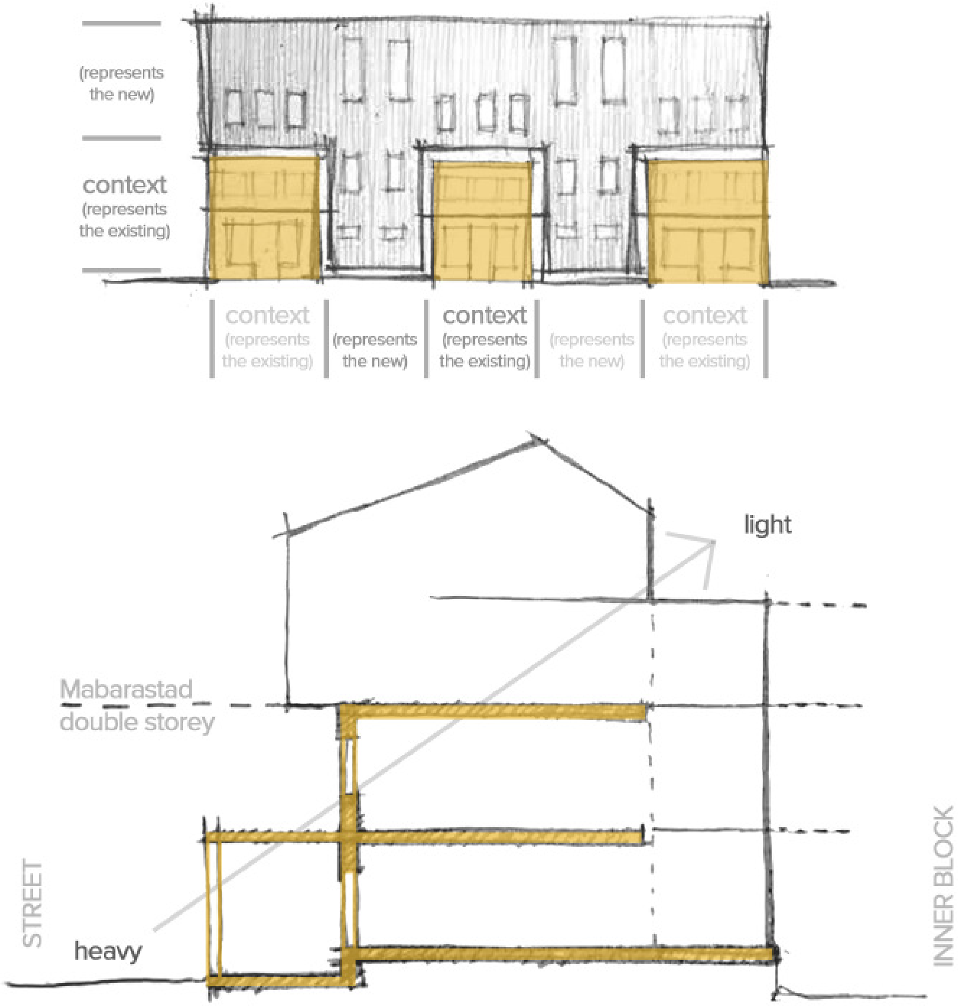
CHAPTER 09

TECHNICAL DEVELOPMENT

Architecture starts when you carefully put two bricks together. There it begins.

- Ludwig Mies van der Rohe -



MARABASTAD	THE USER
existing	additions
fixed	adaptable/flexible
heritage	dynamic
support	*infill*
representing old	representing new
heavy	light
concrete and brick	steel and fabric
historic	contemporary

Figure 9.1 *Technical concept (Author).*

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INTRODUCTION

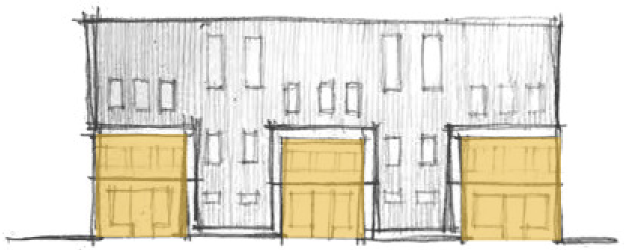
The project acknowledges the existing structures on site. However, the structures that do not have heritage value, are not used efficiently and negatively impact on the environment are demolished. The project is an overall redesign of the city block with identified heritage structure. The new design is driven by the understanding of the context. The design is divided into elements that represent the context/existing (old) conditions and elements that represent the addition/extensions (new), as mentioned in the Chapter 8.

TECHNICAL CONCEPT

The fine grain and scale of Marabastad are the main drivers of the technical concept. The design concept of the fixed and the flexible is further explored and expressed in the technical development.

The identified scale of Marabastad is one- or two-storey buildings with a one-plot-one-house building typology. The urban infill project strives to densify the site and therefore proposes three- to four-storey buildings. This urban infill project consists of elements that represent the existing conditions (fixed) and elements that represent the new conditions/additions (flexible). The elevational composition and primary materials identified in Marabastad will be used to express the existing scale and fine grain in the design. That representing the new, will make use of contextual materials, but will explore contemporary ways of using these materials. For example, corrugated sheeting, which was originally used as a roof material in Marabastad, will be used as a wall material.

Figure 9.2 Sketch highlighting that representing the existing (Author).



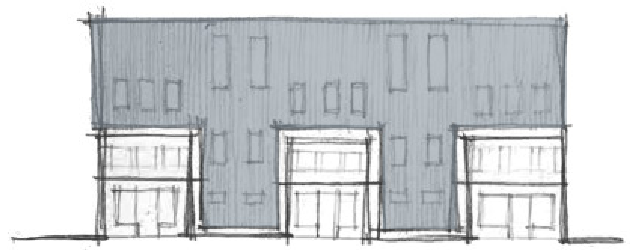
EXPRESSING THE CONTEXT/EXISTING

In Chapter 7, Marabastad's DNA was analysed and summarised. This guided the design process, the choice of material and elevational composition. The most common material used in Marabastad is exposed brick. The masonry construction that gives a sense of permanence is commonly known to create a solid and heavy impression.

The one-house-one-plot typology is another significant characteristic of Marabastad and expresses the fine grain of the area. The identified scale of Marabastad is only two storeys. Therefore, the use of brick on the elevation is limited to the first two floors and continues along the street at intervals to represent the fine grain of Marabastad.

Figure 9.3 Materials used to representing the existing (Author).

Figure 9.4 Sketch highlighting that representing the new (Author).



EXPRESSING THE ADDITION/EXTENSION

The additions/extensions are expressed by Kliplock vertical cladding; a material resembling the Inverted Box Rib (IBR) sheeting that is used throughout Marabastad. This then represents adaptability and flexibility. As stated in Chapter 7, this material relates to the corrugated sheeting used to construct the shack-like structure in the inner part of the block.

This material is used in the gaps between that representing the context/existing (old) conditions and the upper floors of the building. Thus, this material is used to express the things that are not part of Marabastad's DNA. The visual composition of these parts of the building is also different to the parts that represents the existing conditions/context.

Figure 9.5 Materials used to representing the new (Author).

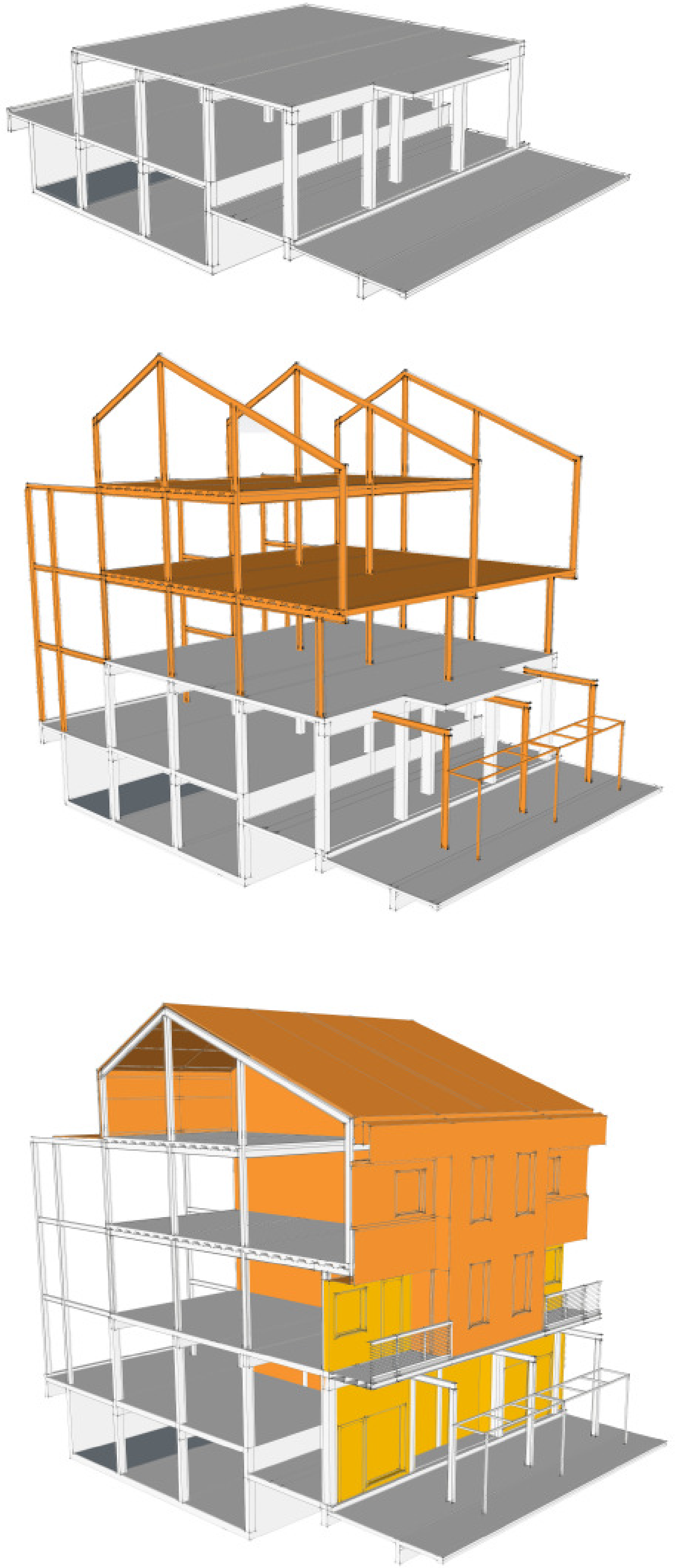


Figure 9.6 Structural system (Author).

