08

TECHNICAL INVESTIGATION

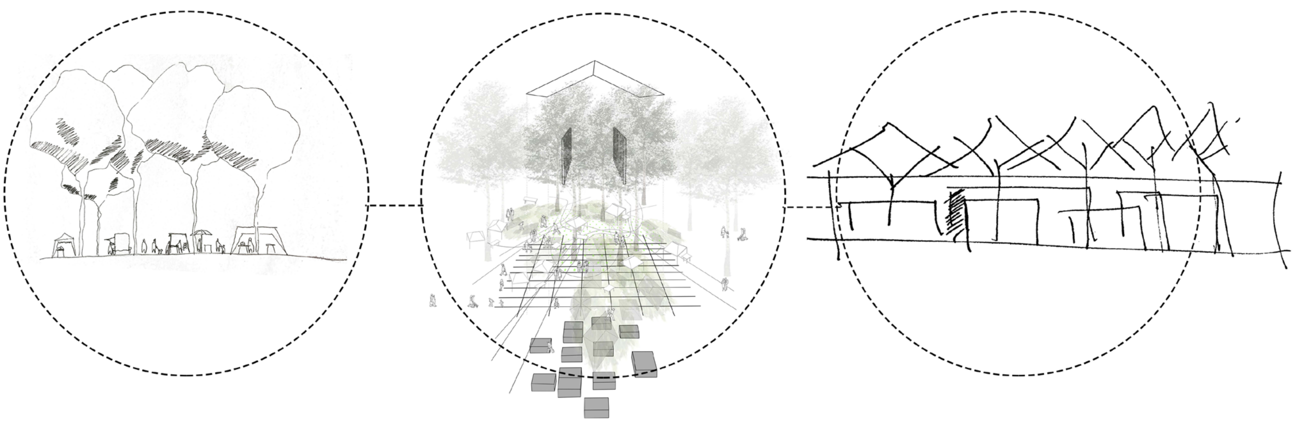


Figure 8.1 The tectonic concept (Author)

8.1 TECTONIC CONCEPT

"Normally, in the village, the public space is an open pace. People gather under a large tree and talk."
Francis Kere (Picchi, 2010.)

As a structural and spatial strategy, the tree as social space is translated from design to tectonic informant of structure and canopy. The structural concept is a representation of the spatial qualities of the tree as entity (Fig 8.1). The aim is to represent the primary structural elements, such as columns, not only as support but as spatial contributors. The structure should be exposed and contribute to architecture through the representation of both the design and tectonic concepts. As the roof is seen as independent entity, it functions on a separate structural grid that in turn influences the spatial layout of the space below.

As a strategy used continuously throughout the project, the tectonic approach is categorised into the three elements of Roof(Canopy and Structure), Ground and Infill. The aim is to mediate between these elements to produce elements of Roof and Floor as permanent and the Infill as temporary and flexible additions. The tectonic concept is then organised around the hierarchy with Roof as primary, Ground as secondary and Infill as tertiary. Though these three entities are approached independently in terms of tectonic applications, but as a whole considering how they will provide and influence each other.

The architectural intention of "Explode" through contextualising and including will serve as strategic informant. The tectonic approach represents and include the context through materiality, spatial layout and construction. All tectonic considerations should aim to produce a low-key architectural language in terms materiality, technology and environmental systems. As conceptual influence, the "Boeremark" and the industrial and suburban hybrid architectural language of Silverton are informants to the tectonic approach.

TIMBER and STEEL is the two primary materials that will be investigated due to their tectonic contribution to context. Timber should be locally sourced while all steel construction is to be standard SABS approved profiles that is sourced from steel recycling plants in Silverton.

