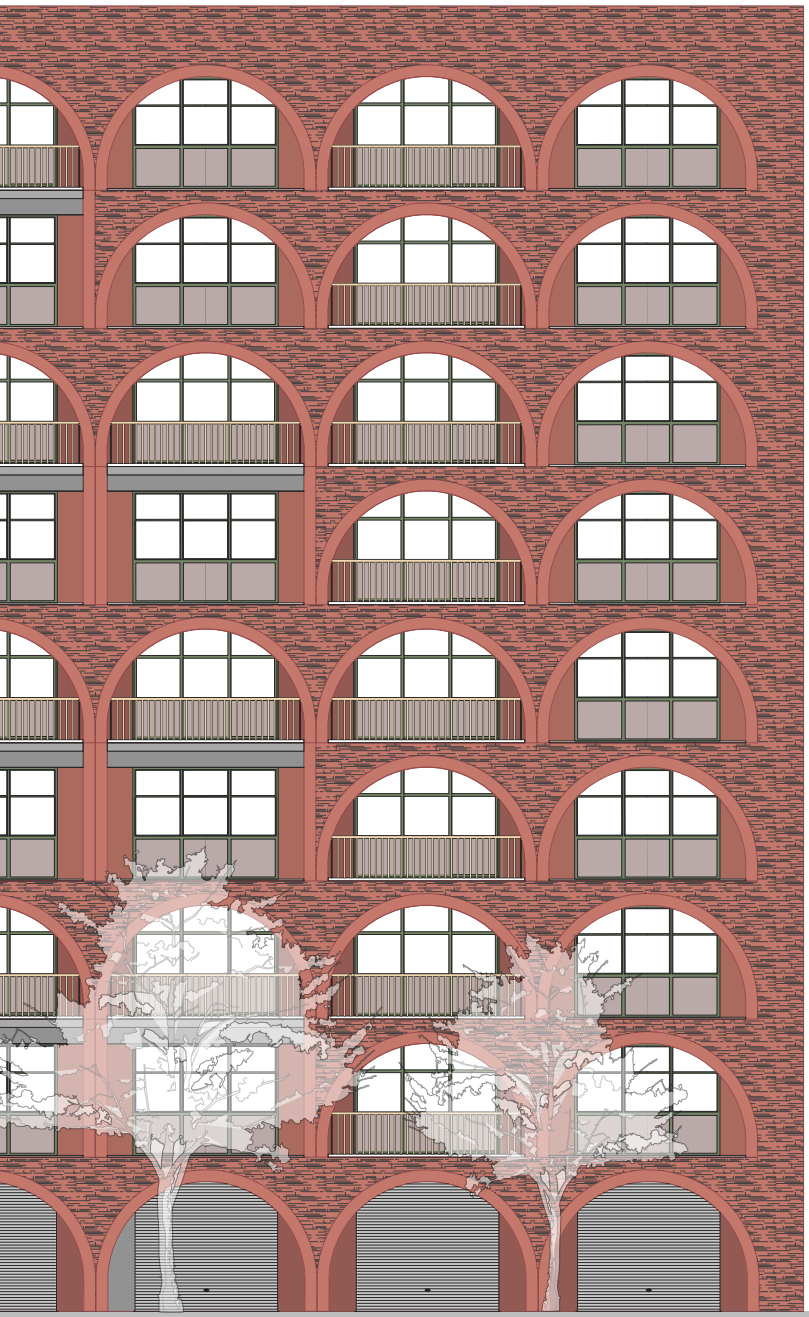


05 Elevations Low-income Cluster

Both the low-income and mid- and high-income clusters share the same exterior appearance on the site to promote a sense of unity, equality, and architectural cohesion. By giving all clusters a consistent facade language, the design avoids visual hierarchy based on income level. This approach fosters social inclusion, reduces stigma, and reinforces the idea that all residents, regardless of income, are part of the same community. It also strengthens the overall identity of the site, creating a harmonious and balanced urban environment.

05 Elevations Mid- & High-income Cluster





05 Elevations Mid- & High-income Cluster

05

05 Technology

- Materials
- Principle structure
- Construction process
- Environmental strategy
- Facade

06 Research Materials - BRAC

BRAC aims to disseminate the handbook among government, multilateral and private sector organisations, donor agencies, NGOs, practitioners, community-based organisations, micro-finance institutions, and others willing to support new housing or rehabilitation projects for low-income urban communities. We believe that this handbook will offer a guideline for ***low-cost and resilient construction in low-income urban settlements of Bangladesh*** (Ali, 2021).

Principles for low-cost house construction (Ali, 2021):

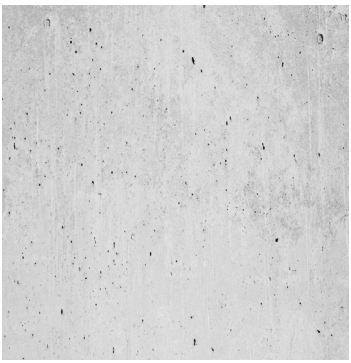
- Optimum use of space
- Use of exposed brick (no plaster)
- Reconsidering wall thickness
- Use of locally available materials
- Reuse of materials (where feasible)

This project utilizes two primary materials: concrete and brick. As an affordable housing initiative, these materials were guided primarily by cost-effectiveness and local availability, both of which are met by these materials. Beyond affordability, each material offers distinct functional and design advantages.

Concrete is used for the frame structure, primarily to meet structural requirements. Since a significant portion of the project exceeds five storeys, concrete framing ensures the necessary stability and load-bearing capacity for mid-rise construction (6–9 floors). Additionally, the flexibility offered by concrete frame systems aligns with the design intent, allowing for more adaptable interior layouts.

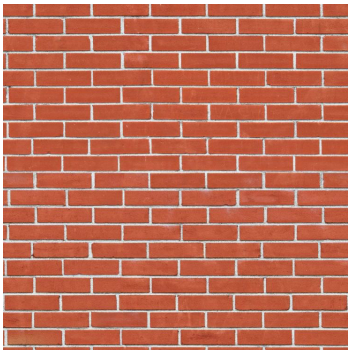
Red brick, one of the most widely used materials in Bangladesh, is employed for the facade and infill walls. It is not only recyclable and reusable, contributing to the project's sustainability goals, but also provides rich aesthetic potential through varied brick bonding patterns that enhance the architectural expression.

Rat-trap bond is used to reduce material costs and improve thermal insulation. By creating internal cavities within the wall, it requires fewer bricks and mortar while enhancing energy efficiency. It also results in a lighter wall, reducing load on the structure, and adds a distinct aesthetic texture to the facade.