STRUCTURAL SYSTEM

This technical concept is also carried through in the structural intention. The upper floors, which are higher than two storeys, will require a different structural language to distinguish them from the elements that represent the existing condition (ICOMOS, 1999). The primary structure of the lower floors is a concrete column-and-slab structure that changes to a steel structure in the upper floors. This symbolises the notion of the new added on top of the existing.

The primary structure is divided into two systems to express the two conditions (existing condition/context and additions/extensions). The basement up to the first floor is a concrete column-and-slab construction with beams spanning two ways. This represents the existing condition, permanence and the context. The steel structure, representing the additions, starts from the first floor level for structural reasons and forms the portal frame used for the upper floors.

The secondary structure, which forms part of the *support* infrastructure of the *Open Building* concept, defines the units, the base unit and the street elevation. From the technical concept, the street elevation is also divided into two conditions. The context/existing conditions are expressed by the use of brick for the first two storeys. The use of IBR sheet cladding for the upper floors expresses the additions/extensions.

The abovementioned structural system includes everything that forms part of the *support* and that which is provided before the occupants move in. This structure must allow the occupants the ability to construct and deconstruct the *infill* after they have moved in, but it should also limit them to their unit area (refer to Chapter 8). This *infill* can be constructed of any material and it is up to the occupant to make the decision based on material availability and cost. Yet, to ensure safety and comfort, a guide is provided with examples of how these panels or walls can be constructed.

SERVICE AND CLIMATIC CONSIDERATIONS

Concentrating people in urban areas have a number of advantages. First of all, it lessens the stain that urban sprawl put ons on infrastructural services and delivery over long distances. Secondly it reduces travel pollution and costs and thus help to reduce the carbon footprint of the city.

From an environmental approach, the development should rely on nature as much as possible. It should rely on nature to develop natural ways of cooling and heating and creating comfort. It should rely on nature to save energy on lighting the interior of a building. It should rely on nature to satisfy water demands and responsibly recycle usable water.

Ventilation and Shading: The solar studies in Figure 9.16, illustrate the abundance of sunlight the northern side of the building gains. Therefore the northern side will deal with sunlight and cooling conditions. The sectional development (shown in Figure 9.16) illustrate the development of overhangs using solar angles. Wall and roof insulation is considered and natural ventilation of the rooms are incorporated.

The southern side of the building will deal with heating systems. A water pipe system is proposed as a space heating device.

The *Open Building* theory requires a fixed infrastructure with a secondary *infill* structure. The provided infrastructure consists of the structural elements, the wall elements defining the unit area and the service core, which includes water systems and electrical supply. The grouping of services reduces the number of service ducts, reducing spatial requirements and ease of access and maintenance. The *Open Building* approach allows enough flexibility for the user to determine room sizes and uses, with the basic services provided.

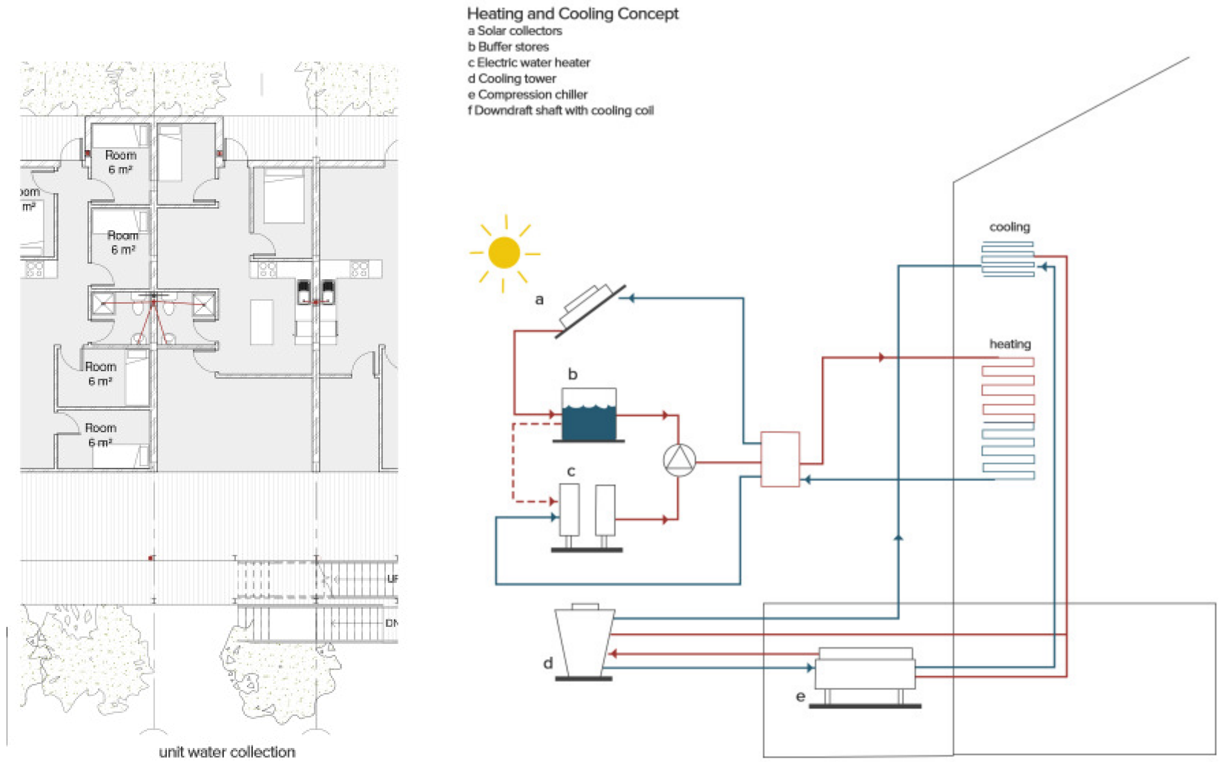


Figure 9.7 Grouping of services on plan (left) and water pipe system as space heating (right) (Author).

WATER COLLECTION

It has been estimated that the daily consumption of a typical household of two parents and three children is about 250 litres (Typical Household Water Consumption 2010). This means that in only one week, the household would have used 7 500 litres of water, which is already exceeding the monthly free water allowance of 6 000 litres (Sash 2015). The monthly water consumption amounts to 37 500 litres.

The water consumption breakdown in Figure 9.10 illustrates that 34% of water consumption is used for toilet flushing. The municipality supplies potable water that is generally used throughout the entire house, including for toilet flushing. In a grey water system, water collected from baths, showers, hand wash basins and the laundry is reused to flush toilets. This reduces the water demand from municipal services by 34%, while also reducing the wasting of fresh water and the production of waste water. Grey water that is collected passes through a filter that removes textile fluff, hair and other particles larger than 1 mm. It is treated to remove foul odours and kill bacteria. The water then passes to a storage tank where it is pumped to the individual toilets (Typical Household Water Consumption 2010).

Water demand can be further reduced by using 6/3-litre dual-flush toilets, instead of the traditional 9-litre cistern toilets. Rainwater harvesting can also reduce water demand by using it for irrigation purposes, and does not require any treatment.

The water demand for only flushing toilets is 2016 litres a day and possible greywater collection amounts to 11004 liters a day. With a reserve of three days the water demand will therefore be 6048 liters. According to the calculations with a 5days reserve for water stored for irrigation purposes, the water tank size required should hold 101m3 water. Therefore 2x 5 500 liter storage tanks.

Ground floor area is valuable space that could be and should be used by users of Marabastad, and therefore the tanks are situated in the basement.