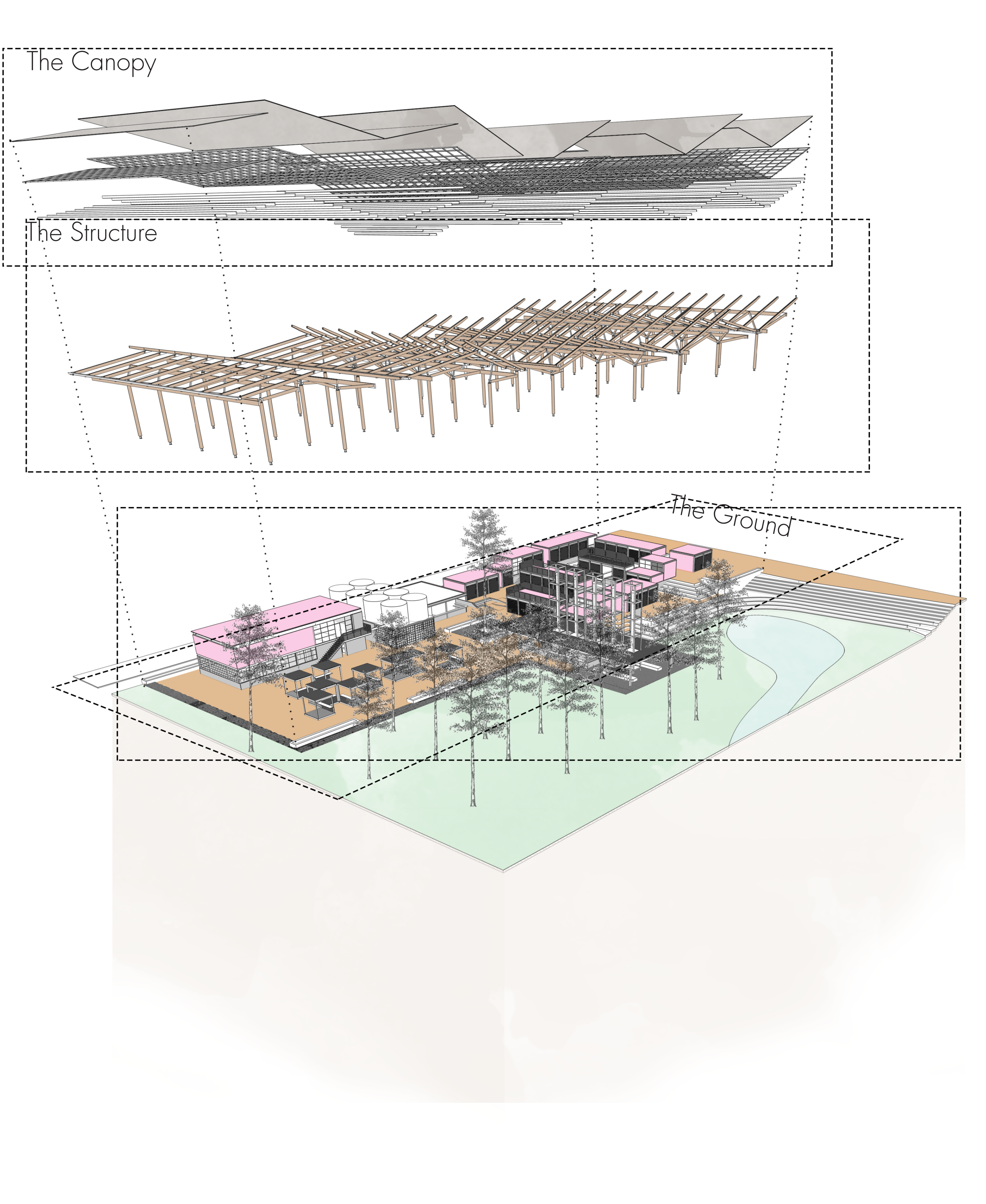


Figure 8.2 The tectonic approach (Author)

8.2 TECTONIC PRECEDENT STUDIES

8.2.1 JOSEY PAVILION

Architects: Lake Flato
Location: Decarut, Texas

This open air pavilion is an education and meeting centre that serves as a demonstration site for the Dixon Water Foundation in Decatur, Texas, United States.

The project consists of two uniformly scaled buildings connected by a porch. The structure is simple, low lying and speak to the surrounding context. It is designed to be flexible and able to adapt to climatic conditions. .The project consists of open-iar spaces sheltered by a unified roof.

The use of natural materials such as timber and human scaled spaces create a serene environment that connects people with the landscape in a holistic, non-intrusive way.

The water management of the building was also considered. The storm water is managed on-site, and the architects designed the gutter as a sculpture with rusted steel and concrete to create a water feature between the two buildings (Brake 2015).

The following aspects of the building was deemed successful and investigated:

-The successful use of local materials.
-The on-site water management system.
-The construction detailing f the project.
-Climate control of the open spaces.
-Successful relation to its context.