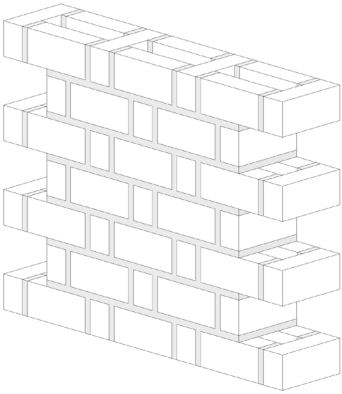
Concrete

Frame structure



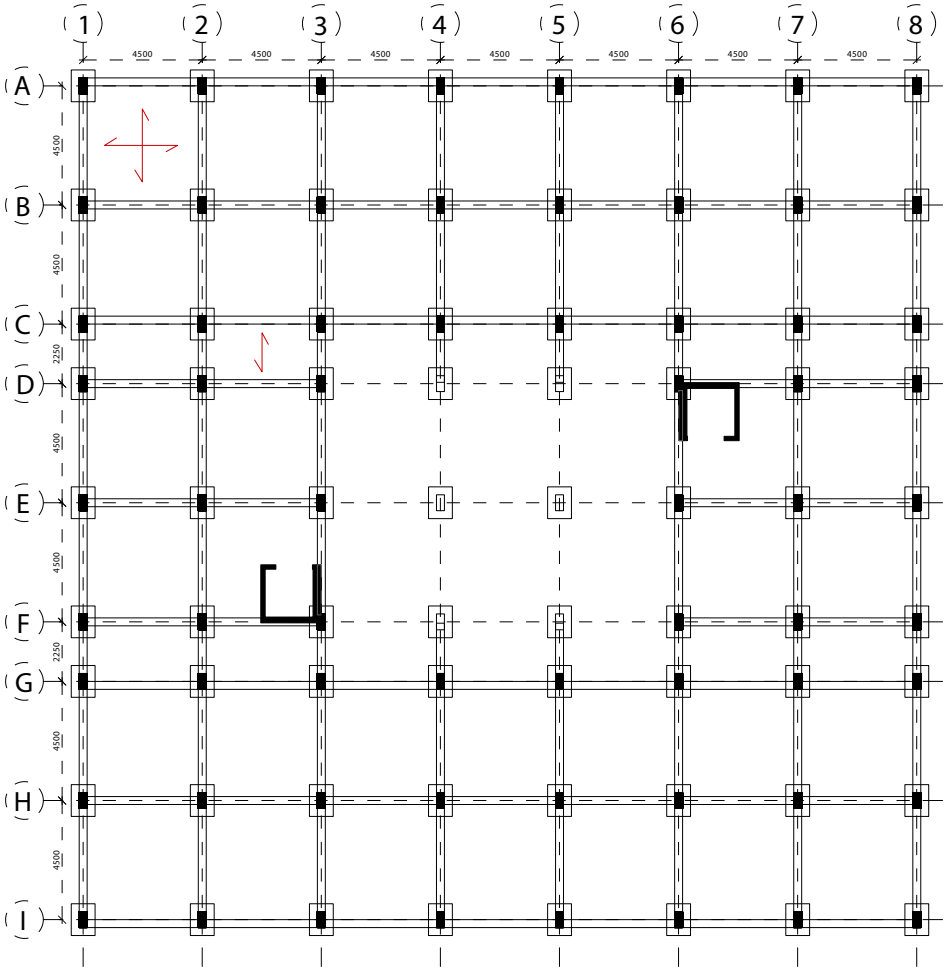
Red brick

Infill



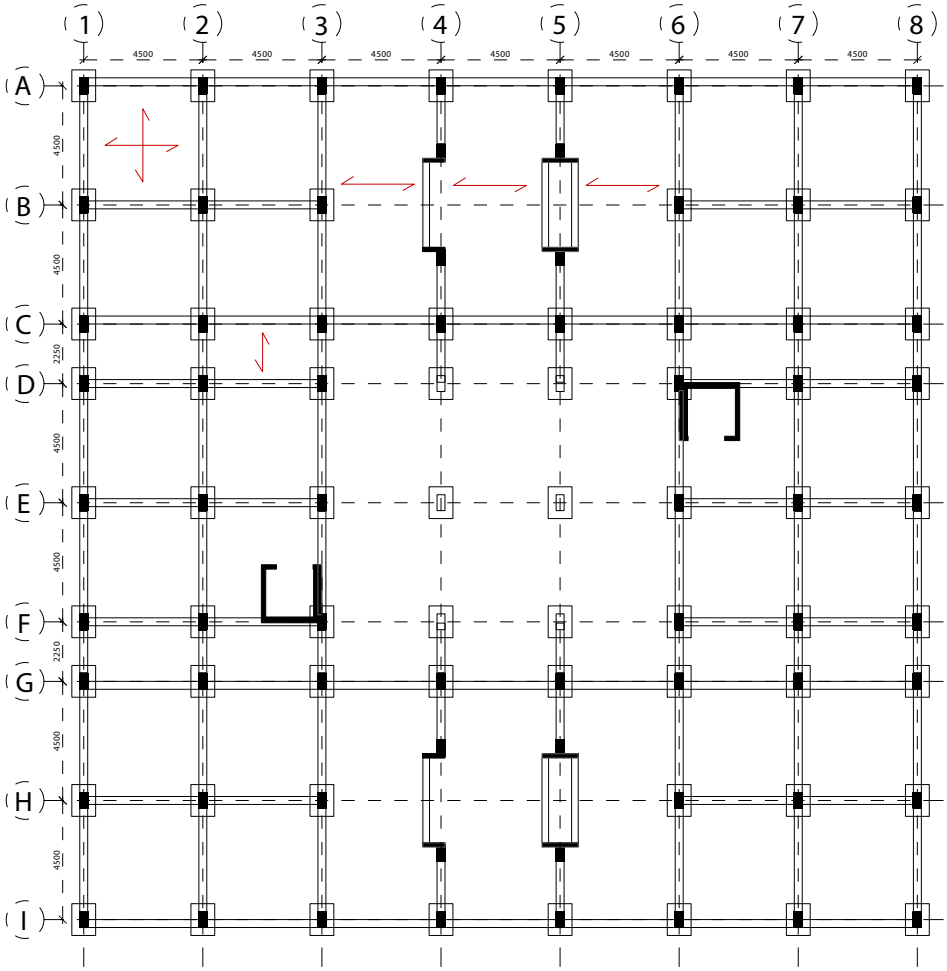
Rat trap bond

06 Principle structure - Floorplans



Low-income cluster

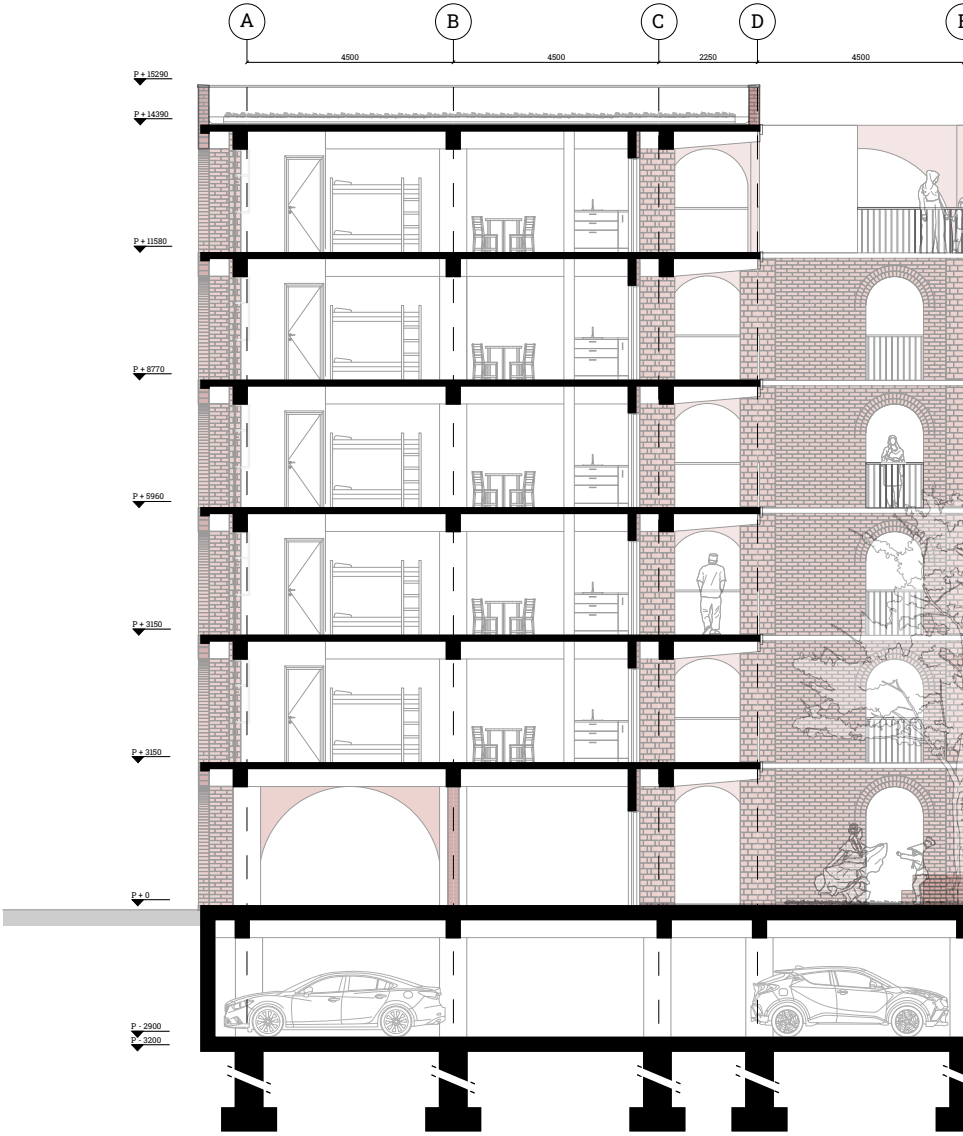
The entire structure is built using reinforced concrete, chosen for its strength, durability, and fire resistance. Most columns are spaced at 4,500 mm, allowing for open floor plans and greater design flexibility. In specific areas, the spacing is reduced to 2,250 mm. This specific structure is used fot the low-income clusters.



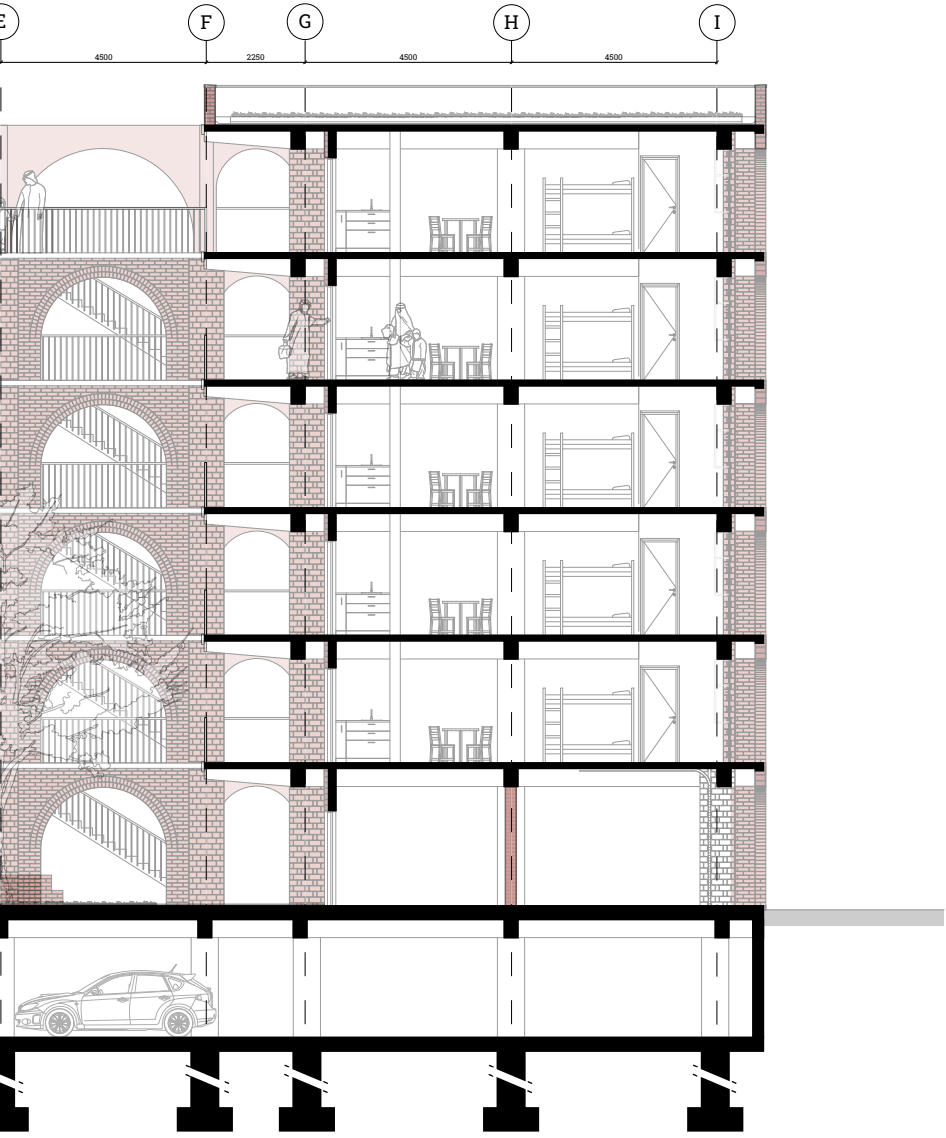
Mid- and High-income cluster

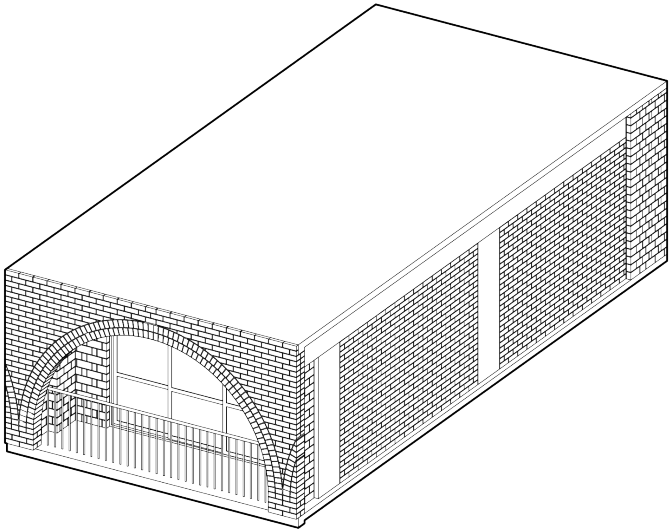
The structural system is designed for the mid- and high-income clusters. To ensure adequate natural ventilation within the residential units, ventilation atriums were incorporated into the design. This requirement led to modifications of the standard concrete structure, allowing air to circulate more effectively through the building.

06 Principle structure - Section

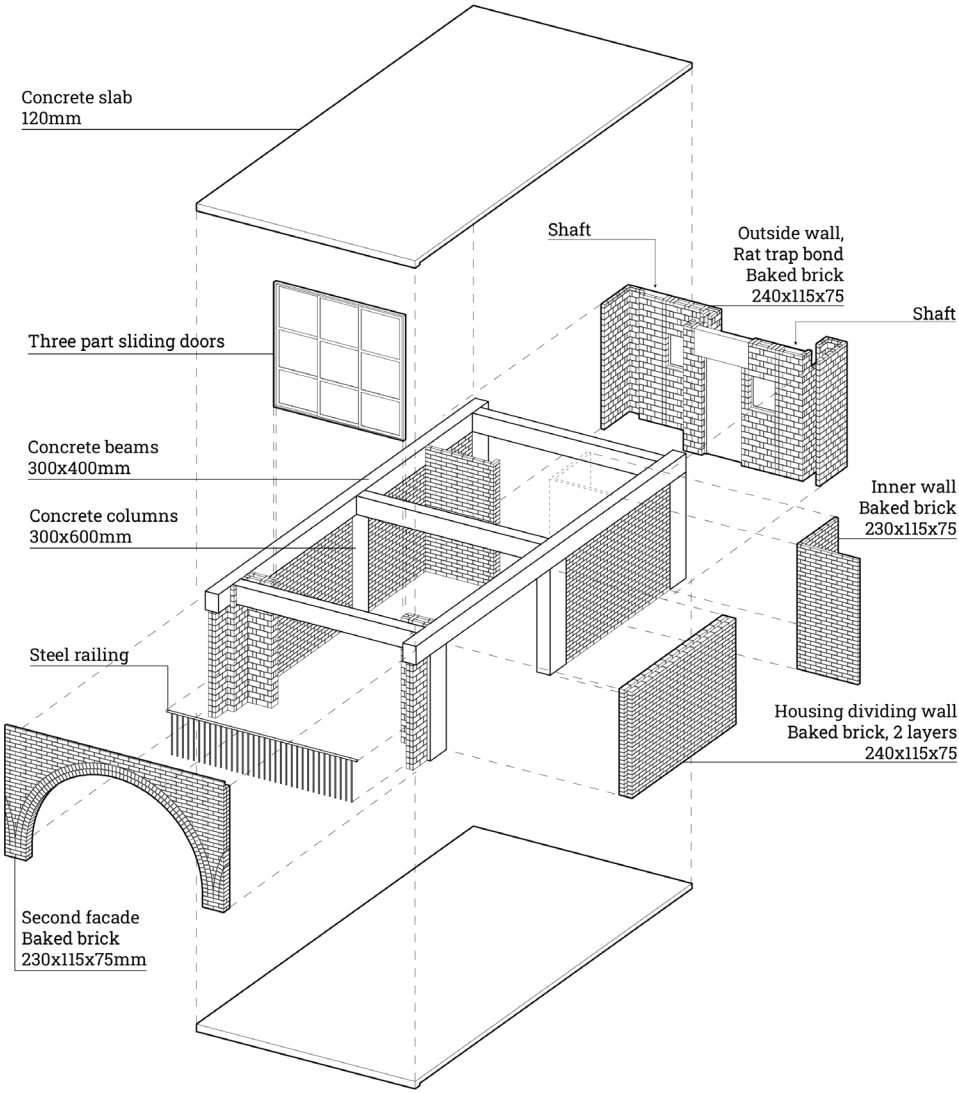


All structural elements are marked in black in this section.
The underground parking garage has thicker structural walls and floors to withstand ground pressure. On the ground floor, the columns are taller than those in the rest of the clusters due to the presence of public spaces.


F
G
H
I
4500
2250
4500
4500



Low-income unit


Concrete slab
120mm
Shaft
Outside wall,
Rat trap bond
Baked brick
240x115x75
Shaft
Three part sliding doors
Concrete beams
300x400mm
Concrete columns
300x600mm
Inner wall
Baked brick
230x115x75
Steel railing
Housing dividing wall
Baked brick, 2 layers
240x115x75
Second facade
Baked brick
230x115x75mm

06 Construction process

The construction sequence shown in the image follows a logical and efficient vertical building process, especially suited for low- to mid-rise masonry and concrete structures.

1. Excavation & Concrete Foundation
Work begins with site excavation and laying the foundation, ensuring a stable base for the entire structure.

2. Concrete Structure for One Floor
The load-bearing concrete frame for the first floor is built next, establishing the structural skeleton.

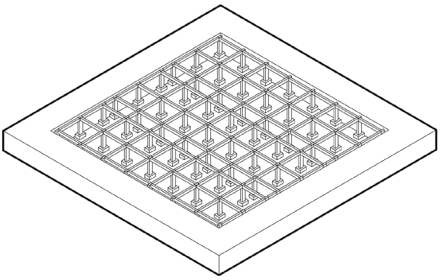
3. Repeated on each Floor
This process is repeated floor by floor, allowing for controlled vertical progress and consistent quality.

4. Inner and Outer Brick Walls
Once the frame is in place, the interior and exterior brick walls are added, enclosing the space and defining rooms.

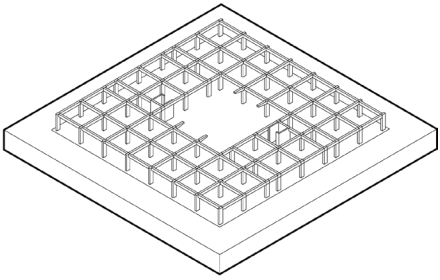
5. Second Brick Facade
A secondary brick façade is then installed, providing both insulation and architectural character.