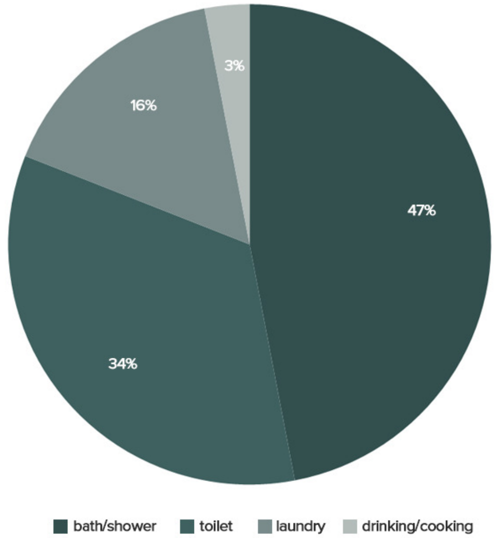


Figure 9.8 Typical household water usage

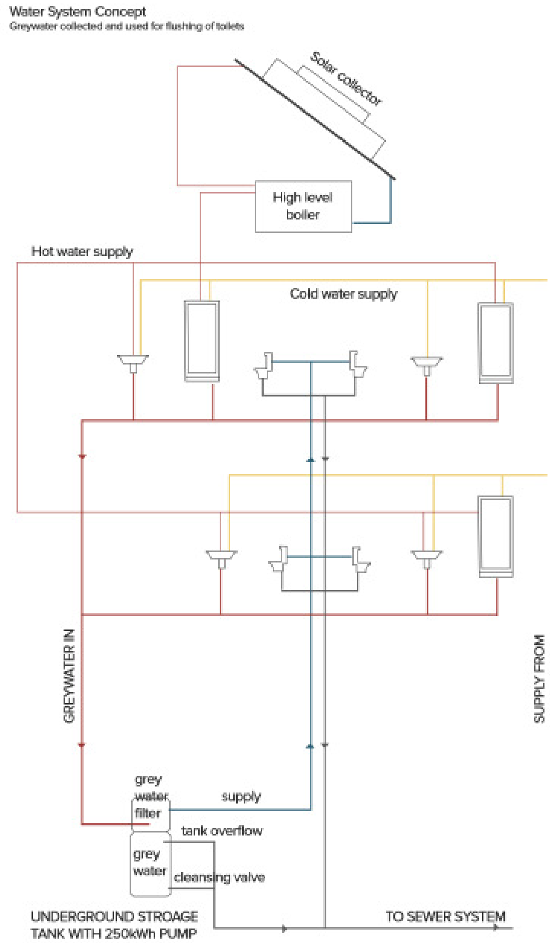


Figure 9.9 Diagramme illustrating greywater system (Author).

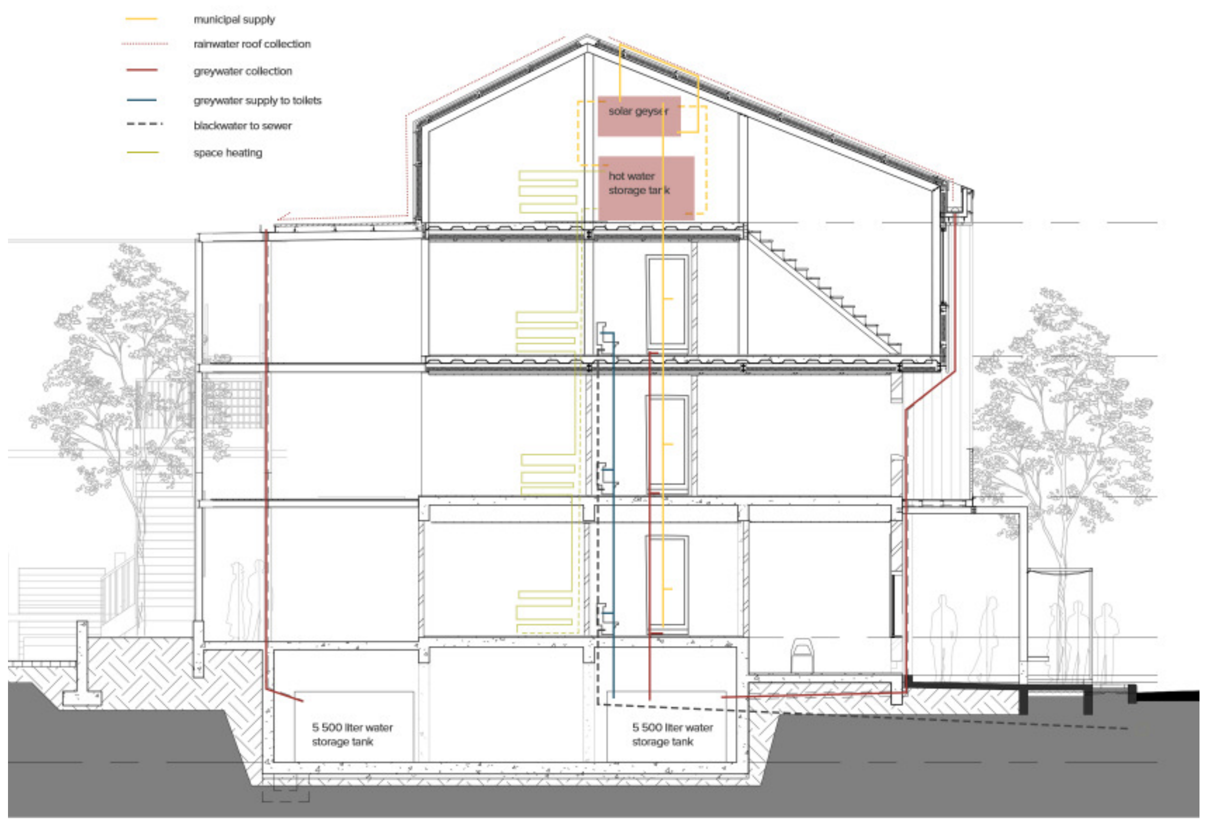


Figure 9.10 Water services and rainwater system illustrated in building section (Author).

IRRIGATION WATER STORAGE CALCULATIONS

1st Calculations

catchment area= 504m²
C=0,6 302,4
effective catchment = 302,4m³ 302,4
irrigation area = 114m²
summer month irrigation required 0,16m³/month = 18,24m³/month
winter month irrigation required 0,125m³/month =14,25m³/month

year 1				
	rainfall m	in m³	out m³	remaining in tank m³
January	0,154	46,5696		
		0	18,24	59,005
February	0,075	22,68		
		81,685	18,24	63,445
March	0,082	24,7968		
		88,2418	18,24	70,0018
April	0,051	15,4224		
		85,4242	18,24	67,1842
May	0,013	3,9312		
		71,1154	18,24	52,8754
June	0,007	2,1168		
		54,9922	14,25	40,7422
July	0,003	0,9072		
		41,6494	14,25	27,3994
August	0,006	1,8144		
		29,2138	14,25	14,9638
Septembe	0,022	6,6528		
		21,6166	18,24	3,3766
October	0,071	21,4704		
		24,847	18,24	6,607
November	0,098	29,6352		
		36,2422	18,24	18,0022
December	0,15	45,36		
		63,3622	18,24	45,1222
year 2				
January	0,154	46,5696		
		91,6918	18,24	73,4518
February	0,075	22,68		
		96,1318	18,24	77,8918
March	0,082	24,7968		
		102,6886	18,24	84,4486
April	0,051	15,4224		
		99,871	18,24	81,631
May	0,013	3,9312		
		85,5622	18,24	67,3222
June	0,007	2,1168		
		69,439	14,25	55,189
July	0,003	0,9072		
		56,0962	14,25	41,8462
August	0,006	1,8144		
		43,6606	14,25	29,4106
Septembe	0,022	6,6528		
		36,0634	18,24	17,8234
October	0,071	21,4704		
		39,2938	18,24	21,0538
November	0,098	29,6352		
		50,689	18,24	32,449
December	0,15	45,36		
		77,809	18,24	59,569

Revised Calculations

Assume 5days early Jan without rain : 5days @ 0,6 m³ equals 3,04 m³ reserve

year 1				
	rainfall m	in m³	out m³	remaining in tank m³
January	0,154	86,7636+3,04		
		89,8036	18,24	71,5636
February	0,075	22,68		
		94,2436	18,24	76,0036
March	0,082	24,7968		
		100,8004	18,24	82,5604
April	0,051	15,4224		
		97,9828	18,24	79,7428
May	0,013	3,9312		
		83,674	18,24	65,434
June	0,007	2,1168		
		67,5508	14,25	53,3008
July	0,003	0,9072		
		54,208	14,25	39,958
August	0,006	1,8144		
		41,7724	14,25	27,5224
September	0,022	6,6528		
		34,1752	18,24	15,9352
October	0,071	21,4704		
		37,4056	18,24	19,1656
November	0,098	29,6352		
		48,8008	18,24	30,5608
December	0,15	45,36		
		75,9208	18,24	57,6808
year 2				
January	0,154	46,5696		
		104,2504	18,24	86,0104
February	0,075	22,68		
		108,6904	18,24	90,4504
March	0,082	24,7968		
		115,2472	18,24	97,0072
April	0,051	15,4224		
		112,4296	18,24	94,1896
May	0,013	3,9312		
		98,1208	18,24	79,8808
June	0,007	2,1168		
		81,9976	14,25	67,7476
July	0,003	0,9072		
		68,6548	14,25	54,4048
August	0,006	1,8144		
		56,2192	14,25	41,9692
September	0,022	6,6528		
		48,622	18,24	30,382
October	0,071	21,4704		
		51,8524	18,24	33,6124
November	0,098	29,6352		
		63,2476	18,24	45,0076
December	0,15	45,36		
		90,3676	18,24	72,1276

Figure 9.11 Rainwater harvesting calculations (Author).

