07 CHAPTER

TECTONICS OF REFUGE

Fig. 114: Precast concrete front facade (Author 2021)

7.1

TECTONIC INTENTIONS

The intention of the dissertation is to explore how temporary acts of refuge can be facilitated by manipulating how space is perceived by the mobile urban dweller. In terms of technology, the perception of space is influenced by articulation of the envelope, materials, light and structure.

7.2

TECTONICS OF A DWELLING

In *Four Elements of Architecture*, Gottfried Semper (1851) argued that the tectonics of the primordial dwelling can be divided into four basic elements: (1) the earthwork or mound, (2) the hearth, (3) the roof, and (4) the envelope. The hearth is seen as the original gathering space, a place of dwelling that require protection. The earthwork separates man from the ground, the lightweight roof provide protection from the rain and sun, and a lightweight membrane encloses the interior (Frampton 1996: 5). Frampton (1996: 5) argues that the primordial hut can be classified into tectonic (light) and stereotomic (heavy) components based on the procedures through which they are assembled. The articulation of the four elements of a dwelling, based on a Caribbean hut, should not be universally applied to all structures but be specific to the venacular building materials, techiques and processes (Frampton 1996:6; Hale 2005:62).

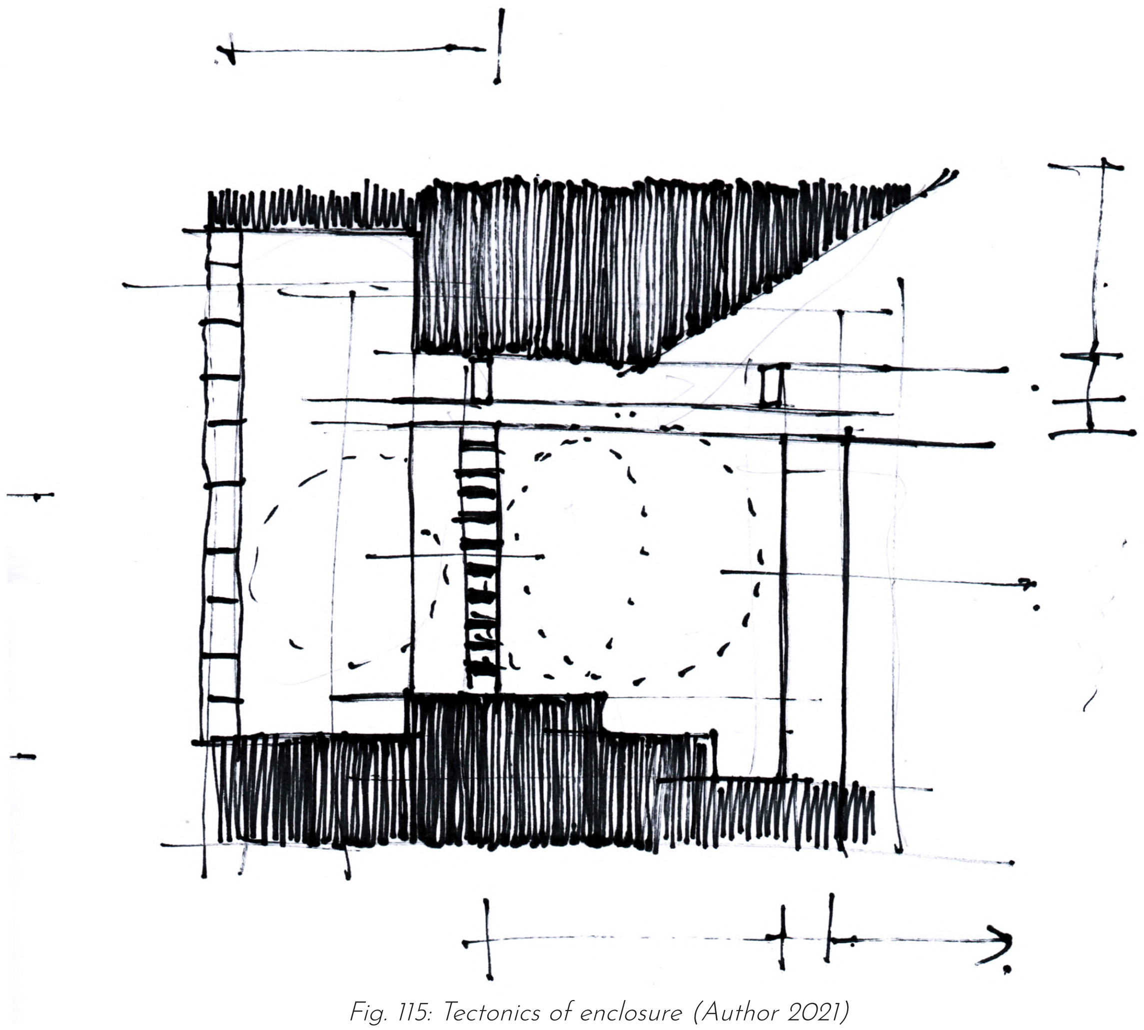


Fig. 115: Tectonics of enclosure (Author 2021)

7.3

TECTONICS OF ENCLOSURE

The hearth, the roof, the envelope and the ground, each play a different role in the creation of shelter. In this dissertation, emphasis will be placed on how the articulation of these four elements can facilitate the act of refuge.

1. OVERHEAD PLANE

The overhead plane is used to manipulate the scale, intimacy, light, and the direction of movement in a space. The overhead plane consists of two main components: reinforced concrete slabs to create usable space above, and deep concrete beams to support the floor slabs. The heavy and stereotomic qualities of concrete are contradicted by its light and tectonic articulation.

2. GROUND PLANE

The floor plane in public spaces of the building is treated as an extension of the sidewalk and the arcades. This is achieved through the continuity of the brick paver in walkways, courtyards and staircases. Changes in level not only affect scale and spatial hierarchy, but also affect how space is used. Sunken seating creates an intimate space of gathering, looking inward towards one another. Extruded benches and plinths create seating that face outwards, promoting observation rather than interaction. .

3. HEARTH

Cooking and eating are primary acts of temporary refuge in the inner city. Built-in fire cooking areas, eating areas and chimneys aim to accommodate the mobile urban dweller's need for shelter, belonging and social interaction.

4. THE ENVELOPE

The confrontation between refuge and exposure is articulated in the envelope.

THE SOLID EDGE:
Solid walls provide a sense of enclosure, separation and protection. A solid edge at the back of a space gives users a safe space to observe from.

THE INHABITED EDGE:
Deep columns and walls are used to widen the edge into an inhabited space. This space serves either as an intimate place of refuge or as a threshold between two spaces. Even though this in-between condition separates two spaces, the openings between columns maintain a direct connection and some degree of continuity.

THE PERMEABLE EDGE:
Precast concrete and brick screens are used to give the illusion of a solid edge from the outside while providing natural light and views from the inside. The screen satisfies the desire for refuge and privacy and provide varying degrees of exposure.

7.5

TECTONIC ARTICULATION AND MATERIALS OF THE SITE

Four main materials characterise the materiality of the neighbouring buildings and the city's public arcades: Concrete, brick, ceramic tiles and steel. Cast in situ reinforced concrete is primarily used for structural columns, floors and overhangs, but is often painted or hidden behind brickwork. Precast concrete elements are used for screens and pavers. The Shoprite building has a smooth plastered front façade and an exposed facebrick rear façade. The buildings of this block have two faces. The block's rough internal envelope with exposed brickwork, concrete and steel is hidden behind an external skin of billboards, glazing, smooth paint and ceramic tiles.

The pedestrian streets are lined with alternating patterns of brick pavers and cobblestones. This changes to ceramic tiles upon entering one of the arcades. The ceramic tile floors provide a cleaner, neater and domestic appearance over external paving, but the space is immediately perceived as an internal and private space. Ceramic tiles and mosaics are also widely used for external walls, columns and artistic expression.

STREET FACING EDGE ARTICULATION

EDGE ARTICULATION OF THE BLOCK INTERIOR

Fig. 116: Photographs of the site (Author 2021)

7.5

MATERIALITY

Exposed brickwork, concrete and ceramic tiles make up the primary materials used in this scheme, along with timber and steel as complimentary materials. The material selection and articulation attempt to respond to the existing urban fabric and aim to enhance the user's experience of refuge.

Off-shutter cast in situ reinforced concrete columns, beams and slabs express how the structural elements of the edge and overhead plane enclose and expose internal space. The project will explore how different types of formwork, pigments and aggregates can be used to manipulate the texture and colour of the exposed concrete. The concrete is contrasted with the warmth of facebrick walls and paved floor surfaces. Differentiation of brick bonds, patterns, openings and textures will be used to contrast the continuity and uniformity of the brickwork. The stereotomic nature of brick and concrete enhances the sense of refuge, enclosure and intimacy experienced by the user. Exterior materials such as the brick and concrete are used in the internal public spaces. These spaces appear to be outside and therefore perceived as being public rather than private. The interior face of brick walls will be bagged and painted to mediate between the exterior and interior conditions. Ceramic tiles are selectively used for public seating, cooking spaces, hand wash stations and planters to encourage temporary acts of refuge.

As a continuation of the existing material language of the site, the exposed brickwork is partially concealed by an external skin facing the street. This skin will be a permeable screen constructed with custom made precast concrete bricks. From street level the screen must be perceived as a solid mass, as a continuation of the solid facades of the neighbouring buildings and to create the perception of a solid wall protecting a place of refuge within. The screen must also manipulate natural light, ventilation and views. A screen made of standard precast concrete elements and bricks has small deep openings which restricts views and limit solar heat gain in winter months. By designing custom concrete bricks, the size, texture and colour can be altered. Recycled sand, cement and aggregates from demolished buildings on site, can also be used to manufacture the concrete bricks off-site. Galvanised mild steel will mainly be used for trimmings and above-ground level staircases. External doors and window frames will be custom built from Mukarati timber to match the Meranti joinery of the interiors. The warmth of natural timber aims to soften interior spaces.

Fig. 117: Photographs of matrials found in context (Author 2021)

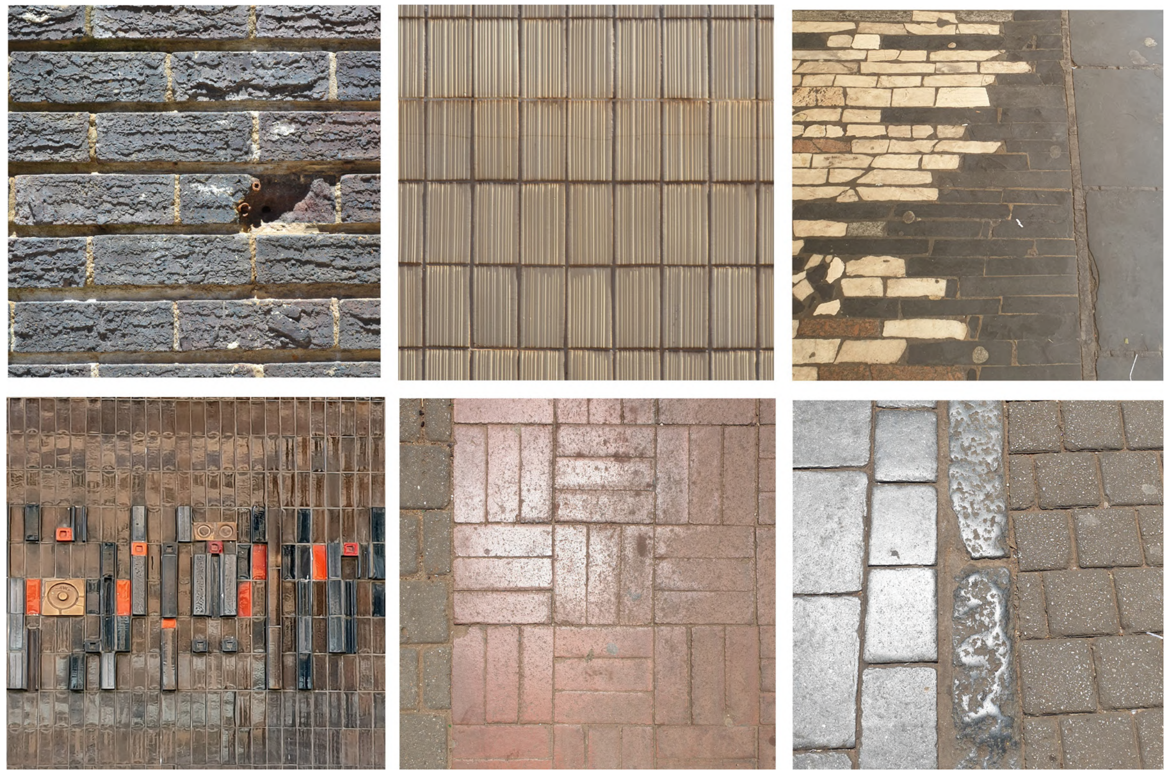
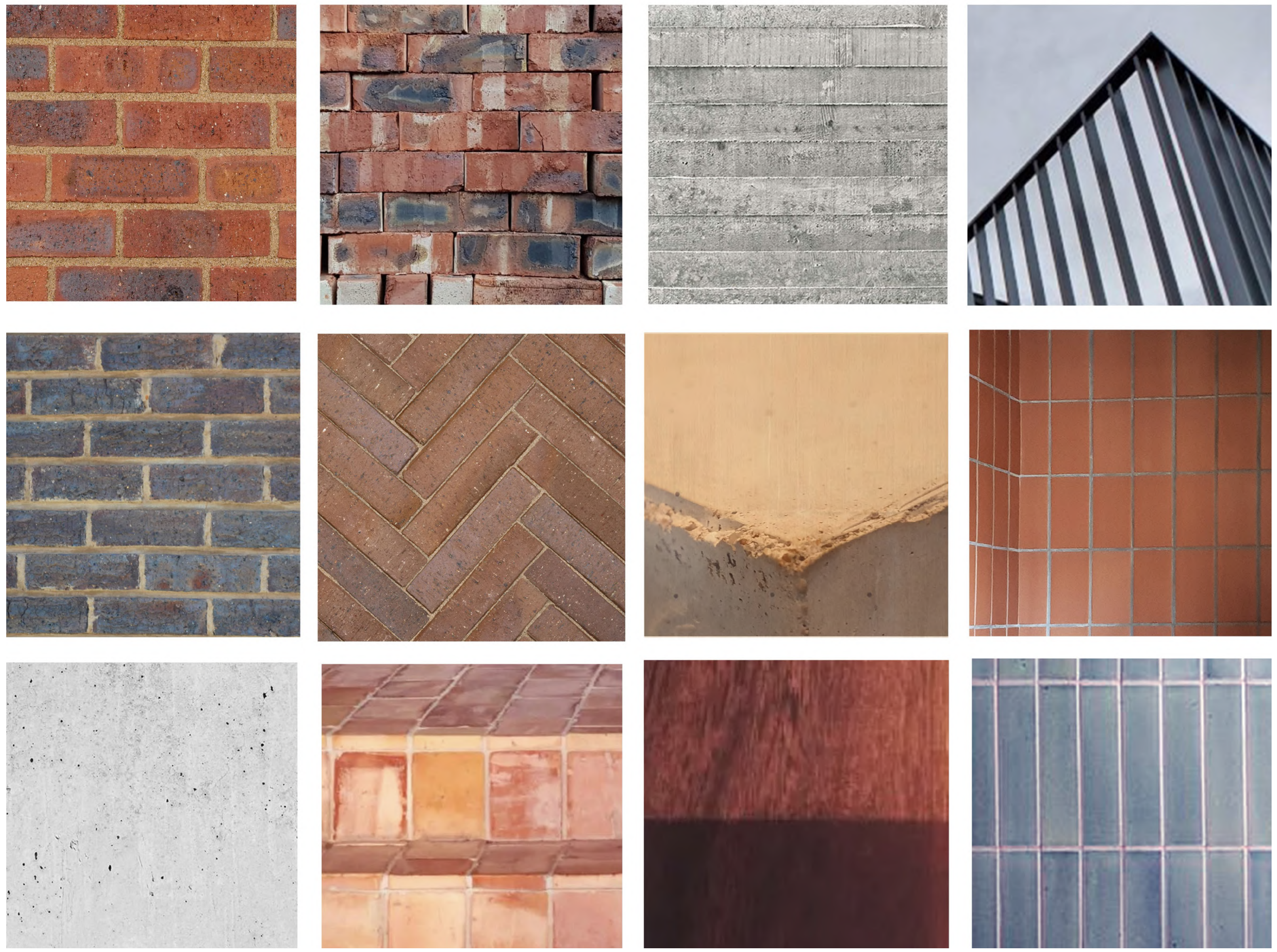


Fig. 118: Proposed material palette(Author 2021)



7.6
TECTONIC ARTICULATION

At a spatial level the design is a reinterpretation of the arcade and courtyard typologies of Pretoria. The following section will explore the tectonic articulation of spaces of transition and spaces of dwelling (lingering, sitting, eating and socializing).

TRANSITION SPACE

The primary role of the ceiling plane is to indicate the direction of movement. As one continuous element the ceiling plane folds up and down to pull the user into a particular space and change the scale of threshold spaces. Concrete beams, spanning in the cross direction of the walkway, prompts the user to engage with the spaces on either side.

The pattern of the floor plane must emphasise the direction of movement. Steps and stairs continue the floor material and pattern to encourage users to access the lower and upper public levels.

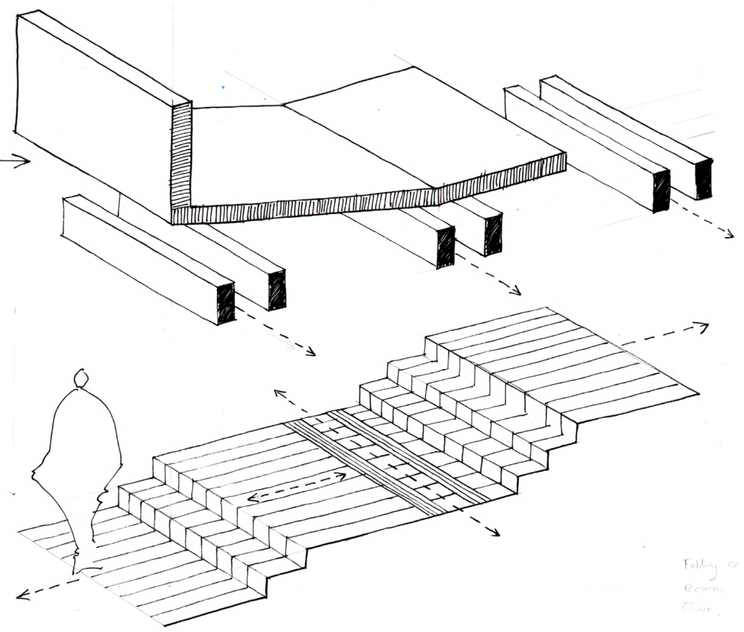


Fig. 119: Transition space (Author 2021)

DWELLING SPACE

Spaces of dwelling require a sense of intimacy and enclosure. The ceiling plane folds down to reduce the scale of a space and folds up to frame a particular view. It mediates both the user's sense of refuge and exposure to others. The space between deep columns or fin-like walls can be used as a place of refuge or as a threshold into a space of refuge. The floor plane steps up and down to create seating and spaces of gathering. Rounded corners and coloured ceramic tiles articulate a seat as a separate element. A shift in paving pattern and strips of tiling indicate the change from a space of transition to a space of dwelling.

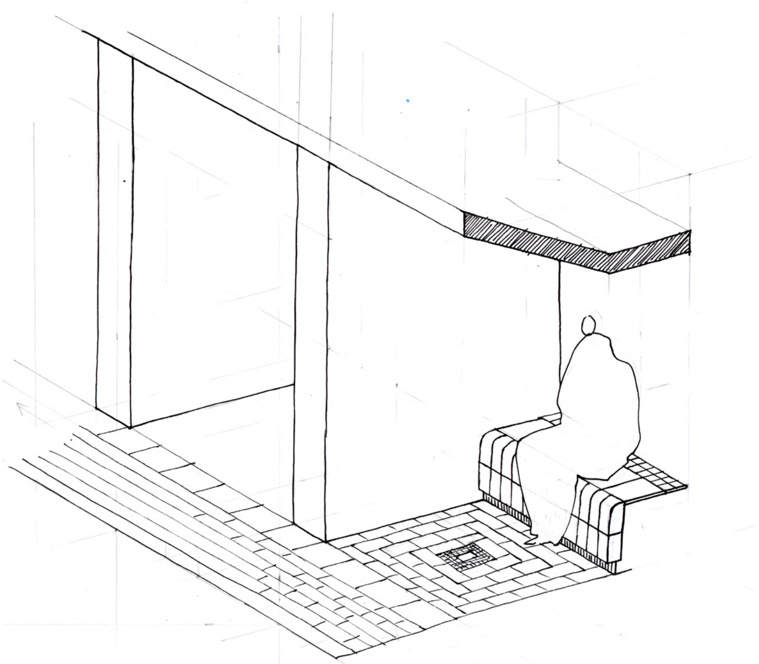


Fig. 120: Dwelling space (Author 2021)

CONTINUATION AND DIFFERENTIATION

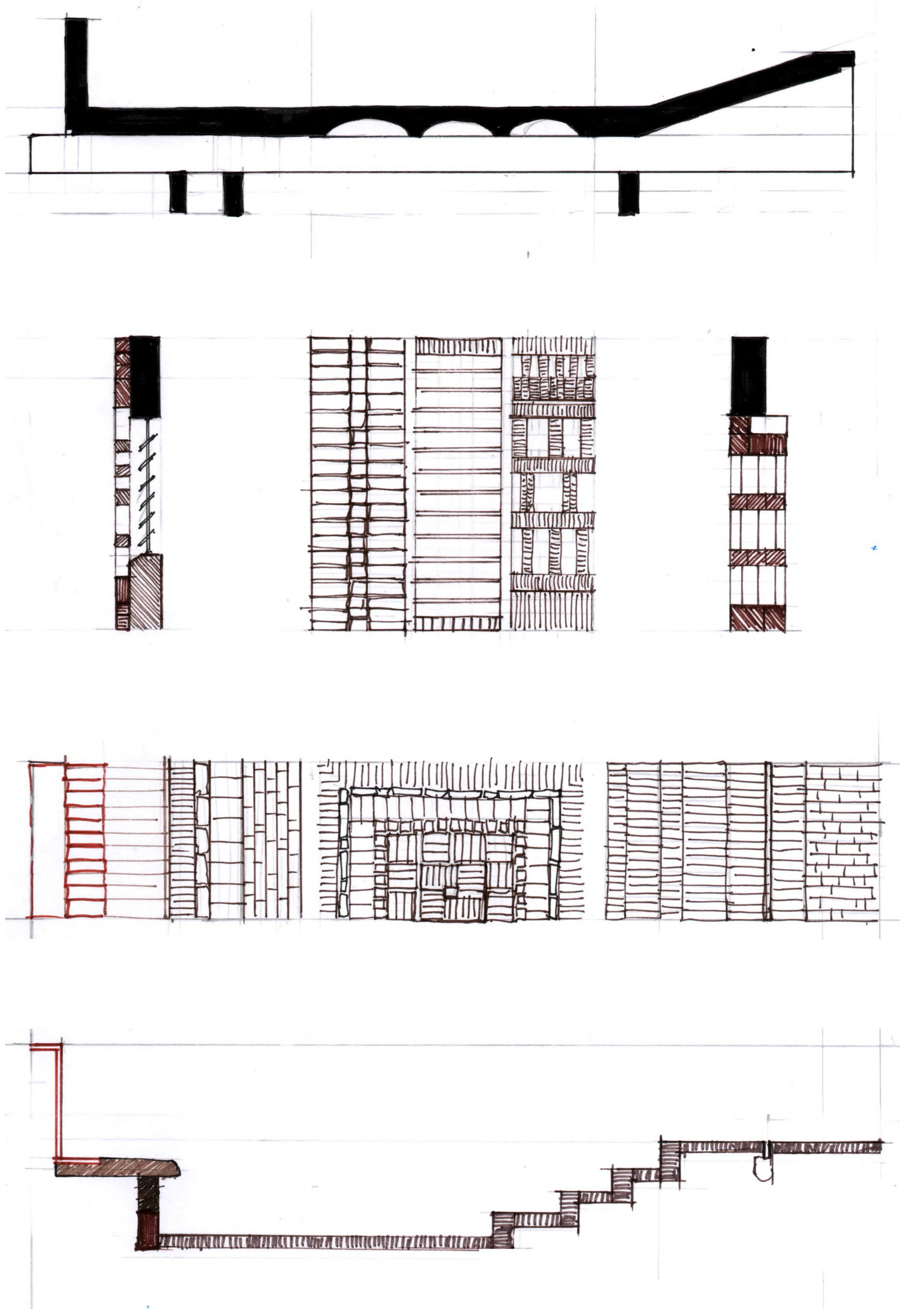


Fig. 121: Continuation and difference in the articulation of overhead plane, envelope and ground plane (Author 2021)

7.7

STRUCTURAL SYSTEM

The edge conditions of spaces are the primary mediator between internal refuge and external exposure. The vertical structure is therefore located on the edges of a space to create an unrestricted open space within. The structure should enable variations in edge conditions such as openings, screens or solid walls.

ITERATION 1 – WALLS AND BEAMS

The first iteration explored an external structural skin supported on a two-way concrete beam system to create large open space underneath. A five-storey external brick skin would require a frame or buttress system for lateral support. Perforations in the building's skin would be severely limited in order to maintain the wall's structural integrity.

ITERATION 2 – STEEL FRAME

The second iteration explored the use of a steel portal frame to contain the structure within the building envelope. A non-structural external skin would hang from the steel frame as a separate element. The skin would accommodate variations in openings and screens, independent from the primary structure. The concrete slabs cannot span the 12m width of the building without internal columns. Steel beams would span across the width of the building between the steel columns to support the one-way concrete slabs. In order to span 12m the steel beams at every level would need to be 750mm deep. A steel system is therefore uneconomical and impractical.