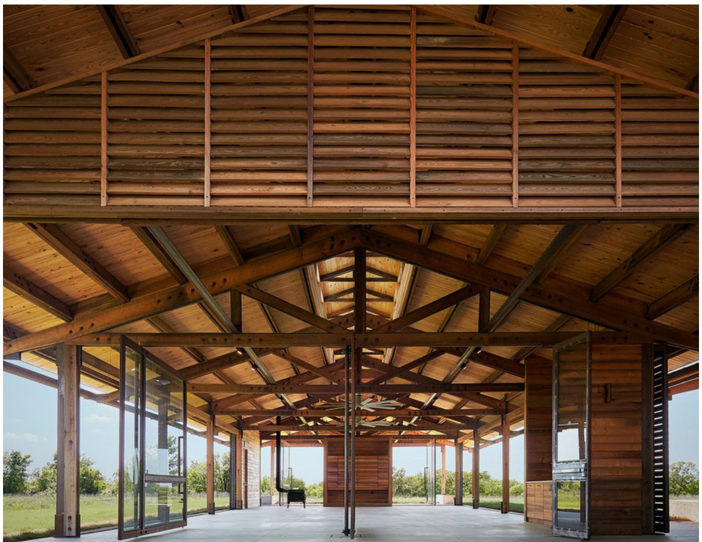


Figure 8.3 Open air space sheltered by roof. (Brake 2015)

Figure 8.4 Relationship between inside and outside (Brake 2015)

Figure 8.5 Gutter and rain chain detailing (Brake 2015)

8.2.2 AKADEMIE MONT CENIS HERNE

Architect: Helene Jourda
Location: Mont Cenis, Germany

This building was developed in partnership with French architects Hélène Jourda and Gilles Perraudin and constructed on a 25-hectare former colliery site. Planned as a centrepiece in the middle of a large oval open space, the building is both a public space housing urban development and a milestone on he way to the energy patterns of the future (HSS 2001). The building has two components the outer shell consisting of translucent roof and facade construction and the interior spaces that function as independent pods. The facade and roof consist of integrated single glazing and photovoltaic modules. The varying density of these modules enables the light and shade in the interior space to be specifically controlled without additional intervention. Within the shell a climate is created that in comparable to the Mediterranean region (HSS 2001).

The image is characterised by the use of natural materials. The loadbearing structure of the outer shell is of timber, as are the structural elements and cladding of the interior houses.

The roof of this project was investigated as it relates to the tectonic approach of this dissertation. Specific attention was given to the use and application of the timber columns through its material finish, detailing and construction. The materiality of the project convey a tectonic language of roughness that was taken into consideration. The materiality of the public spaces between the pods was also considered. The narrative of sheltered public space contained by an outer shell (roof and facade) as well the methods of naturally ventilating this space was investigated.

Figure 8.6 Sheltered public space, Akadamie Mont Cenis Herne (HSS 2015)

Figure 8.7 Materiality of Akadamie Mont Cenis Herne (HSS 2015)

Figure 8.8 Column detailing (HSS 2015)

8.3 THE ROOF

8.3.1 STRUCTURE

THE PRIMARY STRUCTURE:
The primary structural support for the roof is a column and beam structure system that consists of 400mm round structural timber poles as sub-structure and four 114 x 286mm laminated timber beams that sprout at the top that is conected to 140 x 429mm laminated timber beams that runs horizontally from east to west along the entire length of the roof. The timber poles are locally sourced from plantations in Mpumalanga. The poles are Eucalyptus Gandi tree trunks that are rough sawed from the tree once the tree reaches the required thickness (up to 400mm). They are available in lengths of up to 18 metres (Pullscar Timber 2016). The timber poles are tempered due to the natural growth pattern of the trees, but are kept unfinished (except for treatment) to convey the tectonic language of simplicity. The columns are supported by 600 x 600 x 850mm concrete footings. The columns are placed on a 7000mm horizontal grid.

The four laminated timber beams are connected to the poles through a custom made steel bracket. The bracket consists of a 193mm diameter hollow round steel tube that is 400mm in height and welded to a 12mm steel round plate that is bolted to the timber poles. The beams are connected to the bracket with 12mm steel plates that are welded to the hollow round steel tube. All steel to be painted with black intumescent paint.

THE SECONDARY STRUCTURE
The secondary structure is pairs of 75 x 286 laminated timber beams spaced at 3500mm intervals on top of te horizontal beams of the primary structure. These beams serve as bracing for the entire roof structure as they connect the roof throughout with steel plate connections.