6. Windows, Doors, and Railings
Finally, the building is completed with the placement of windows, doors, and railings, finalizing the envelope and ensuring safety and functionality.

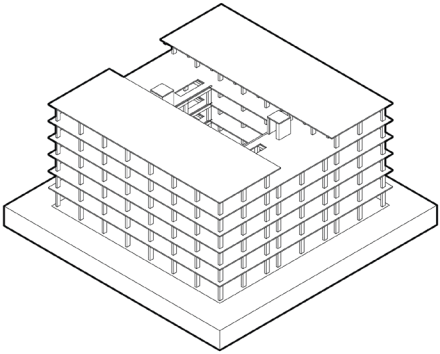
This step-by-step method ensures structural integrity, ease of construction, and logical coordination of materials and labor. It's a widely used and reliable approach for efficient, phased building progress.



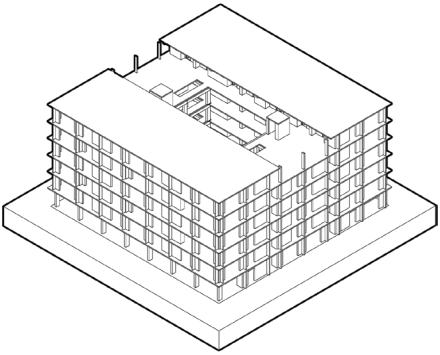
1. Excavation & Concrete foundation



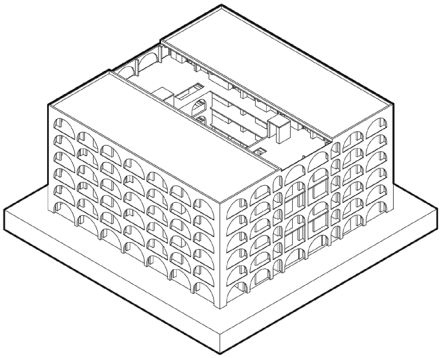
2. Concrete structure one floor



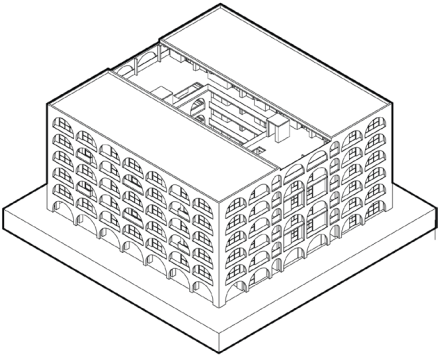
3. Repeated on each floor



4. Inner and outer brick walls placement

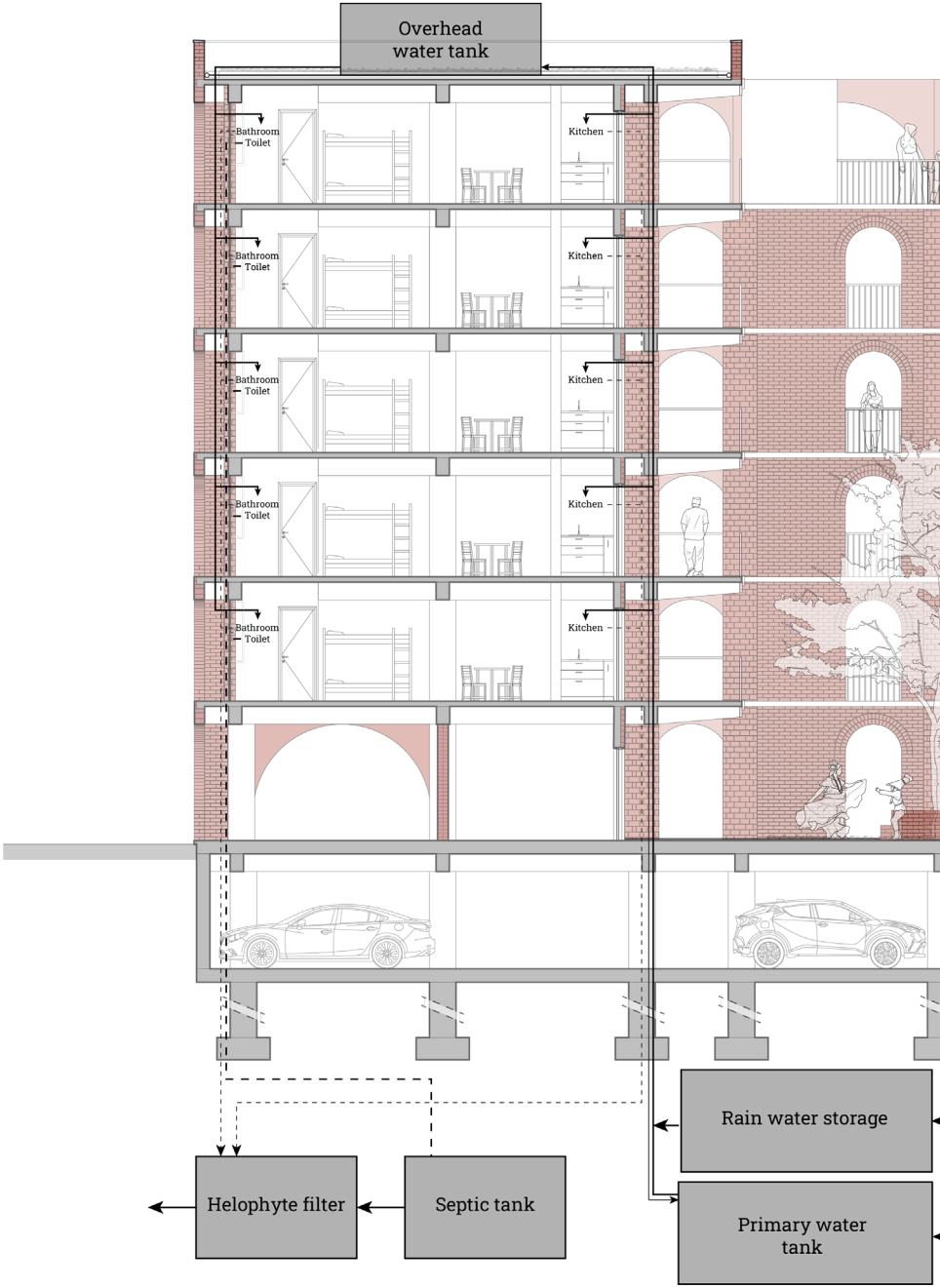


5. Second brick facade placement



6. Windows, doors and railings placement

06 Environmental Strategy - Water Conservation




Rain water treatment
Emergency water tank

06 Environmental Strategy - Water Conservation

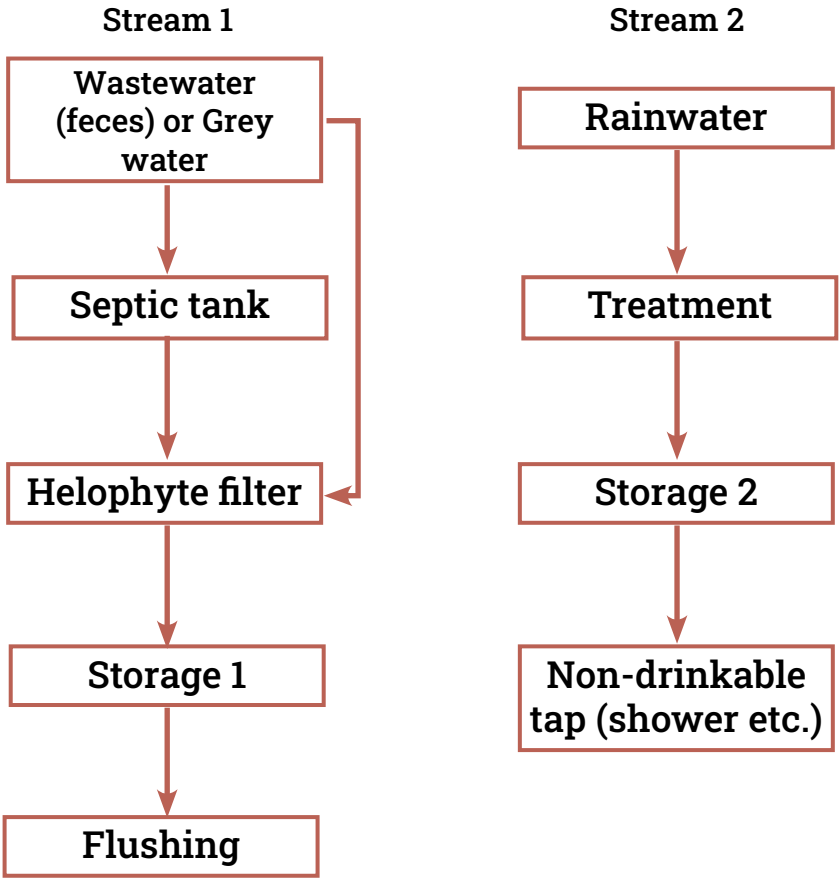
The project incorporates a dual-stream water conservation system designed to reduce freshwater demand and support sustainable water management, particularly suited to the climatic and environmental context of Sylhet, Bangladesh.

Stream 1 begins with the collection of wastewater and greywater from the building. Blackwater (from toilets) is first directed to a septic tank for primary treatment. From there, it flows into a helophyte filter, a natural, plant-based system that further purifies the water through biological processes. Greywater (from sinks, basins, etc.) is sent directly to the helophyte filter, bypassing the septic tank. After filtration, the treated water is stored in storage tank 1, where it is reused for toilet flushing. This significantly reduces the consumption of fresh water for sanitary use.

Stream 2 captures rainwater from rooftops. The water is first filtered and treated to remove debris and contaminants, and then stored in storage tank 2. This clean, non-potable water is reused for household purposes such as showering, washing, and other domestic uses that do not require drinking-quality water.

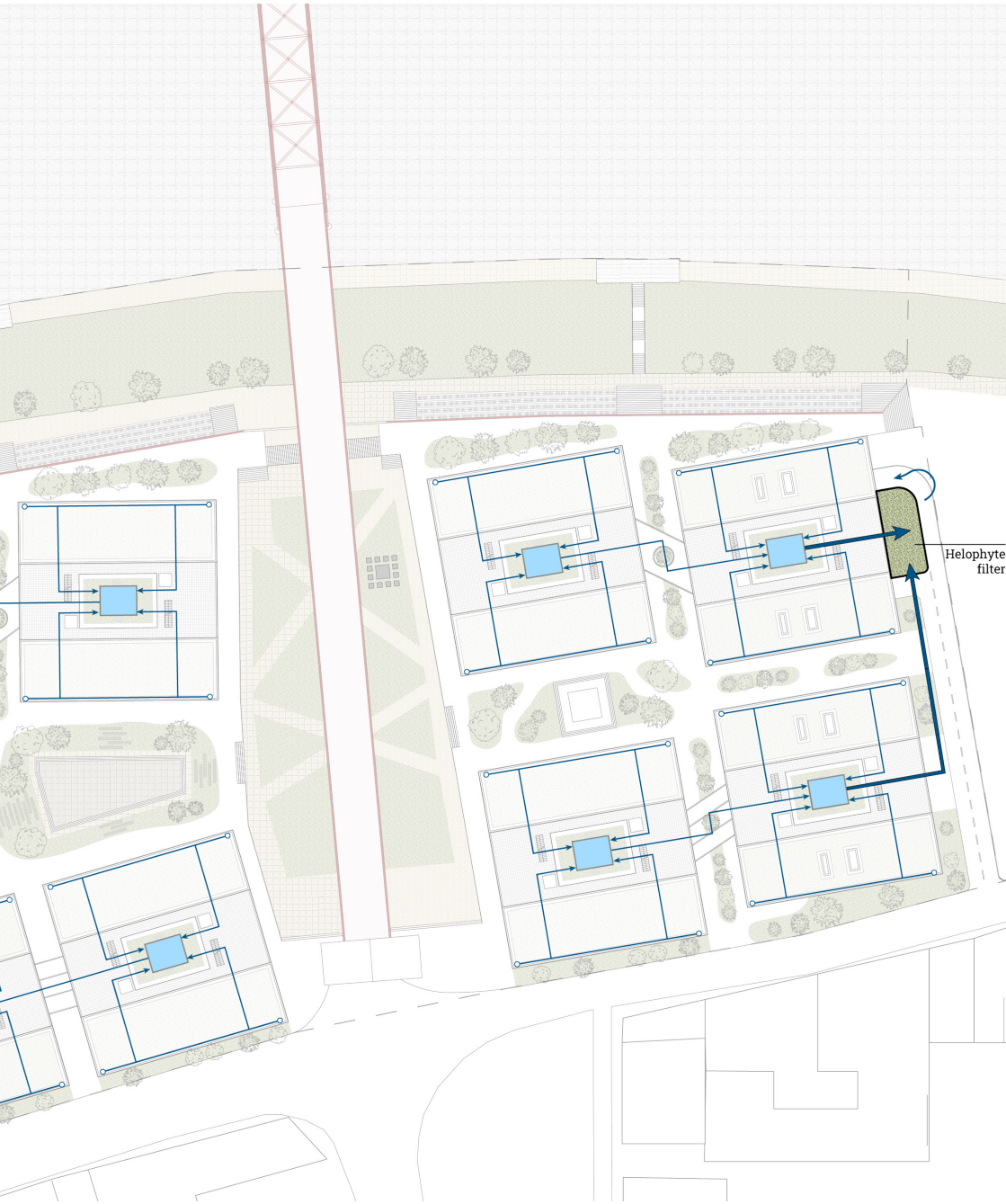
The use of a helophyte filter is especially effective in Sylhet, where the high rainfall and humid subtropical climate support the year-round growth of aquatic plants used in the system. These filters are low-tech, low-maintenance, and environmentally friendly, making them ideal for regions with limited infrastructure and high water tables like Sylhet.