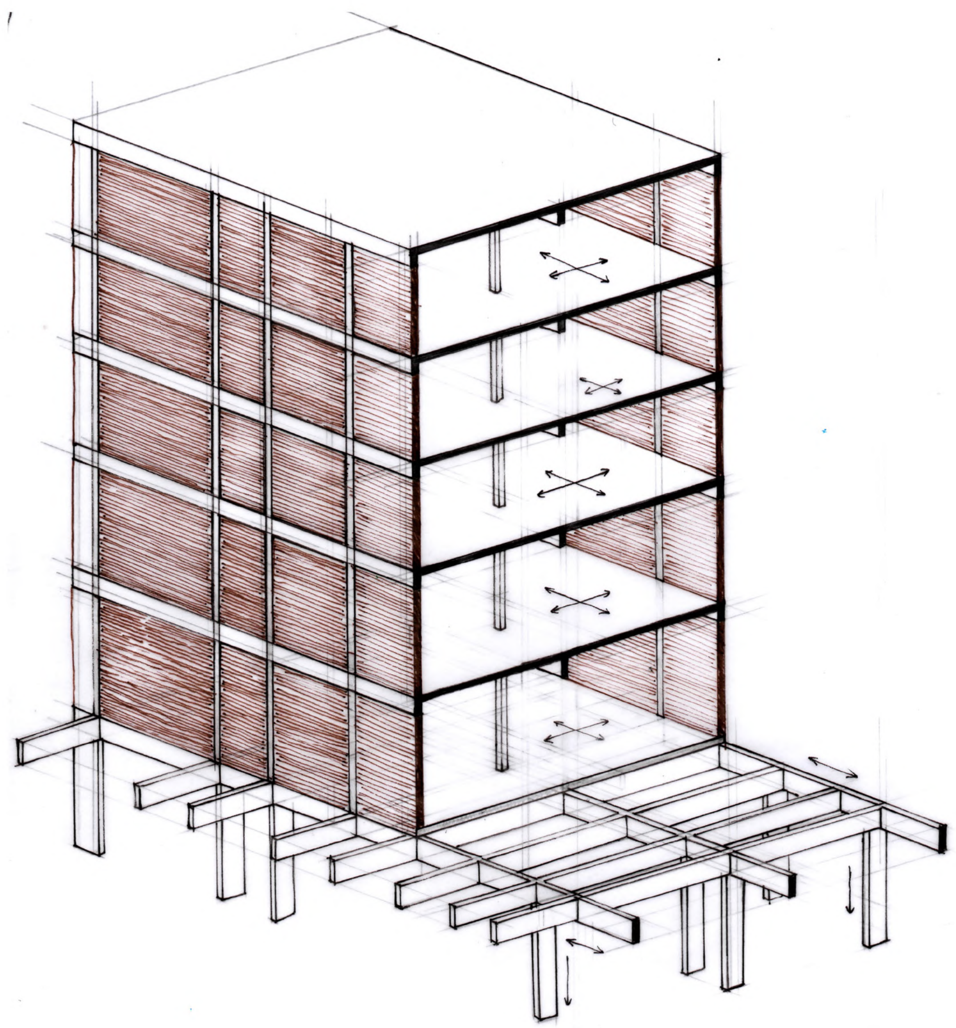


Fig. 122: Stucture iteration 1 (Author 2021)

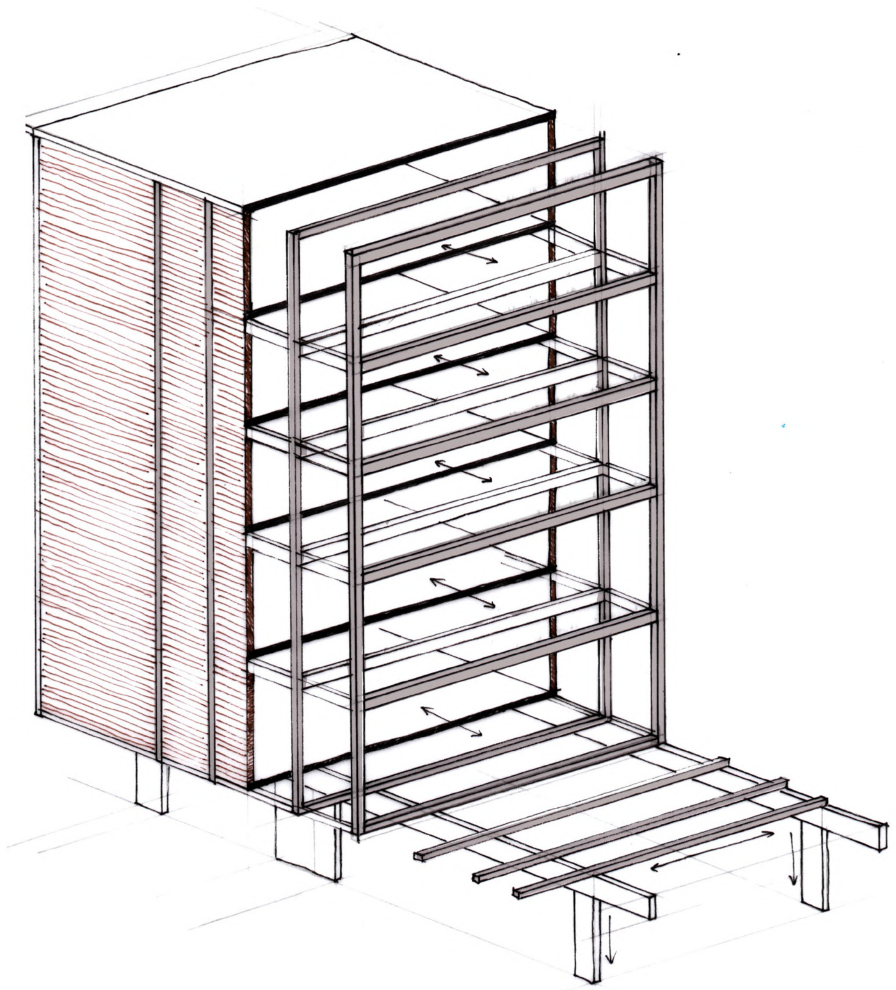


Fig. 123: Stucture iteration 2 (Author 2021)

ITERATION 3 – CONCRETE FRAME

The final iteration is a reinterpretation of the typical concrete frame structural system. The concrete frame, with infill brick walls, is used by neighbouring buildings similar in scale to the proposed building. A concrete frame is economical, quick to construct in a constrained site and allow for flexible internal configuration of spaces.

The use of deep fin-like concrete columns on opposite edges of the building reduce the internal span to 8m, which eliminates the need for internal columns. Exposed concrete beams span between the columns across the internal space to frame openings and connections between the street, the internal space and the courtyard. The deep columns create an intermediate space between the external and internal condition. The envelope of the main building facing the street consists of an external screen that respond to the city and an internal skin between the columns that respond to the needs of each individual space.

All the main spaces use the same structural logic: structural columns along two opposite edges of a space, connected with beams spanning across the space to support and overhead slab.

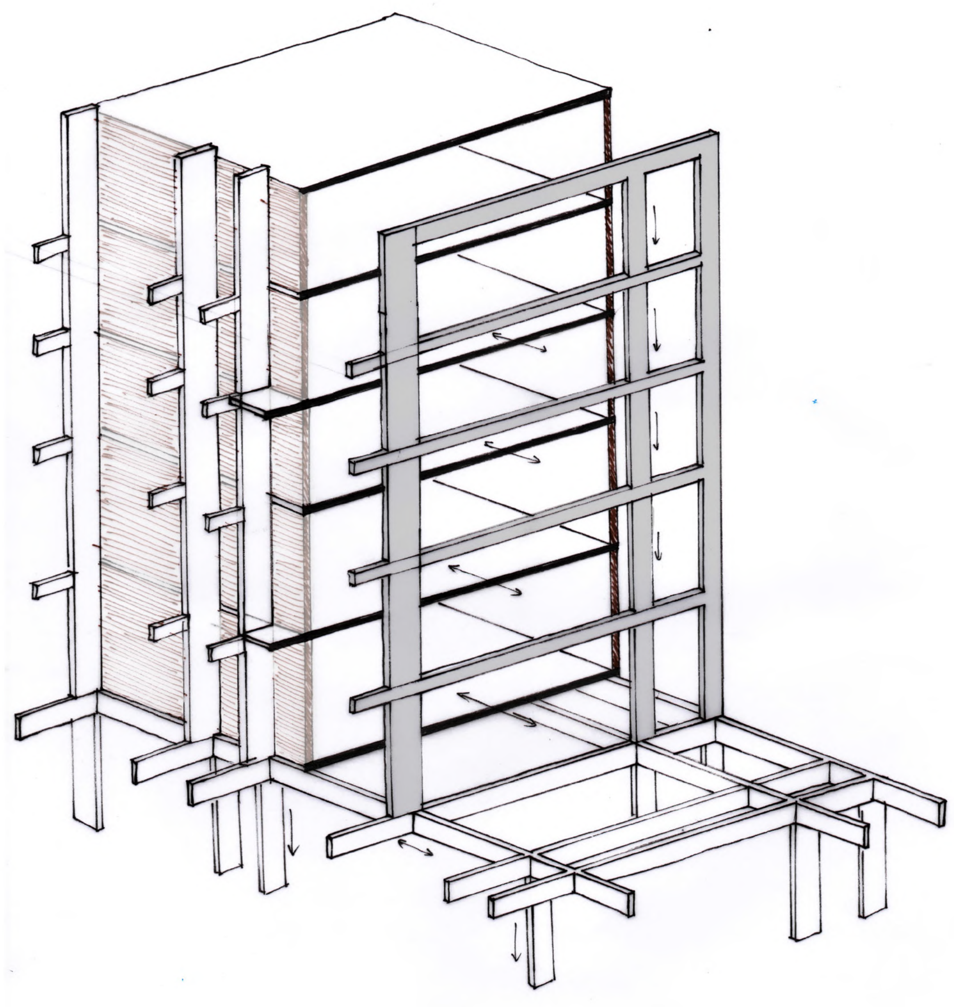


Fig. 124: Stucture iteration 3 (Author 2021)

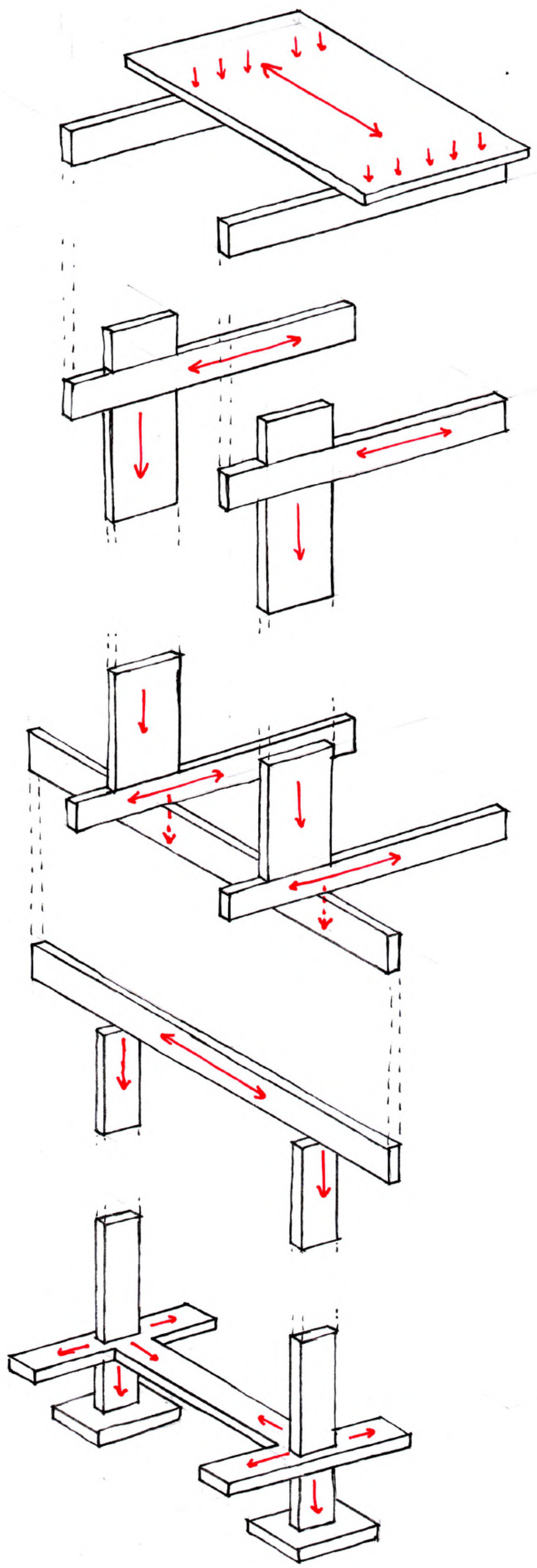


Fig. 125: Stuctural logic (Author 2021)

7.8

TECNOLOGY EXPLORATIONS

THE ENVELOPE

Technological explorations of the envelope were primarily focused on the the precast concrete screen that form the front facade of the education building. The intention of the screen was to give the apprence of a solid facade, but still allow natural light and ventilation to enter the interior, and views out towards the city. This acts as a critique and reinterpretation of the existing typologies surrounding the site, where the facades above ground floor are solid and unresponsive to the street. The appearance of the screen as a solid element, reinforces the users' perception of the building as a place of refuge. Lightweight materials such as steel, polycarbonate panels and glass could not provide the appearance of solidity. Bricks and standard precast concrete elements were considered but had limitations in terms of size and variations of openings that could be created. Therefore, custom made precast concrete 'bricks' were designed. The elements are larger that standard bricks to be able to create large openings and variations according to the internal spaces' requirements. Multiple iterations of the precast bricks were cast to explore different mixes, colouring and recycled aggregates.

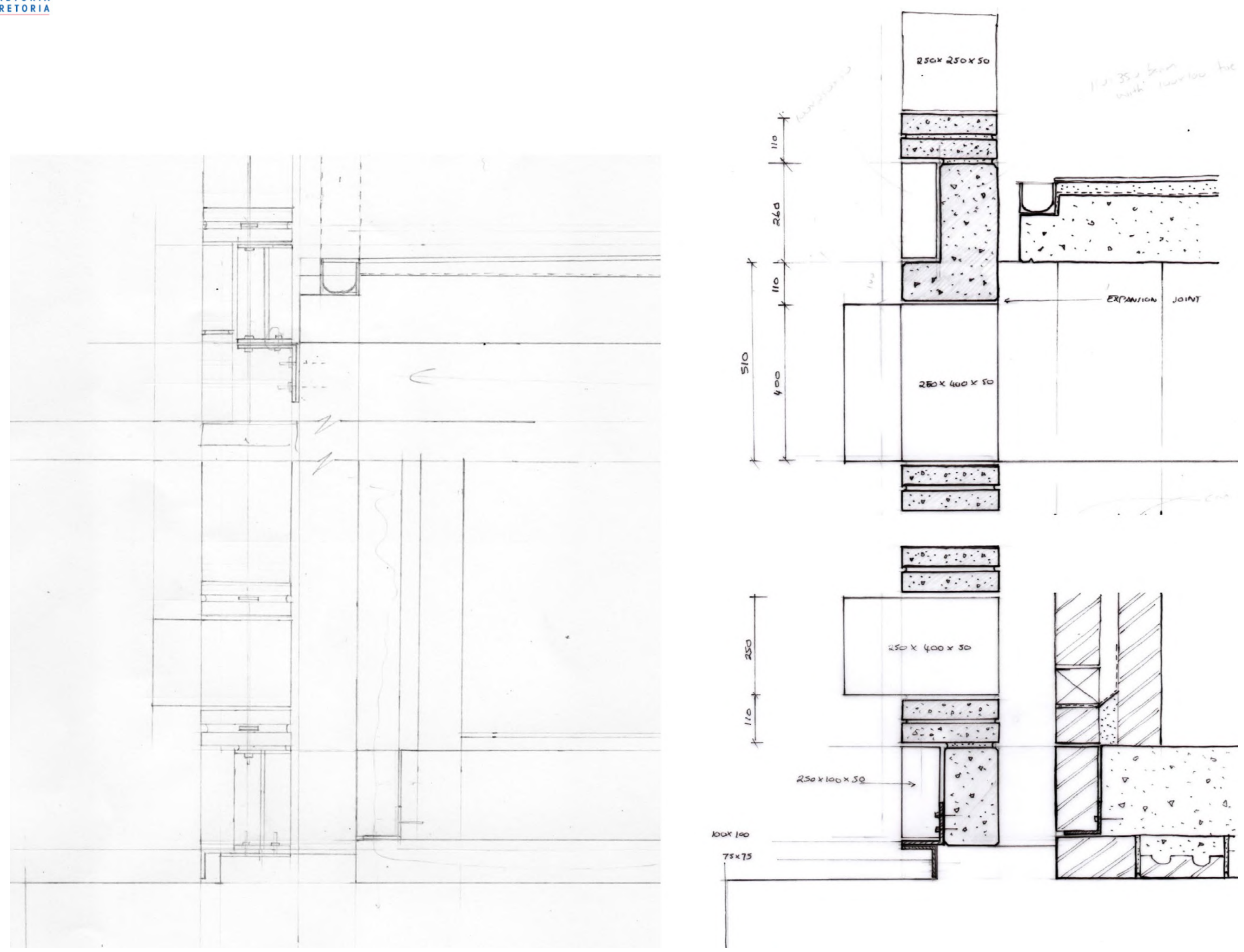


Fig. 126: Exploration of precast concrete screen (Author 2021)

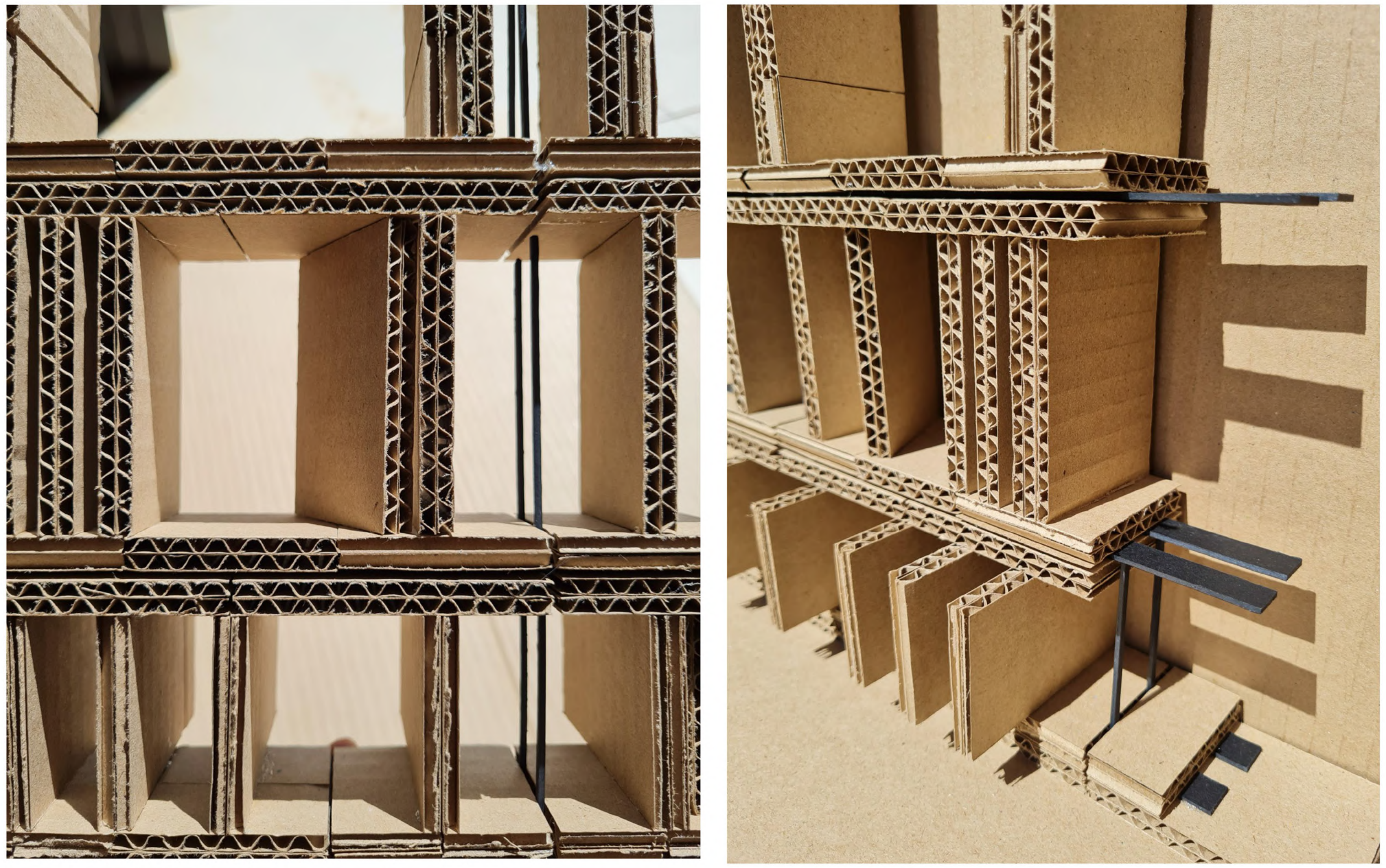
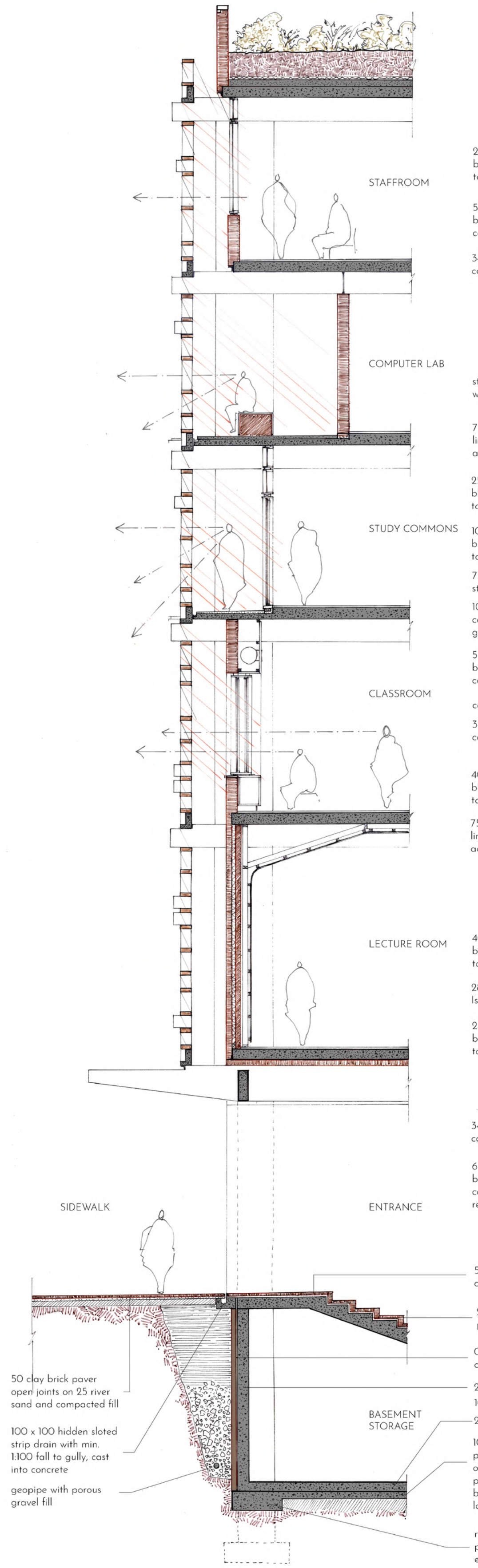
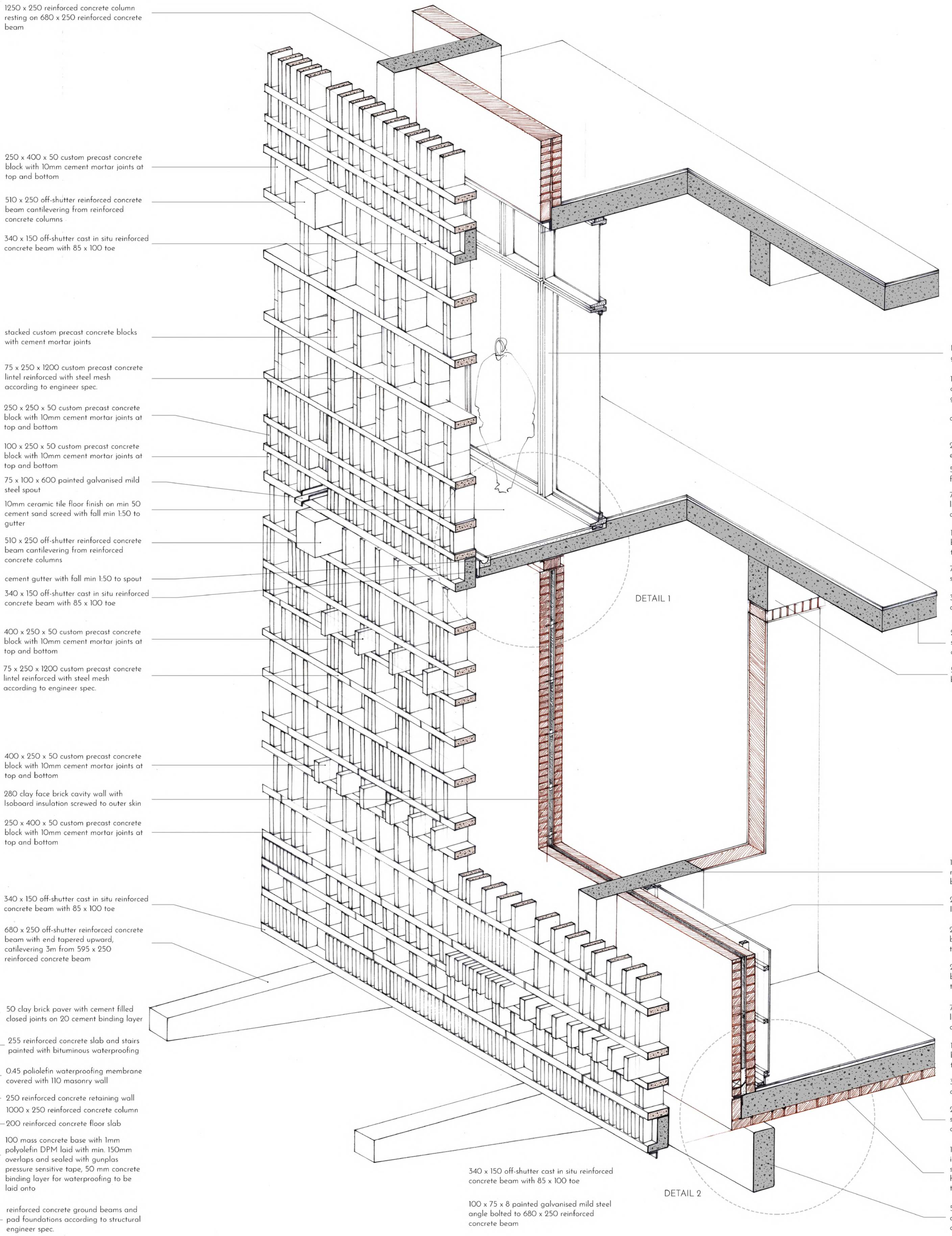


Fig. 127: 1:5 model of the screen's structural system. An iteration using steel reinforcement. (Author 2021)

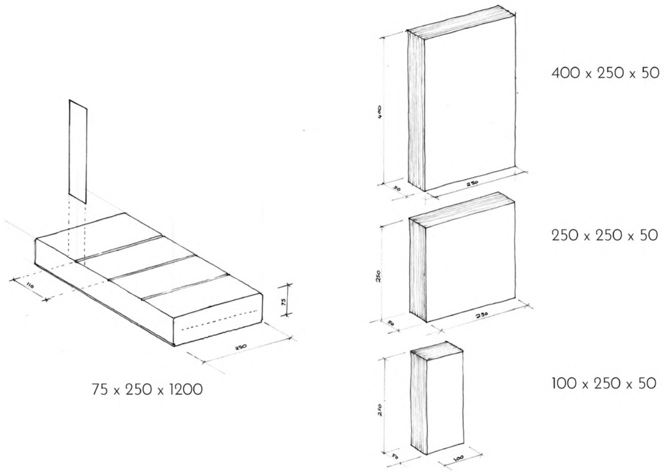
Fig. 128: Full scale precast concrete brick castings (Author 2021)