THE TERTIARY STRUCTURE:
The tertiary support is 75 x 220mm laminated timber purlins. They are spaced at a maximum 1200mm intervals as required support for the roof and ceiling materials. The roof and ceiling are fixed to a 1200 x 1750 timber purlin grid system of 73 x 73mm purlins that is fixed on top of the laminated purlins. This allow the roof covering to function as a seperate "pan" that gently rests on the “primary” purlins. The 73mm purlins provide adequate space for insulation and thicken that emphasise the roof as separate element.

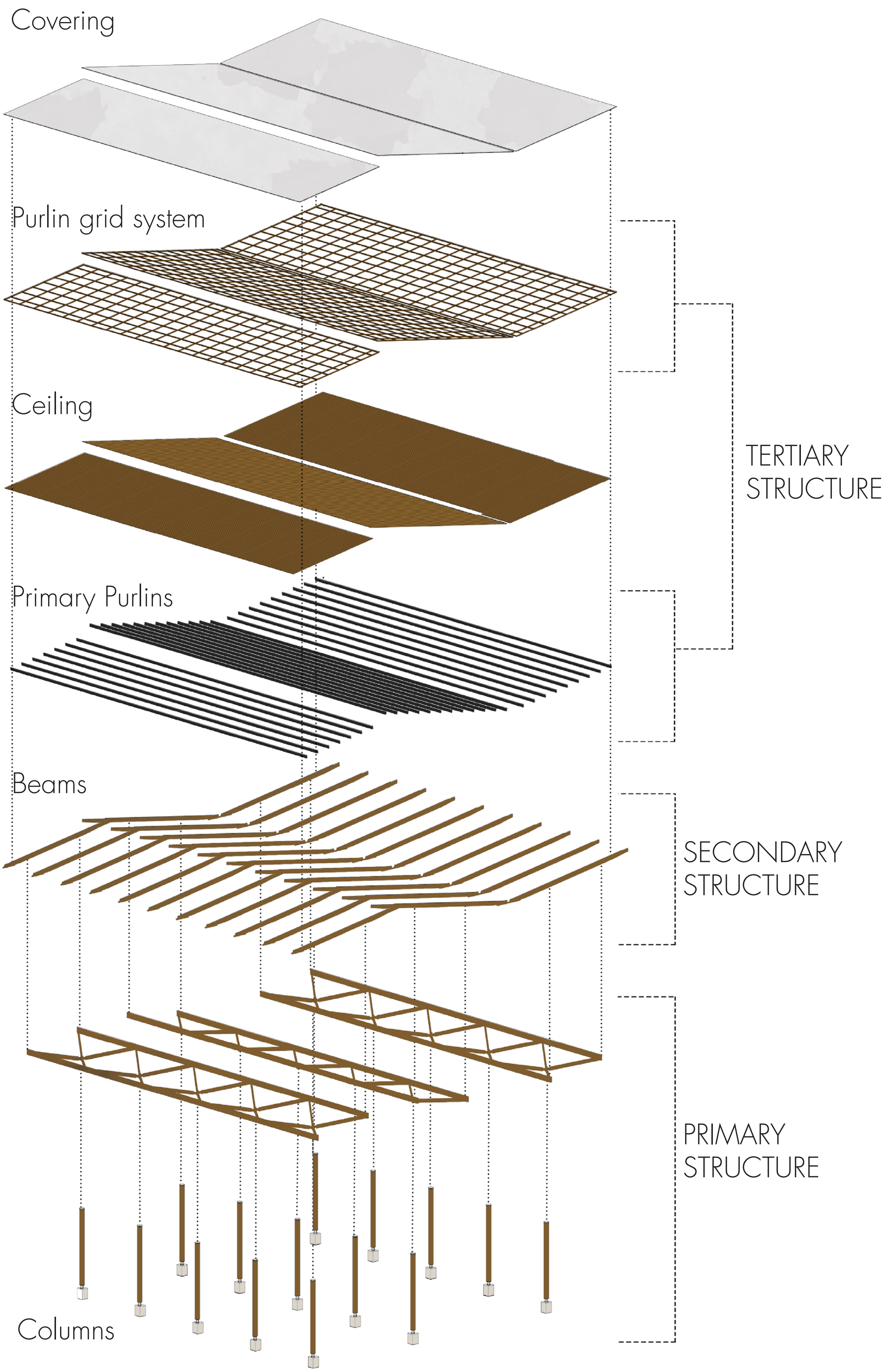


Figure 8.9 The structural elements of the roof (Author)

8.3

8.3.2 MATERIAL APPLICATIONS:

CONNECTIONS:

Although the roof is broken into separate elements that allow for daylighting and natural ventilation, connections should be provided that will allow the roof to perform as an entity that will make it structurally sound. To emphasise each roof plane as a separate element, the connections should be tectonically lighter. In this regard, steel is to be used to differentiate between the roof elements.