These two separate water streams make the system both efficient and resilient. Stream 1 focuses on reuse of wastewater, reducing pollution and pressure on local sewage systems. Stream 2 harvests natural rainfall, lowering dependency on municipal water supply. Together, they contribute to a more sustainable, affordable, and climate-responsive water strategy.



Roof area of cluster:	650m2
Maximum rainfall per day:	303,6mm
Collection rate:	50-70%
Maximum collection capacity: 650 x 0,3 x 0,7 =	**136m3**
Number of residents (estimation):	370
Water consumption per person:	100L/day
Water consumption per cluster per day 370 x 100 = 37.000L =	**37m3**
Reusability	60-80%

06 Environmental Strategy - Water management


Helophyte
filter

06 Environmental Strategy - Water management

A helophyte filter is a natural water purification system that uses aquatic plants and a gravel-based substrate to clean wastewater through biological and physical processes. The system begins with an inlet pipe that delivers wastewater into a distribution zone filled with gravel. This zone ensures the even spreading of water across the filter bed. An impermeable liner beneath prevents leakage and keeps the treatment process contained.

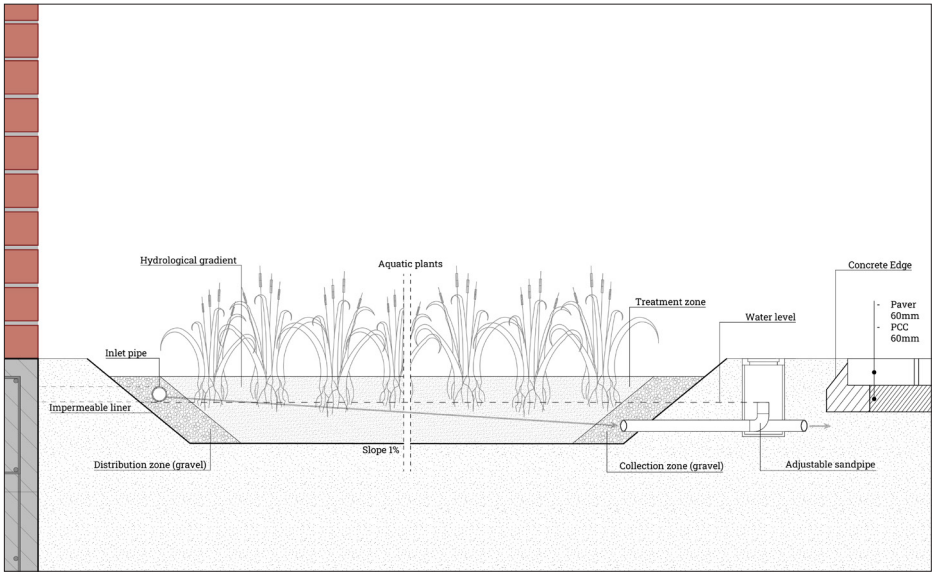
From there, the water flows gradually through the filter, following a slight slope of about 1%, which creates a hydrological gradient. The core of the system is the treatment zone, where aquatic plants are rooted. These plants play a crucial role in the purification process. Their roots provide oxygen to beneficial microorganisms that break down organic matter and absorb nutrients and pollutants from the water.

As the water passes through the treatment zone, it undergoes filtration and biodegradation. It then reaches the collection zone, which is also filled with gravel. This area gathers the treated water. An adjustable sandpipe is installed here to control the water level within the system and allows for maintenance or drainage when needed.

Finally, the treated water exits the system and will go to storage 1. The helophyte filter is an environmentally friendly solution for treating greywater or lightly polluted wastewater, using natural processes to improve water quality without chemicals or energy-intensive equipment.

The helophyte filter system is low-cost and low-maintenance because it relies on natural processes instead of complex mechanical treatment. This makes it affordable to build, inexpensive to operate, and easy for local residents to maintain without requiring technical expertise.

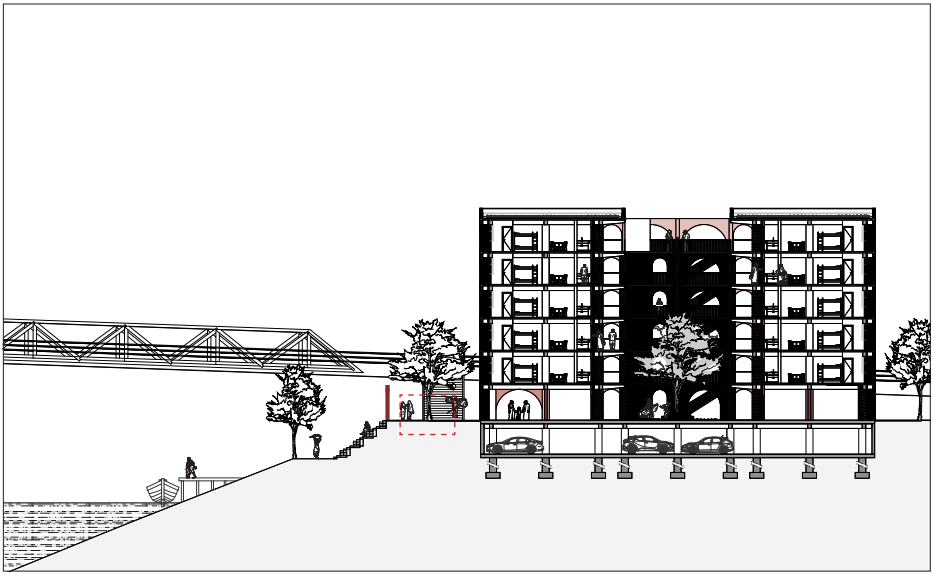
Watermanagement masterplan



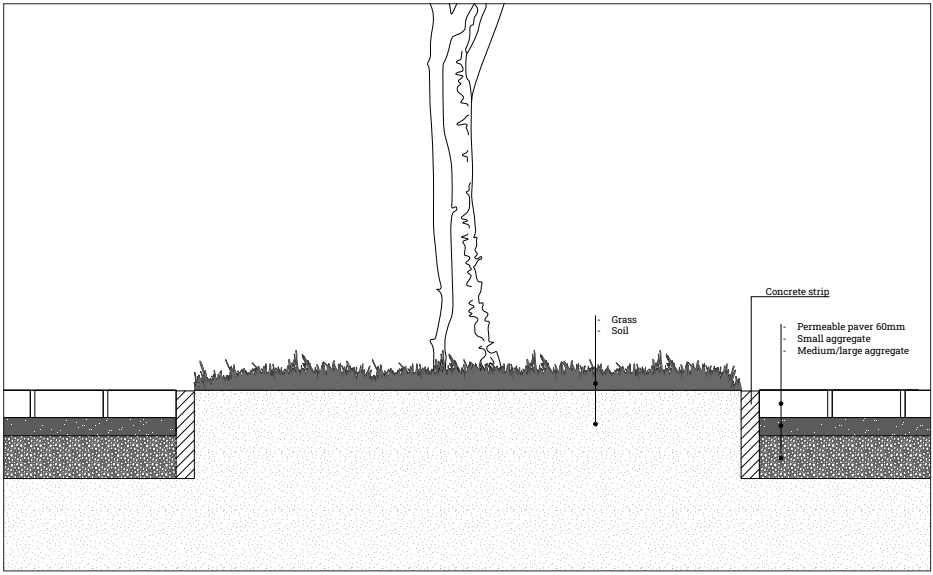
Detail Helophyte filter

06 Environmental Strategy - Greenery

A permeable paving system is designed to manage rainwater sustainably across the entire site. It consists of permeable pavers laid over layers of small and medium-to-large aggregate, allowing water to pass through the surface and gradually infiltrate into the ground. This system is applied site-wide, reducing surface runoff, preventing flooding, and supporting groundwater recharge, all while maintaining a functional and environmentally friendly landscape.