FIRST CALCULATIONS

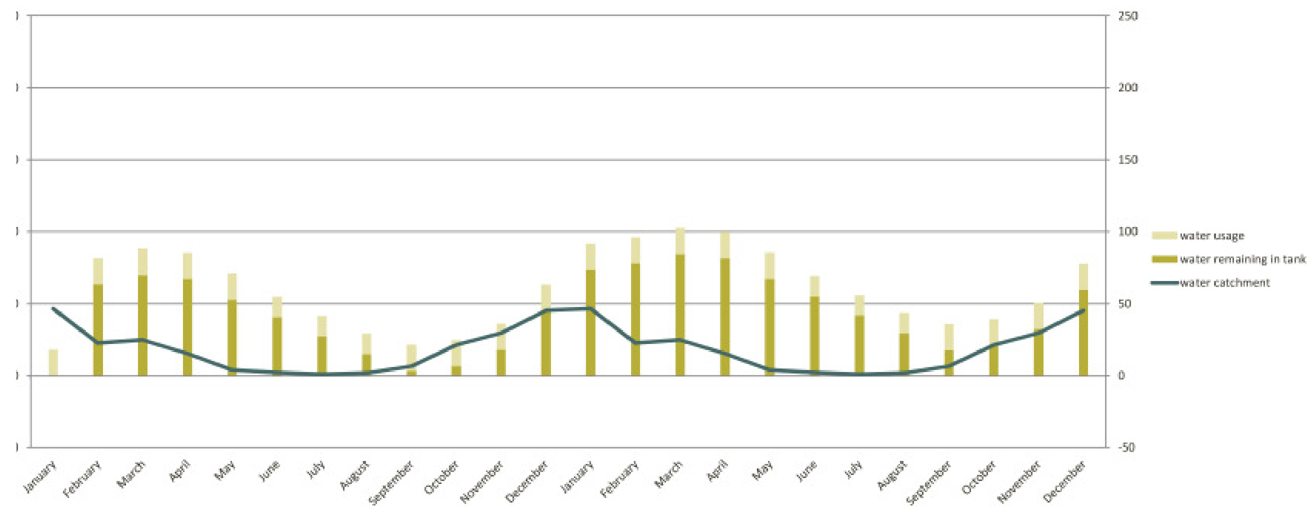


Figure 9.12 Diagramme illustrating rainwater harvesting FIRST CALCULATIONS (Author).

REVISED CALCULATIONS WITH 5 DAYS RESERVE

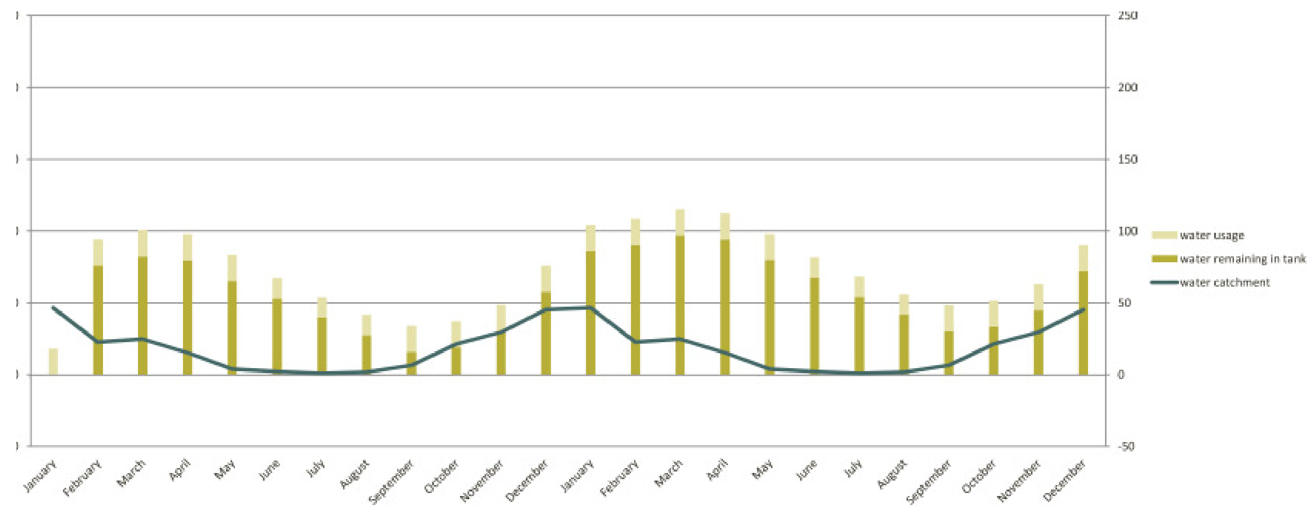


Figure 9.13 Diagramme illustrating rainwater harvesting with a REVISED CALCULATIONS with a 33m² top-up (Author).

SOLAR STUDIES

Figure 9.14 illustrates the required lux levels to perform specific tasks relating to the different rooms throughout a residential house. The first light analysis was done on the base model shown in Figure 9.16. This indicated that the northern side of the building receives excess sunlight, the southern side receives insufficient light levels and the core of the unit receives no sunlight.

On the second analysis, overhangs were applied on the northern side, and the overhang created by the deck area on the southern side was reduced. This resulted in adequate lux levels required in the rooms and deeper light penetration to the core of the building, but was still inadequate.

The third light analysis resulted in better light conditions in the core of the building through the installation of a multi-level light shaft. The light shaft is lined with aluminium carcassing with aluminium composite mirrors. Light penetrates the rooms through the openings in rooms closed by obscure glazing panels on the interior of the building (see figure 9.15). Although this might have additional construction costs, the use of natural light will greatly improve the atmosphere in the room and will reduce energy costs.

Standard Maintained Illuminance (lux)	Characteristics of Activity	Representative Activity
50	**Interiors rarely used for visual tasks** *(no perception of detail)*	Cable tunnels, nighttime sidewalk, parking lots
100 - 150	**Interiors with minimal demand for visual acuity** *(limited perception of detail)*	Corridors, changing rooms, loading bay
200	**Interiors with low demand for visual acuity** *(some perception of detail)*	Foyers and entrances, dining rooms, warehouses, restrooms
300	**Interior with some demand for visual acuity** *(frequently occupied spaces)*	Libraries, sports and assembly halls, teaching spaces, lecture theaters
500	**Interior with moderate demand for visual acuity** *(some low contrast, color judgment tasks)*	Computer work, reading & writing, general offices, retail shops, kitchens
750	**Interior with demand for good visual acuity** *(good color judgment, inviting interior)*	Drawing offices, chain stores, general electronics work
1000	**Interior with demand for superior visual acuity** *(accurate color judgment & low contrast)*	Detailed electronics assembly, drafting, cabinet making, supermarkets
1500 -2000+	**Interior with demand for maximum visual acuity** *(low contrast, optical aids & local lighting will be of advantage)*	Hand tailoring, precision assembly, detailed drafting, assembly of minute mechanisms

Figure 9.14 *Required lux levels (Author).*

Live Project - LIGHT GUIDE IN A COUNTRY HOUSE, Switzerland

Figure 9.15 *Live project of a light shaft/guide in a country house, Switzerland (Limitless (2015), edited by Author).*