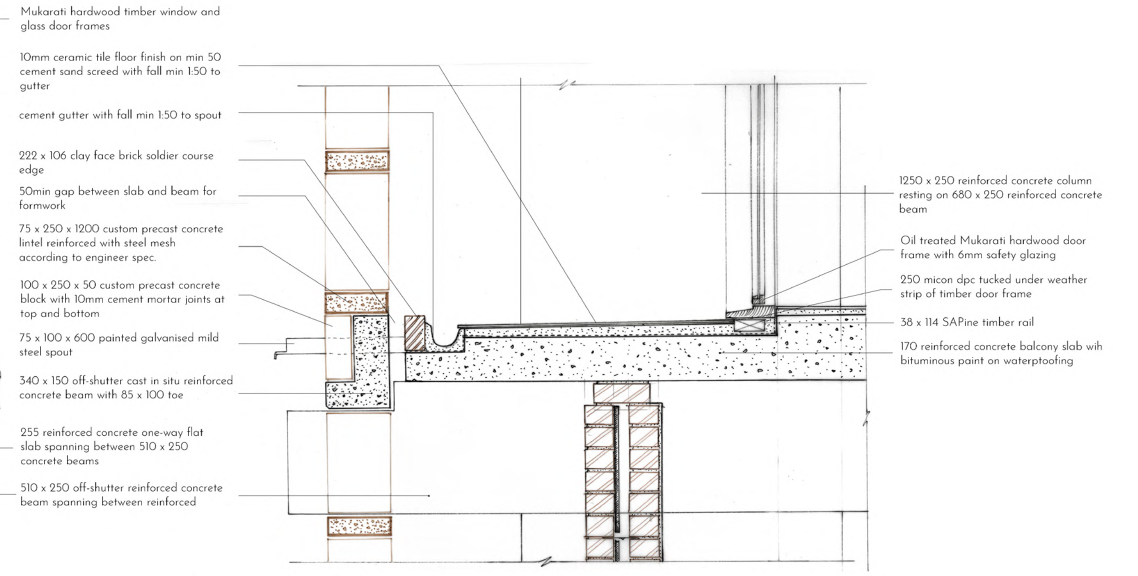
1:50 SECTION OF NORTH FACADE



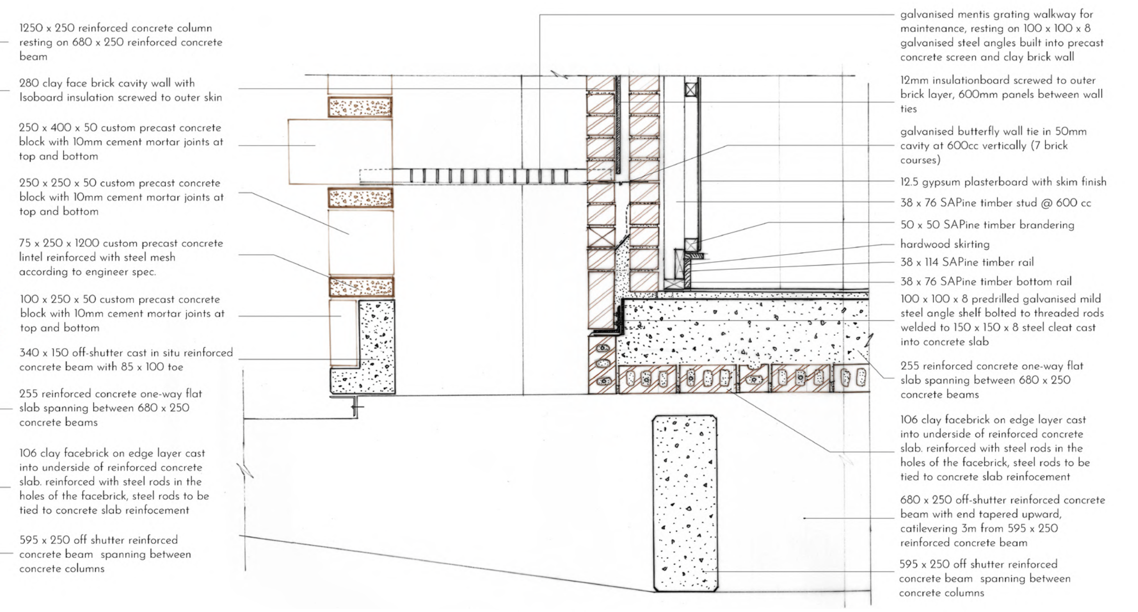
1:20 SECTION OF PRECAST CONCRETE SCREEN



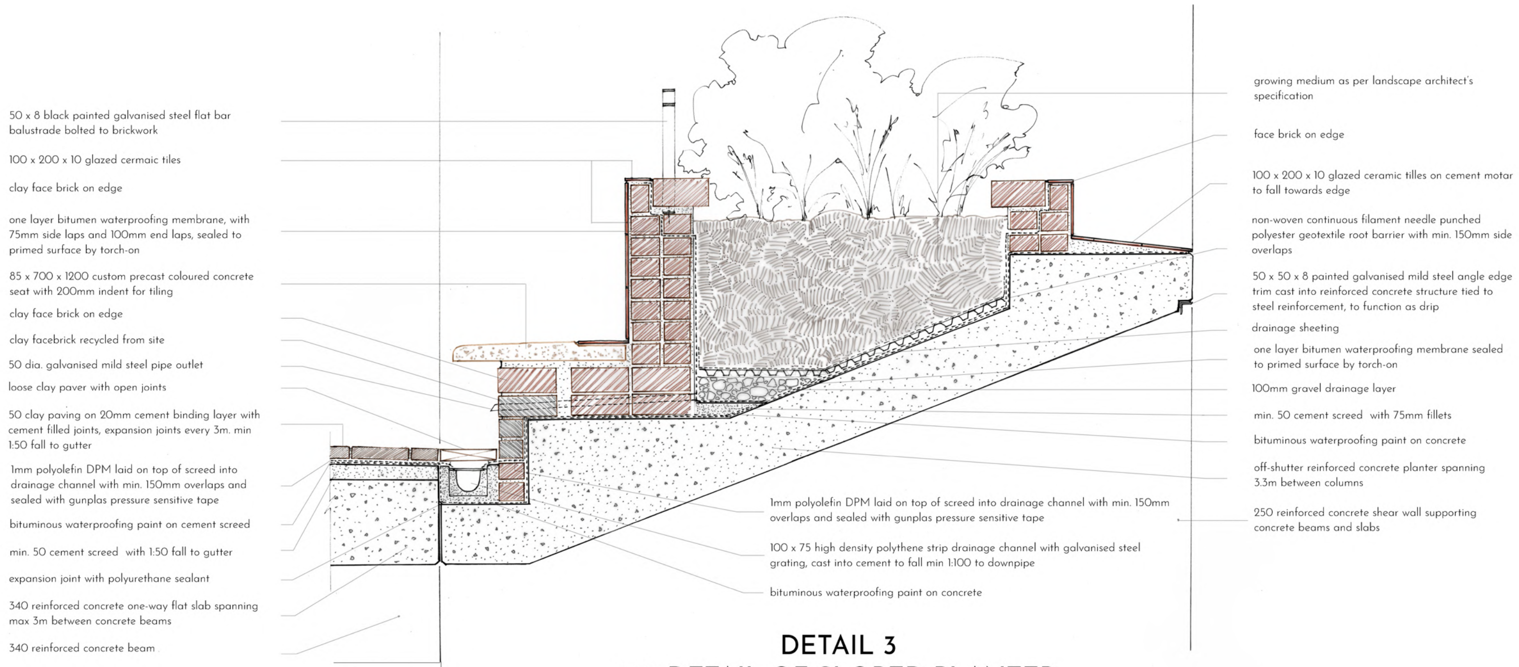
PRECAST CONCRETE SCREEN COMPONENTS



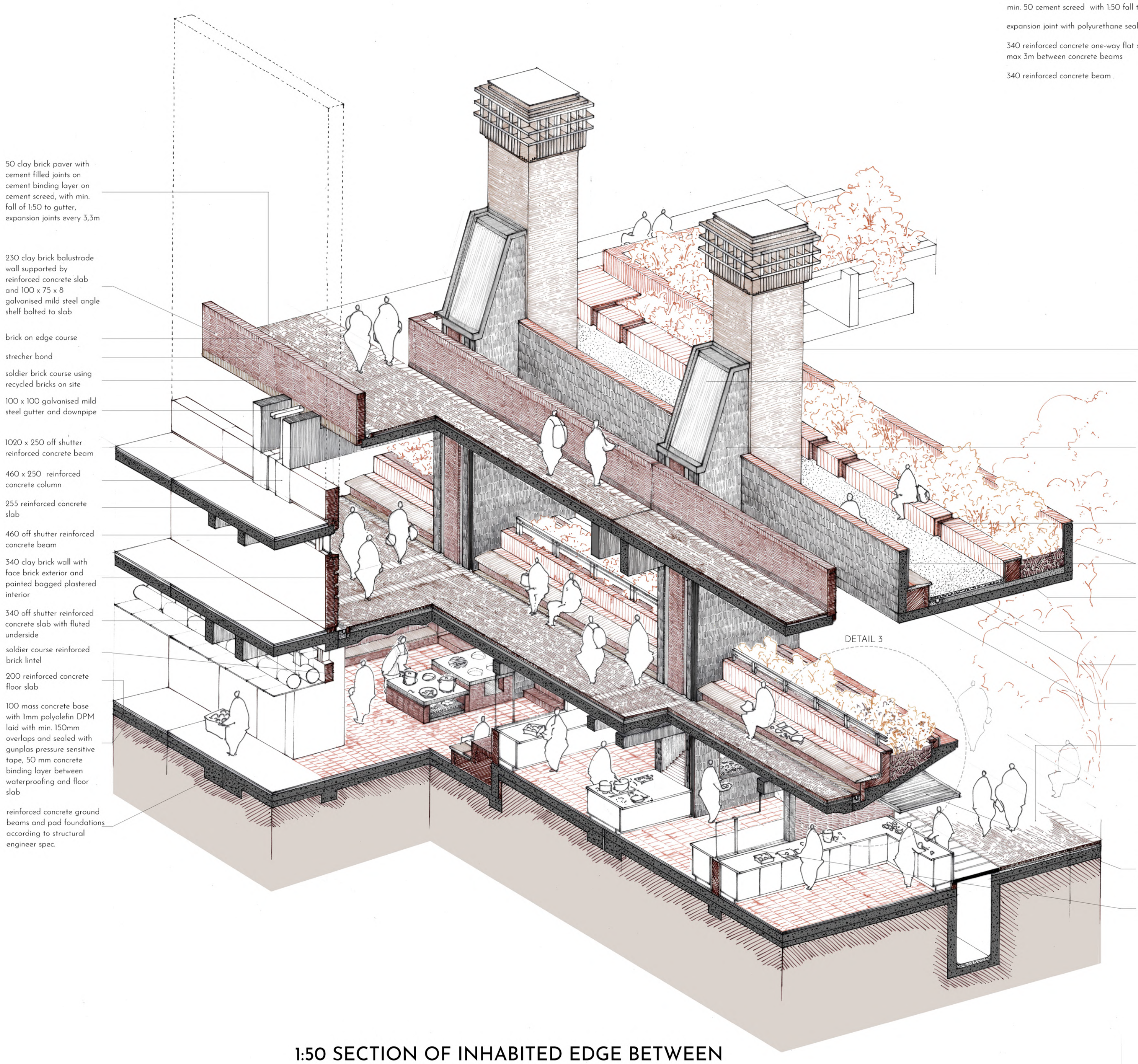
DETAIL 1
1:10 SECTION OF PRECAST CONCRETE SCREEN AND BALCONY



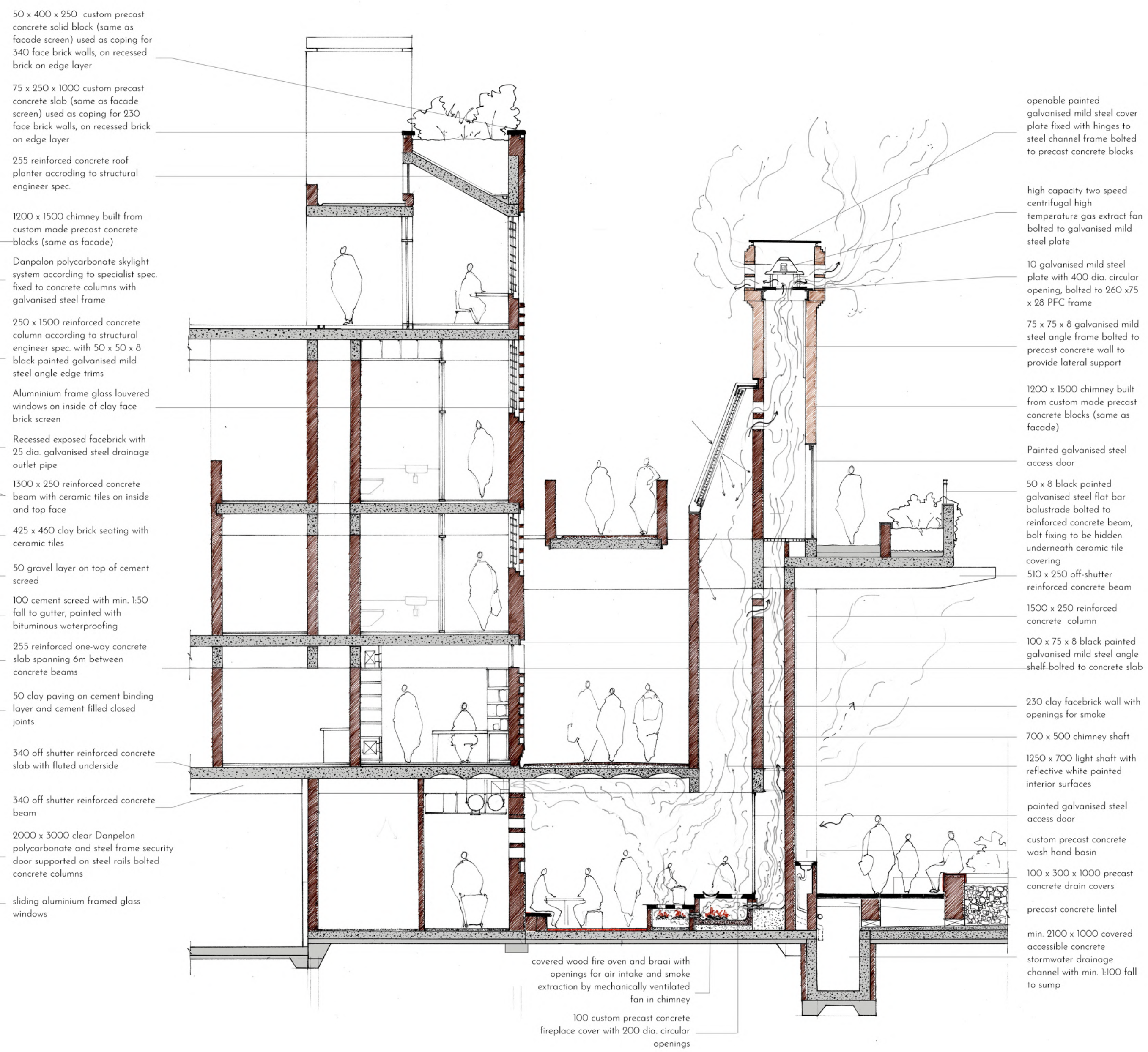
DETAIL 2
1:10 SECTION OF PRECAST CONCRETE SCREEN AND BRICK EDGE ARTICULATION



DETAIL 3
1:10 DETAIL OF SLOPED PLANTER



1:50 SECTION OF INHABITED EDGE BETWEEN ARCADE AND COURTYARD



1:50 SECTION THROUGH CHIMNEY AND COOKING SPACE

GROUND PLANE

The articulation of the paving, stairs and seating in public spaces affect the way in which spaces are used and appropriated. Brick pavers are used for external stairs as a continuation of the public surface into the courtyards. Custom made precast concrete seating facilitate the act of dwelling and socialising. Ceramic tiles rather than exposed brickwork are used where dwelling is promoted.

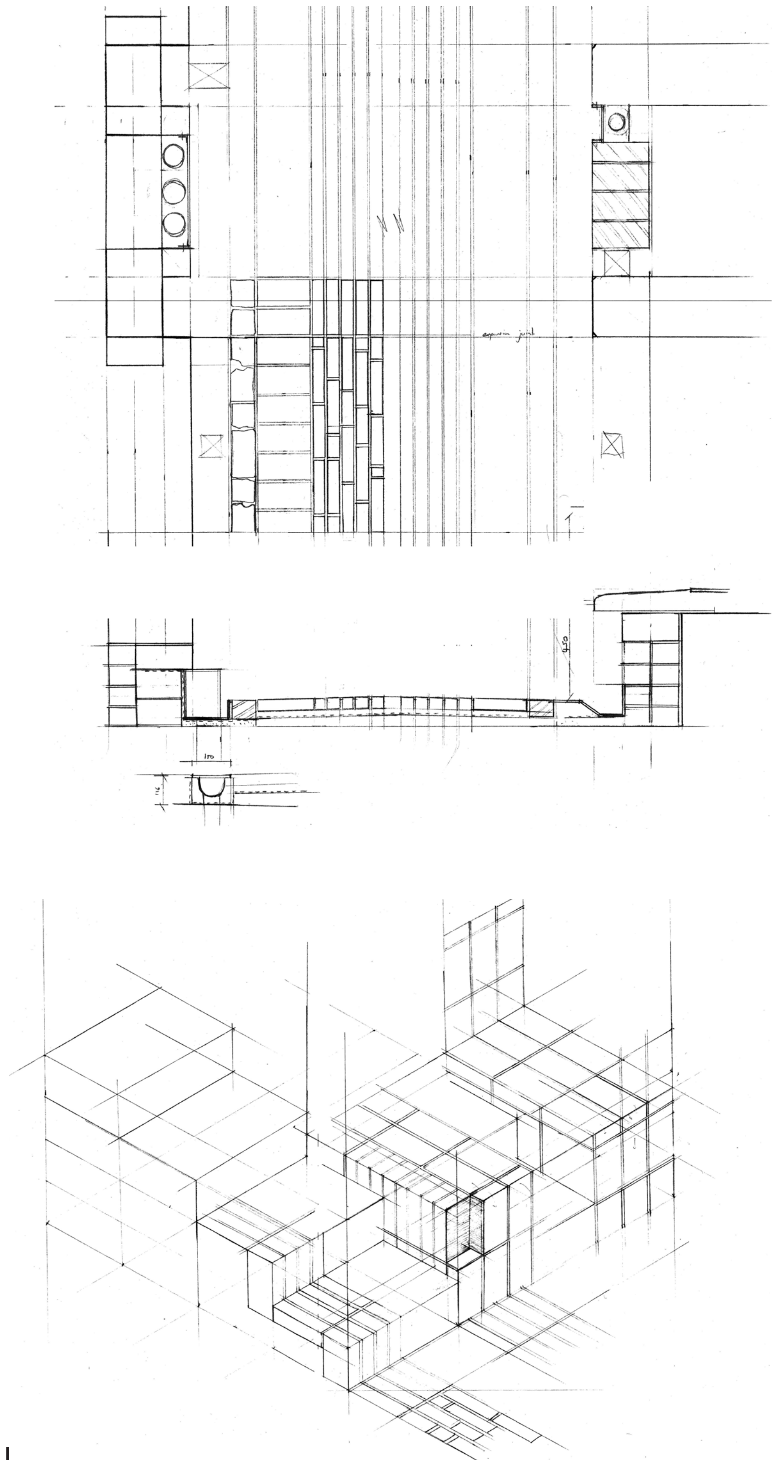
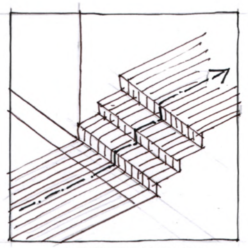
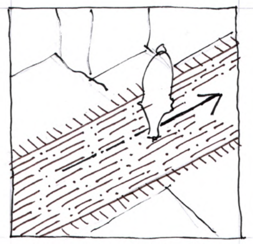


Fig. 129: Explorations of the ground plane (Author 2021)

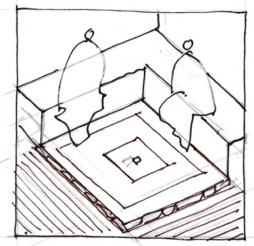
FLOOR PLANE ARTICULATION INTENTIONS



STAIRS TO BE TREATED AS A CONTINOUS SURFACE EXTENDING THE GROUND PLANE UP OR DOWN

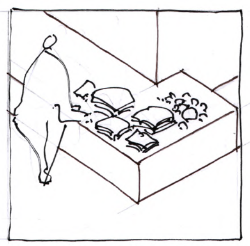


PAVING OF TRANSITION SPACES IN LINEAR ROWS TO IN DIRECTION OF MOVEMENT

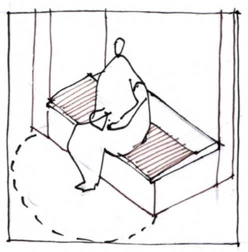


PAVING OF DWELLING SPACES RADIATING FROM A CENTRAL POINT SIGNIFYING A PLACE OF GATHERING

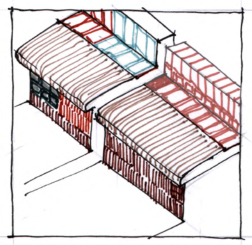
SEATING ARTICULATION INTENTIONS



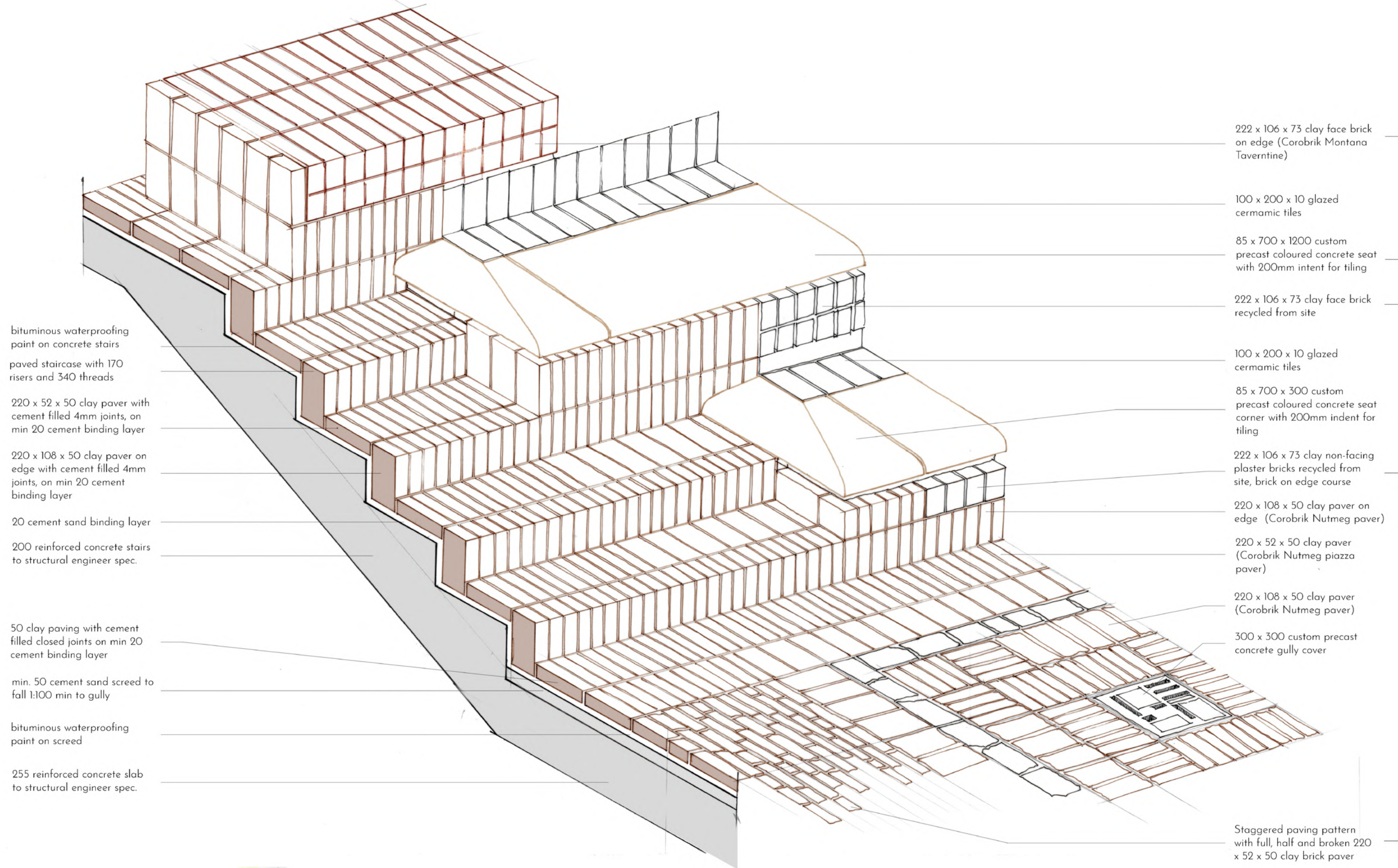
BRICK PLINTHS ALLOW FOR INFORMAL APPROPRIATION

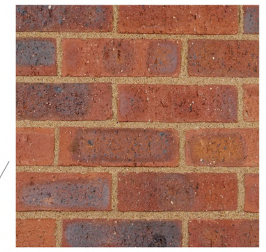


PRECAST CONCRETE SEATING DEMARCATES SPACE FOR ACTS OF RESTING/GATHERING

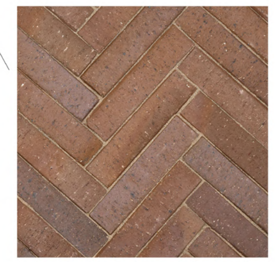


DIFFERENTIATION OF TILES AND RECYCLED BRICK USED FOR SEATING PROMOTE THE USERS' ATTACHMENT TO PLACE

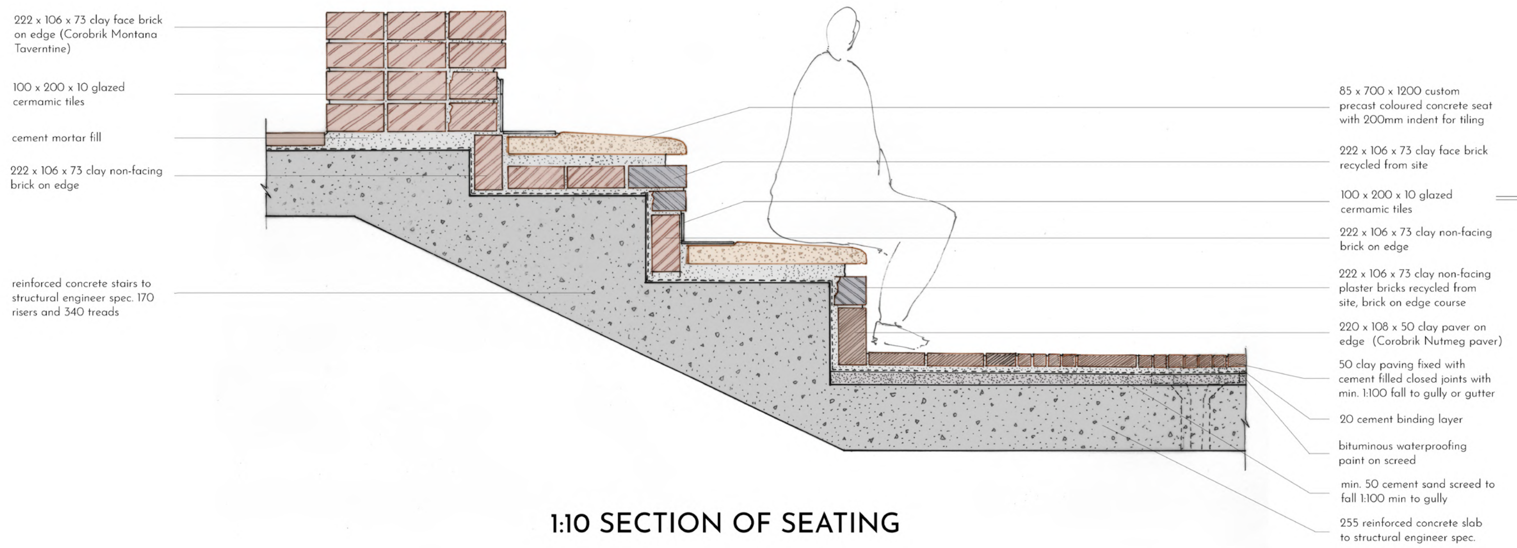


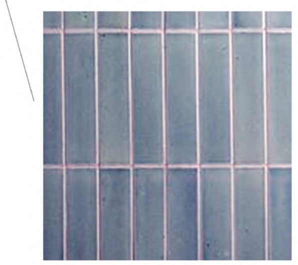






1:10 SECTION OF STAIRS AND SEATING



1:10 SECTION OF SEATING

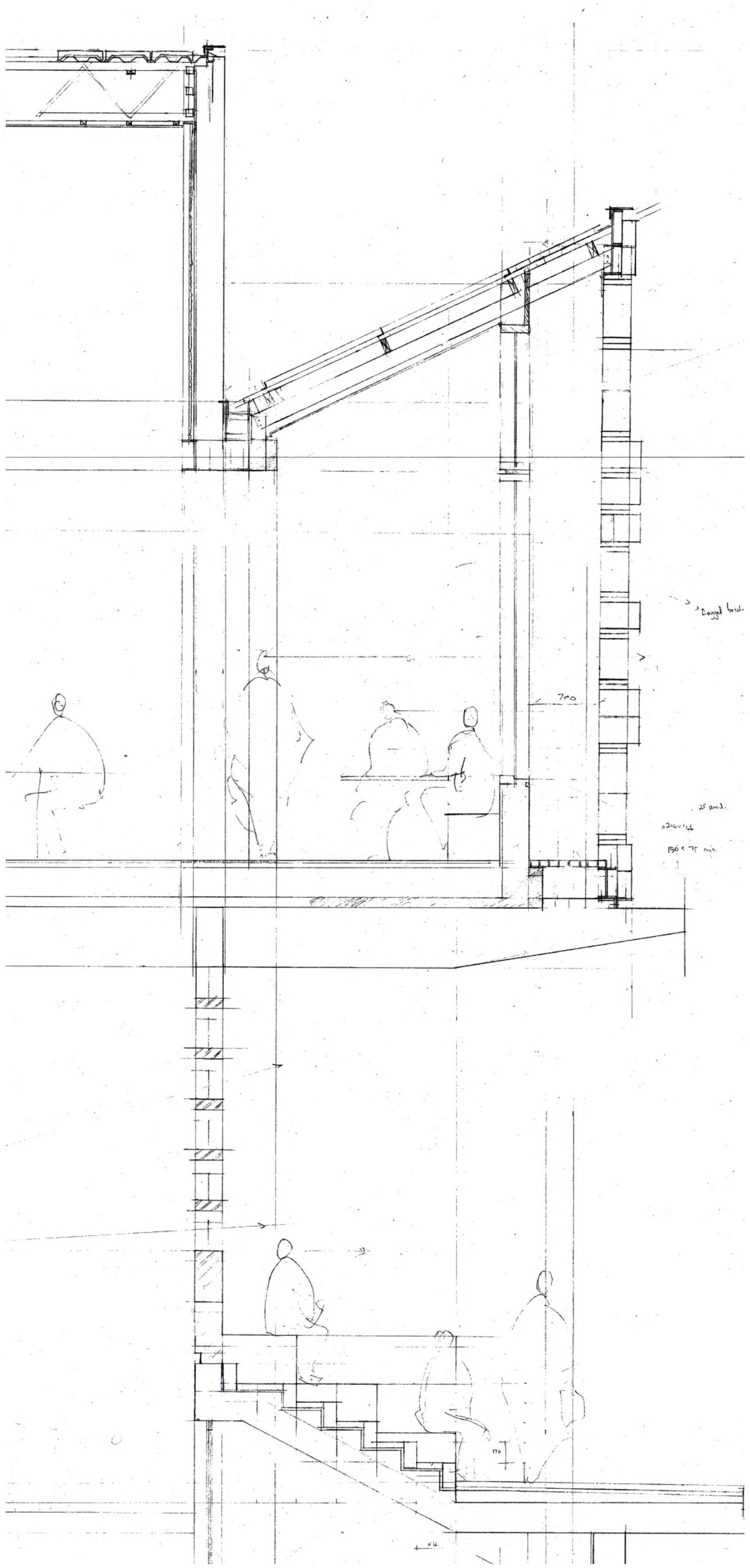


Fig. 130: Iteration 1 of the refectory/eating space (Author 2021)