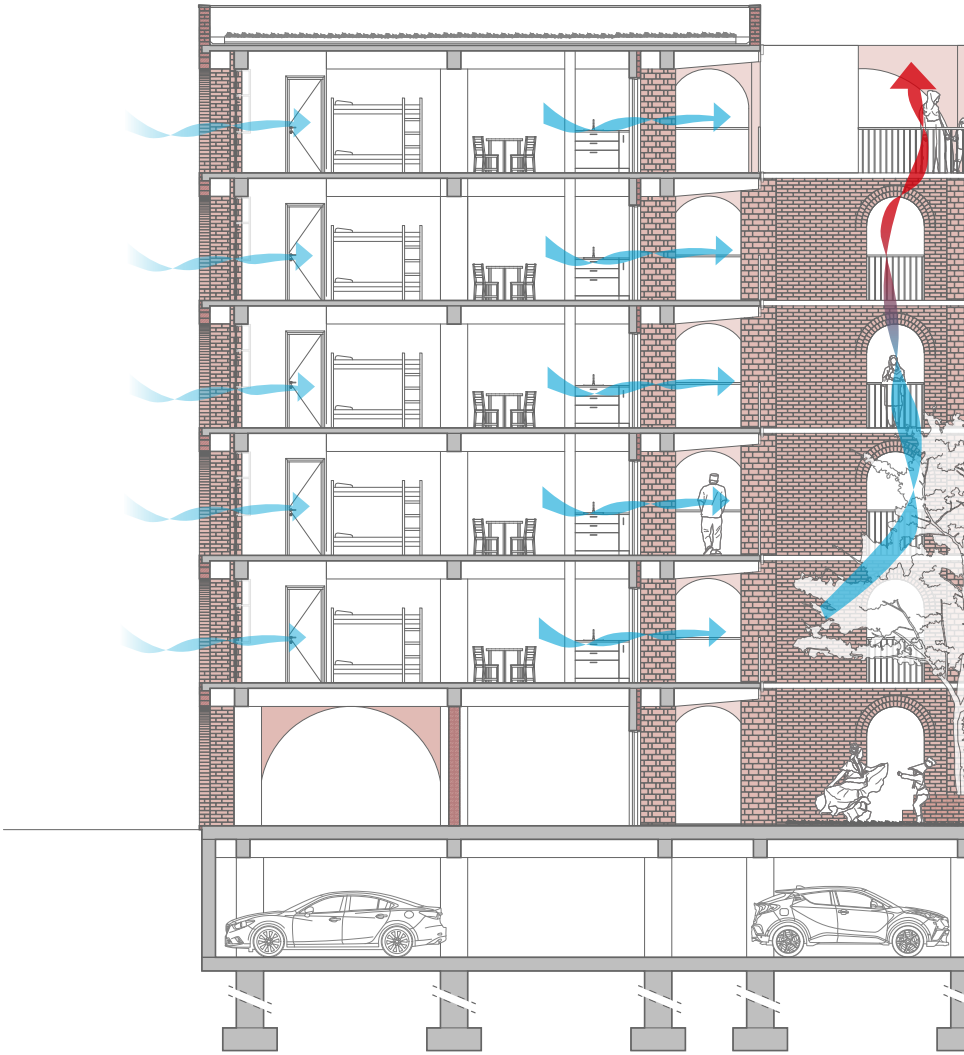


Section through site

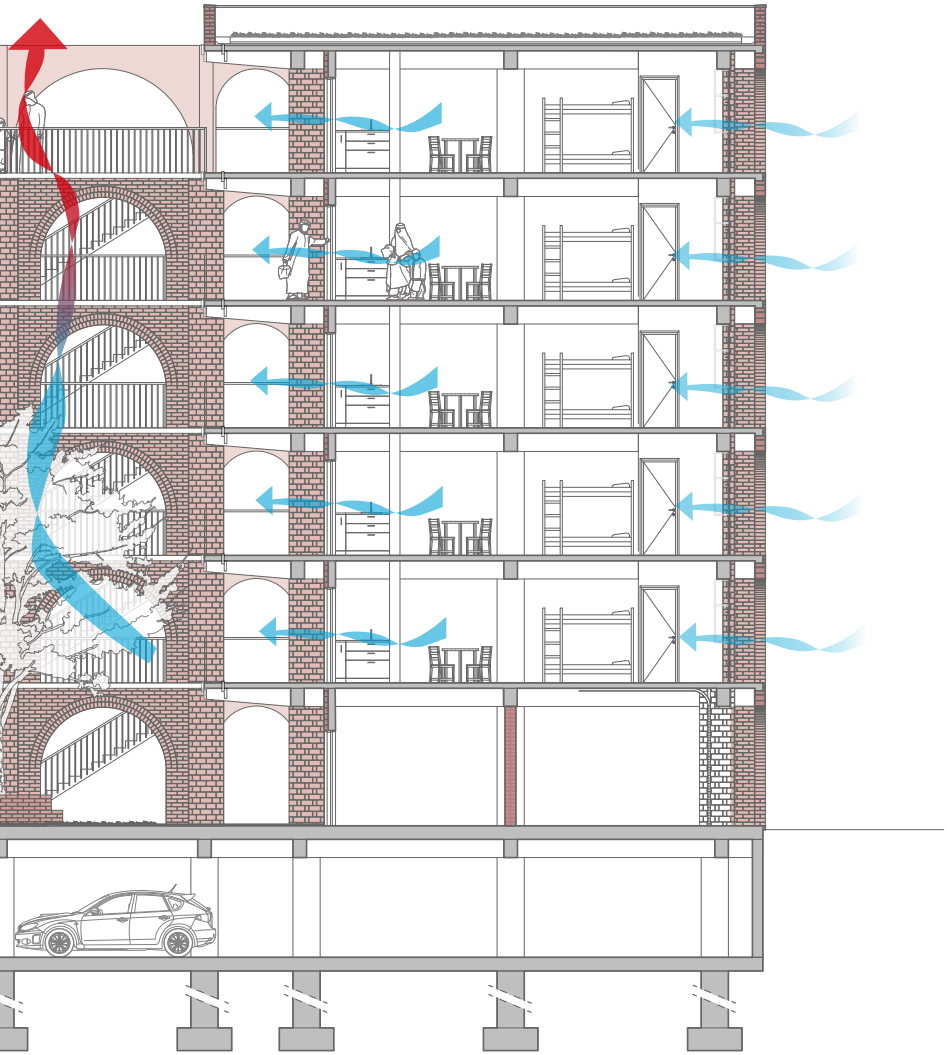


Detail Greenery

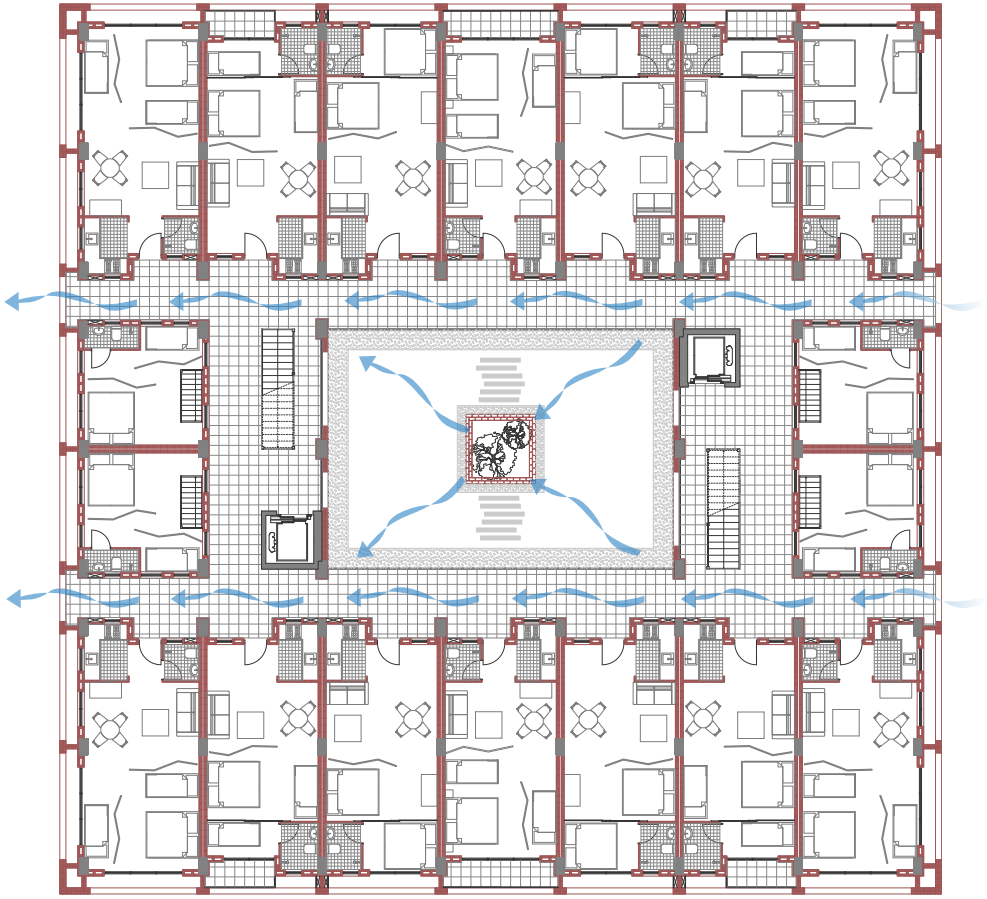
06 Environmental Strategy - Ventilation



Natural ventilation is clearly demonstrated in this section, with the central courtyard enabling stack ventilation. Stack ventilation uses the natural rise of warm air to cool buildings. As hot air escapes through high openings, cooler air is drawn in from below, creating a steady airflow. In this design, the central courtyard acts like a vertical chimney, allowing warm air to rise and exit, while fresh air flows in, keeping the space naturally cool and ventilated.

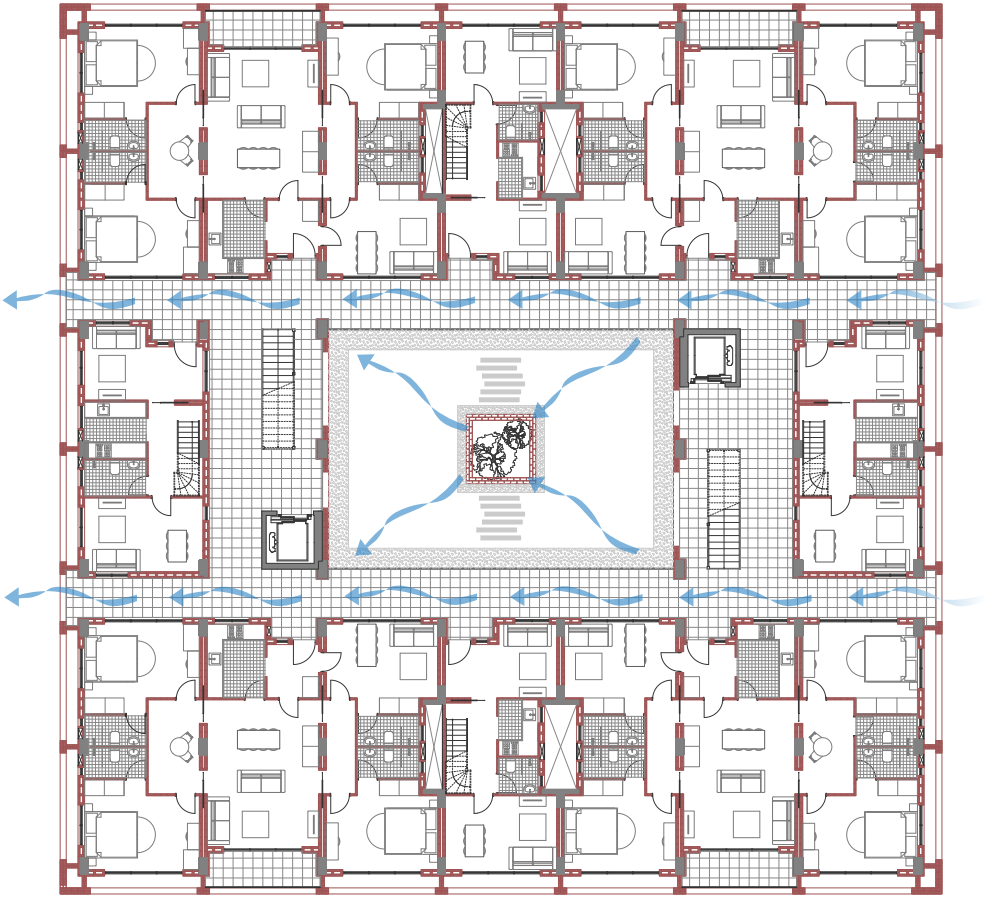


06 Environmental Strategy - Ventilation



Low-income cluster

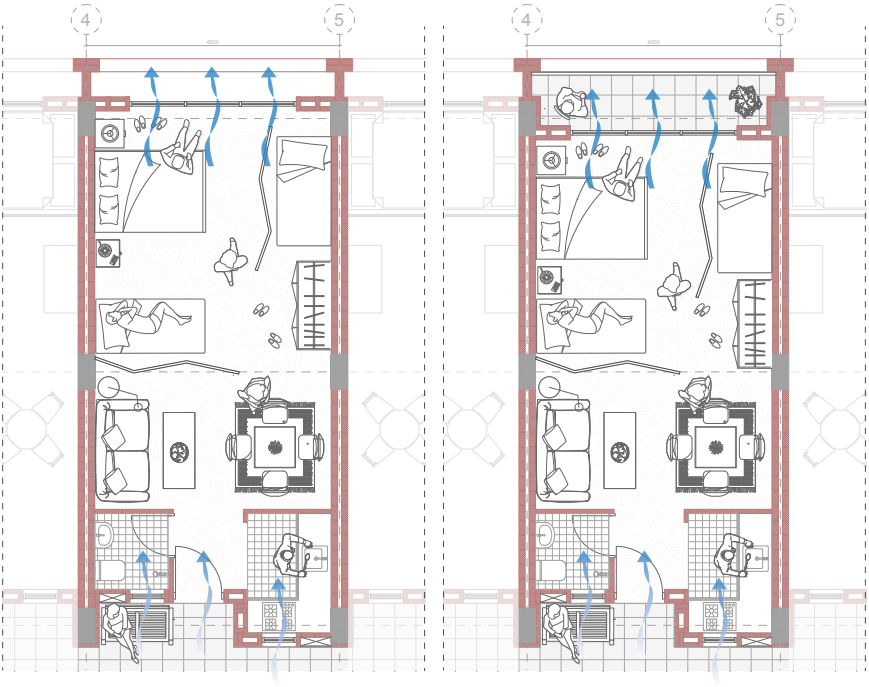
The building's design supports effective cross ventilation through the combination of an mostly east–west oriented gallery and a central courtyard. This layout allows air to enter from one side of the building and exit through the other, creating a natural flow of fresh air across the interior spaces. The central courtyard enhances this effect by acting as a ventilation core. Together, these elements create a comfortable environment.