CEILING:

The ceiling material is to be 22 x 152mm pine timber planks that is to be fixed diagonally to the purlins.

ROOF COVERING:

0.5mm Klip-Lok 700 galvanised steel sheeting to be used. The profile has 4 trapezoidal ribs at 233mm centres giving a net cover of 700mm. The male rib will have spurs to ensure a positive double interlocking action at side-laps. Each pan will incorporate two stiffener ribs. No. 10-11 x 45mm long self-drilling wafer head PH2 screws will be used to fix sheeting to timber purlins (Global Roofing 2016). As an environmental strategy, the roof structure needs to be open at times to allow for maximum daylighting to enter the structure, while at the same time to let the roof serve as shelter from the sun. 0.8mm Clear Klip-Lok 700 Polycarbonate roof sheeting is to be used at openings. Clear Polycarbonate transmits 90% of natural lights, while at the same time have an R-value of 0.83 and provides a high degree of fire retardancy (Modek 2016).

INSULATION:

50mm Polyester thermal insulation will be placed between ceiling and roof covering. The South African National Standard 204, as published by the SABS, provides a standard of energy efficiency in buildings. Compliance to this standard can be achieved by meeting the terms of SANS 204-2 which defines an easy “Deemed to Satisfy” requirement based on the climatic zones (Isotherm 2016). Pretoria is in zone 2. The thermal resistance required in this region 2.3 to 3.35 where the “Deemed to Satisfy” recommends a minimum thickness of 100mm (Isotherm 2016). Since the roof is at a height that provides a substantial space between roof and the habitable space on the ground floor, and taking into consideration the fact that the structure is not enclosed, the insulation is to be minimised to a thickness of 50mm.

TREATMENT OF TIMBER:

As the timber structure is mostly outdoor and in close proximity to spaces where open-fire and industrial machinery will be used, precautions need to be taken to treat the timber structure that will not only protect it against water, but also serve as a fire retardant. As the timber structure will be exposed to outdoor conditions it is classified under H3 of the South African Woof Preservation Hazard Classification (Forestry and Sawmilling Directory 2015). H3 is used to explain timber that is outdoor, above ground and subject to periodic wetting and leaching.

In response to the above information, Timberlife Flambor as treatment shall be used. It is a clear liquid finish that functions as a dual-purpose chemical system and contains both a borate-based wood preservative (Topro 94) and phosphate-based fire retardant (Fyrcon) for timber treatment. Flambor provides permanent and wide-spectrum protection against biological attack, water and imparts a high degree of fire retardation in comparison to timber treated by pressure impregnation (Timberlife 2016).