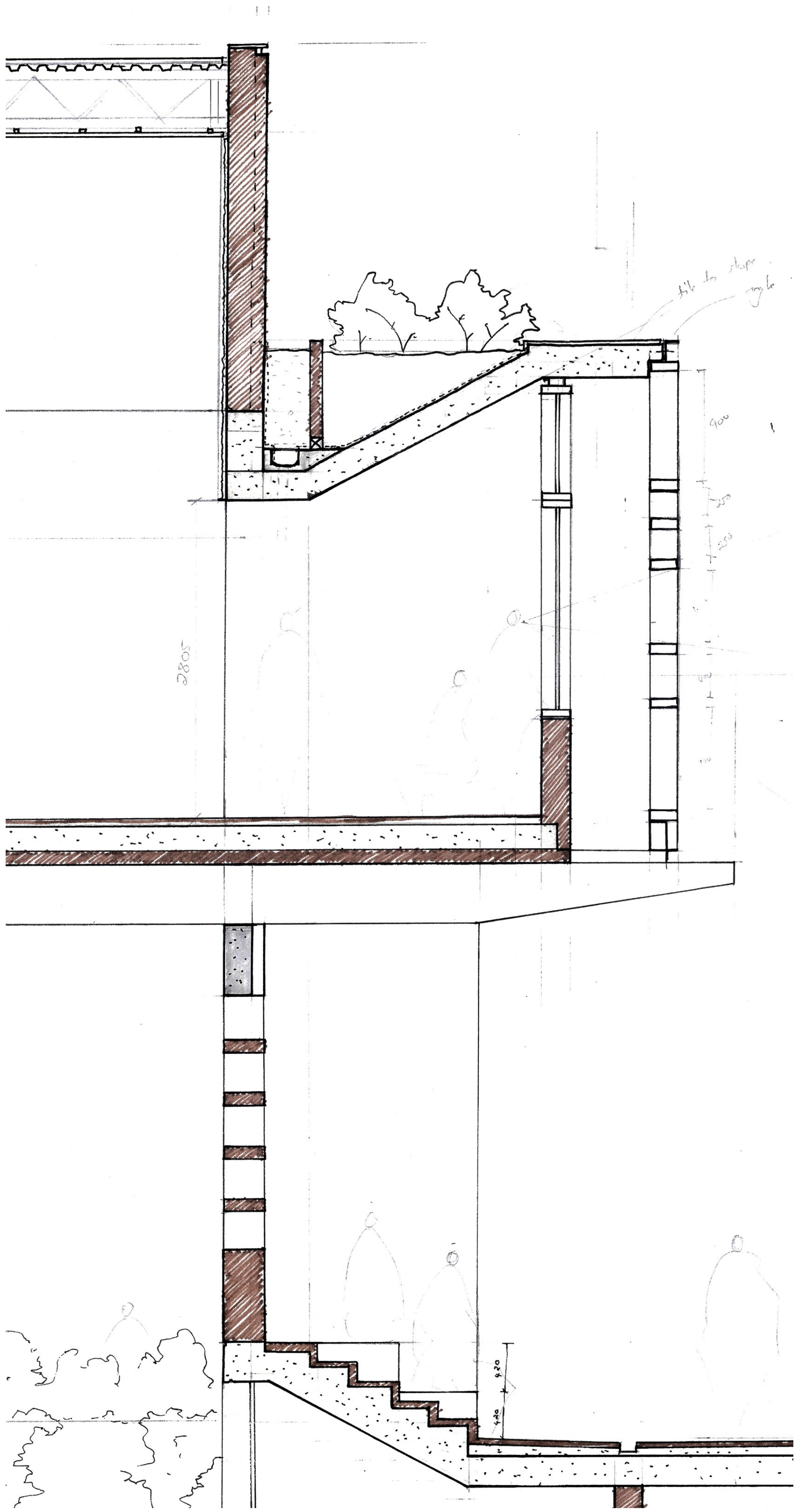


Fig. 131: Iteration 2 of the refectory/eating space (Author 2021)

Fig. 132: 1:20 section model of iteration 3 of the refectory/eating space (Author 2021)

7.9

SHADOW STUDY

The site is partially enclosed and surrounded by multi-storey buildings to the east, west and north (across the street), which restricts access to direct solar radiation and natural light. The site is predominantly shaded during winter months and receives full sun during summer months. In an ideal condition, direct sun exposure is necessary in winter months for solar heat gain of interior spaces; and summer months open spaces and building fenestrations should be shaded.

The design must therefore mediate between the ideal condition and the climatic limitations of the site. In winter months a shaded site (especially towards the street edge) is unavoidable, as is the result of surrounding buildings, and any new intervention will worsen the condition. Emphasis was placed on providing cool shaded spaces during the summer months. Shade in public spaces promote lingering, socialising and sitting - acts of refuge.

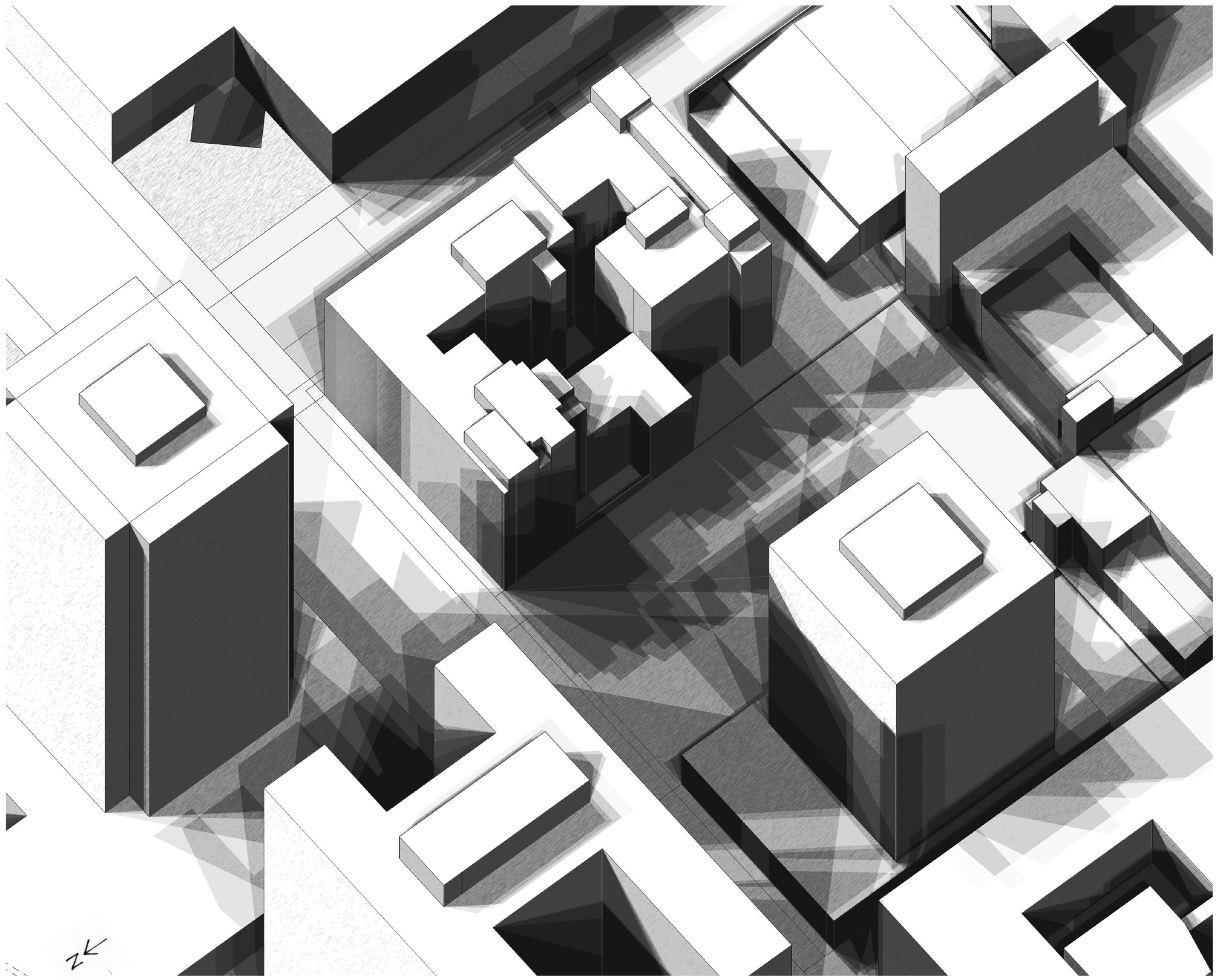
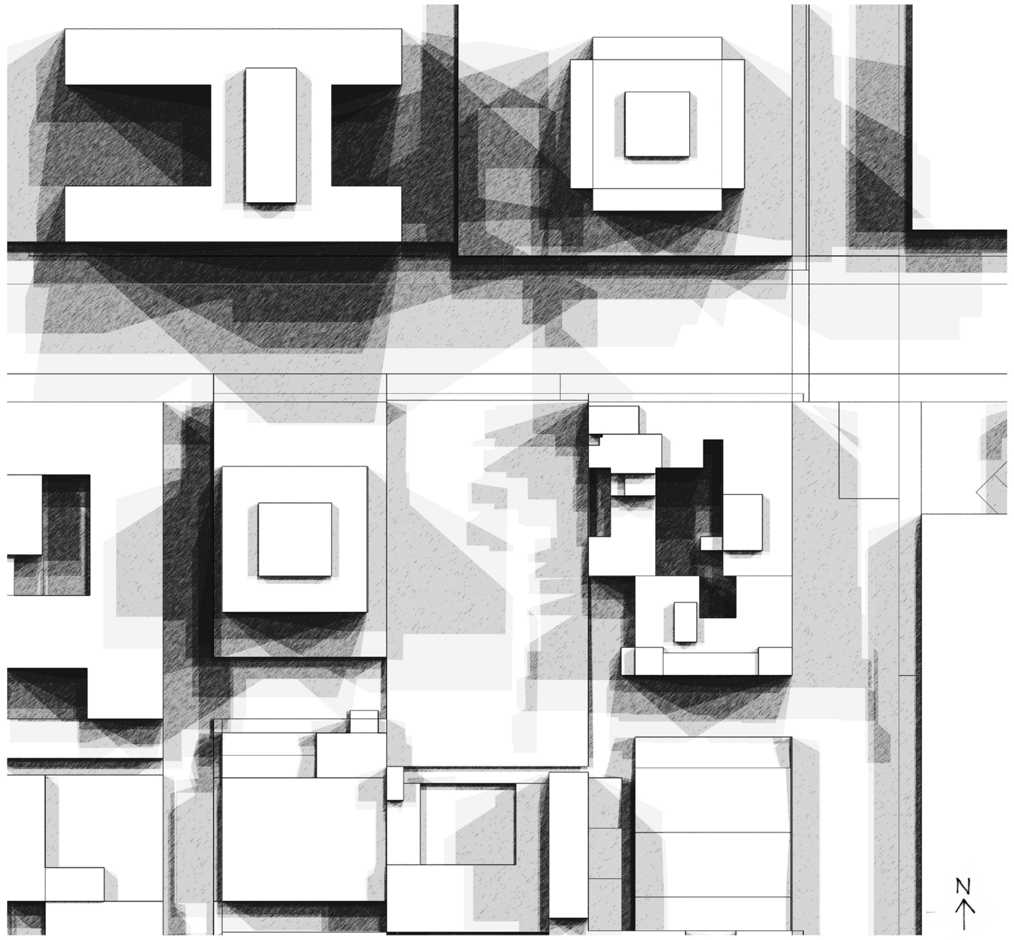
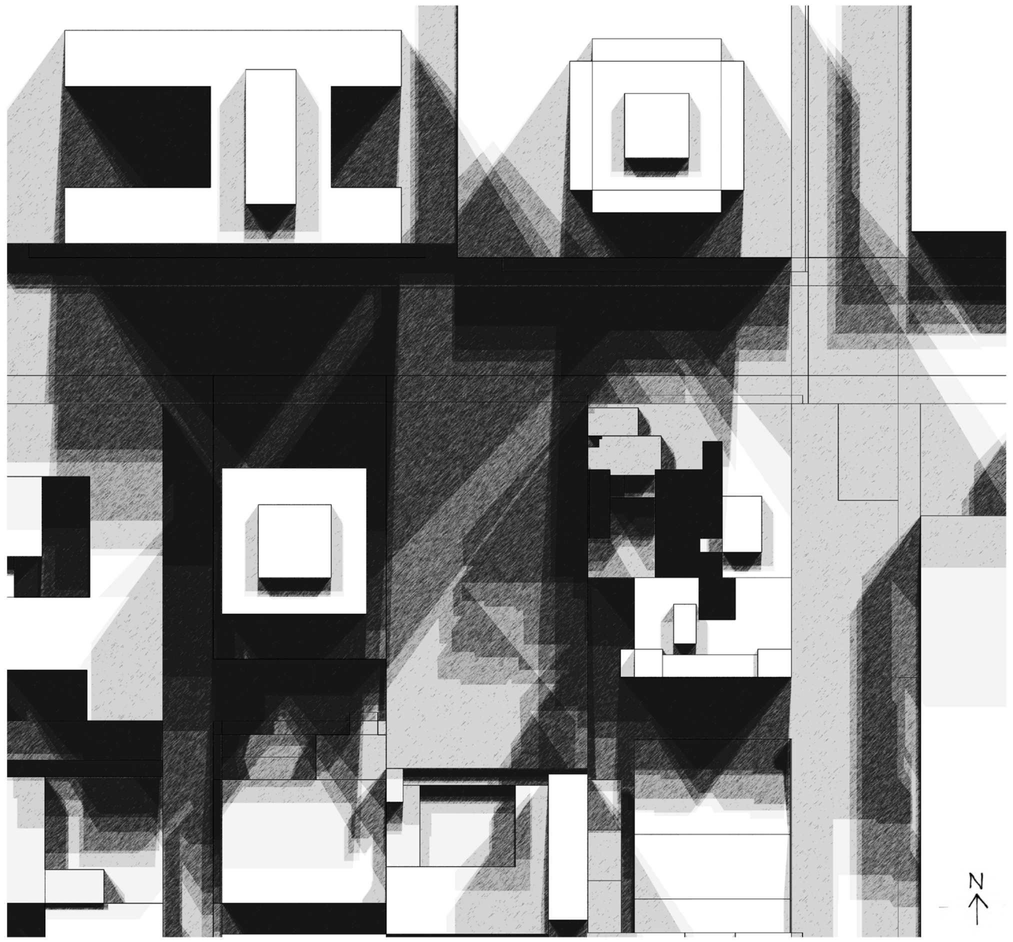


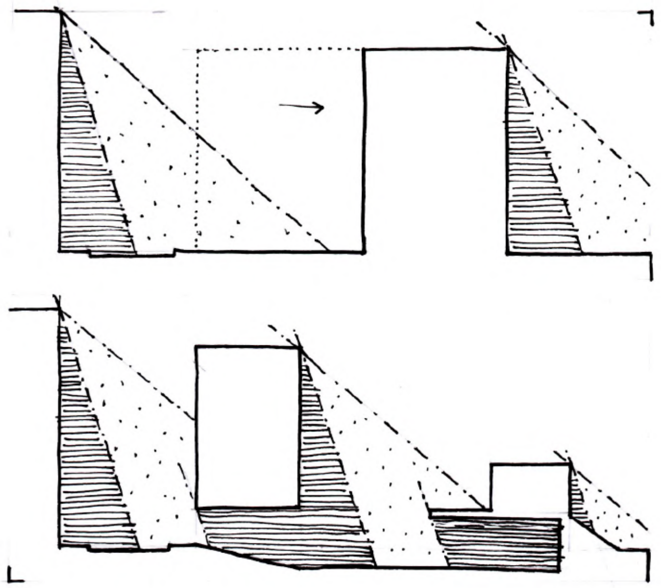
Fig. 133: Shading of the existing site(Author 2021)

EMPTY SITE
OVERHEATED PERIOD
21 September - 21 March



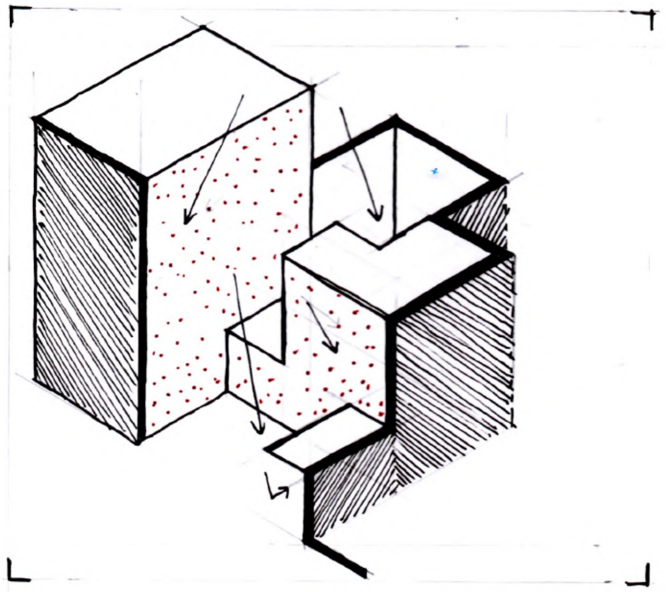
EMPTY SITE
UNDERHEATED PERIOD
21 March - 21 September





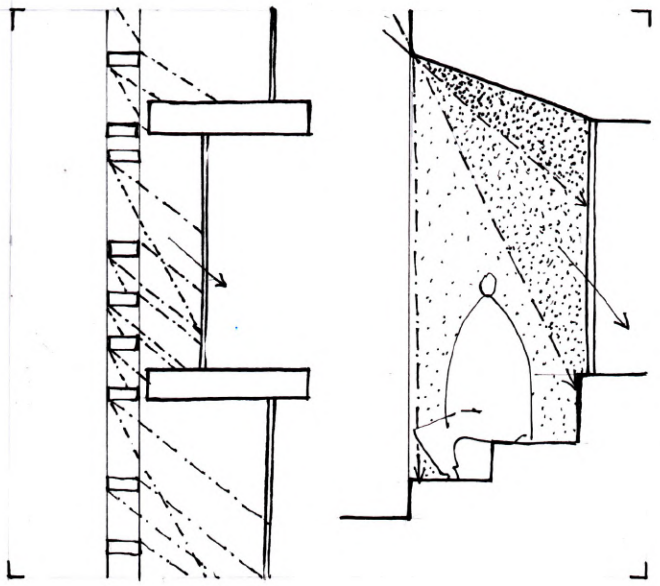
SHADED OPEN SPACES

The largest mass is positioned on the street edge to create shaded public spaces underneath and behind. Spaces that required sun exposure in winter months were placed towards the back of the site.



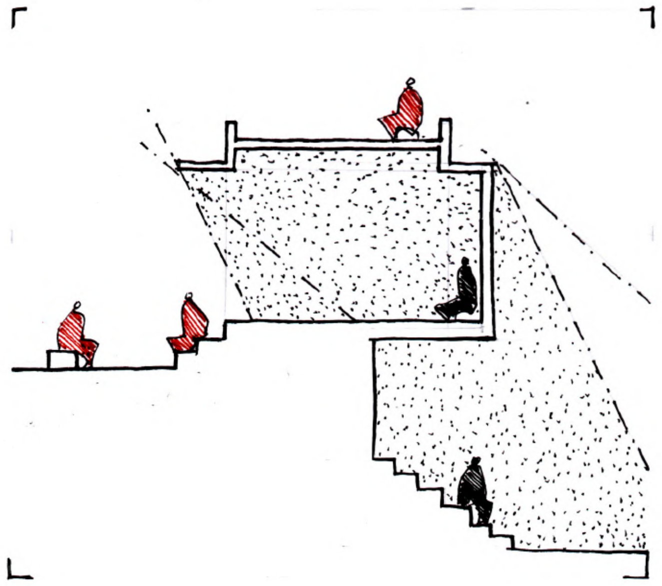
COURTYARDS

The design consists of smaller fragmented spaces placed around internal courtyards to increase access to indirect natural light, views and ventilation.



EDGE CONDITIONS

Screens and deep overhangs on the northern edges provides shade for interior and exterior spaces in overheated months, and sun exposure in underheated months.



CHOICE

People's desire for shade or sun are different and constantly changing. Therefore, the design provides different conditions for users to choose from.

Fig. 134: Design principles related to shading (Author 2021)

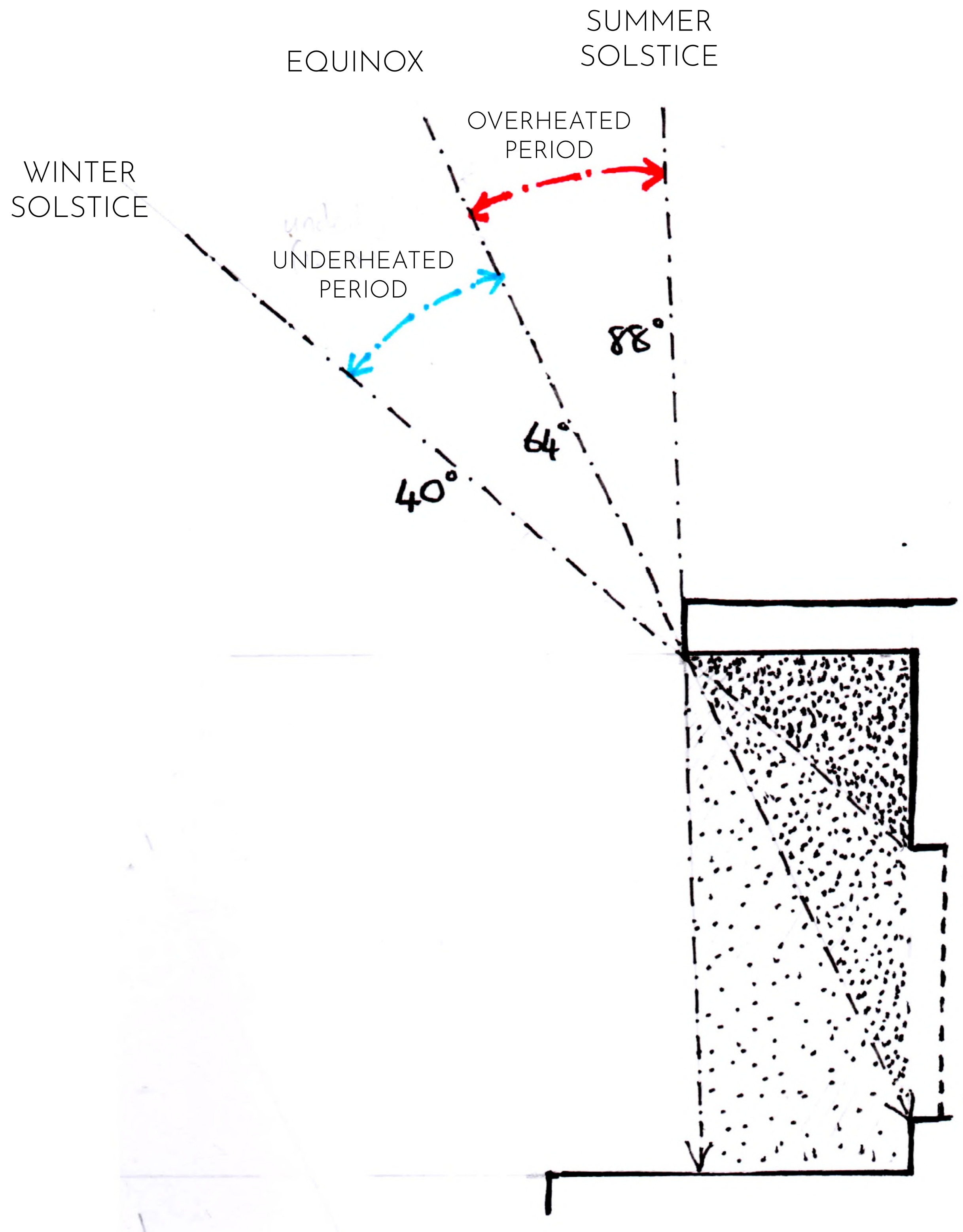


Fig. 135: Solar angles of Pretoria (Author 2021)

SHADOW STUDY OF THE DESIGN

The central courtyard is shaded but provides indirect natural light to the basement and interior. The front building is stopped short on the western corner to capatalise on the setback of the neighboring building.

Access to direct sun exposure on the front facade is unevenly distributed. Bathrooms, services and fire stairwells are positioned on the east and west sides of the building, which receives little to non direct sunlight.

Buildings towards the back of the site has access to direct sunlight in winter months.