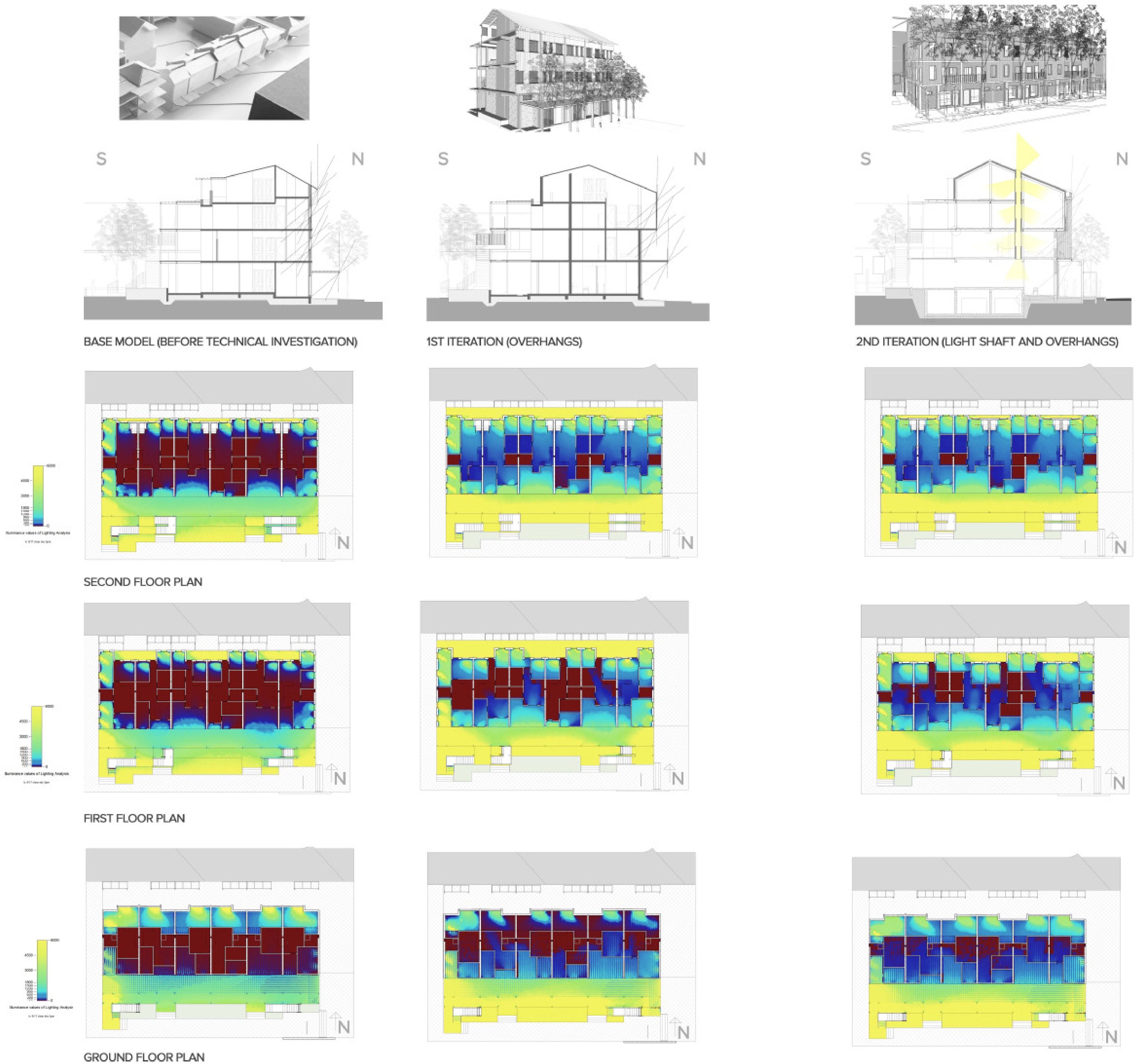
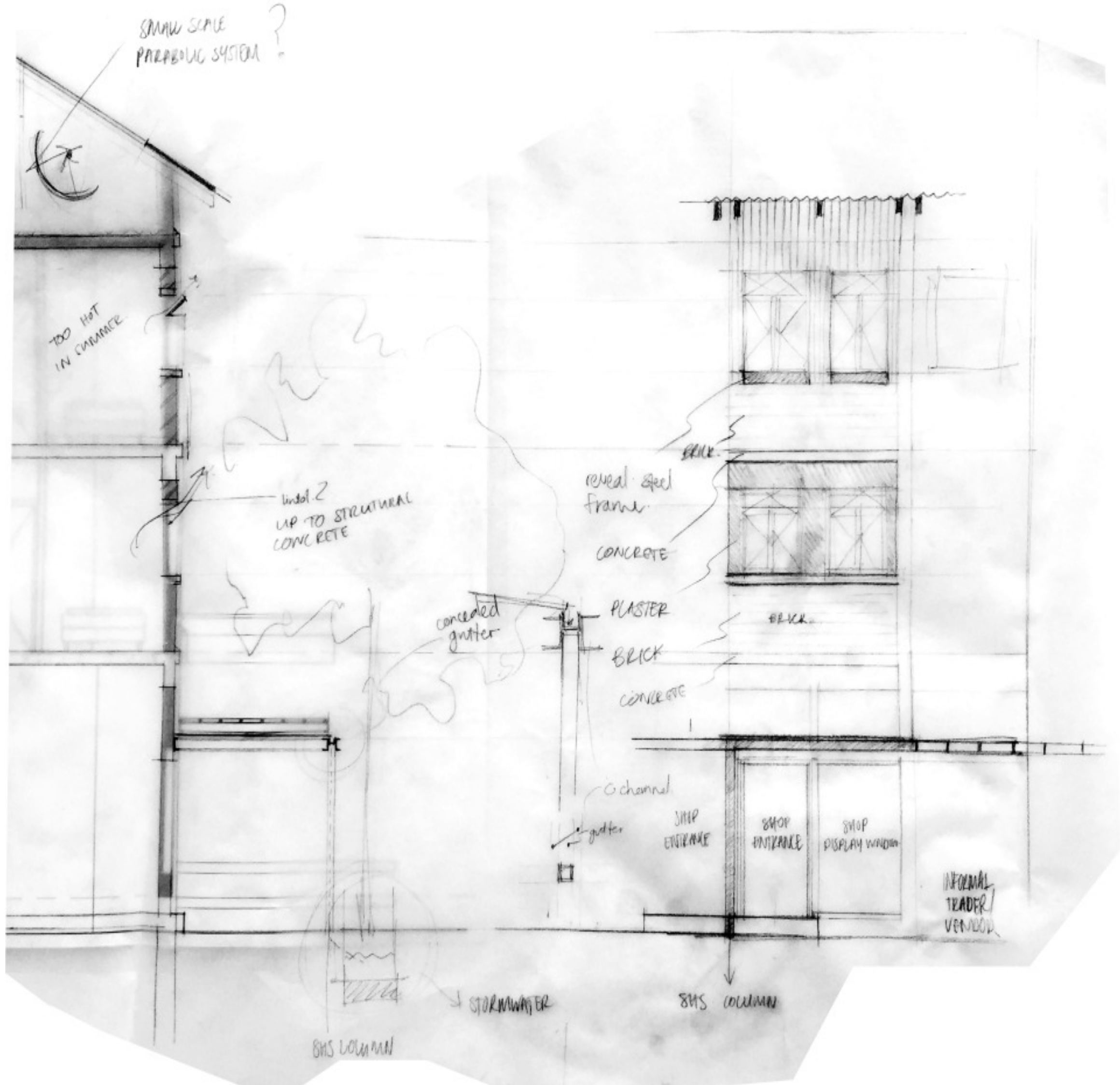
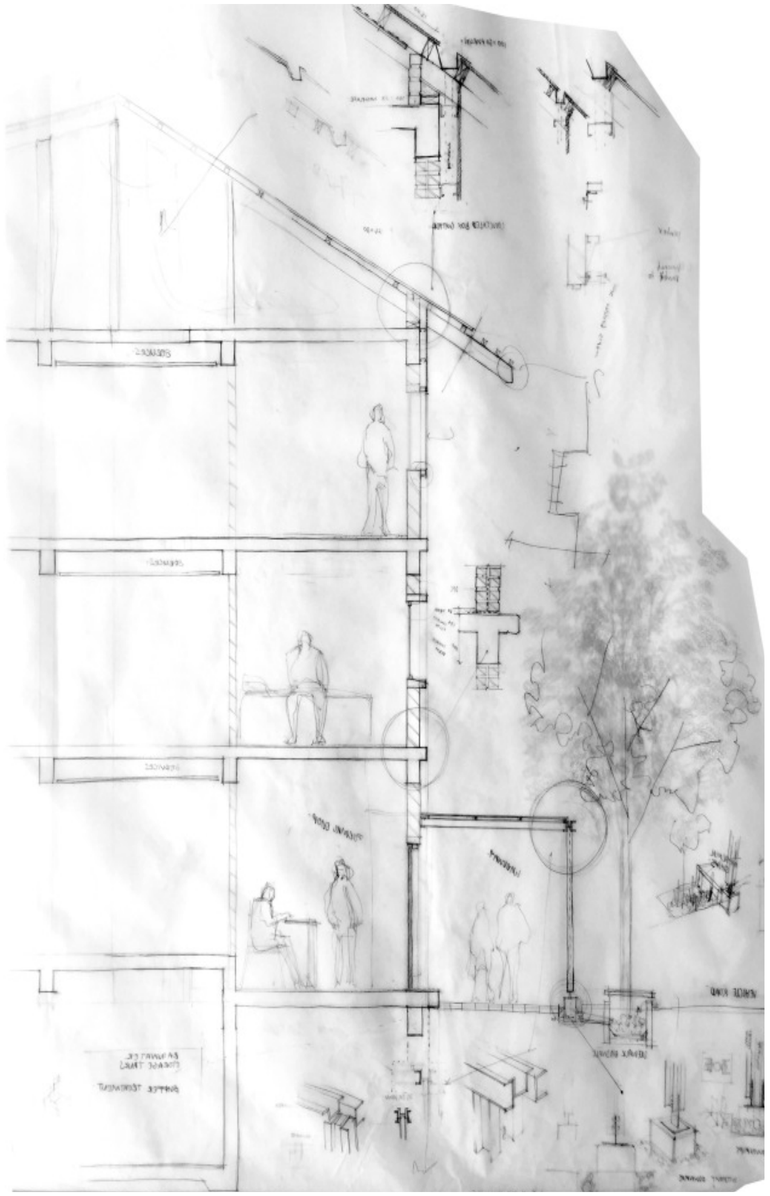
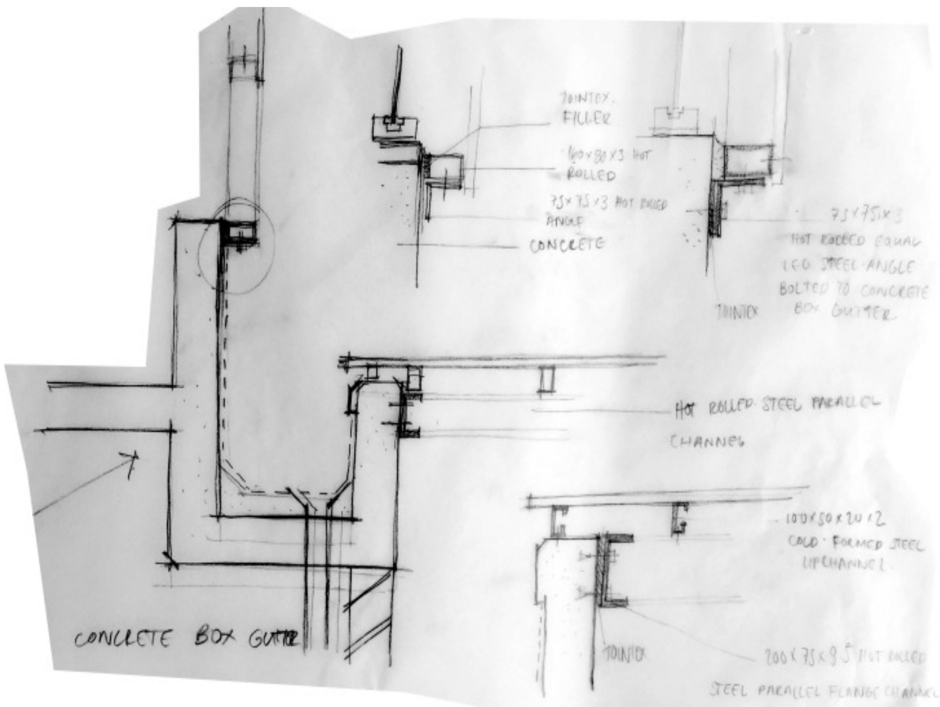
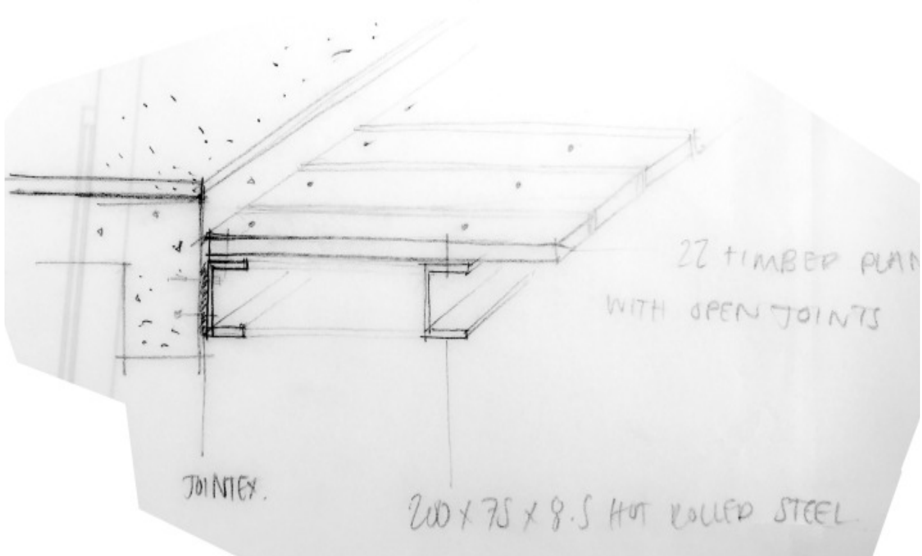