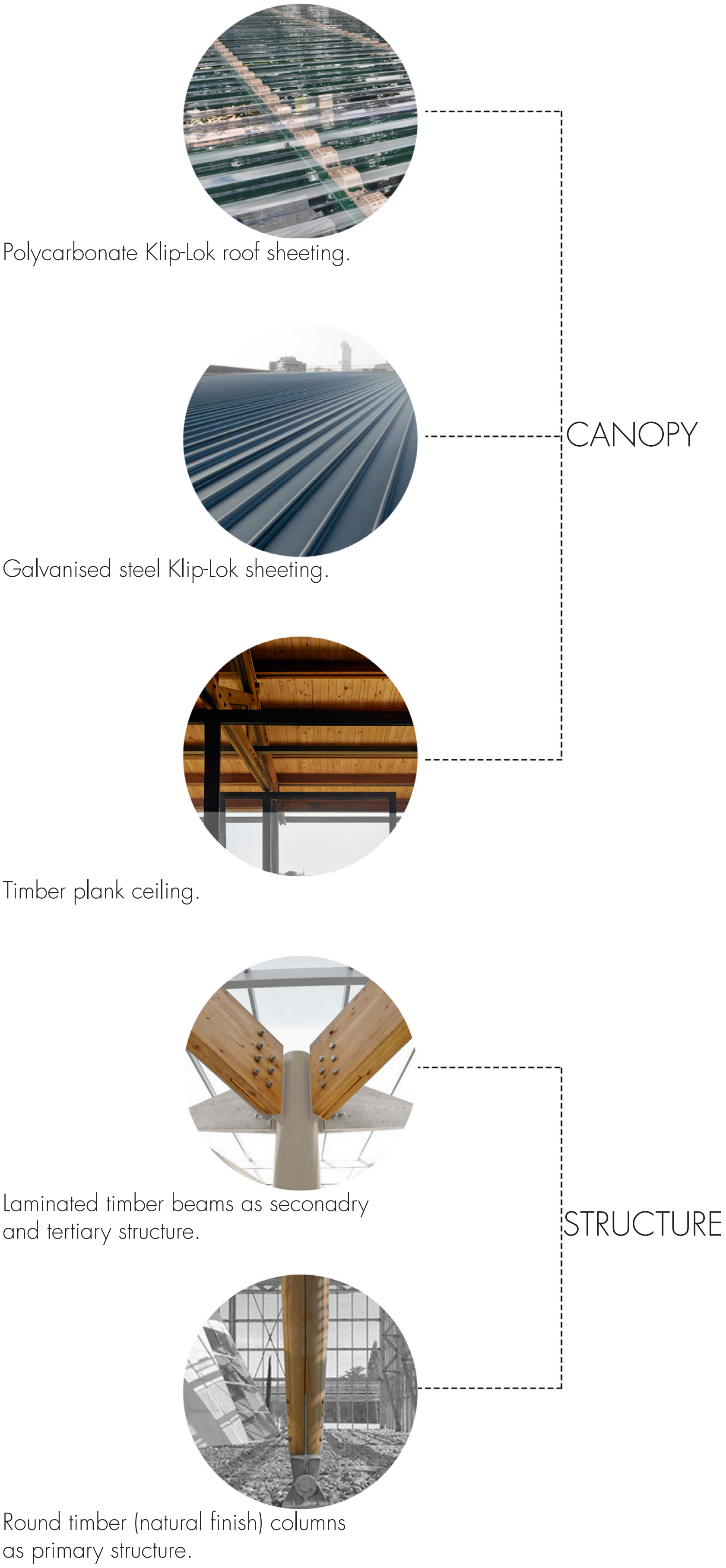


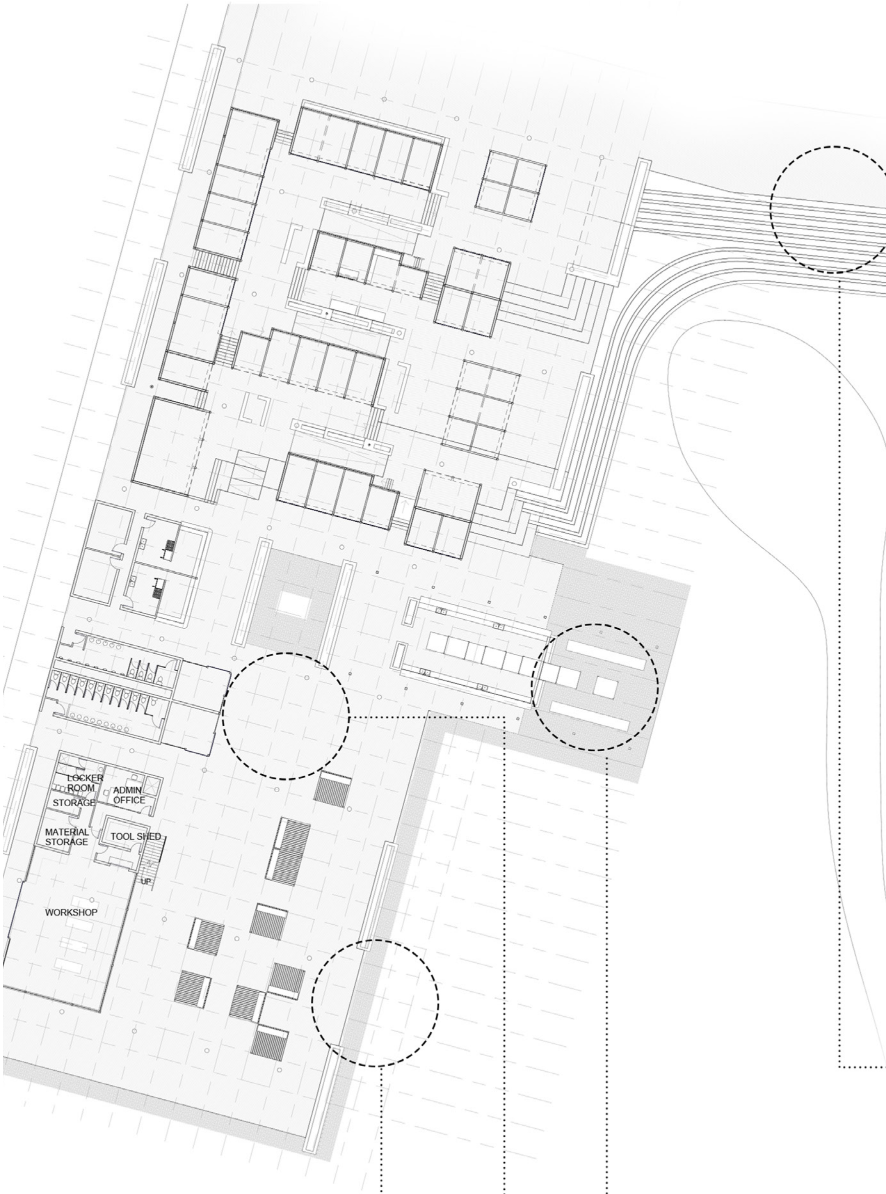
Figure 8.10 Material applications of roof structure and canopy (Author)