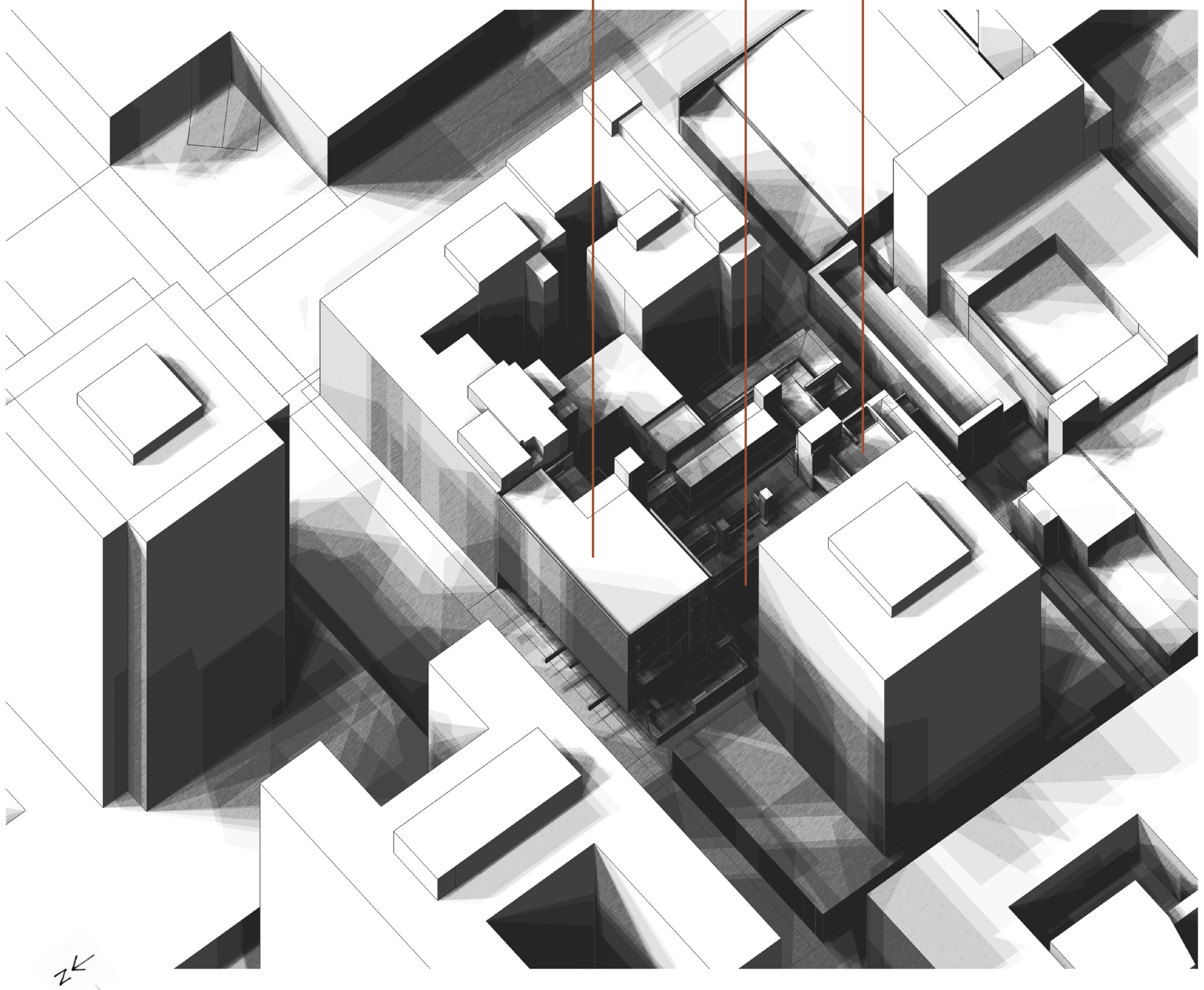
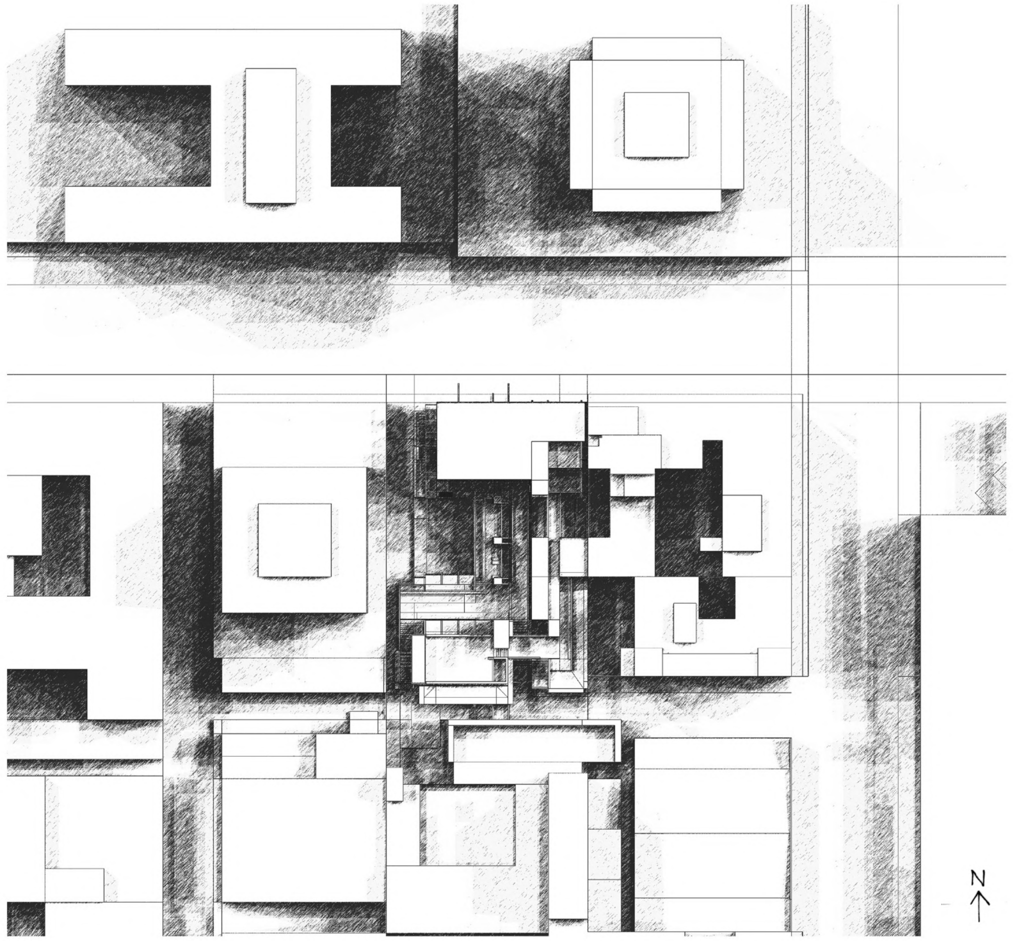
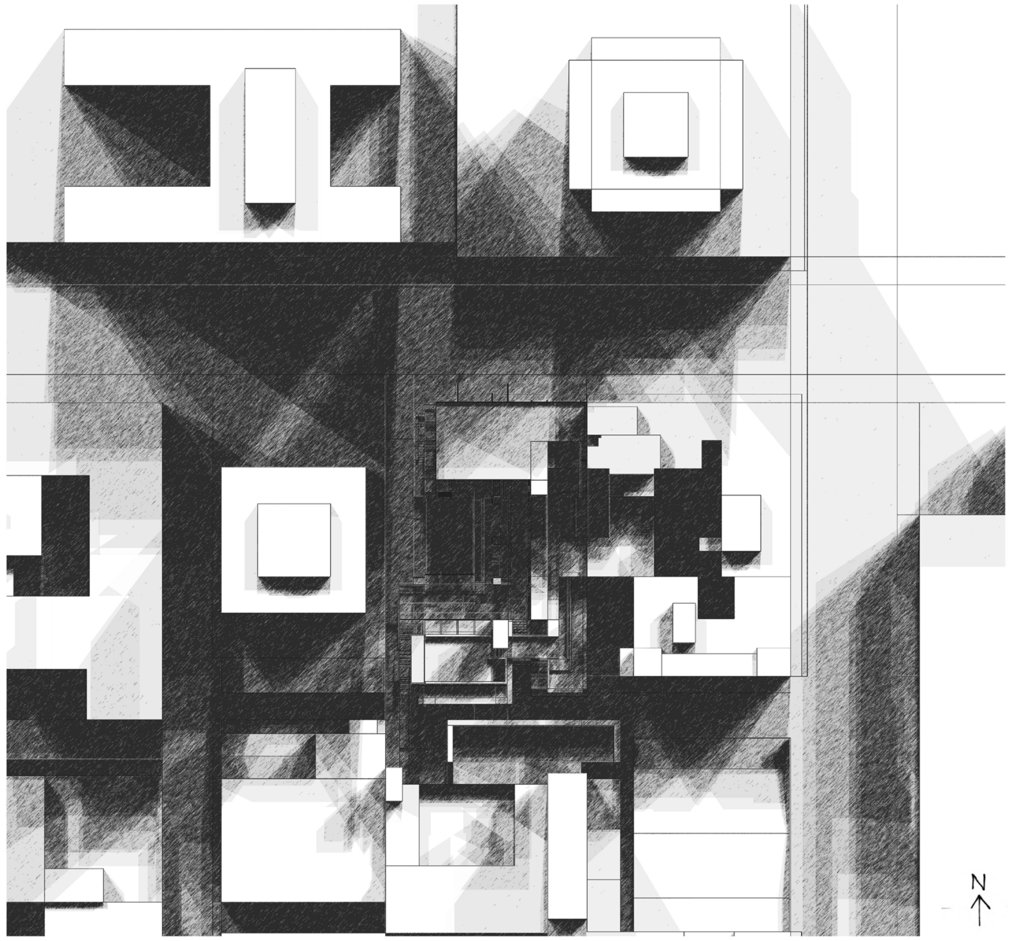


Fig. 136: Shading of the proposed design (Author 2021)



BUILDING IN CONTEXT
OVERHEATED PERIOD
21 September - 21 March



BUILDING IN CONTEXT
UNDERHEATED PERIOD
21 March - 21 September

7.10

DAYLIGHTING

PERCEPTION OF LIGHT

Natural light plays an important role in whether a space is perceived as a public external space or a private interior. Public spaces require high levels of illumination and exposure to direct natural light, in order to be perceived as public. Spaces of refuge should be darker and dependent on soft, indirect light. However, spaces of refuge should not be too dark to discourage people from entering, or too dark to accommodate activities such as cooking or eating. In spaces of refuge the feeling of being exposed can be reduced by placing the light source at the back of a space. Those within the space can then comfortably observe others outside, while the outside observer looking in, can only see their silhouettes.

STUDY AREA

The daylighting analysis and iterations were focused on the basement cooked food market as the main space of public refuge. This space contains cooking spaces that require high levels of lux, but has very limited access to natural light.

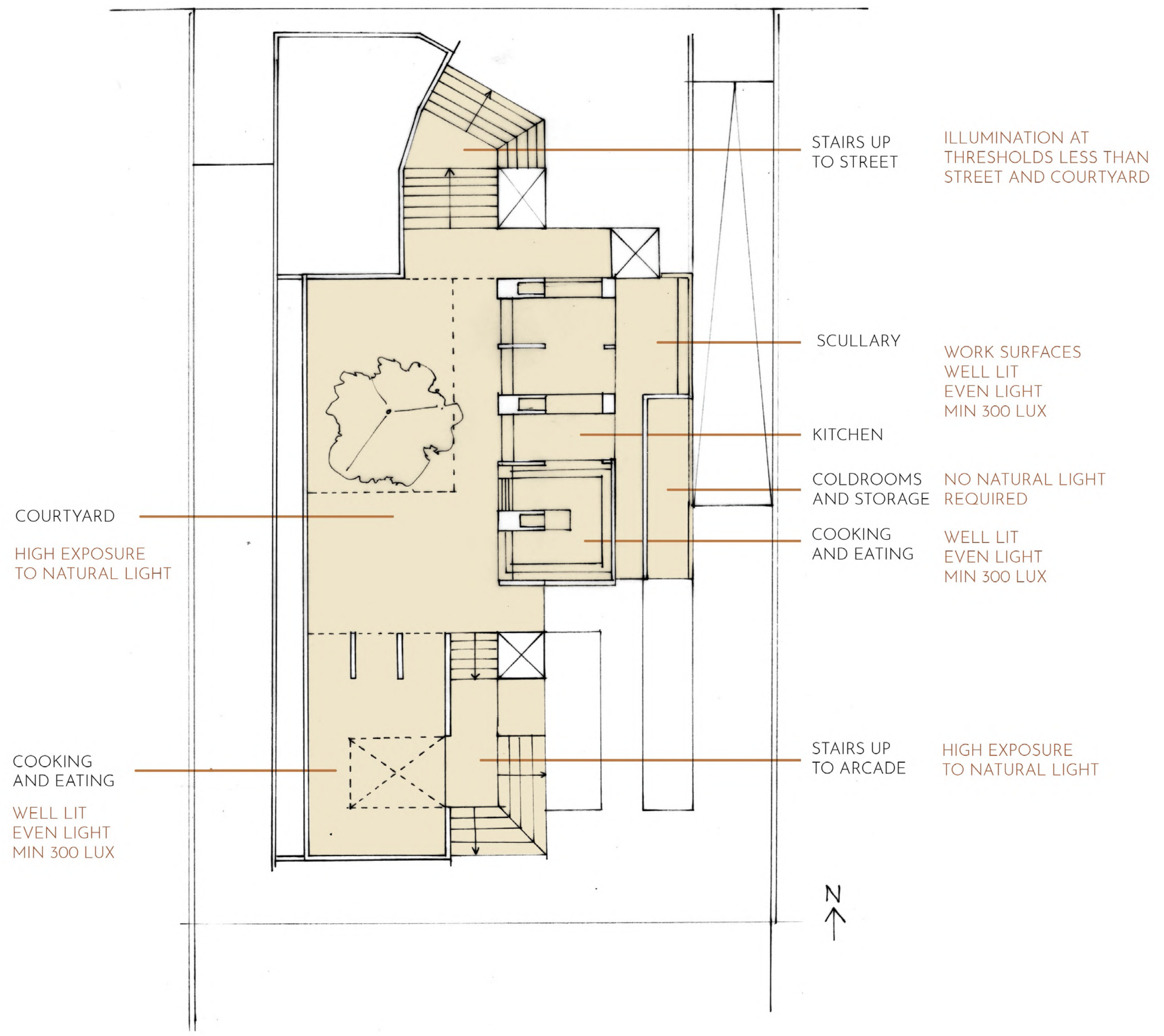


Fig. 138: Basement level indicating area of study (Author 2021)

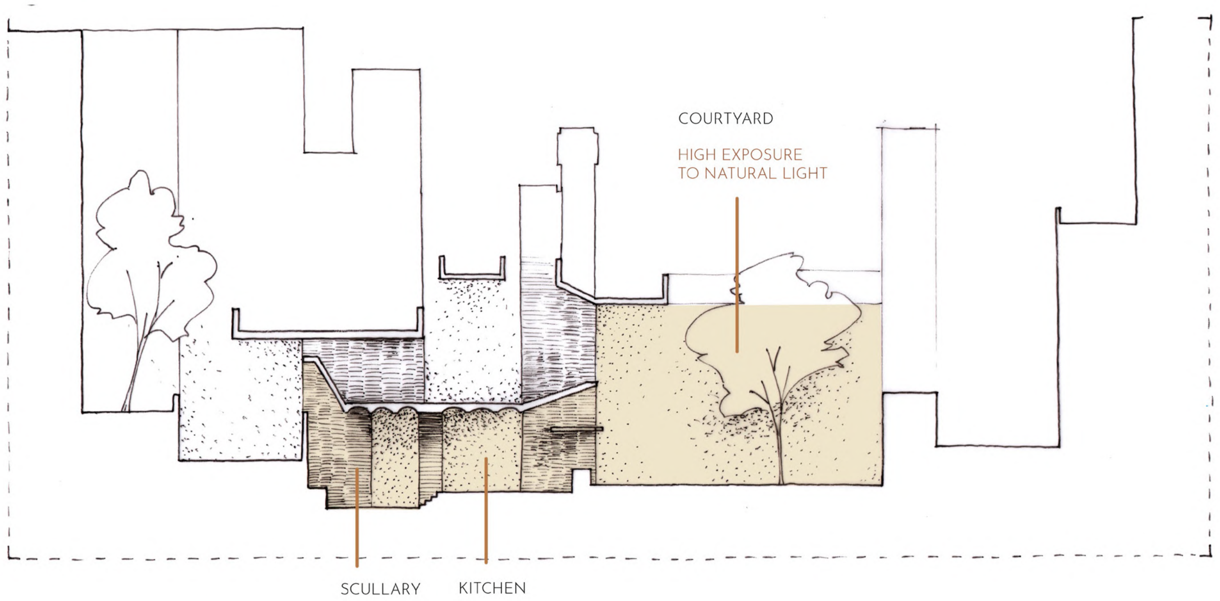


Fig. 137: Cross section indicating area of study (Author 2021)

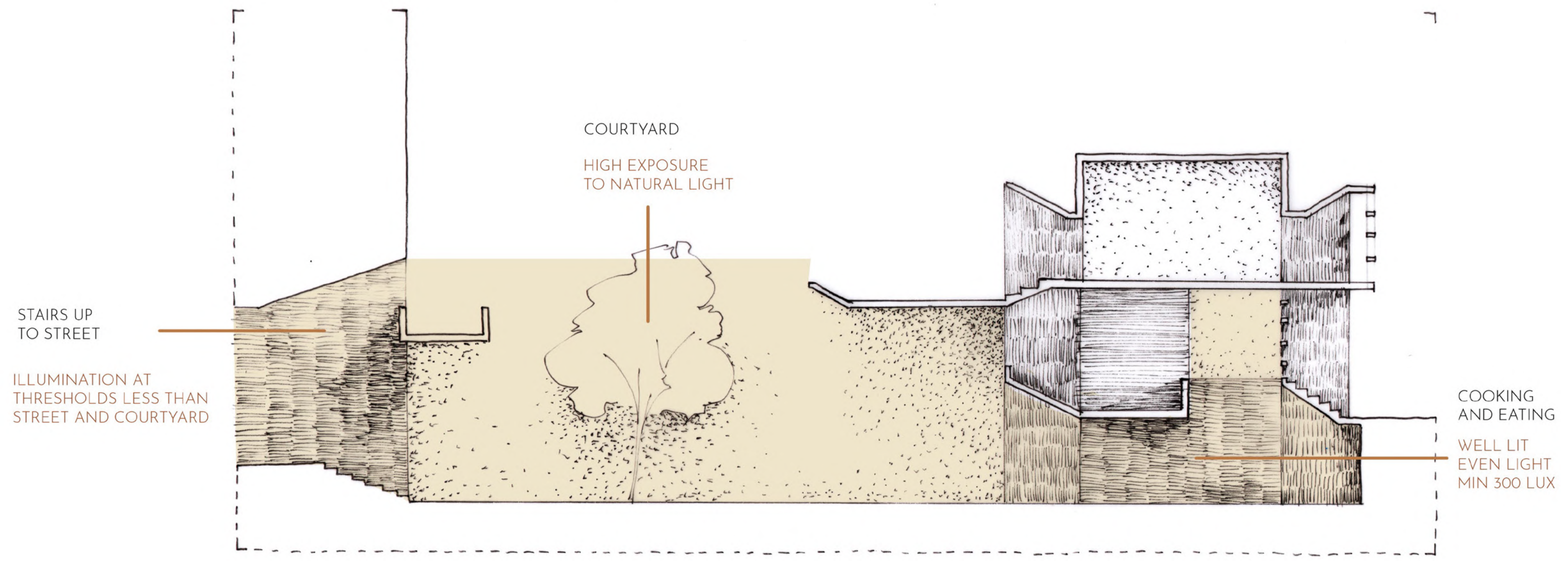


Fig. 139: Long section indicating area of study (Author 2021)

DAYLIGHTING ANALYSIS

Using Sefaira's daylighting software, two types of simulations were completed to analyse the levels of illuminace of each of the design iterations. The first simulation is a visual test that indicate what portion of a space is overlit, well-lit, or underlit according to the following perameters: (1) an underlit space receives less than 300 lux more than 50% of occupied hours. (2) An overlit space receives more than 1000 lux of direct natural light for more than 250 occupied hours per year. (3) lux is measured at a height of 800mm above floor level.

The Spatial Daylight Autonomy (sDA) value and the Annual Sunlight Exposure (ASE) value were also calculated in the first simulation. The sDA refers to the percentage of floor area receiving 300 lux for more than 50% of occupied hours (Hugo 2019: 13). The sDA can be seen as the percentage floor area that is well or overlit. An adequate sDA value according to the Green Star Council falls between 60% - 90% of the occupied space (Hugo 2019: 13).

The ASE refers to the percentage of floor area which is exposed to direct sunlight, receiving more than 1000 lux for more than 250 occupied hours per year (Hugo 2019: 14). The ASE can be seen as the percentage of floor area that is overlit. A high ASE value can indicate a high level of glare and should be as low as possible, preferably below 10%. Because the space being analysed include exterior spaces, the sDA values were calculated for each space individually.

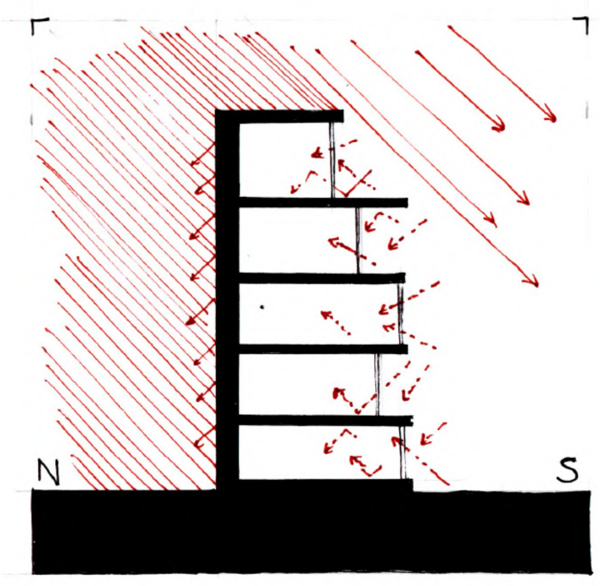
The second simulation measured the percentage of occupied hours per year, where the level of illuminace is at least 300 lux measured at 800 mm above floor level. 300 lux provides adequate illuminace for general spaces within kitchens (IESNA 2000:662), but the countertops and work surfaces should ideally receive up to 500 lux. Eating areas can be comfortable at between 150 and 200 lux (IESNA 2000:663).

The analysed spaces are located in the basement, they have to accommodate multiple activities that require different lux levels and will be used during early mornings and late afternoons when daylight levels are low.. Therefore, it is not realistic to expect natural light alone to achieve 500 lux or 100% annual illuminace. Daylighting will be improved as much as reasonably possible to reduce the building's energy demand, but natural light will be supported with artificial light sources, especially in critical areas.

DAYLIGHTING GOALS

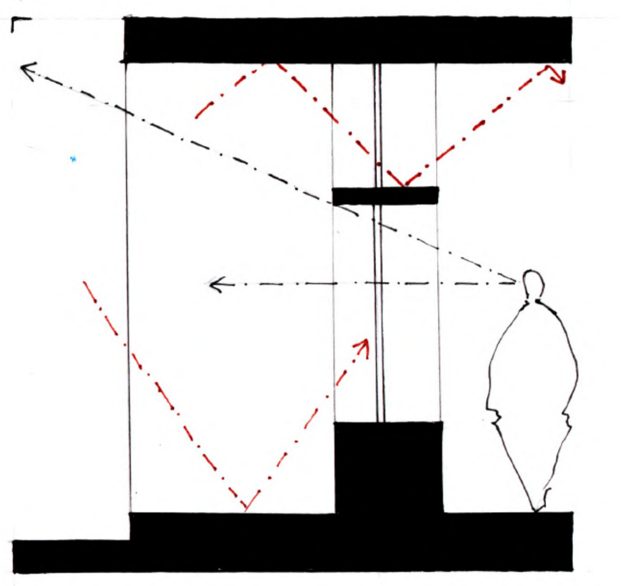
- sDA of 60 - 90%
- ASE of less than 10%
- Annual illuminace between 70 - 100% in critical areas
- High illumination of work surfaces
- Reduce glare
- Even distribution of light
- Refuge spaces to avoid overlighting
- Spaces of exposure to avoid underlighting

DAYLIGHTING STRATEGIES



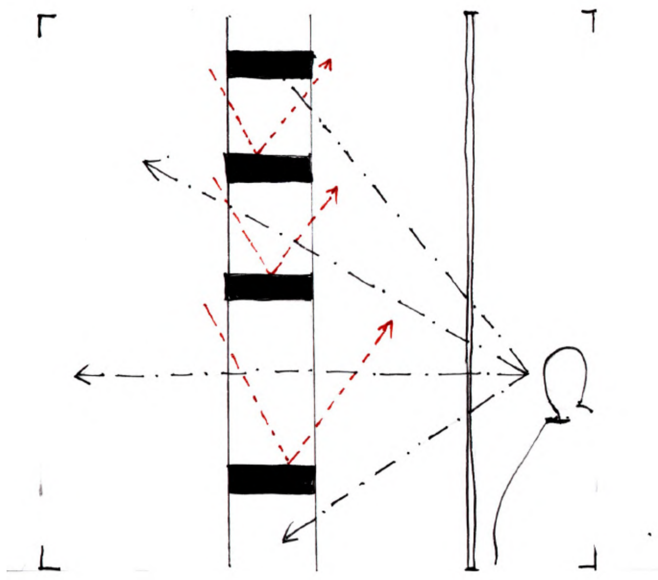
INDIRECT LIGHT

Indirect light is prefered over direct sunlight because it reduces glare, is more evenly distributed, more comfortable and consistent. Fenestration in the design aim to face south or into shaded courtyards.



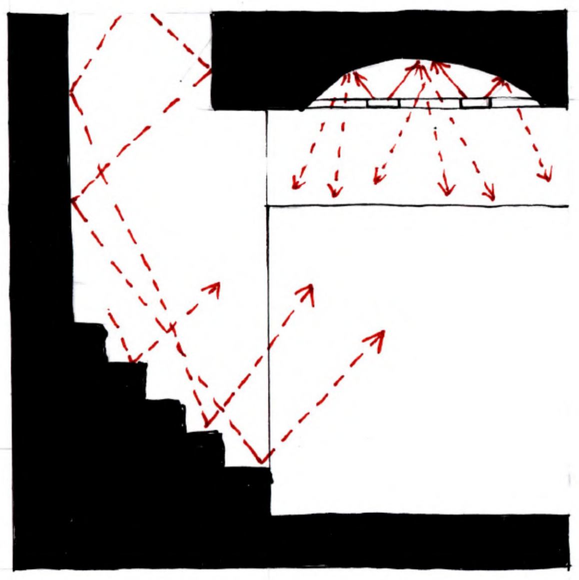
LIGHT SHELVES

Light shelves and deep edges are used to reduce glare by limiting the user's view of the sky (IESNA 2000: 453) and creating a shaded space in front of fenestration to reduce contrast between internal and external illuminance.



SHADING DEVICES

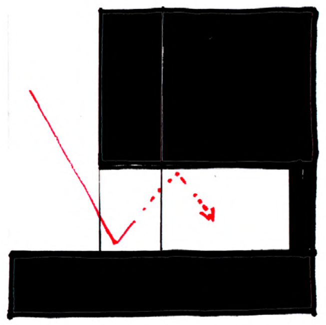
Screens are designed to shade windows, limit the user's view of the sky and reflect direct light, while framing a view for the user.



LIGHT REFLECTION

Internal light wells with rough white interiors provide soft and diffused light over cooking surfaces. Artificial light shining upward onto vaulted ceilings distribute the light evenly throughout the space.

BASE MODEL



The base model indicates an overlit courtyard, which is the intention, but also severly underlit cooking and eating spaces. The 'internal' spaces are deep with small openings and the light source (opening in courtyard) is too small. The largest issue to address is the low illuminace in the cooking spaces surrounding the courtyard.