Figure 9.16 Light analysis of housing units at different floor levels during different sectional development stages (Author).









The technical approach is a continuation of the design. The 1:20 section developed the elevation by the conceptual approach of expressing the old and the new and solar angles defined overhang that further informed the elevation and section to the street.

Figure 9.17 *Technical process sketches (Author).*

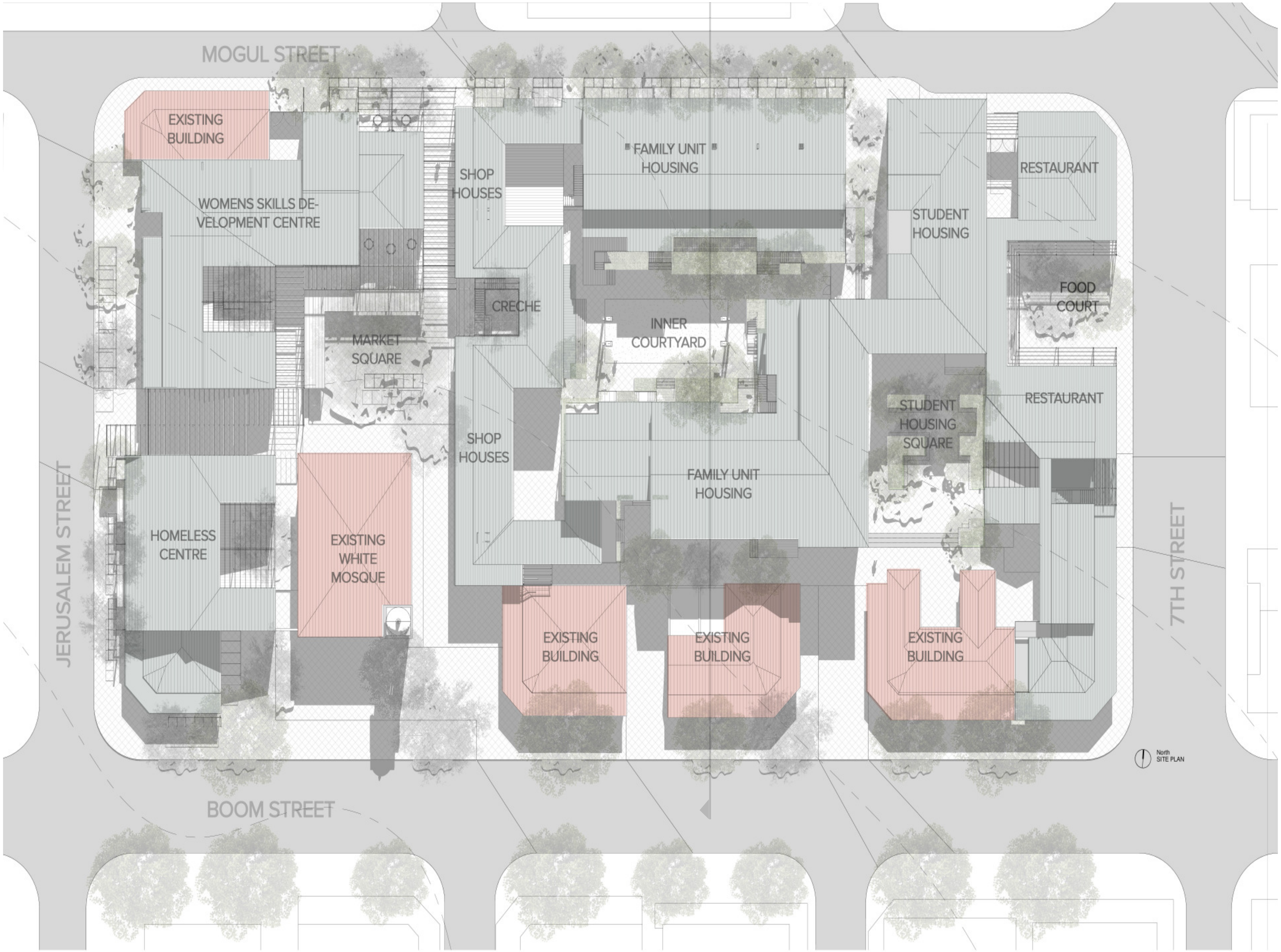


Figure 9.18 Site plan (Author).

