CHAPTER 09

TECHNICAL DEVELOPMENT

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

- Ludwig Mies van der Rohe -
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.
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.

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.
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.
Concentrating people in urban areas have a number of advantages. First of all, it lessens the stain that urban sprawl puts 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.

**SERVICE AND CLIMATIC CONSIDERATIONS**

![Figure 9.7](image-url)
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.
IRRIGATION WATER STORAGE CALCULATIONS

1st Calculations:

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<thead>
<tr>
<th>Month</th>
<th>Irrigation 90 m²</th>
<th>80 m²</th>
<th>70 m²</th>
<th>Watering in tank m³</th>
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Revised Calculations:

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Assume 35 days daily on without rain: 35 days x 90 m² equals 3,150 m³ reserve

REVISED CALCULATIONS WITH 5 DAYS RESERVE

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Assume 30 days early on without rain: 30 days x 90 m² equals 2,700 m³ reserve

Figure 9.11 Rainwater harvesting calculations (Author).

Figure 9.12 Diagram showing rainwater harvesting FIRST CALCULATIONS (Author).

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

**SOLAR STUDIES**

Figure 9.15: Live project of a light shaft/guide in a country house, Switzerland & mittels (2010), 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).
Roof Construction
0.40mm thick factory coated charcoal grey Kliplock fixed to steel purlins @ 1200 c/c with self-tapping screws at 22 degrees fall to gutter
155mm Factorylite™ Insulation
125x75x28x2mm cold formed lipped channel purlins bolted @ 5300 c/c to angle creasts with M10 bolts
9.5mm Gyproc RhinoBoard fixed to lipped channels @ 1200 c/c with Gyproc RhinoBoard Sharp Point Screw
203x133x30mm I-section galvanised steel portal frame bolted @ 5300 c/c with flat plates shopwelded to ends and bolted together on site, finished with one coat Selfcoat Bind and two coats Selfcoat Elite in charcoal grey.
357x171x57mm structural I-section galvanised steel spanning between portal frames @ 5300 c/c welded to end plated and bolted to portal frame column

Upper Floor Composite Floor Construction
20mm Weber Self-Leveling Screed on structural composite steel floor system
170 mm thick composite floor system with 25MPa fibre reinforced concrete to structural engineers specifications
0.58mm Z275 galvanised wide span steel sheet fixed to beam
IPE 200 floor beam bolted to fin plate that is which is bolted to the structural I-section
9mm tapered-edge Lafarge Plasterboard fixed to Main tee's spaced @ 1200mm and cross tee's @ 400mm with 25mm drywall screws @ 150mm c/c joints are to be tapped and jointed and plastered in Lafarge Skim Stone 3mm to manufacturer specification

First Floor Construction
20mm Weber Self-Leveling Screed
170 mm thick 25MPa reinforced concrete to structural engineers specifications
230x400mm 25MPa reinforced concrete beam to structural engineers specifications

Ground Floor Construction
20mm Weber Self-Leveling Screed
170 mm thick 25MPa reinforced concrete to structural engineers specifications
DPM Bitumen sheet tanking with cast iron passing through tanked basement

Basement Floor Construction
250mm 25MPa Structural concrete floor slab
100mm Subfloor slab
Horizontal and vertical 0.25 Polytetrafluoroethylene membrane applied externally to be lapped for 150mm
0.40mm thick factory coated charcoal grey Kliplock fixed to steel purlins @ 1200 c/c with self-tapping screws at 22 degrees fall to gutter, fixed to 125x50x20x2 cold-formed steel lip channels @ 1200mm c/c

9.5mm Gyproc RhinoBoard fixed to lipped channels @ 1200 c/c with Gyproc RhinoBoard Sharp Point Screw

203x133x30mm I-section galvanised steel portal frame @ 5300 c/c with flat plates shopwelded to ends and bolted together on site, finished with one coat Selfcoat Bind and two coats Selfcoat Elite in charcoal grey.

Damp proof membrane

Metal flashing custom-formed to fit over Kliplok roof profile fixed to lip channel

IPE 100 hot rolled steel beam with endplate welded to 203x133x30 steel column

135mm Factorylite™ insulation

203x133x30 hot rolled steel column with endplate bolted to endplate of 203x133x30 hot rolled steel beam to form portal frame @ 5300 mm c/c

50x330x3mm custom formed steel box gutter with 150mm dia. downpipes @ 5300mm intervals

120x60x4mm hollow steel section welded to 203x133x30 steel column at 5.3 m c/c to form structural support for window

Aluminium window head welded to I-section galvanised steel portal frame @ 5300 c/c and all around window frame with sealant fixed to 120x60x4 hollow steel section

Figure 9.21 Gutter detail (Author).

Figure 9.22 Balcony detail (Author).
50x50x6mm steel angle welded to IPE 100 steel frame
1220x460x6mm flat steel plate welded to IPE100 bench beam
IPE 100 hot rolled steel beam @ 1000 mm c/c, welded to IPE 180 hot rolled steel column
250x250mm baseplate bolted to concrete stub column with M12 anchor bolts
20mm non-shrink grout
IPE 180 hot rolled steel column frame @ 3500mm c/c, welded to steel baseplate and bolted to 300x300mm concrete stub column
20mm non-shrink grout
100mm concrete paver blocks
170mm concrete surface bed

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).
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.

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.
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 safe space through units looking onto the space. The architecture facing the inner courtyard is controlled by the occupant and can vary in materiality. Greenery is introduced to create a welcoming feeling to the space.
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 Woman’s 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 9.31 Final model from Women’s 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).