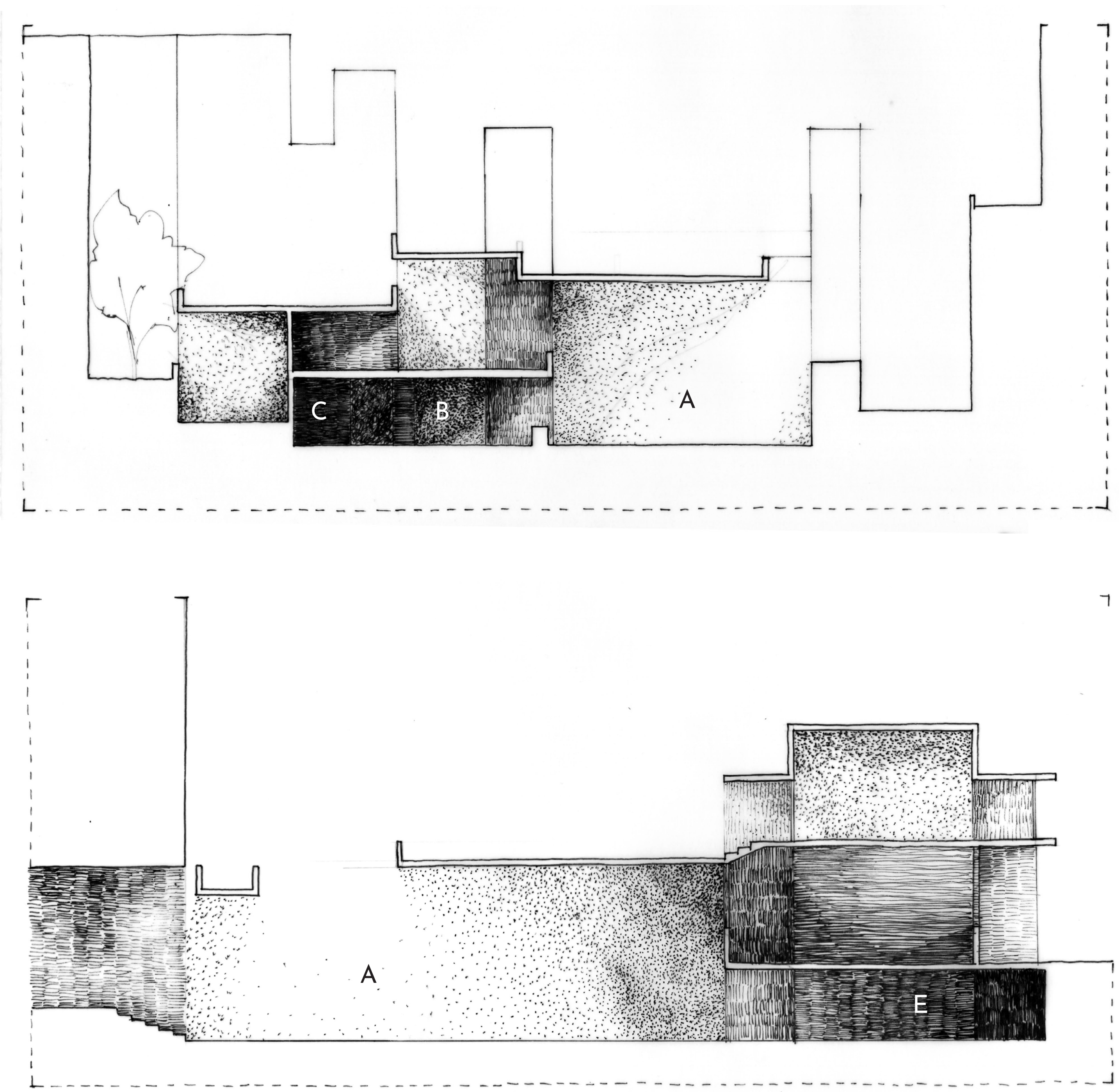


Fig. 140: Sections of daylight of base model(Author 2021)

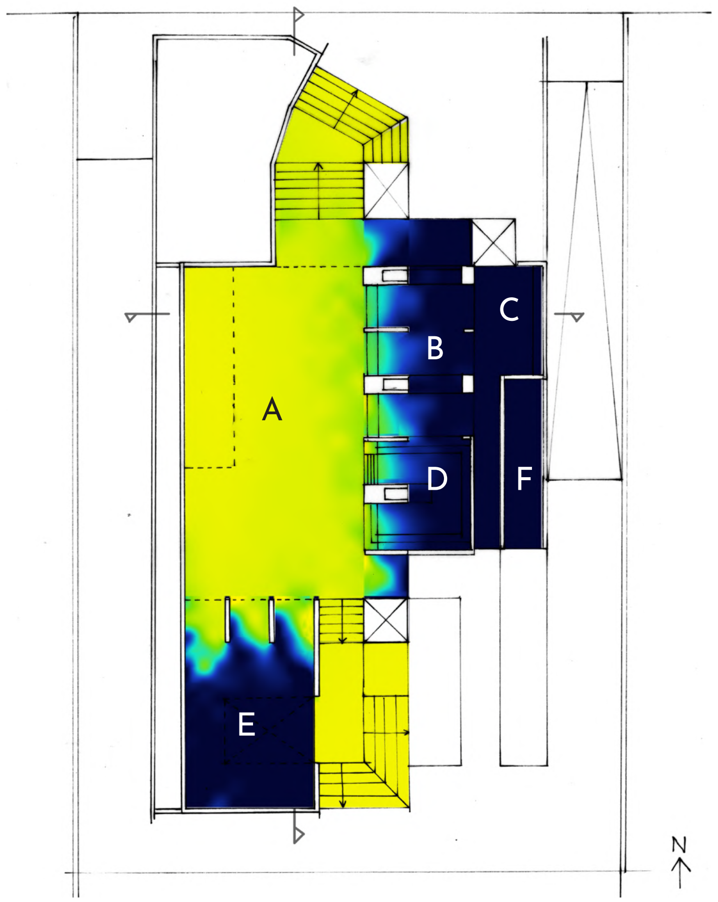


Fig. 141: Illuminance of base model adapted from Sefaira (Author 2021)

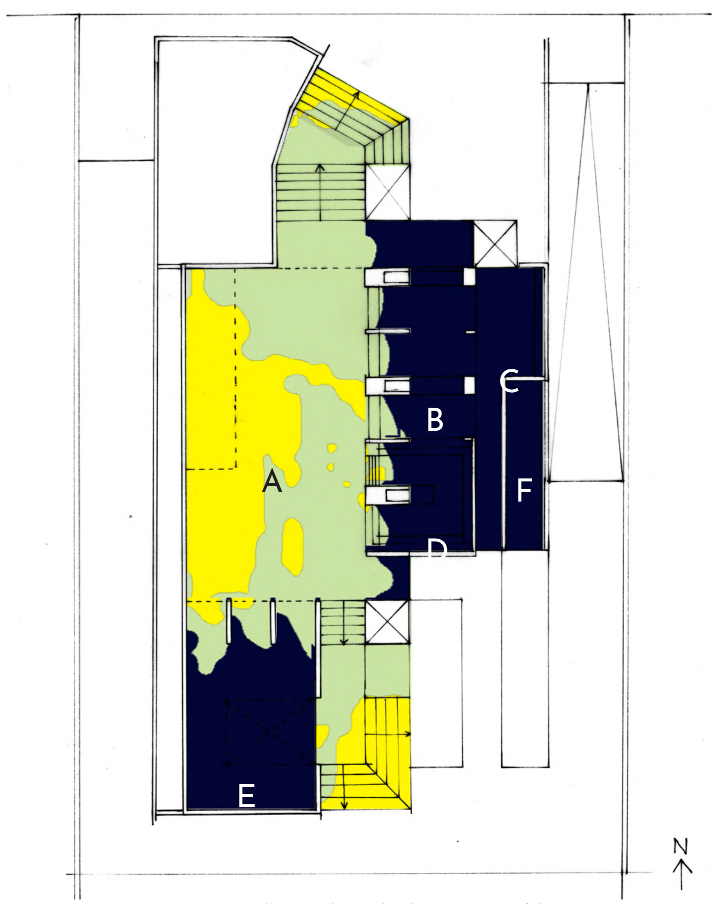


Fig. 142: Overlit and underlit areas of base model adapted from Sefaira (Author 2021)

ANNUAL ILLUMINANCE

Internal spaces : 0 - 30 %

- 0%
- 25%
- 50%
- 75%
- 100%

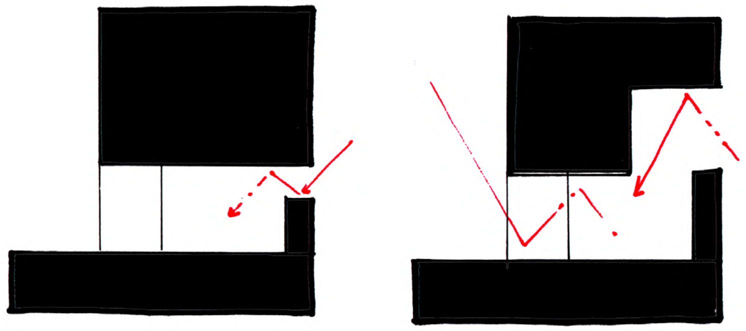
Percentage of occupied hours per year, where the level of illuminance is at least 300 lux measured at 800 mm above floor level

OVERLIT AND UNDERLIT AREAS

	sDA	ASE
A - Courtyard	100 %	40 %
B - Kitchen	22 %	0 %
C - Scullery	0 %	0 %
D - Cooking / eating	23 %	0 %
E - Cooking / eating	16 %	1 %
F - Storage	0%	0%

- OVER - LIT
- WELL - LIT
- OVER - LIT

ITERATION 1 - OPENINGS



The first iteration aimed to increase illumination by creating new openings or enlarging extisting openings.

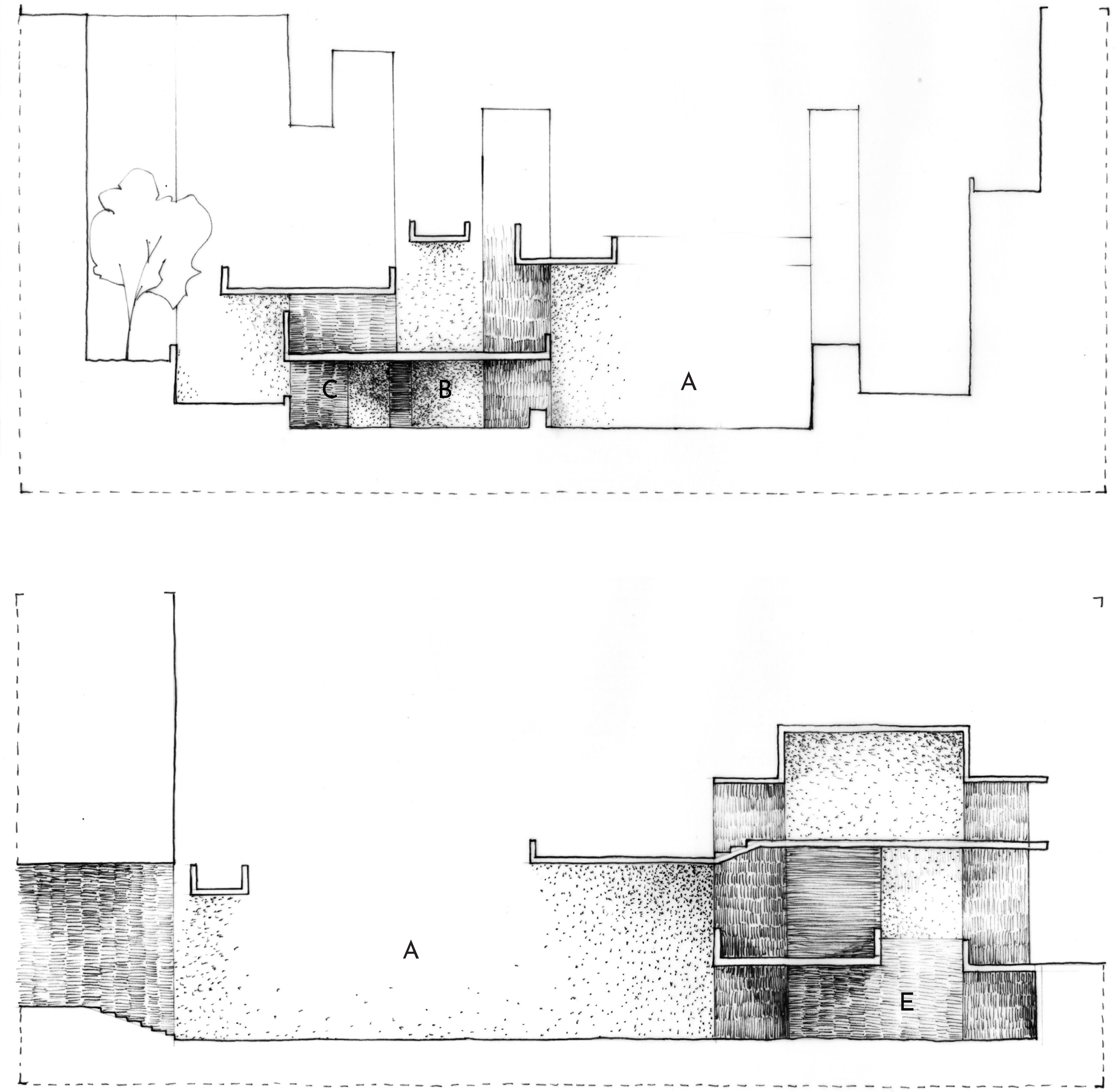


Fig. 143: Sections of daylight iteration 1(Author 2021)

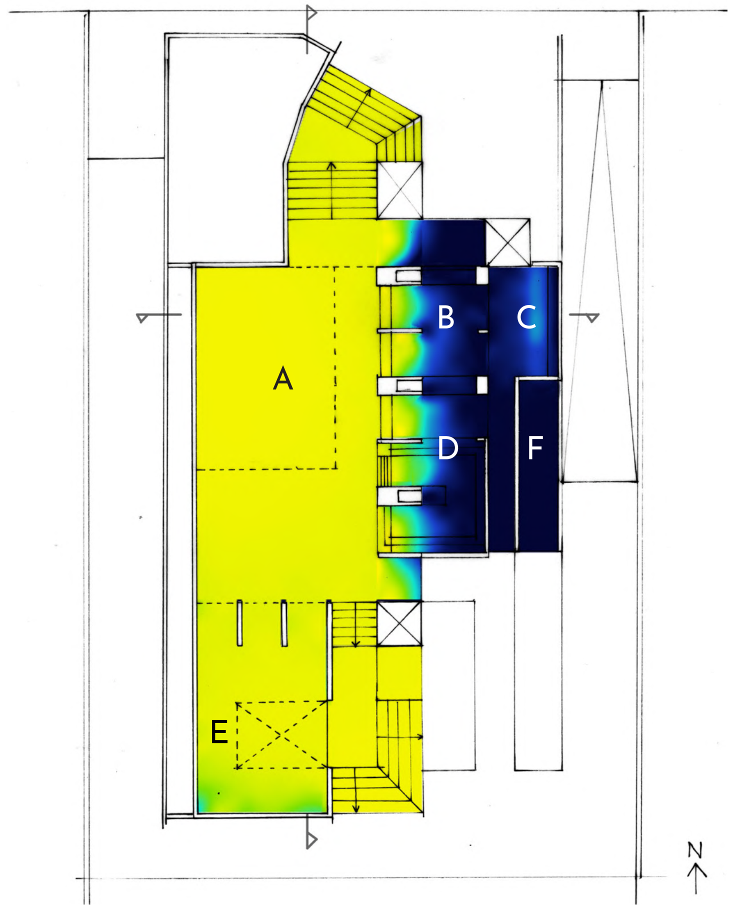


Fig. 144: Illuminance of iteration 1 adapted from Sefaira (Author 2021)

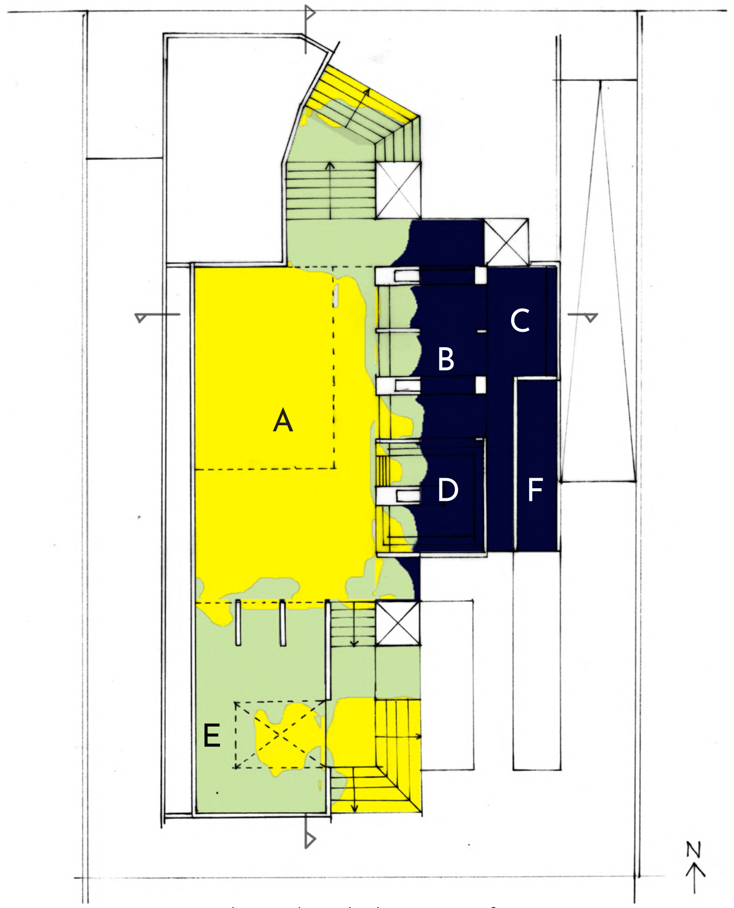


Fig. 145: Overlit and underlit areas of iteration 1 adapted from Sefaira (Author 2021)

ANNUAL ILLUMINANCE

Internal spaces : 50 - 70 %

Illuminance in space E was improved by creating a shaded opening for indirect light to enter. The roof opening in the courtyard was enlarged to improve to increase illuminance in spaces B and D, but it is still underlit towards the back.

- 0%
- 25%
- 50%
- 75%
- 100%

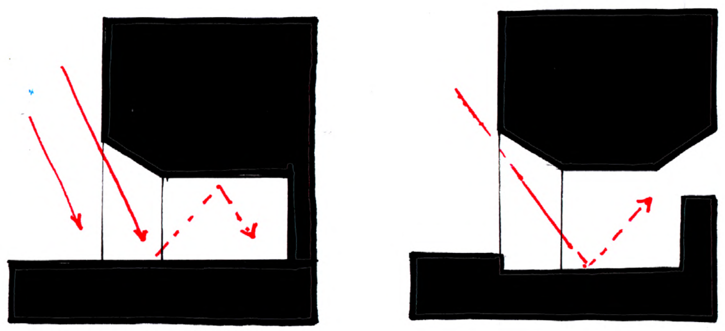
Percentage of occupied hours per year, where the level of illuminance is at least 300 lux measured at 800 mm above floor level

OVERLIT AND UNDERLIT AREAS

	sDA		ASE	
A - Courtyard	100 %	(-)	85 %	(+45)
B - Kitchen	48 %	(+26)	12 %	(+12)
C - Scullery	0 %	(-)	0 %	(-)
D - Cooking / eating	47 %	(+24)	19 %	(+19)
E - Cooking / eating	97 %	(+81)	13 %	(+12)
F - Storage	0%	(-)	0%	(-)

- OVER - LIT
- WELL - LIT
- OVER - LIT

ITERATION 2 - SLANTED CEILINGS



The second iteration explored how to improve light penetration in the cooking spaces (B, C and D). The depth of the spaces could not be altered but the ceilings could be sloped to increase the opening sizes and the floor levels could be lowered to allow light to penetrate deeper into the spaces.

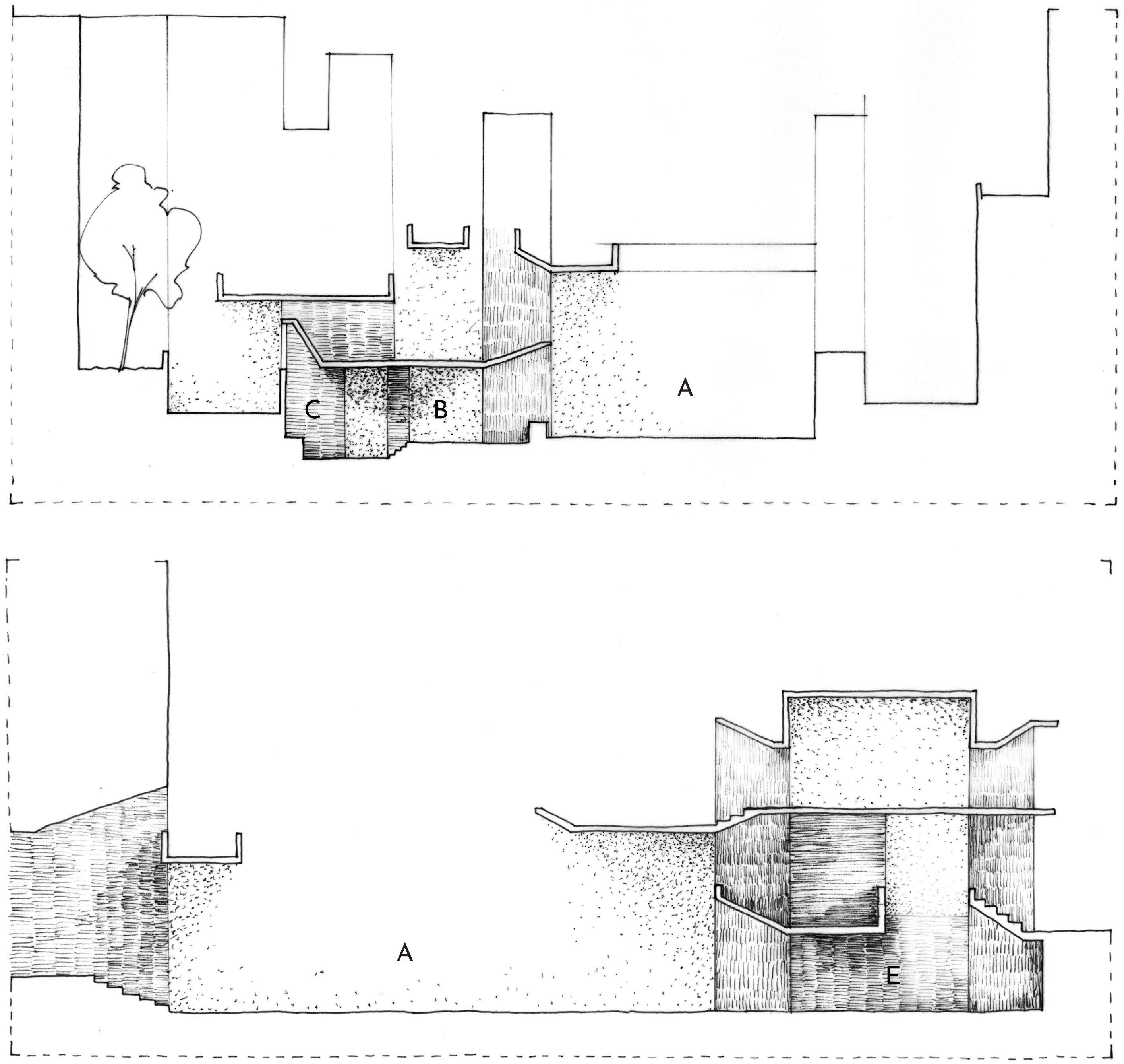


Fig. 146: Sections of daylight iteration 2(Author 2021)

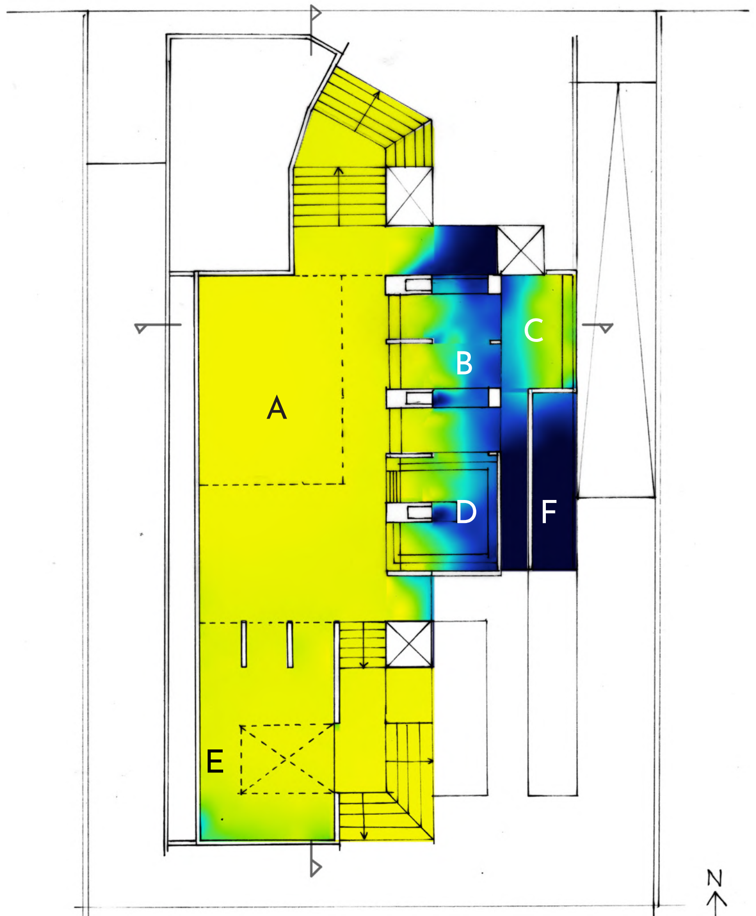


Fig. 147: Illuminance of iteration 2 adapted from Sefaira (Author 2021)

ANNUAL ILLUMINANCE

Internal spaces : 70 - 80 %

Illumination of cooking spaces were improved in B, C and D but this resulted in some work surfaces being overlit. The countertop do require higherlux levels but should be protected from surface glare. Space F consist of dry and cold storage and do not require access to natural light.