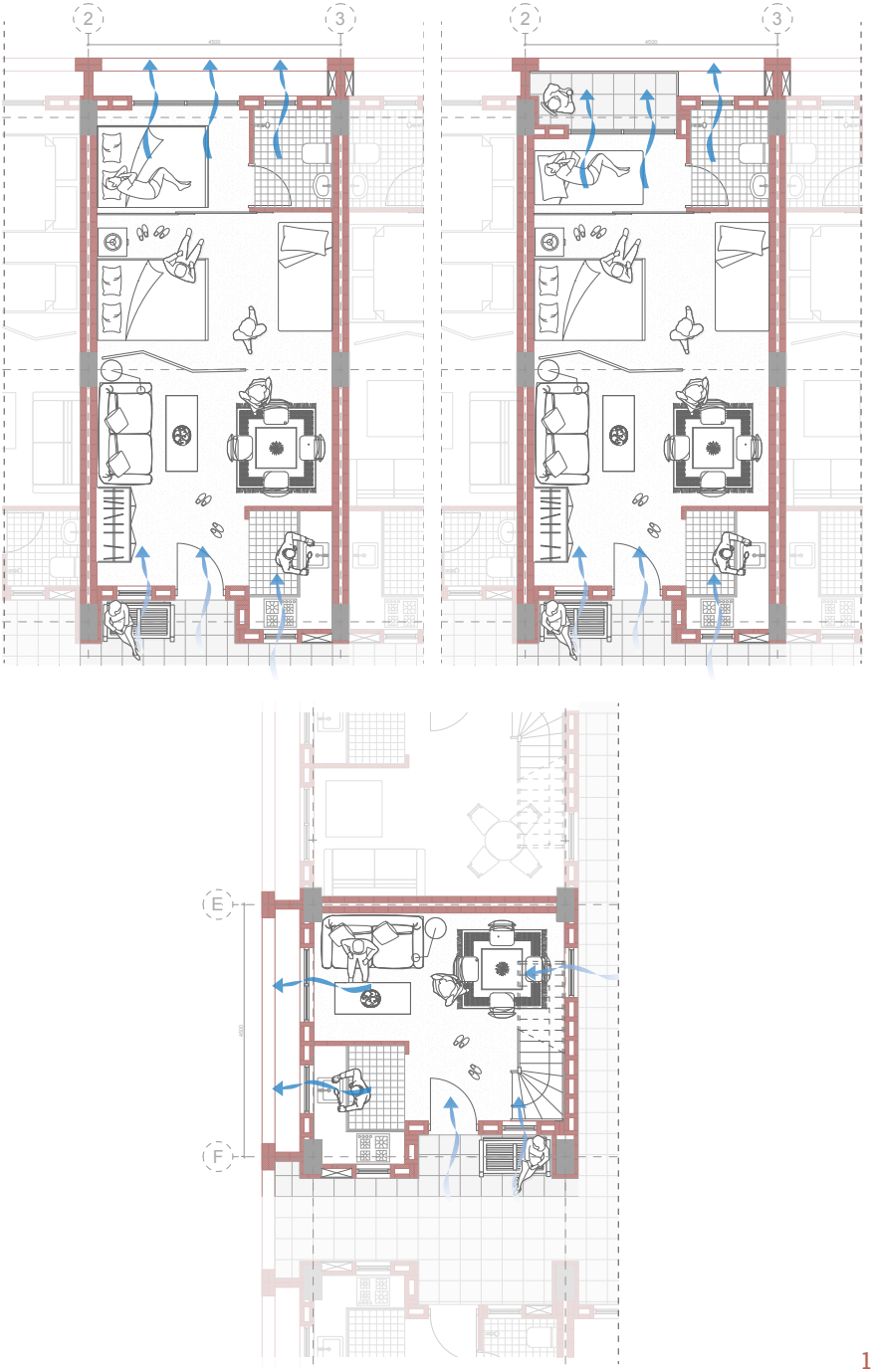
Mid- and High-income cluster

06 Environmental Strategy - Ventilation

Passive ventilation low-income

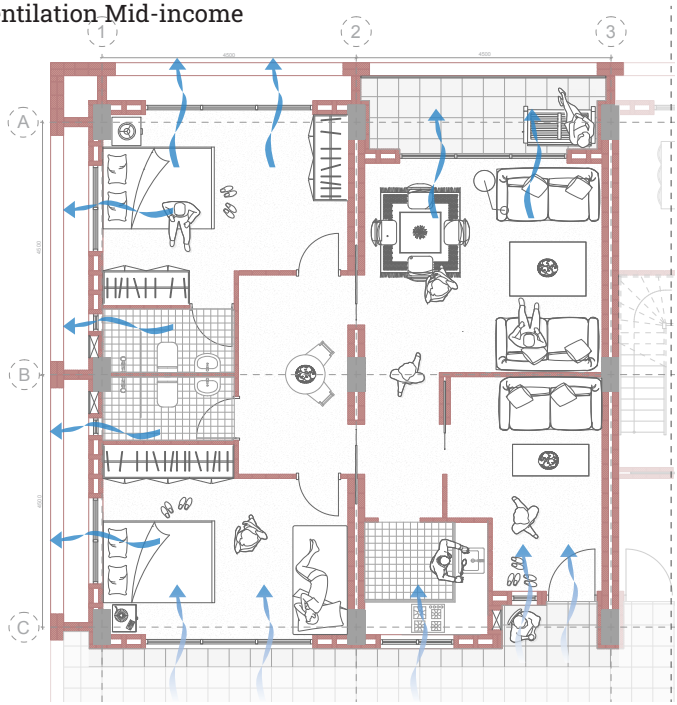


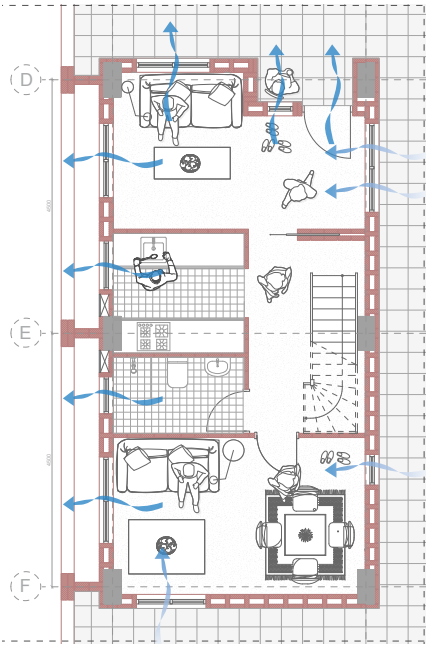
Passive ventilation low-income



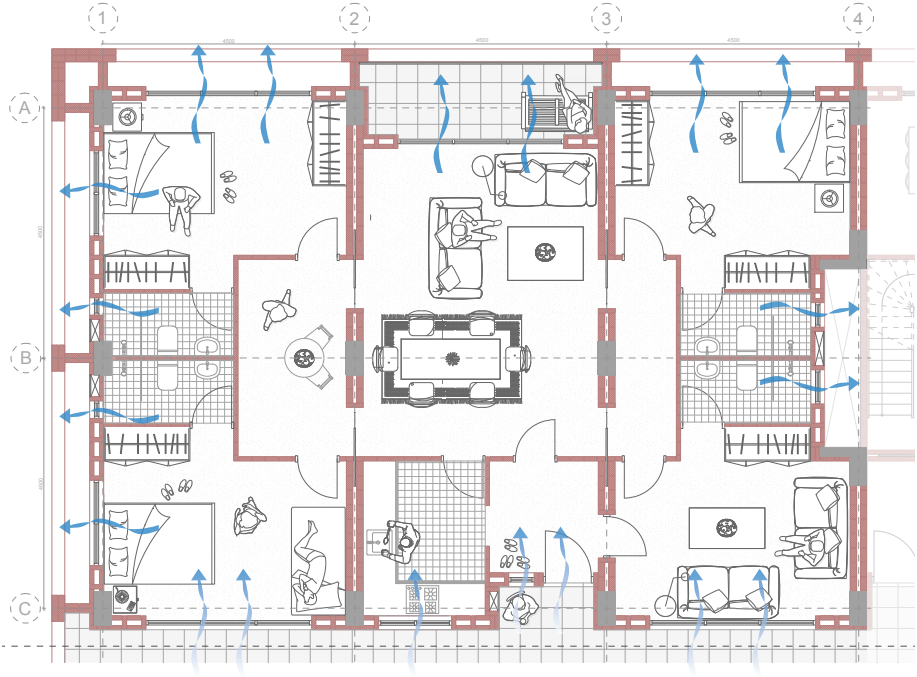
06 Environmental Strategy - Ventilation

Passive ventilation Mid-income

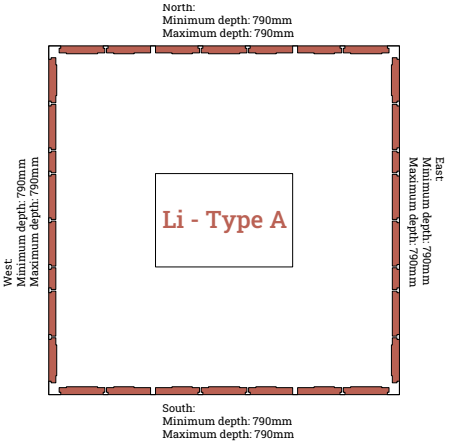


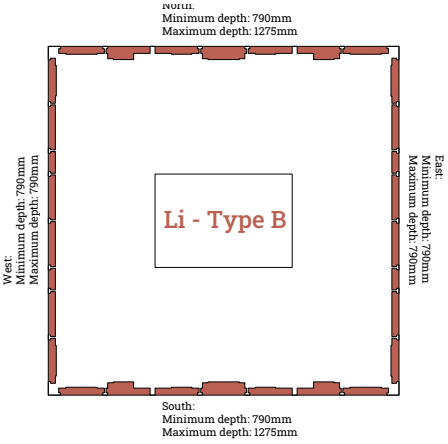


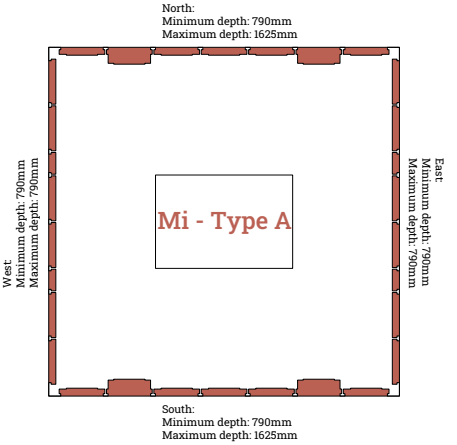
Passive ventilation High-income

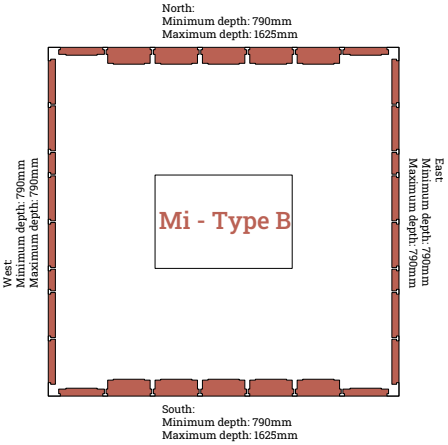


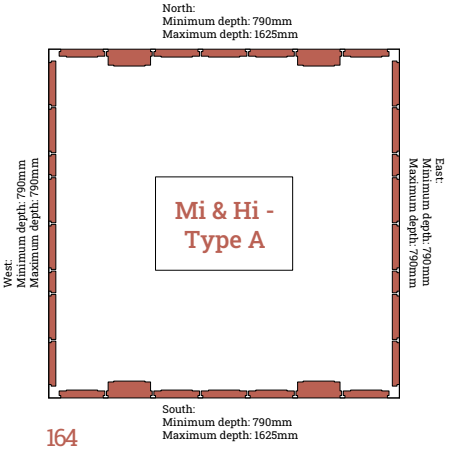
06 Environmental Strategy - Solar protection