SITE SECTION

Figure 9.19 *Site section (Author).*

1:20 WALL SECTION

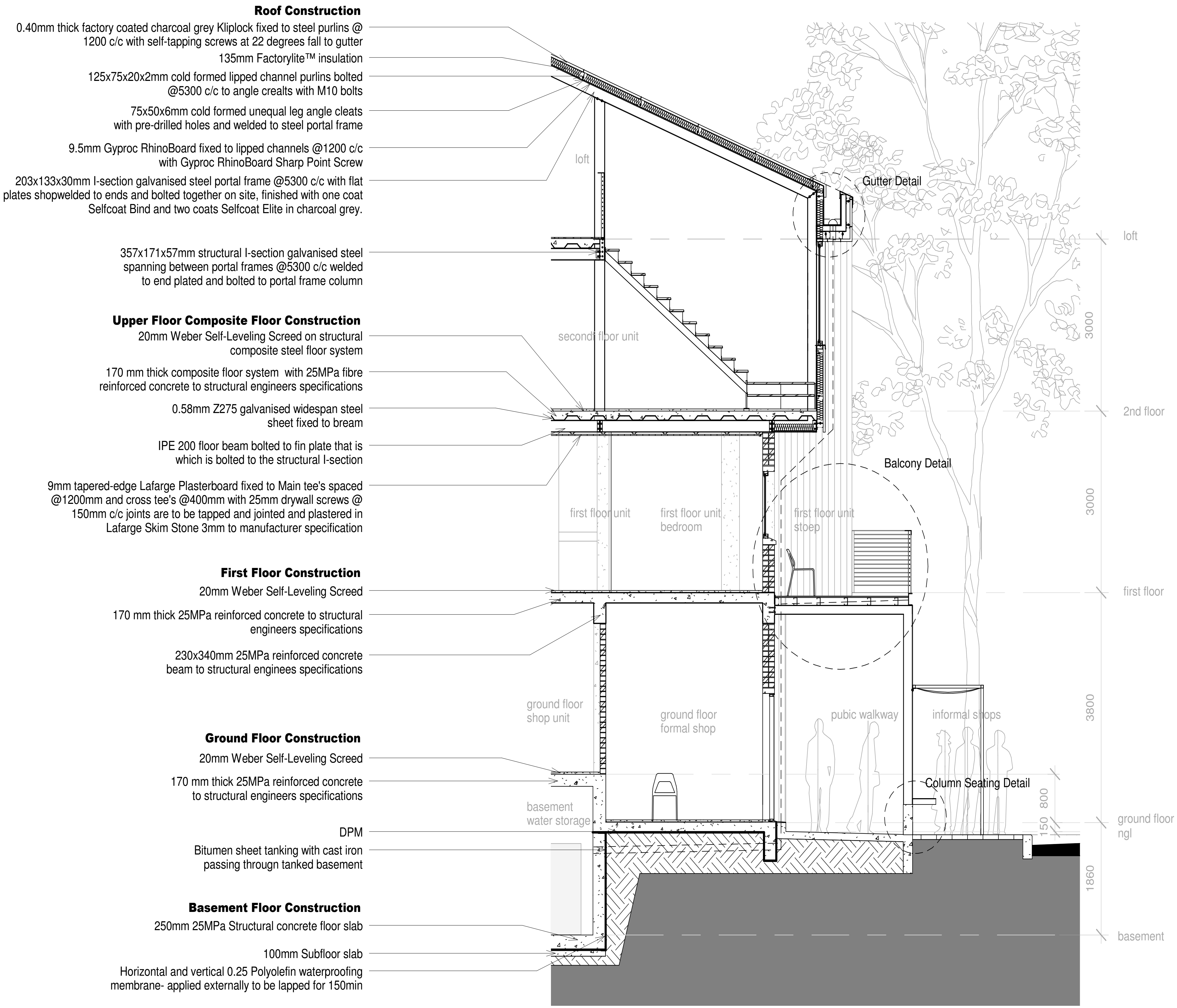


Figure 9.20 *1:20 Section version 5 (Author).*

GUTTER DETAIL

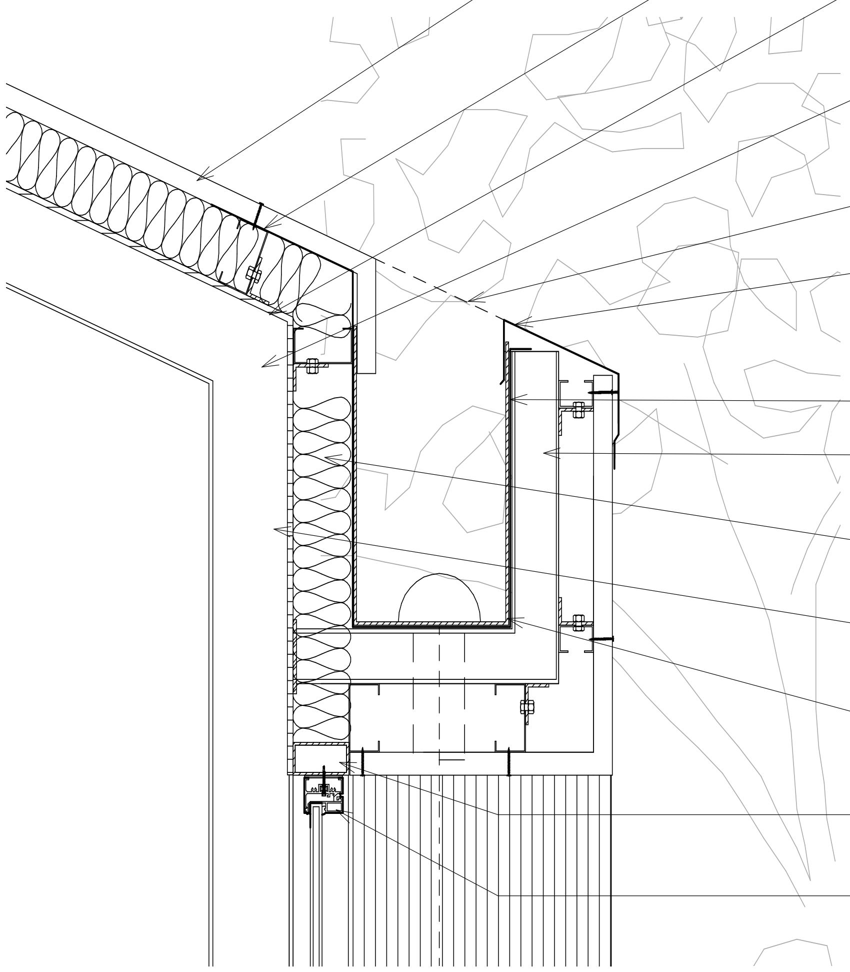
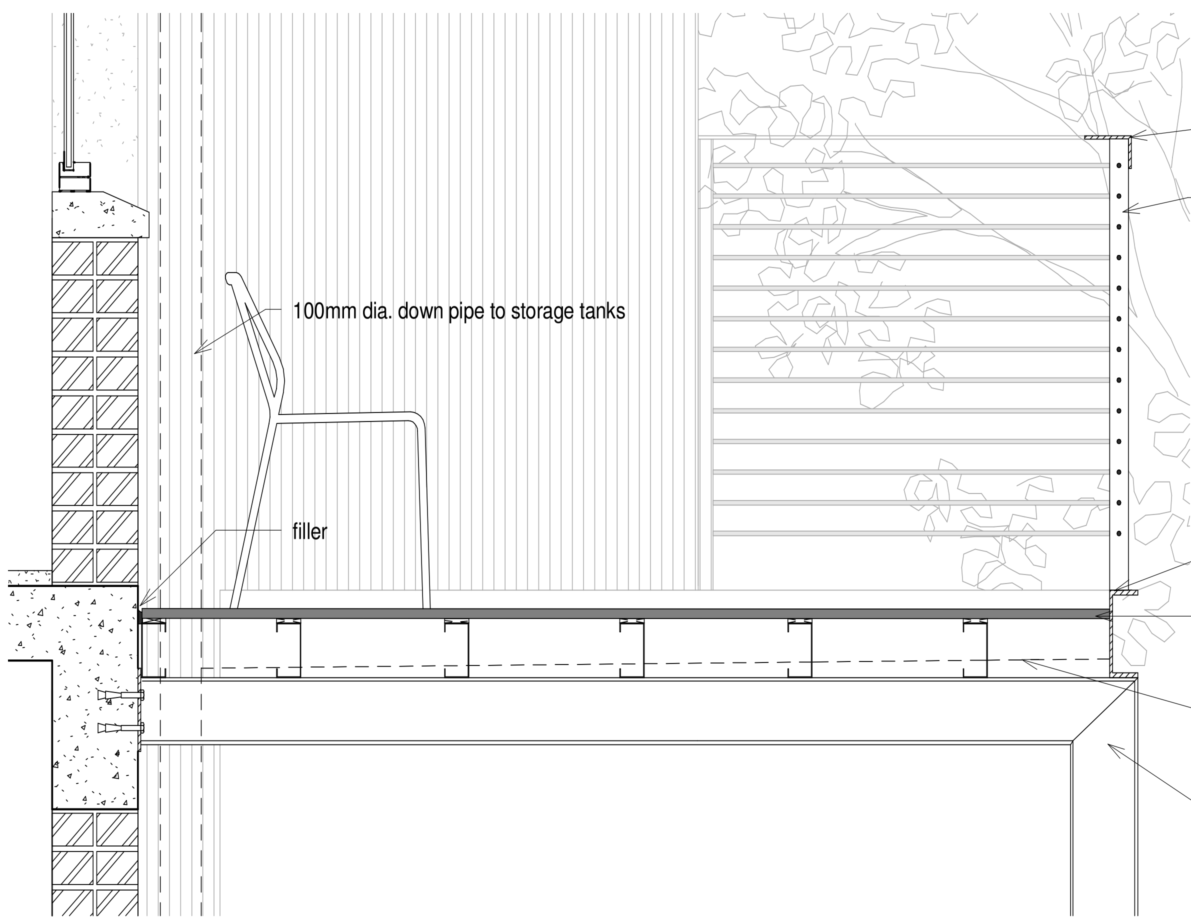


Figure 9.21 Gutter detail (Author).

Figure 9.22 Balcony detail (Author).