- 0%
- 25%
- 50%
- 75%
- 100%

Percentage of occupied hours per year, where the level of illuminance is at least 300 lux measured at 800 mm above floor level

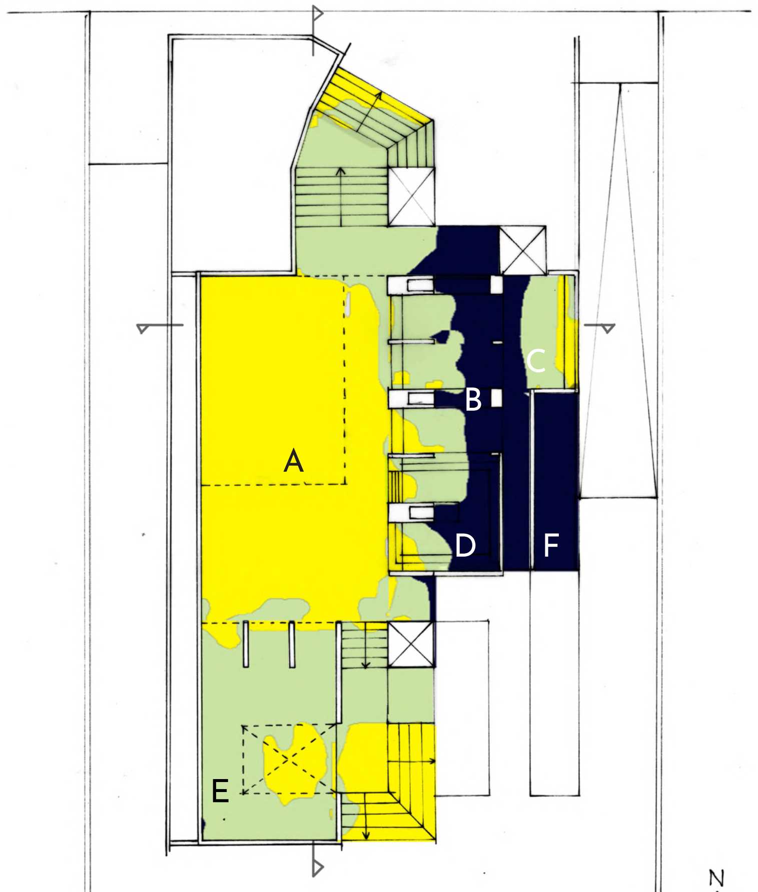


Fig. 148: Overlit and underlit areas of iteration 2 adapted from Sefaira (Author 2021)

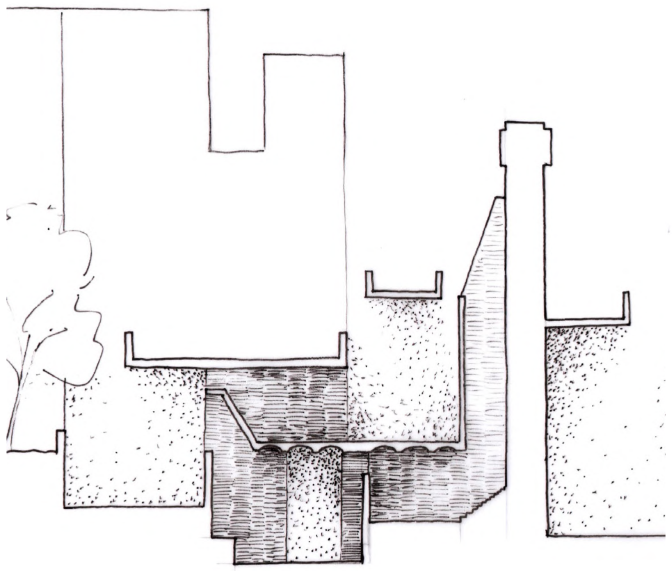
OVERLIT AND UNDERLIT AREAS

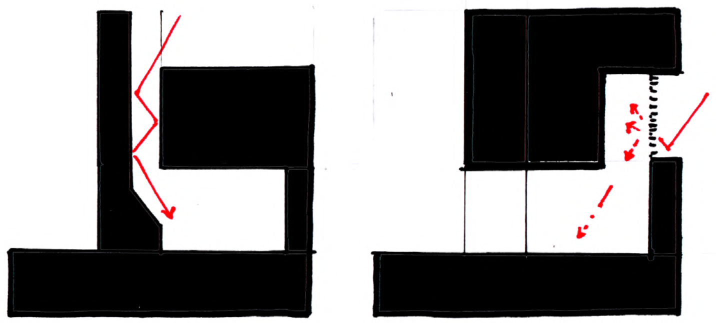
	sDA		ASE	
A - Courtyard	100 %	(-)	85 %	(+45)
B - Kitchen	71 %	(+49)	15 %	(+15)
C - Scullery	29 %	(+29)	13 %	(+13)
D - Cooking / eating	75 %	(+52)	19 %	(+19)
E - Cooking / eating	93 %	(+77)	13 %	(+12)
F - Storage	0 %	(-)	0 %	(-)

- OVER - LIT
- WELL - LIT
- OVER - LIT

ITERATION 3 - GLARE CONTROL

The third iteration explored various methods of improving the even distribution of light, controlling glare and increasing illuminace in critical areas





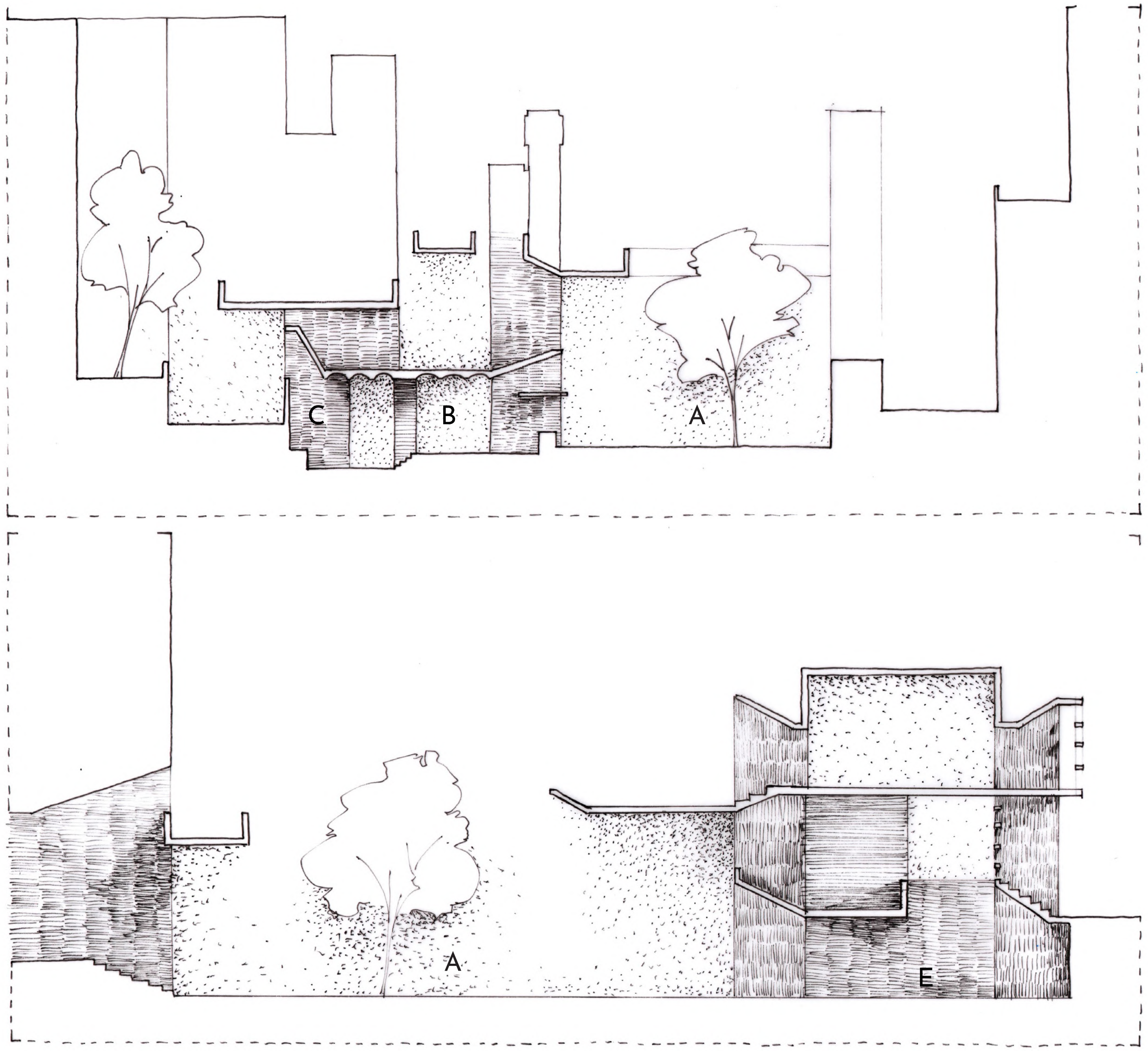


Fig. 149: Sections of daylight iteration 3(Author 2021)

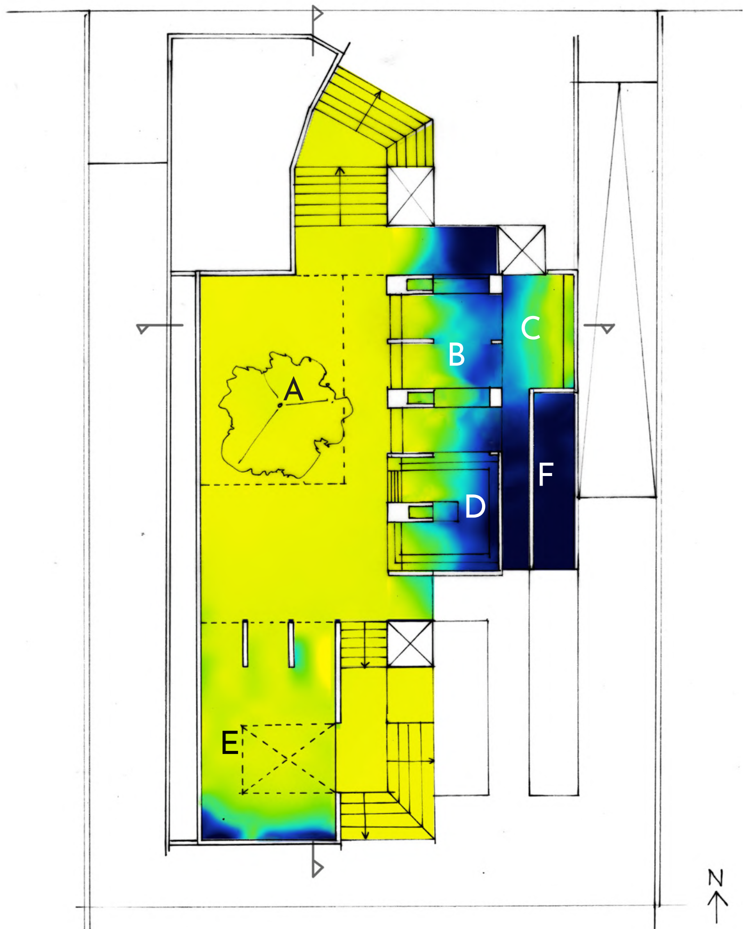


Fig. 150: Illuminance of iteration 2 adapted from Sefaira (Author 2021)

ANNUAL ILLUMINANCE

Internal spaces : 60 - 70 %

Lightwells were added in spaces B and D to improve illuminace of underlit countertops with a diffused light source. Lightshelves were added above the countertops facing the courtyard to reduce surface glare and allow reflected light to penetrate deeper into the space. Overlighting in space E was reduced by intoducing a vertical screen to partially enclose the opening.

- 0%
- 25%
- 50%
- 75%
- 100%

In critical internal spaces the average sDA were improved from 15% to 70% (goal between 60% and 90%) and the average ASE only slightly worsened from 0% to 8% (goal below 10%).

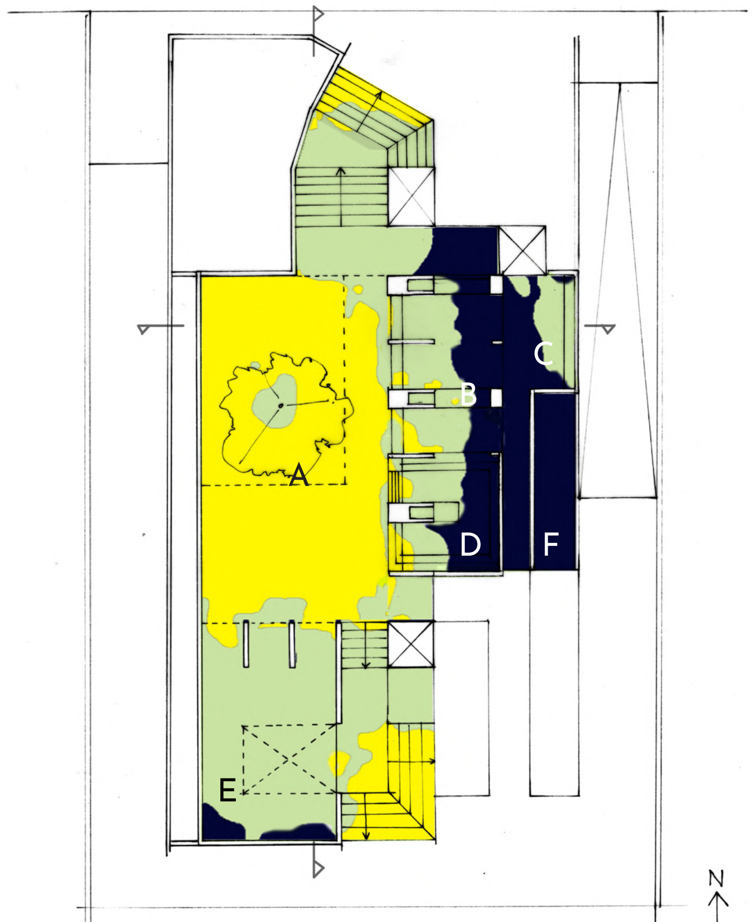


Fig. 151: Overlit and underlit areas of iteration 3 adapted from Sefaira (Author 2021)

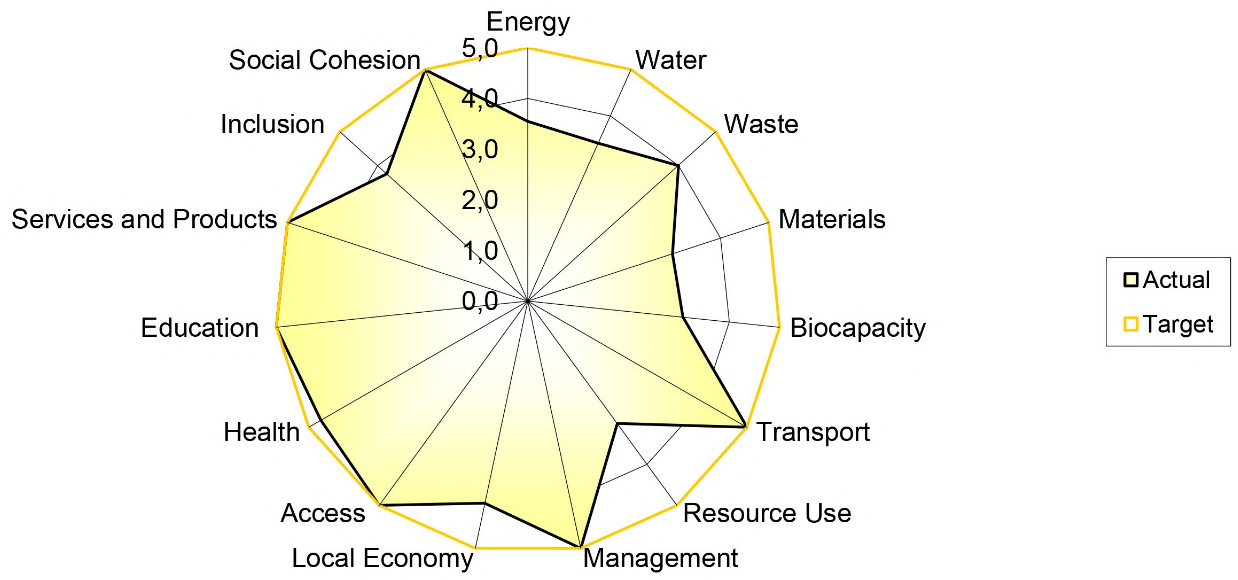
OVERLIT AND UNDERLIT AREAS

	sDA		ASE	
A - Courtyard	100 %	(-)	76 %	(+36)
B - Kitchen	63 %	(+41)	5 %	(+5)
C - Scullery	71 %	(+71)	13 %	(+13)
D - Cooking / eating	61 %	(+38)	12 %	(+12)
E - Cooking / eating	86 %	(+70)	1 %	(-)
F - Storage	0%	(-)	0%	(-)

- OVER - LIT
- WELL - LIT
- OVER - LIT

		Achieved
SB	SBAT REPORT	4,2

SB3 SBAT Graph



SB4	Environmental, Social and Economic Performance	Score
Environmental		3,4
Economic		4,4
Social		4,7
SBAT Rating		4,2

SB5	EF and HDI Factors	Score
EF Factor		3,8
HDI Factor		4,4

SB6	Targets	Percentage
Environmental		68
Economic		88
Social		94

		Target	Achieved
BI	Building Information	5,0	4,2

BI 1	Building Targets	Target	Achieved
EN	Energy	5,0	3,5
WA	Water	5,0	3,4
WE	Waste	5,0	4,0
MA	Materials	5,0	3,0
BI	Biocapacity	5,0	3,1
TR	Transport	5,0	5,0
LE	Local Economy	5,0	4,1
MN	Management	5,0	5,0
RE	Resources	5,0	3,0
SP	Services and Products	5,0	5,0
AC	Access	5,0	4,7
HE	Health	5,0	5,0
ED	Education	5,0	5,0
IN	Inclusion	5,0	3,8
SC	Social Cohesion	5,0	5,0

BI 2	Priority Key (Not Performance Key)		
VH	Very High	5,0	
HI	High	4,0	
ME	Medium	3,0	
LO	Low	2,0	
VL	Very Low	1,0	
NA	None / Not Applicable	0,0	

Fig. 152: SBAT report of the final design aided by the Sustainable Building Asssement Tool (Author 2021)

7.11

FIRE PROTECTION

The building includes space for cooking with fire, contain multi-storey structures and have to ensure public safety. Therefore, fire protection was selected as the primary service to resolve.

The aim is to not only comply with the necessary SANS 10400 (SABS 2011) regulations but also to use fire protection as a design tool to achieve the design and tectonic intentions.

Fire protection will be discussed in three parts: (1) fire prevention, (2) fire control, and (3) public safety.

FIRE PREVENTION

For fire prevention, the cooking spaces within the basement will serve as the area of focus. The primary aim was to ensure that the users can safely cook with the use of fire. The design focused on preventing a fire, extracting smoke from the cooking spaces and ensuring adequate fire resistance of structural elements.

The design provides the opportunity for informal street food traders to cook food over fire with the use of flammable materials such as charcoal or wood. These spaces are located in the interior of the building on the basement level. The cooking over fire occurs in two types of places: either in a built in steel braai with a chimney, or in a custom built fire pit. The pit is however not completely open. A custom precast fire resitent concrete countertop covers the pit. The concrete cover has holes at the top to accommodate pots, pans or grids, and ensures that the fire is contained within the pit. The pit can function either as an fire oven, stove or braai.

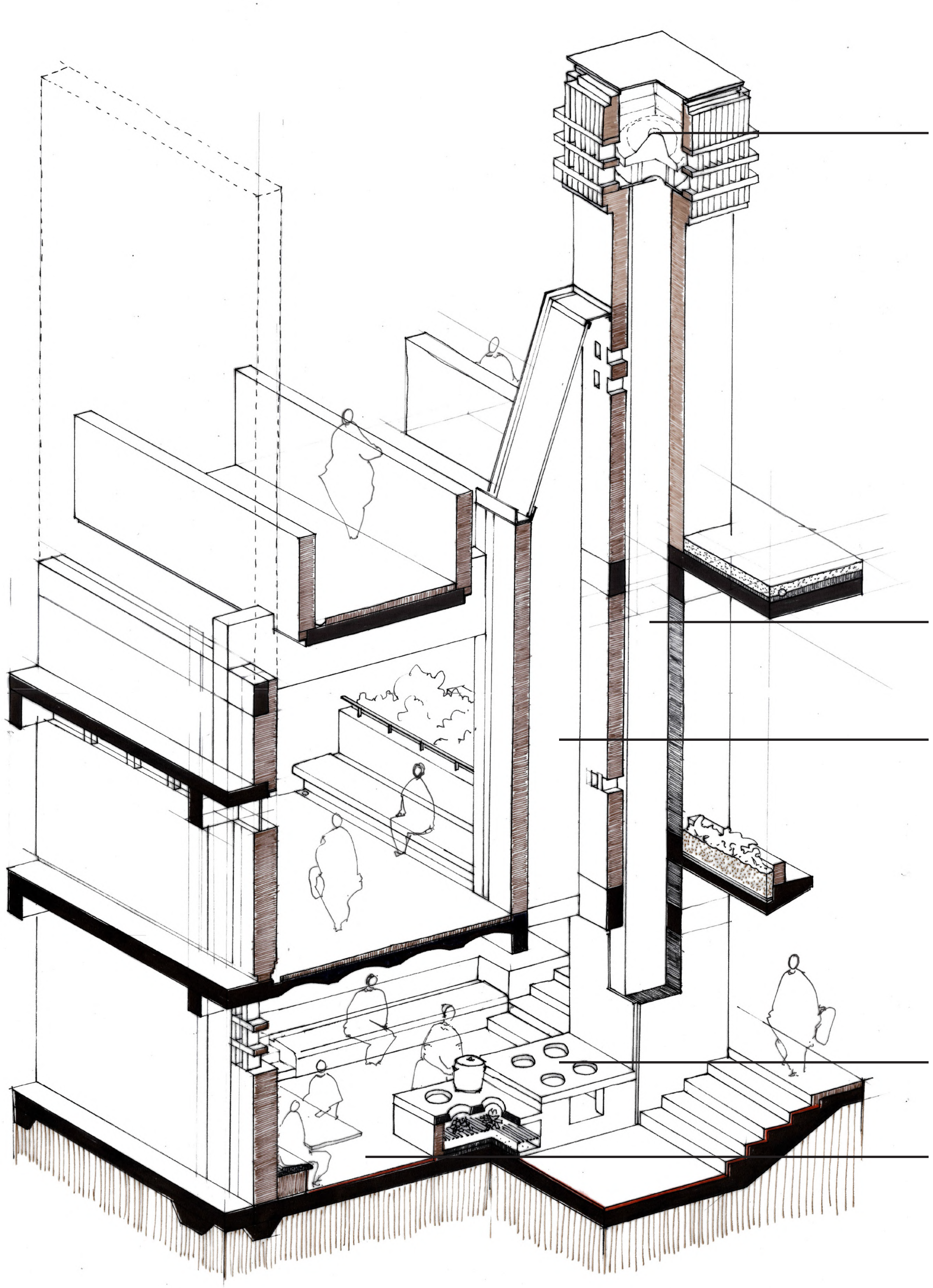


Fig. 153: Axonometric section of the cooking space and chimney (Author 2021)

Smoke in the interior spaces are managed by a mechanically ventilated chimney that extracts smoke directly from the pit (underneath the concrete cover) and from the space in general. Mechanical ventilation at the back on the space extract any smoke not extracted by the chimney. The cooking spaces are also open to the internal courtyard on one side to allow fresh air into the spaces.

The cooking spaces are enclosed by 230mm brick walls, reinforced concrete columns, beams and slabs to provide a fire resistance of 240 minutes which is double the required 120min according to SANS 10400 Part T section 4.6.1 (SABS 2011: 24) and 120 min of structural stability required (SABS 2011: 27). The design does not use steel for any primary structure, only to support glazing or screens, and for trimmings. The galvanised mild steel elements need to be painted with intumecent paint as a passive fire resistance measure.

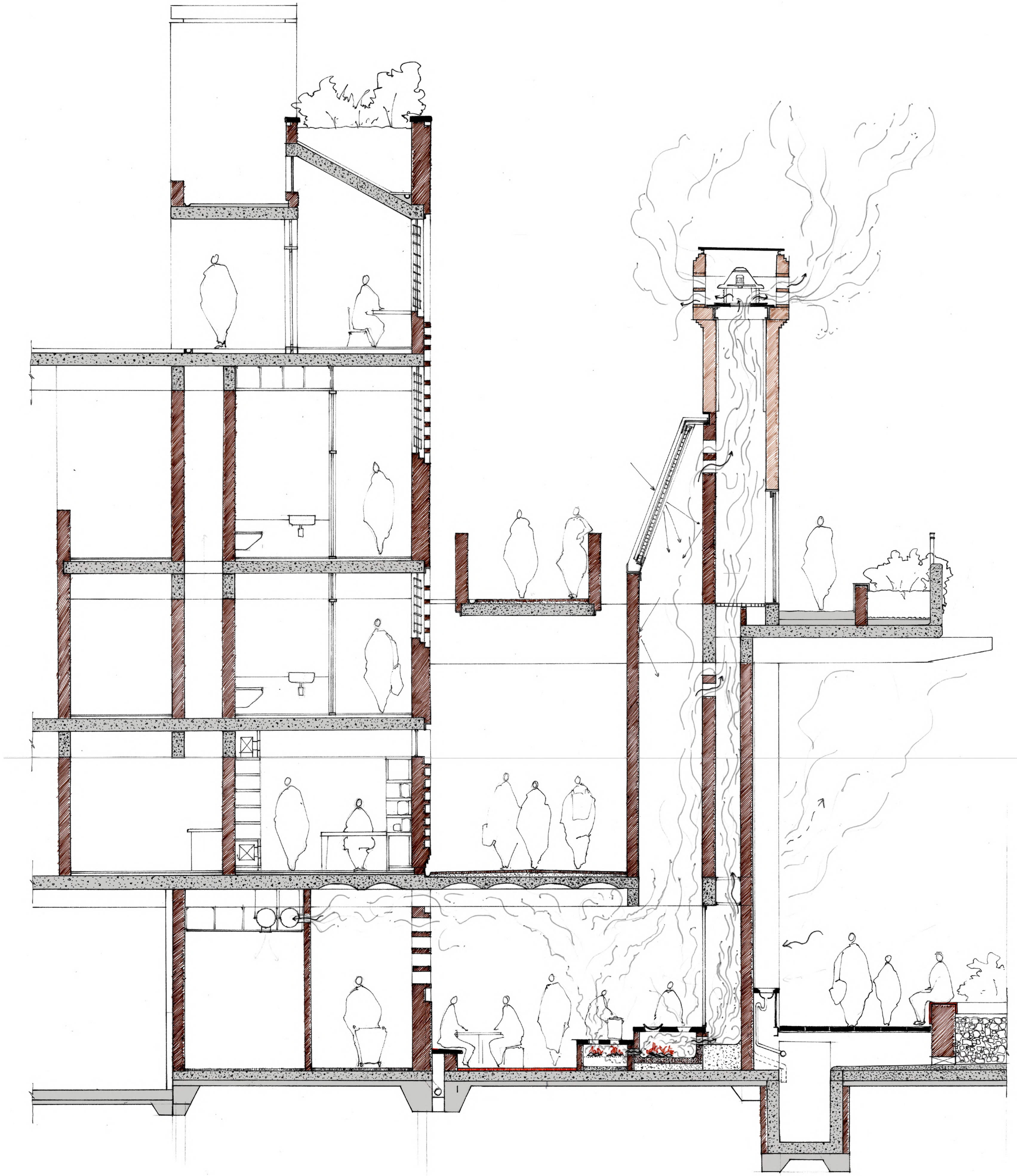


Fig. 154: Section of the basement cooking space and chimney (Author 2021)

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FIRE CONTROL

In the event of a fire, systems need to be in place to extinguish and prevent the fire from spreading. According to SANS 10400 Part T section 4.36 (SABS 2011: 49), the building does not require an automatic sprinkler system in any part of the building other than the existing basement for goods delivery. SANS 10400 Part T section 4.34 (SABS 2011: 48) requires one fire hose reel for every 500m² of the floor area in any storey that can reach any point in that area with a 30m hose length. The plans indicate the position of fire hose reels, the demarcation of different areas (max 500m²) its serves and reach of the hose reels. In compliance with SANS 10400 Part T section 4.34 - 4.38 (SABS 2011: 48-50), each area is provided with 1 fire hose reel and 2 x 4.5kg portable fire extinguishers, or 2 x 9kg portable fire extinguishers (in the eating hall and library) where water supply is unavailable. One fire hydrant (FH) must be provided for every 1000m² with at least one per storey (SABS 2011: 48).