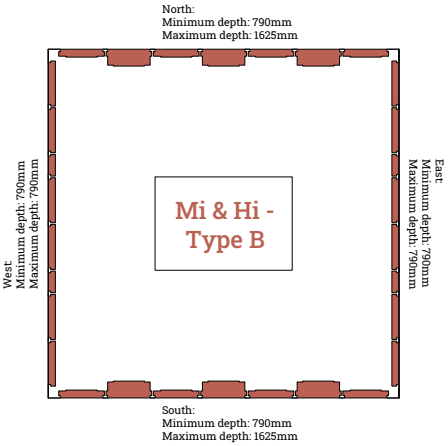








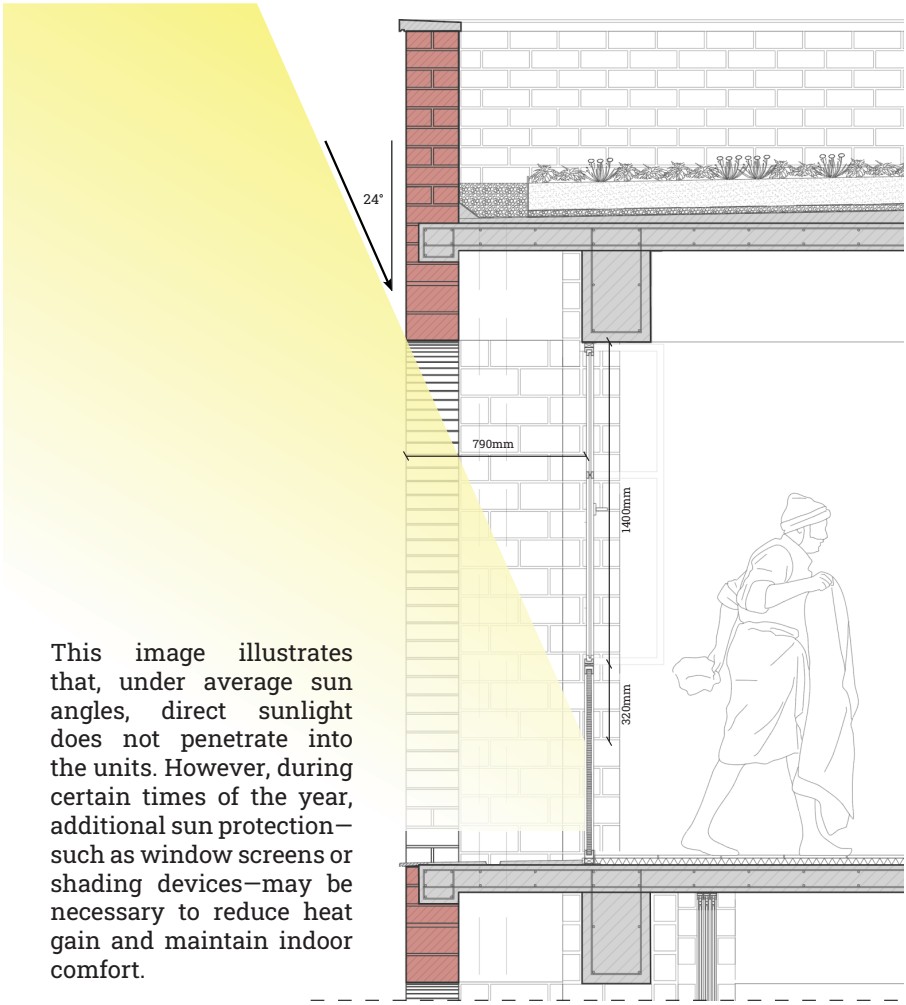




Extra shading needed

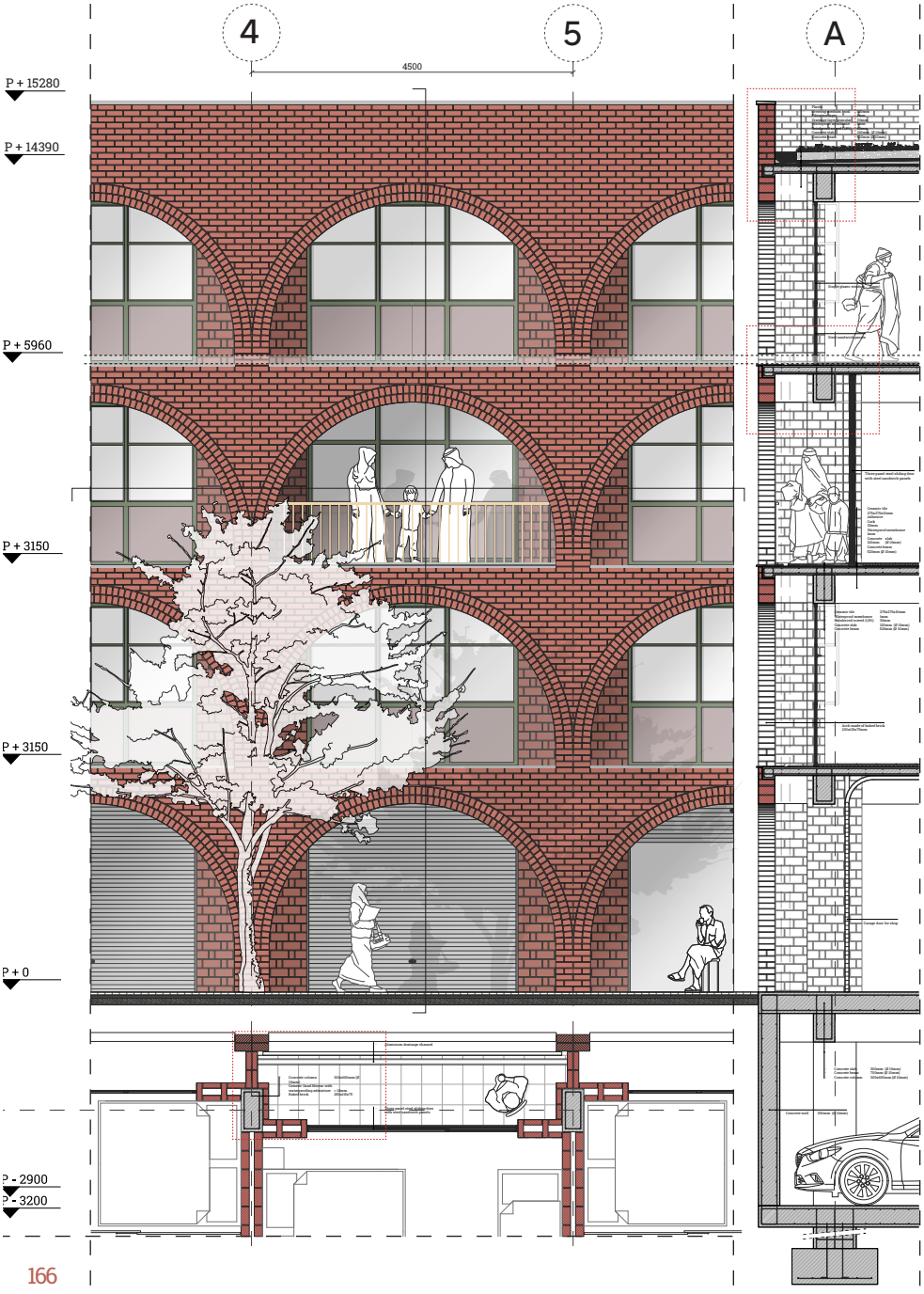
Depth: 790mm Minimum angle sun: 30°	South Sep-Feb	West May 13:00-18:00	East May 06:00-11:00
Depth: 1275mm Minimum angle sun: 43°	South Nov-Jan	West -	East -
Depth: 1625mm Minimum angle sun: 50°	South -	West -	East -

Average sun angle south



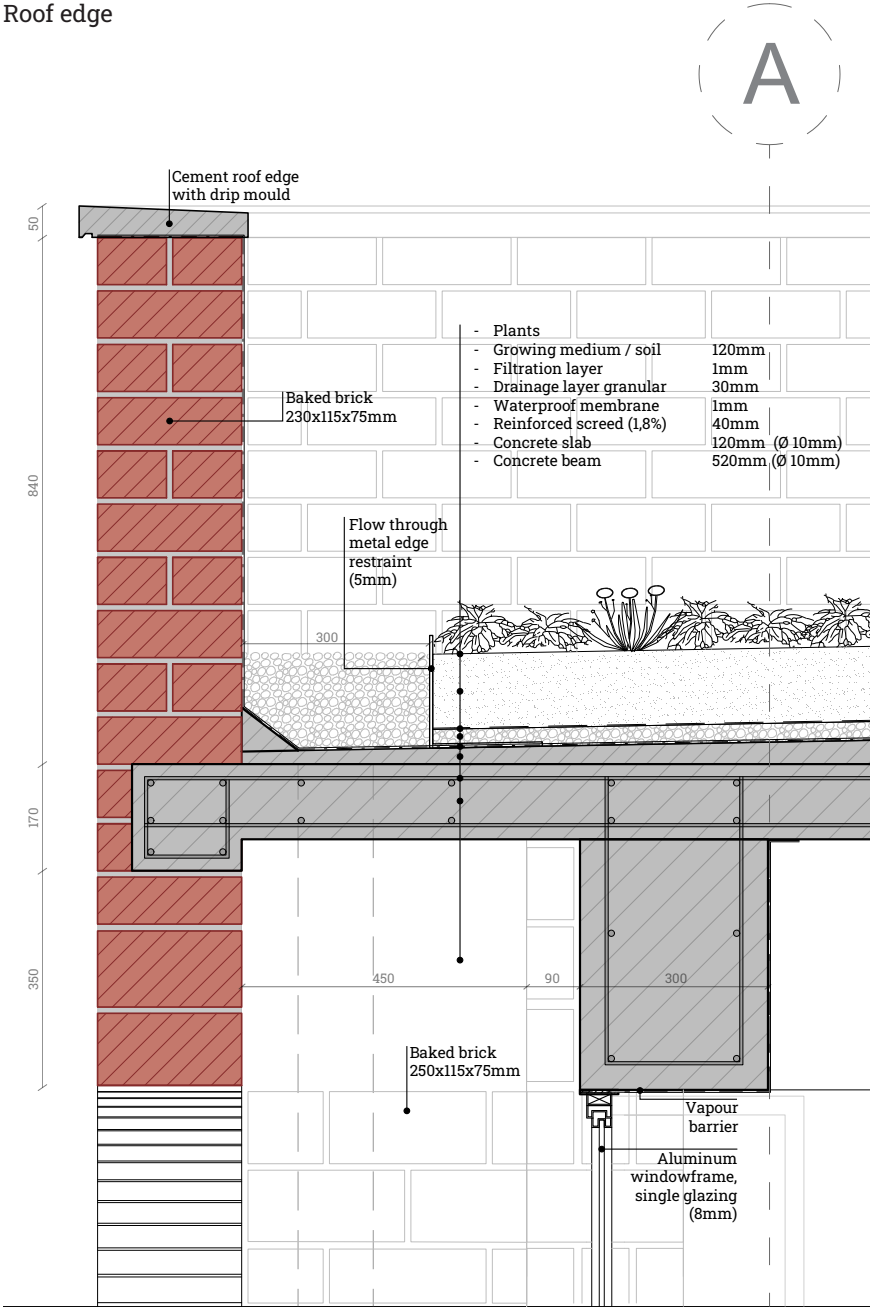
This image illustrates that, under average sun angles, direct sunlight does not penetrate into the units. However, during certain times of the year, additional sun protection—such as window screens or shading devices—may be necessary to reduce heat gain and maintain indoor comfort.