BALCONY DETAIL



COLUMN SEATING DETAIL

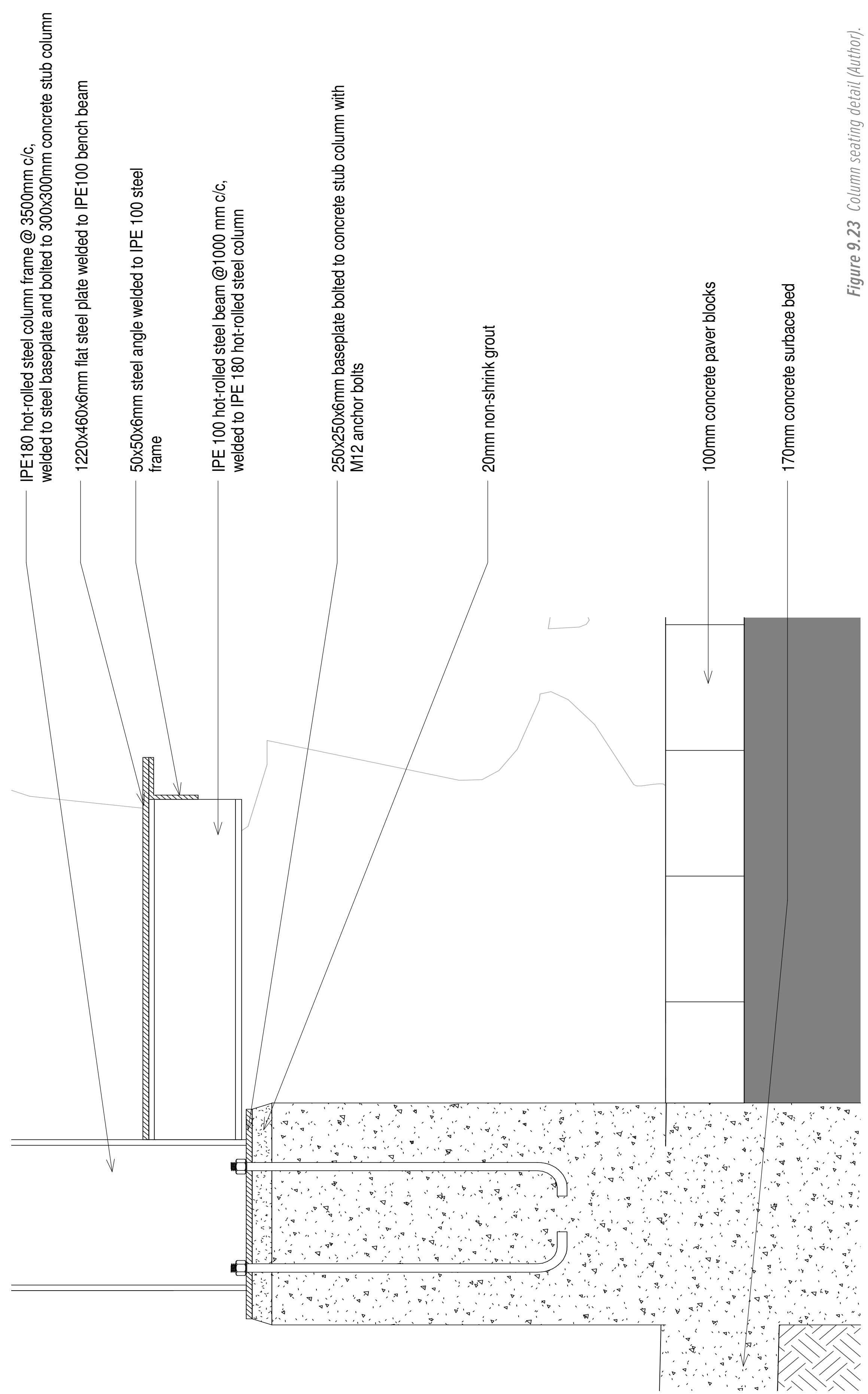


Figure 9.23 Column seating detail (Author).

Figure 9.24 Perspective of Mogul street (Author).

Figure 9.25 Ground floor plan (Author).

Figure 9.26 First floor plan (Author).

FOOD COURT

The food court is located to the east of the site with high activity levels during the day. The proposed Food court encourages existing activities of informal restaurants and bars to establish and develop into formal shops/restaurants/bars.

Figure 9.27 *Perspective of Food court (Author).*

STUDENT HOUSING SQUARE

The square links to Boom street and the Food court but is defined as a semi-public space as it is framed by the buildings all around. The space is intended as a space to sit and interact. This space also introduces greenery into the fabric of Marabastad.

Figure 9.28 Perspective of Student square (Author).

INNER COURTYARD

The inner courtyard is a semi-private space which is defined by the buildings with family units framing the space. This creates a passively surveillanced save space through units looking onto the space. The architecture facing the inner couryard is controlled by the occupant and can vary in materiality. Greenery is introduced to create a welcoming feeling to the space.

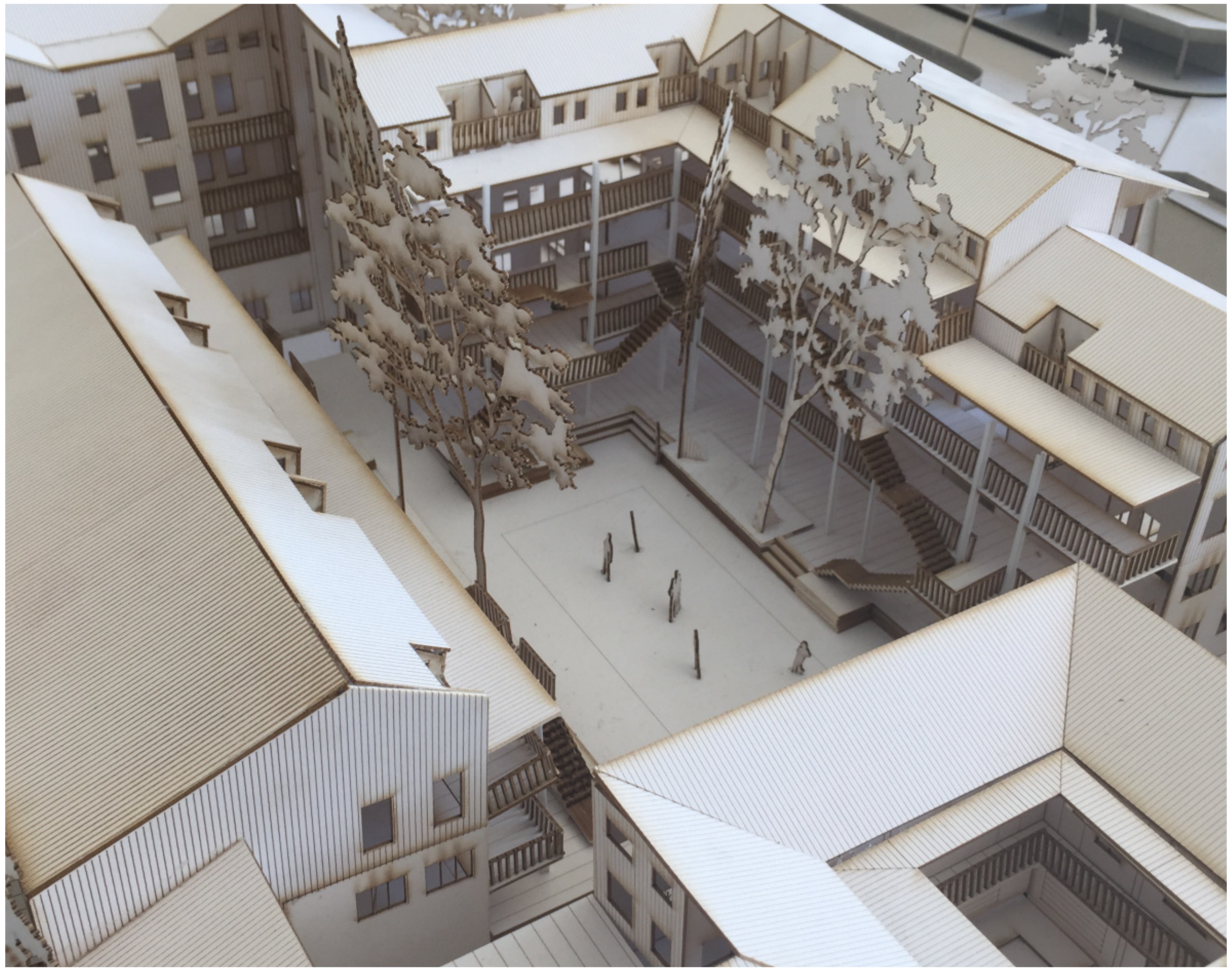


Figure 9.29 Perspective of Inner courtyard (Author).

MARKET SQUARE

The market square is situated to the middle of the block behind the White Mosque. The existing Tipuana tree is an alien tree, but due to its heritage value is conserved. The tree is often related to markets because of the large canopy it creates. The proposed market space links to the Womens Centre where goods are made and can be sold at the market. The square allows for informal and formal traders to interact with one another and activates the middle part of the city block as a public space.

Figure 9.30 Perspective of Market square (Author).

Figure 9.31 Final model from Womens centre (Author).

CONCLUSION

The project aimed to create a truly integrated urban infill project. The complexity and richness of the project lies in the approach to the sense of place, heritage character and the position it takes on current housing legislations for the poor.

The project originated from potential of place (Marabastad), diversity of people and the future vision of the City of Tshwane to densify. The compaction strategy is a key concept in urban regeneration and to creating greener cities. Marabastad, being identified as a priority precinct by the Pretoria Inner City Partnership, is a unique area described as an experience and not place. The strong heritage character of Marabastad contributes to the sense of place and cannot afford to lose its unique architectural expression.

The proposal is a good example of how an urban infill project could sit in harmony with its context, by responding to architectural references found in Marabastad. The project saw to seek the elements contributing to the life of Marabastad and to identify where and why others fail. These findings led to user driven architecture taking responsibility of accommodating the variety of people and uses in Marabastad.

The issue of housing in South Africa holds great potential for architectural exploration. Some may argue that there is no place for architecture in housing for the poor and that it is only financially driven. However, innovative and participative approaches to housing initiated by architects, have led to wonderful architectural housing solutions around the world. This project illustrates an alternative solution to housing through the use of *Open Building*. If *Open Building* is applied and regulated to a relevant extent it can hold great potential for a user driven housing solution.

Open Building allows occupants to adapt structures to better suit their immediate needs. This adaptive approach is very relevant in the context of South Africa. Informality, found in informal settlements and Marabastad, allows users to build what they can afford and extend as their needs their financial capabilities change. Through the application of *Open Building* the architecture which forms part of the shell can be controlled by the architect, however the structure then allows for occupant to fill in the gaps how they want and need it. Because the structure can adapt to the family structure, a diversity of social groups can be accommodated and prevents the development of homogenous areas within the city.
The urban infill approach helps with unlocking well-located land in urban areas, such as Marabastad, and should acknowledge the value of the existing activities, architectural elements and networks. The proposal of a mixed-use residential infill development in Marabastad truly gives a foothold to the city for the urban poor.

Figure 9.32 *Final model Mogul street elevation at night (Author).*

Figure 9.33 Final model from 7th street at night (Author).