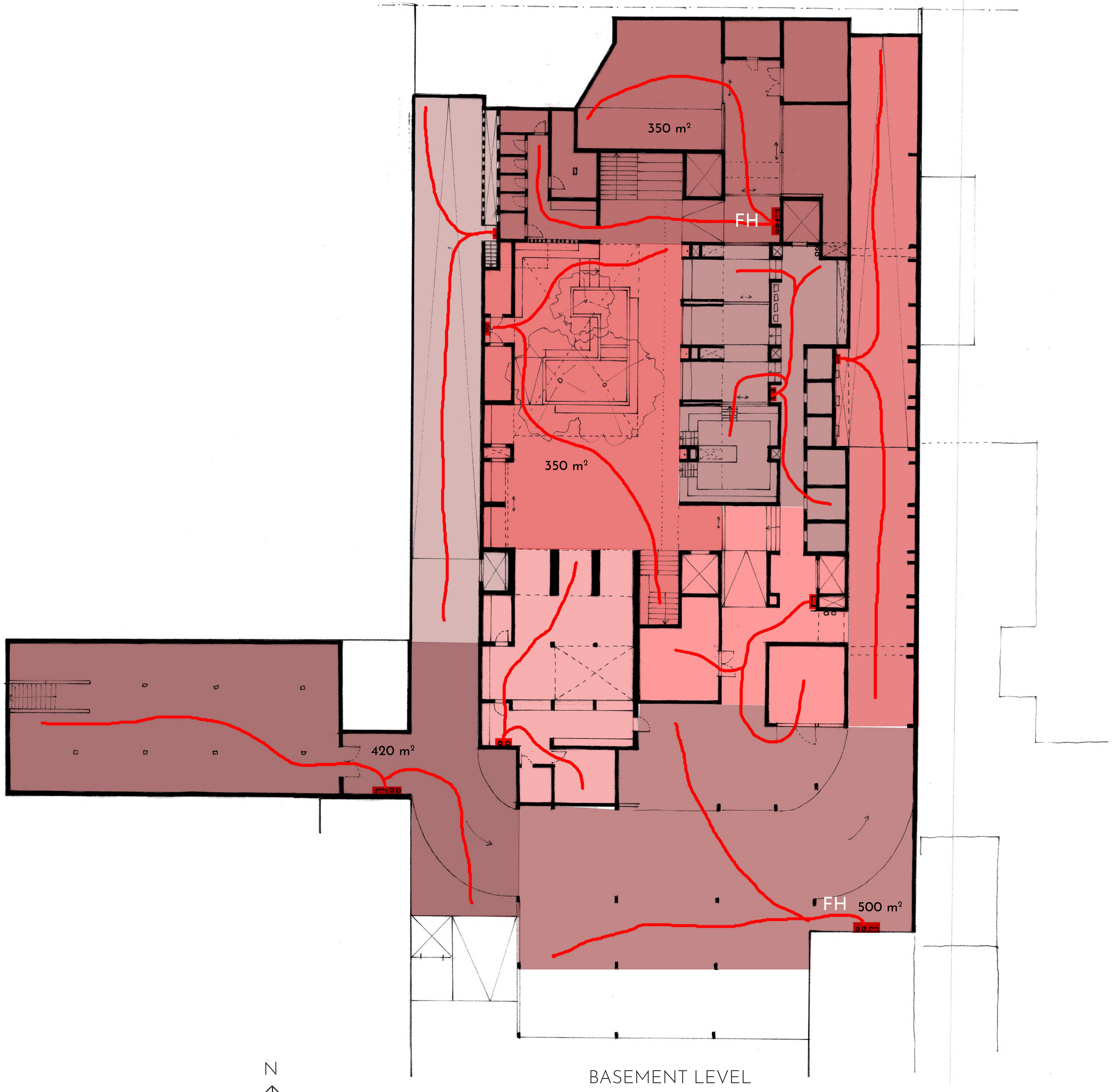


Fig. 155: Plan of basement level indicating fire protection areas(Author 2021)

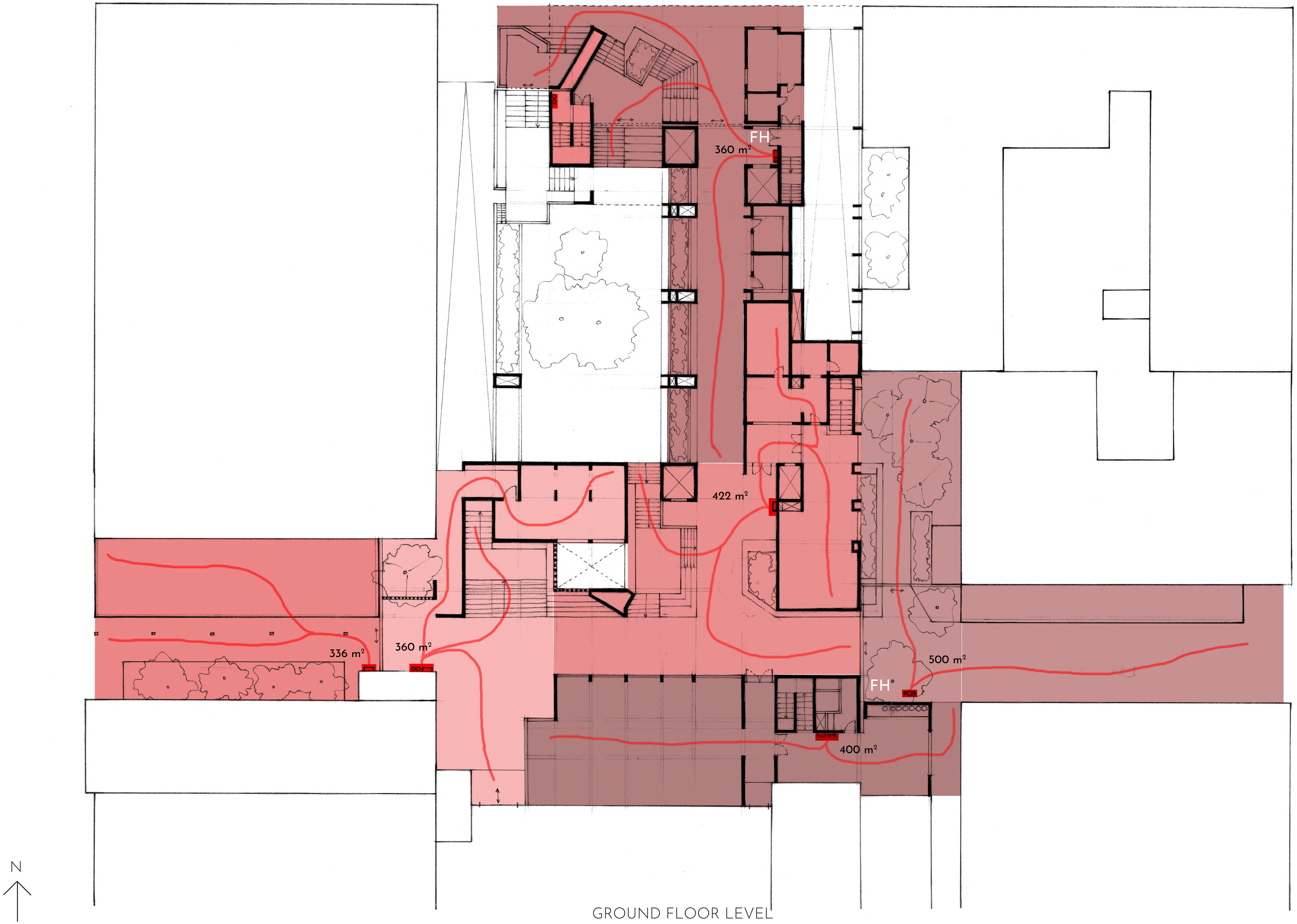


Fig. 156: Plan of ground floor level indicating fire protection areas(Author 2021)

FIRST FLOOR LEVEL

Fig. 157: Plan of first floor level indicating fire protection areas(Author 2021)

PUBLIC SAFETY

To ensure public safety in the event of a fire, the design must provide safe and accessible escape and emergency routes. The design consist of multi-storey, public accessible buildings, which according to SANS 10400 Part T section 4.16 (SABS 2011: 40) requires at least two escape routes, of which an emergency route must form part of. The total allowable travel distance with a room to an exit door or feeder route (red line in drawings) may not be more than 15m (SABS 2011: 40). The maximum travel distance from the furthest point to an access door (leading an emergency route) or escape door (leading to an open space on ground floor) is 45m (combined length of red and orange line in drawings).

Uncovered open courtyards and circulation spaces (green) allow occupants to safely travel to the street or open space on ground floor. The path of travel to access doors or escape doors should be through feeder routes (orange) with the opportunity to travel in two different directions.

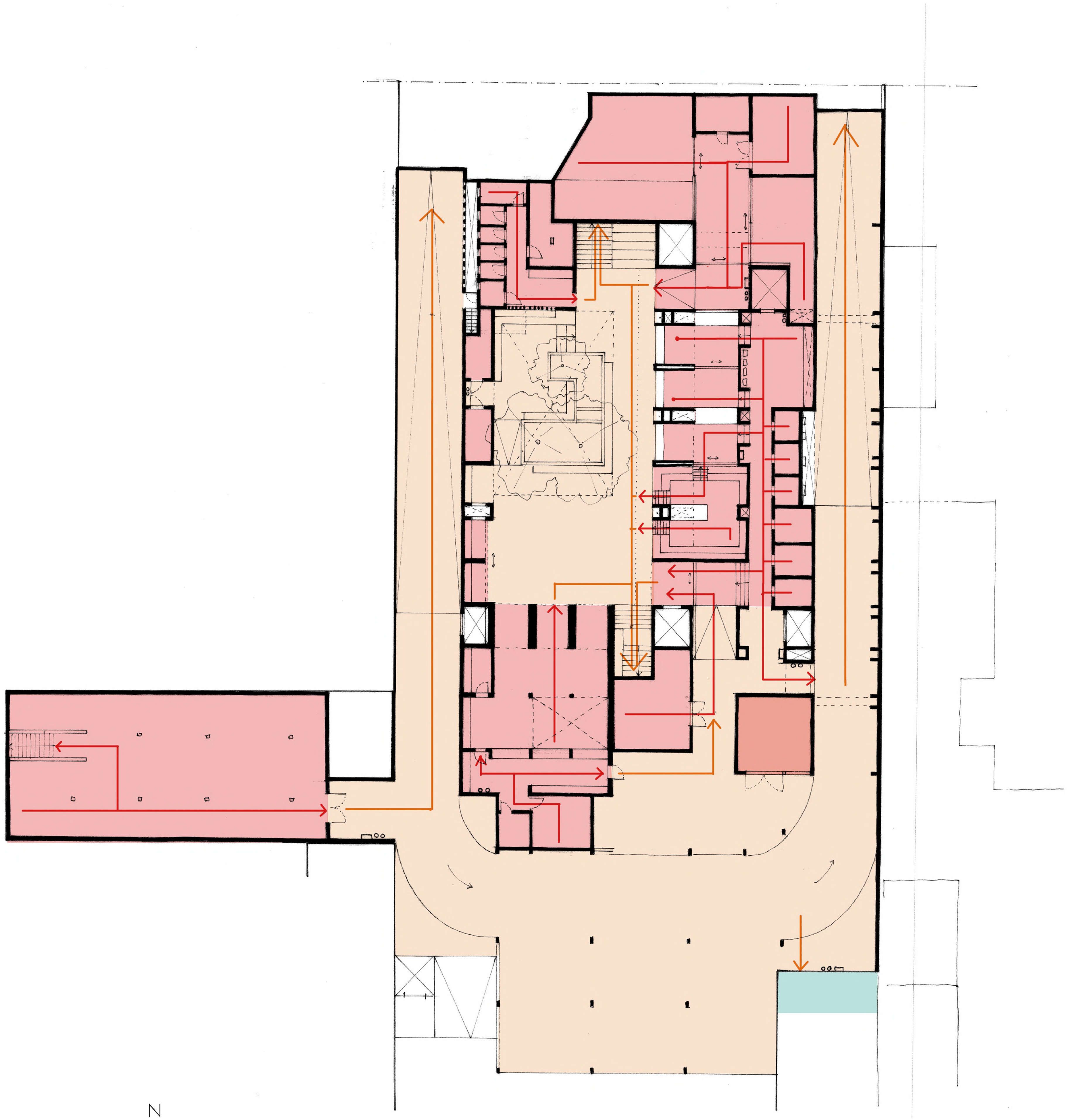
PATH TO EXIT DOOR → | ROOM INTERIOR

PATH TO OPEN SPACE OR EMERGENCY ROUTE → | FEEDER ROUTE

PATH TO STREET → | UNCOVERED OPEN CIRCULATION

PATH TO STREET → | EMERGENCY ROUTE

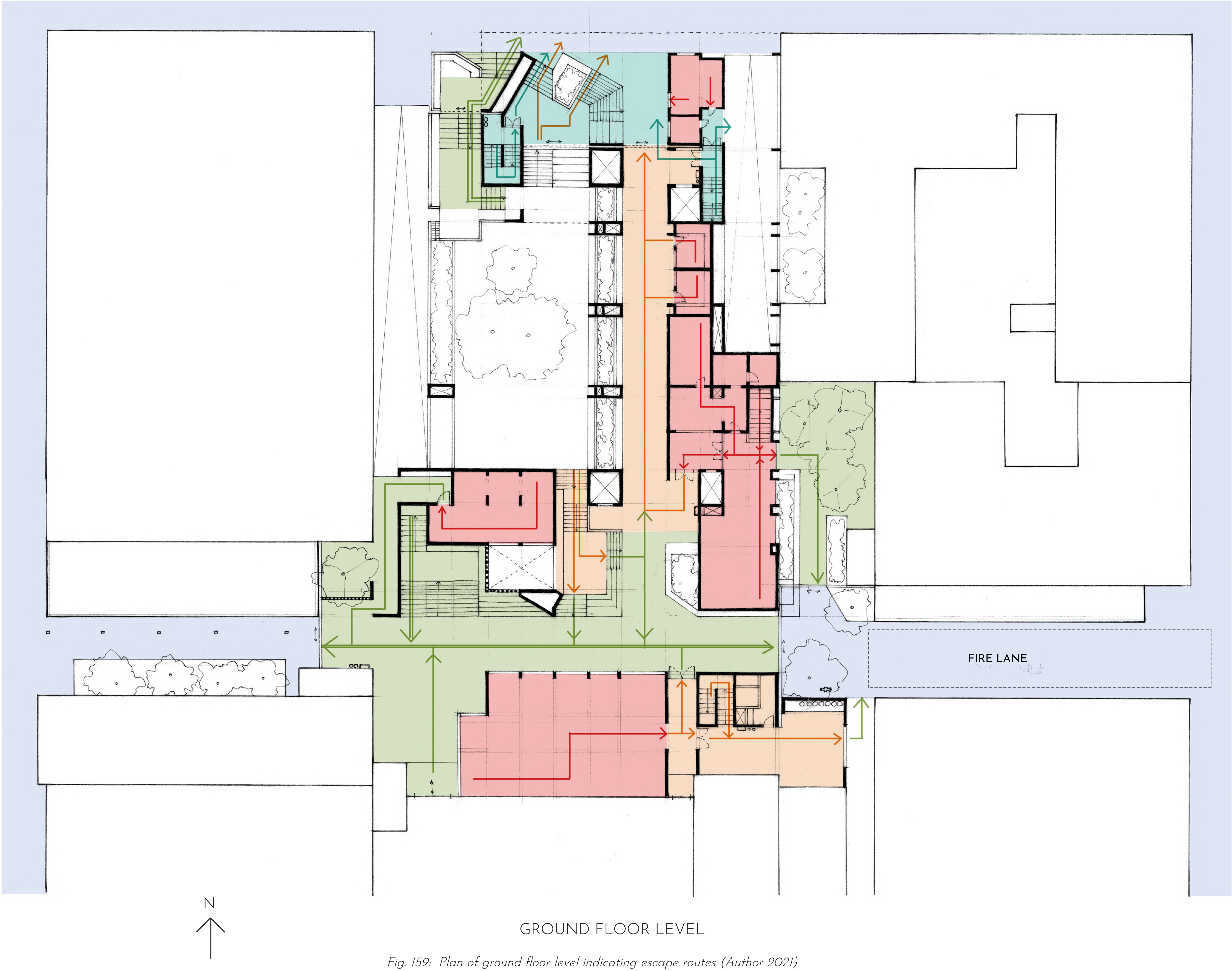
PUBLIC STREET



N

BASEMENT LEVEL

Fig. 158: Plan of basement level indicating escape routes (Author 2021)

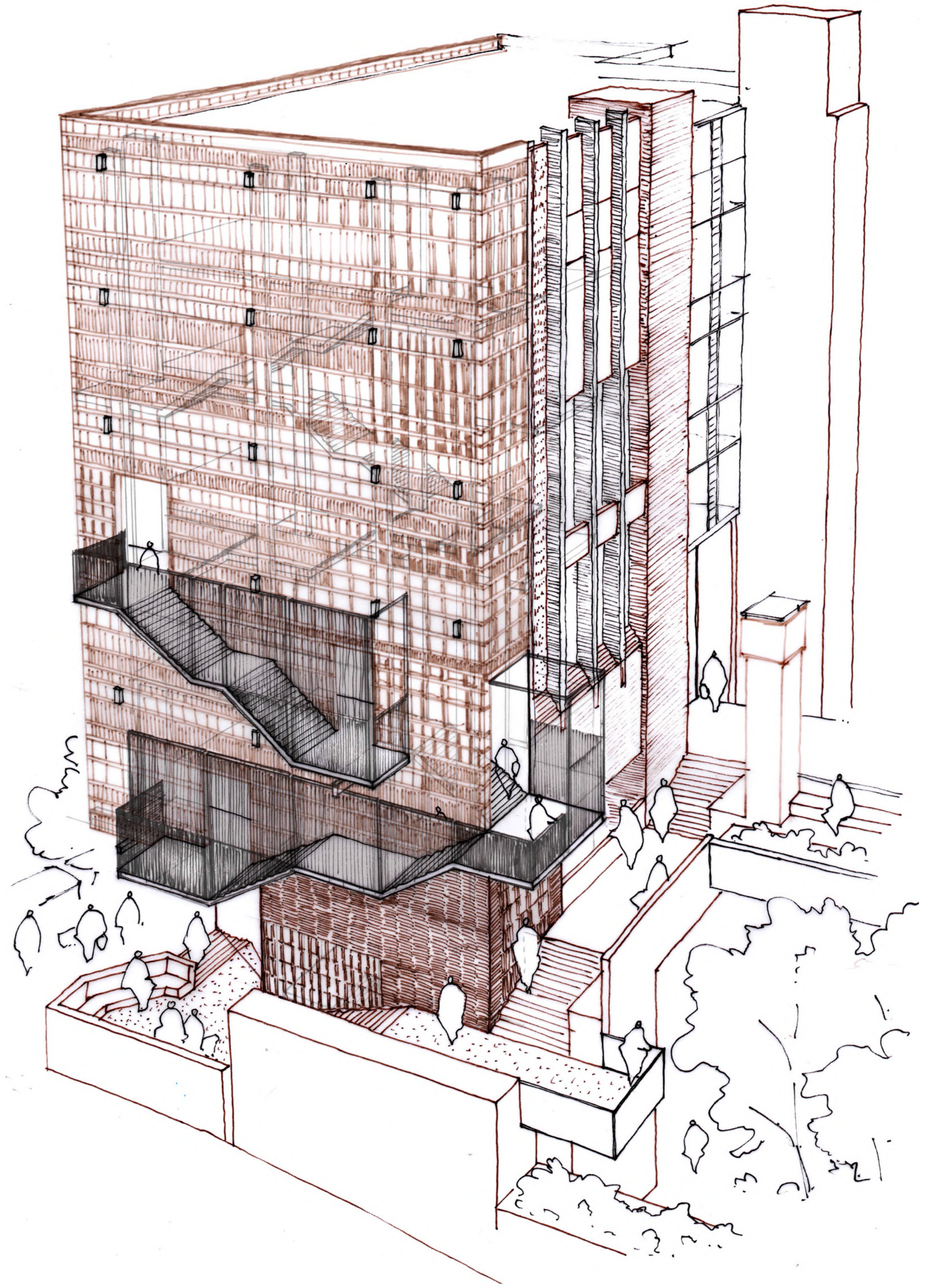


GROUND FLOOR LEVEL

Fig. 159: Plan of ground floor level indicating escape routes (Author 2021)

Fig. 160: Plan of first floor level indicating escape routes (Author 2021)

Emergency stairways were designed to not only comply with the required regulations but also to express the design and tectonic intentions. The emergency stairway of the 6-storey education building will be used as an expample of how refuge and exposure were incorporated.



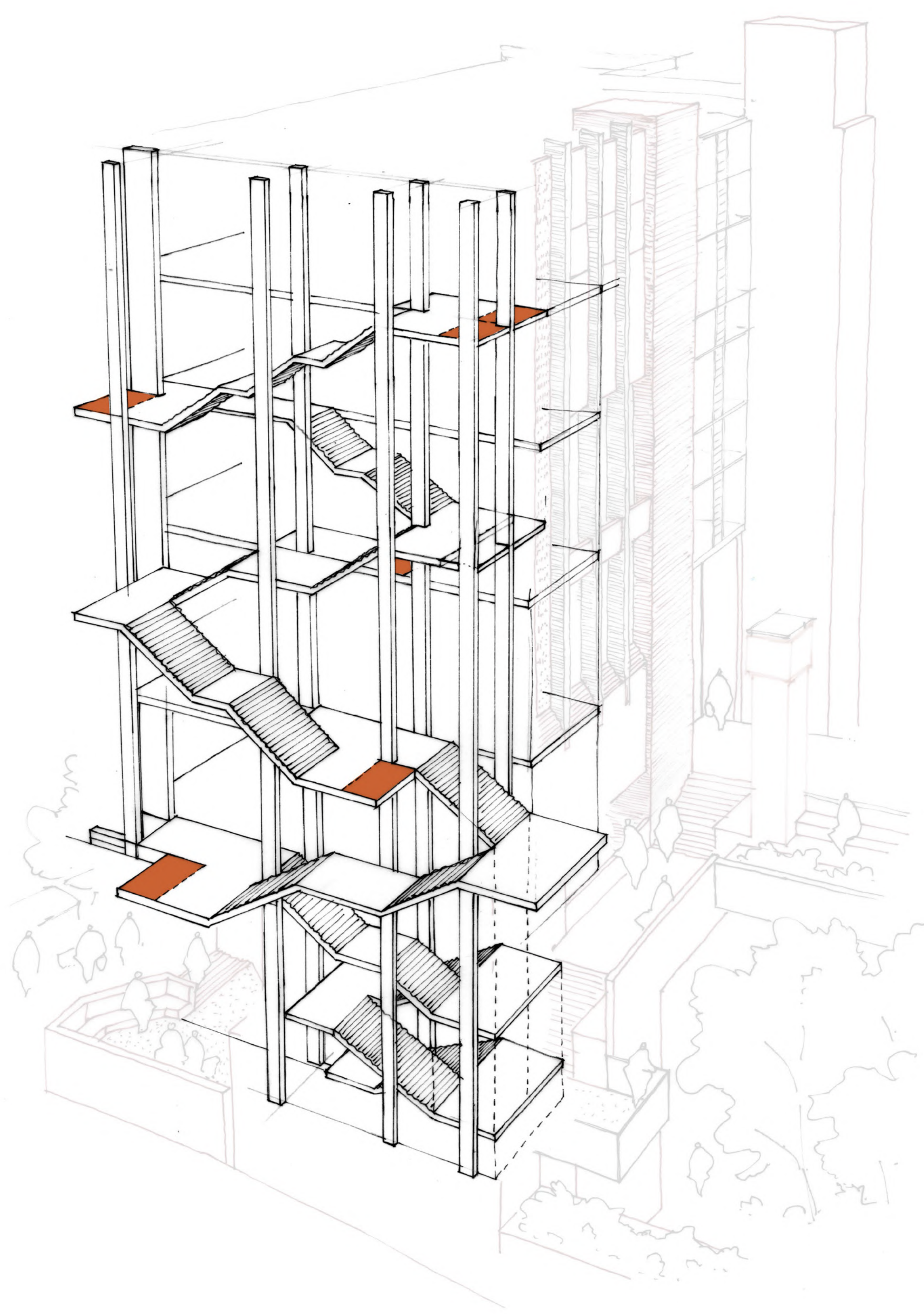
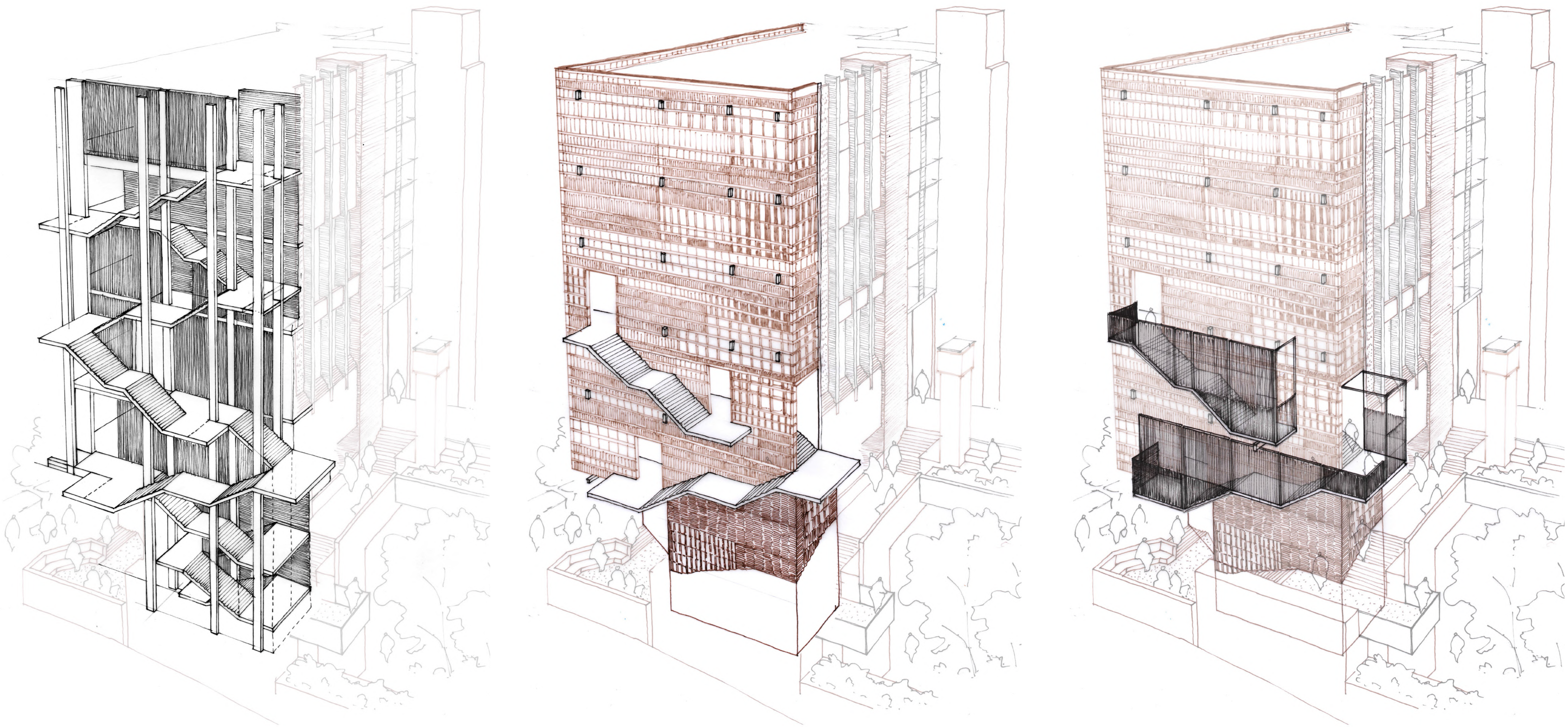


Fig. 161: Education builing emergency staircase (Author 2021)

The cast in situ reinforced concrete staircase is supported by concrete columns and beams. As an emergency staircase is must comply with SANS 10400 part S (SABS 2011) which limits the height of a flight of stairs between landings to 1530mm. Indicated in brown, is the positions of refuge areas within the emergency staircase at each storey to accommodate a wheelchair.



On the side facing the building, the staircase is enclosed with 230mm brick walls, with a minimum fire resistance of 120min, and class B fire doors (SABS 2011: 40).

On the other three sides of the external staircase is enclosed by a precast concrete screen that allows natural ventilation. The staircase steps out in front of the screen to create a sense of intimacy on the circulation space below, and to contrast the screen's sense of refuge with exposure. The lower portion of the staircase that leads to the street is enclosed by brick walls.

The portion of the staircase that extrudes beyond the concrete screen is partially enclosed with a galvanised mild steel balustrade / screen to allow for visual interaction with the city without creating a sense of vertigo. As the building is higher than 18m, any external stairway must be partially enclosed to prevent the occupants from experiencing vertigo.

Fig. 162: Education builing emergency staircase (Author 2021)