06 Fragment



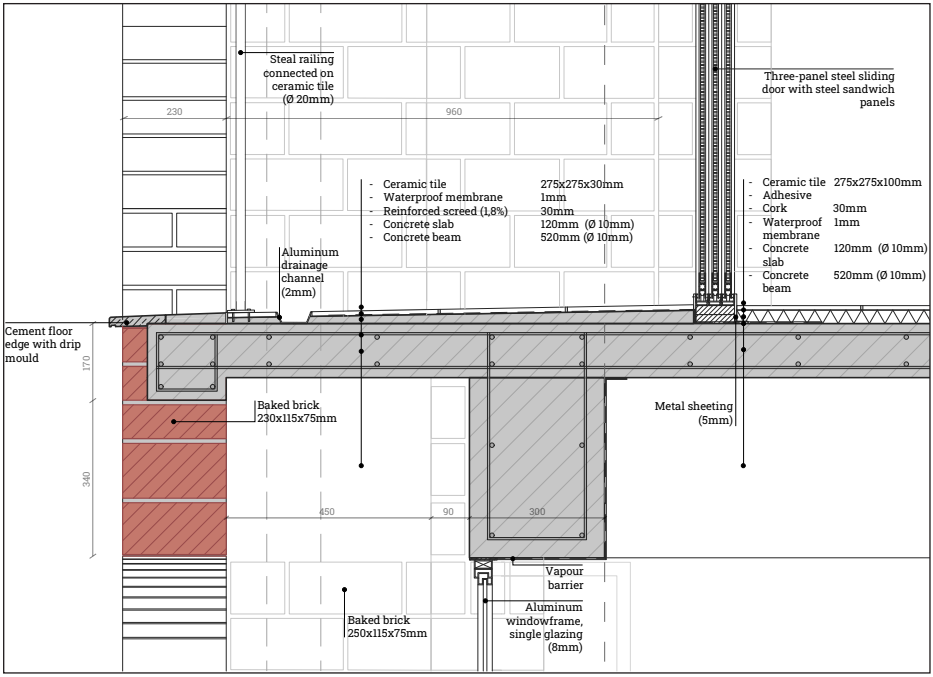
06 Fragment - Details

Roof edge



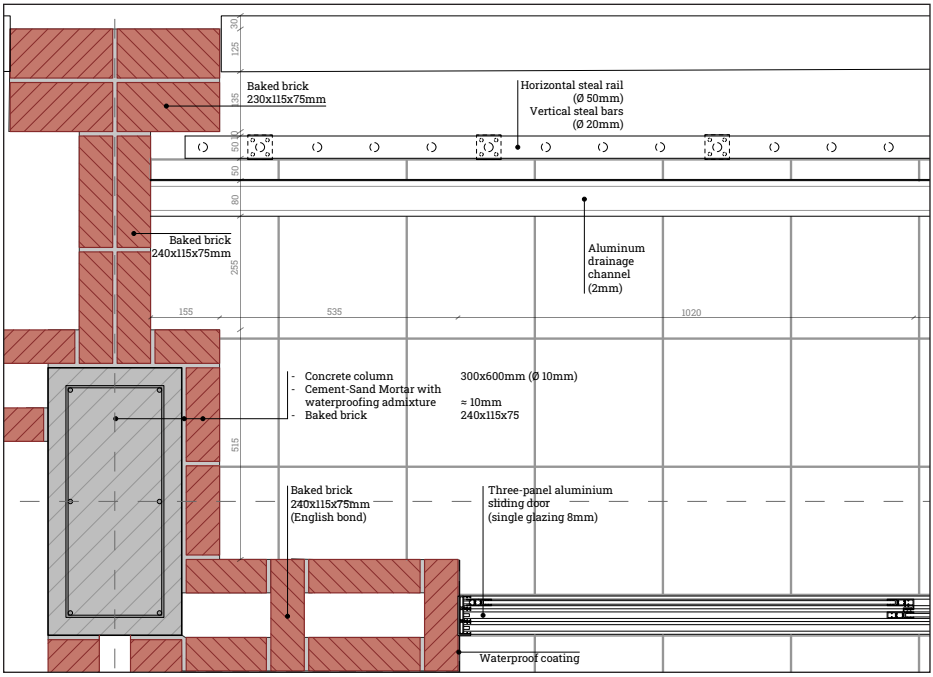
06 Fragment - Details

Floor edge



06 Fragment - Details

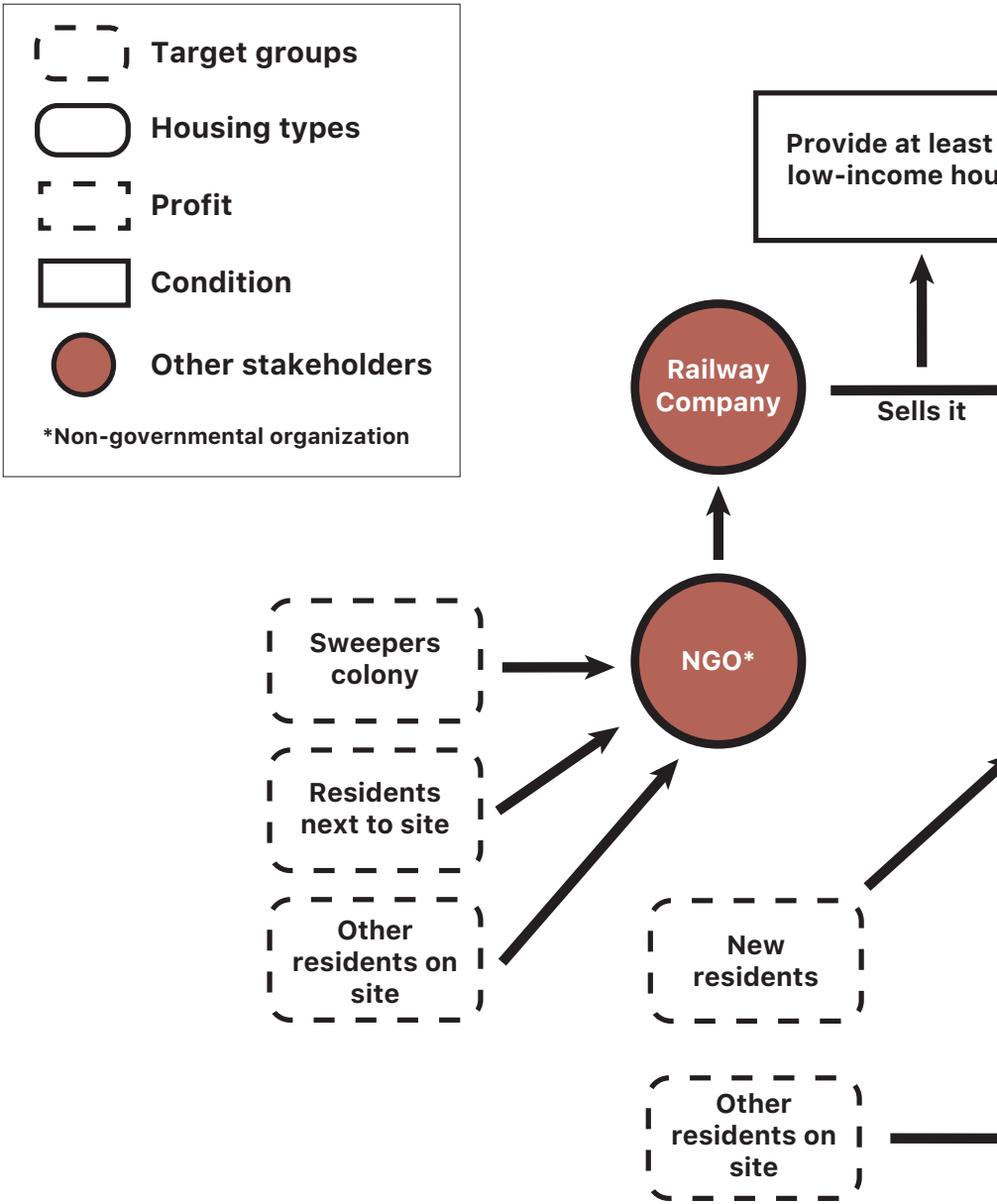
Horizontal

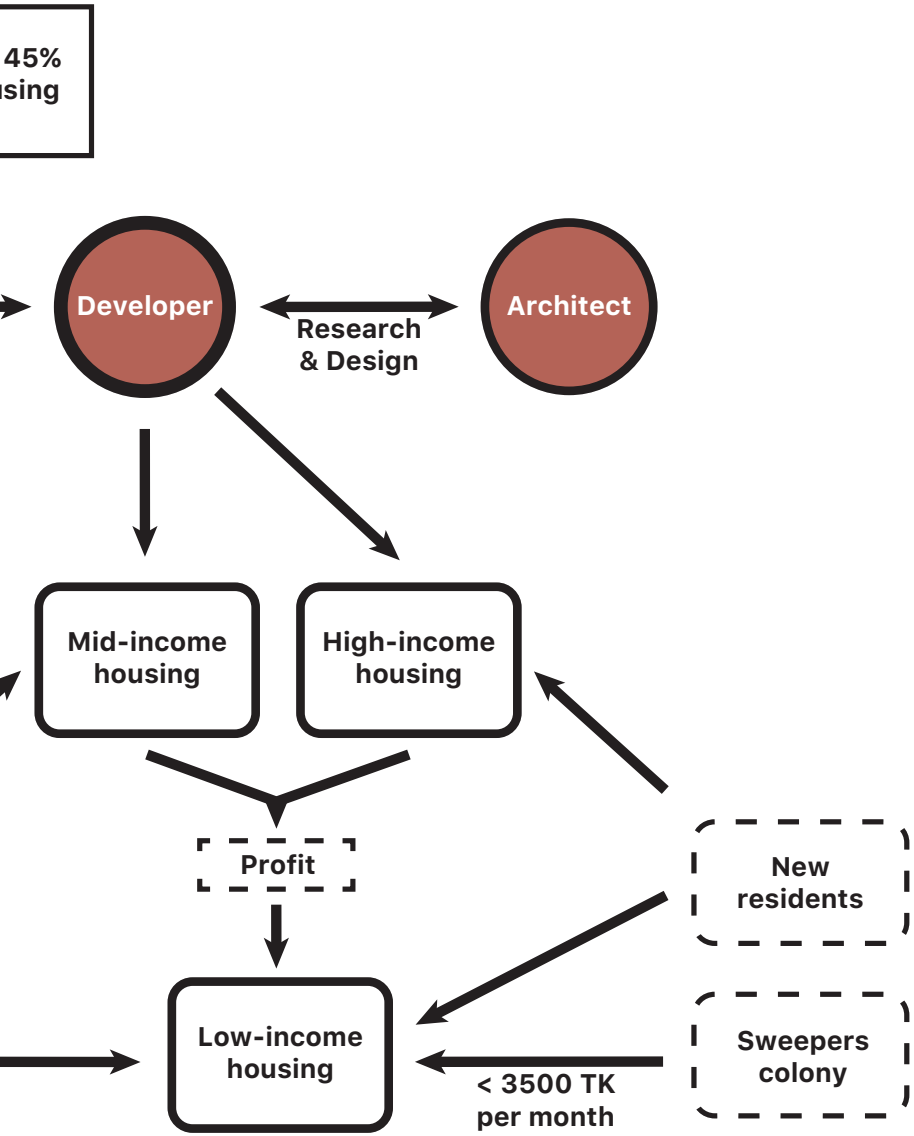


06

06 Managerial Strategy

- Financial model
- Phasing
- Abacus


Target groups
Housing types
Profit
Condition
Other stakeholders
*Non-governmental organization
Provide at least
low-income hou
Railway Company
Sells it
Sweepers colony
Residents next to site
Other residents on site
NGO*
New residents
Other residents on site


45%
sing
Developer
Research
& Design
Architect
Mid-income
housing
High-income
housing
Profit
New
residents
Low-income
housing
Sweepers
colony
< 3500 TK
per month

07 Financial model

Main funtion list

Low-income housing

	Unit	Area	Area loggia
	Type A	36,8 m2	-
	Type B	34,7 m2	4,1 m2
	Type C	36,8 m2	-
	Type D	35,6 m2	2,5 m2
	Type E	37,8 m2	-

Mid-income housing

	Unit	Area	Area loggia
	Type A	70 m2	5,5 m2
	Type B	71,5 m2	5,5 m2
	Type C	80,4 m2	-

High-income housing

	Unit	Area	Area loggia
	Type A	115,9 m2	5,5 m2

Shops	Area
	38 m2
	18,9 m2

Cafes / Restaurant	Area
	38 m2
	18,9 m2

Parking

Units
150
50
200
100
36

Total units
536

Total area (inside)
19.536 m2 (46,7%)

Estimated construction costs
965.850000 Tk

Units
104
90
38

Total units
232

Total area (inside)
16.770 m2 (40,1%)

Units
48

Estimated construction costs
1.381.380.000 Tk

Total units
48

Total area (inside)
5.562 m2 (13,2%)

Selling costs
2.762.760.000 Tk (ROI 100%)

Units
24
90

Total units
114

Total area
2613 m2

Units
26
14

Total units
40

Total area
1.253 m2

Parking spots
130 (46,4%)

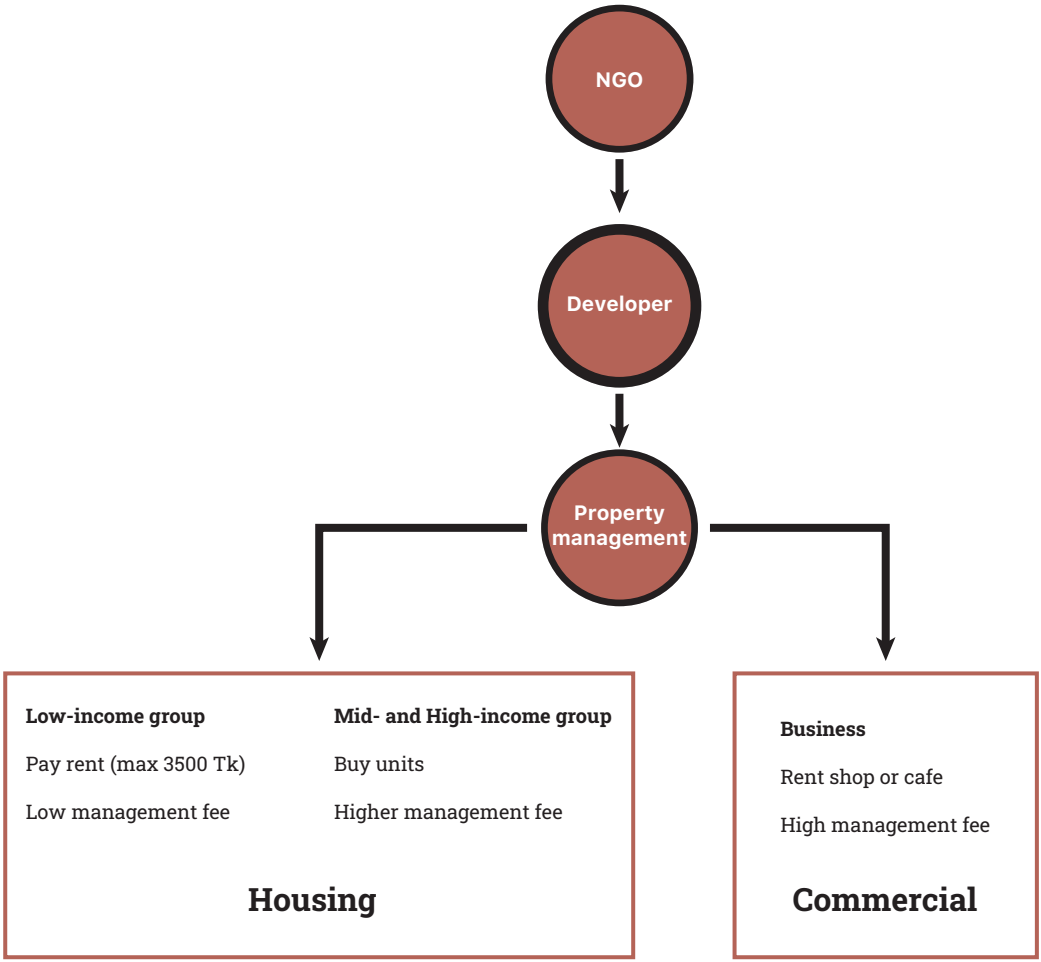
Total area
6447 m2

07 Abacus

	Previous situation	New Development
Area	3,41 ha	3,14
FSI	0,22	2,11
GSI	0,17	0,32
Unit / ha	17	239
Low income	60	536
Middle income	-	232
High income	-	48

07 Financial model - Maintenance

The maintenance system is designed to be financially sustainable and socially inclusive, involving a collaboration between the developer, an NGO, and a property management entity. The property management team oversees the upkeep of all housing units, shared spaces, and commercial areas. Low-income residents pay affordable rent, capped at 3,500 BDT, which includes a low management fee to ensure essential maintenance without financial strain. Mid- and high-income residents, who purchase their units, contribute through a higher management fee. Additionally, commercial tenants such as shops and cafés pay rent along with the highest management fees, generating extra revenue to support the overall maintenance of the site. This tiered model ensures that those with greater financial capacity help subsidize the costs, creating a balanced, well-maintained, and equitable living environment for all residents.


NGO
Developer
Property management
Low-income group
Pay rent (max 3500 Tk)
Low management fee
Mid- and High-income group
Buy units
Higher management fee
Housing
Business
Rent shop or cafe
High management fee
Commercial

07 Phasing

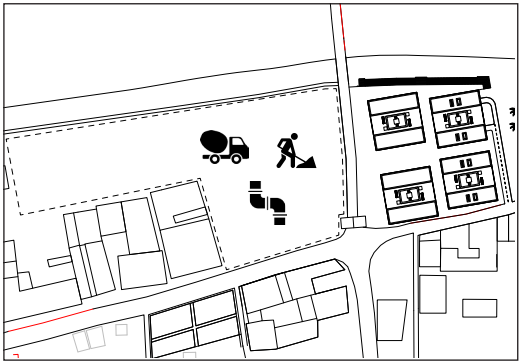
This phasing strategy ensures a smooth and inclusive redevelopment of the site while minimizing displacement, particularly for the vulnerable Sweeper community. The process begins with the demolition of the uninhabited sawmill area (Step 1), followed by excavation and the installation of essential infrastructure (Step 2). Once the groundwork is ready, new housing clusters are constructed in this cleared zone (Step 3), allowing the Sweeper community to relocate from their current informal settlement into the newly built units. With the Sweeper colony vacated, their former housing can be safely demolished (Step 4). The second half of the site then undergoes similar infrastructure preparation (Step 5), after which the remaining housing clusters are built (Step 6), completing the residential redevelopment. Finally,, the landscaping and public spaces of the masterplan are completed (Step 7), enhancing the overall livability and environmental quality of the site. This phased approach prioritizes the needs of the most vulnerable while ensuring continuous housing access and a smooth transition to a resilient and inclusive urban community.

1. Demolition (Sawmill area)

2. Excavation and infrastructure installation

3. Clusters construction, Sweepers colony can move in

4. Demolition (Sweepers Colony)



5. Excavation and infrastructure installation

6. Clusters construction, people can move in

07 Phasing - 7. Landscaping

This project began with the belief that architecture should serve those who are most often overlooked. The sweepers community in Sylhet, living at the margins of the city yet performing essential work, exemplifies a population caught between structural neglect and environmental vulnerability. Designing for this community meant navigating complex terrain, social, cultural, and physical, and continuously asking how architecture can respond with care, resilience, and equity.

The outcome presents a housing model that is affordable, climate-resilient, and allows residents to remain on-site throughout the development process. In doing so, the design directly responds to the research question: *How can housing models be designed to enhance climate resilience and affordability for slum residents in Sylhet, Bangladesh, without requiring relocation?*

What started as a motivation rooted in empathy evolved into a layered exploration of climate-adaptive design, cultural sensitivity, and spatial justice. The limited opportunity for direct engagement with residents posed challenges, but even the brief interactions during the site visit offered powerful insight into the values, routines, and struggles of daily life. These shaped the project in ways no amount of theory alone could.

Throughout the process, I wrestled with the tension between top-down requirements and bottom-up needs. The scale of the site demanded efficient, structured interventions, while the realities on the ground called for flexible, human-centered design. Reconciling these pushed me to grow, not only in architectural skill, but in humility and reflection. I learned that even when participation is constrained, respect for lived experience can still guide thoughtful and grounded outcomes.

This thesis has been more than a design project; it has been a learning journey, about responsibility, context, and the power of space to affirm dignity. As I look toward the future, I carry with me the lessons of Sylhet: that architecture can be a quiet advocate, a protector against rising waters, and a scaffold for community life.

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