8.4 THE GROUND

As part of the tectonic concept and strategy, the ground plane is the secondary spatial element. It is sculpted and provides the grid that accommodates the retail infill. The ground floor is the principal component on distorting the threshold while producing a clear relationship between inside and outside space. The floor serves as uniform structural element that should provide the support for flexible and movable retail spaces.

To produce a relationship between inside and outside space and to impart an architectural language of informality and low-key, paving is to be used throughout the building as floor covering. Semi-face brick is used as it is suitable for paving and structural uses such as in the case of retaining walls. As paving is used, the floor plane is laid out according to a 900 x 900mm grid that will maximise the use of material. This grid influenced the overall spatial grid of the project that is 2700 x 2700mm.

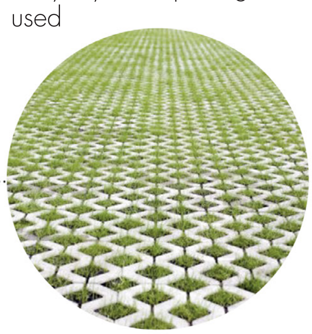
The paving is to be laid out on a 150mm concrete surface bed that prevents the paving from warping while providing the structural support for flexible space. Permeable paving with plant infill is used at the edges of floor to distort the threshold between the outside grass and interior paving. Permeable paving is also used at communal gathering spaces. Benches are also provided at these spaces. The floor surface is at a fall that allows water run-off towards the permeable paving and will be filtered in cases of cleaning, as well as when storm water might enter the structure. The planting at these will be Acorus Gramineus Aurerea as they are able to handle a high degree of foot traffic and can be grown in shaded and semi-shaded areas (Stepables 2016).



Example of concrete seating at amphitheatre

Clay lay brick paving to be used

Concrete seaters to be provided trhoughout



Permeable concrete paving blocks with Acorus Gramineus Aurera planting infill.

Figure 8.11 Material applications of ground plane (Author)

8.5 THE INFILL

THE SEMI-FLEXIBLE

The tertiary element, the retail space, is explained through the semi-permanent and the temporary. The semi-permanent is semi-flexible retail space. As these spaces are rent out to tenants on periods of three months, there will be a regular change of tenants. The construction of these spaces will need to be able to expand and change accordingly.

The pods will be constructed from recycled steel modules that are supplied by two existing steel recycling plants in Silverton. Both these recycling plants reclaim all standard SABS steel modules (Silverton steel). The primary structure of these pods will be 150 x 150mm steel square tubes columns supported by the concrete floor slab. The secondary structure is 152 x 152mm steel H-Beams. The tertiary structure is 75 x 50 x 20mm steel lipped channel purlins and battens that support the wall, roof and floor finishes. The structure will be bolted together to allow the structure to be easily adjustable. All steel to be finished with intumescent paint.

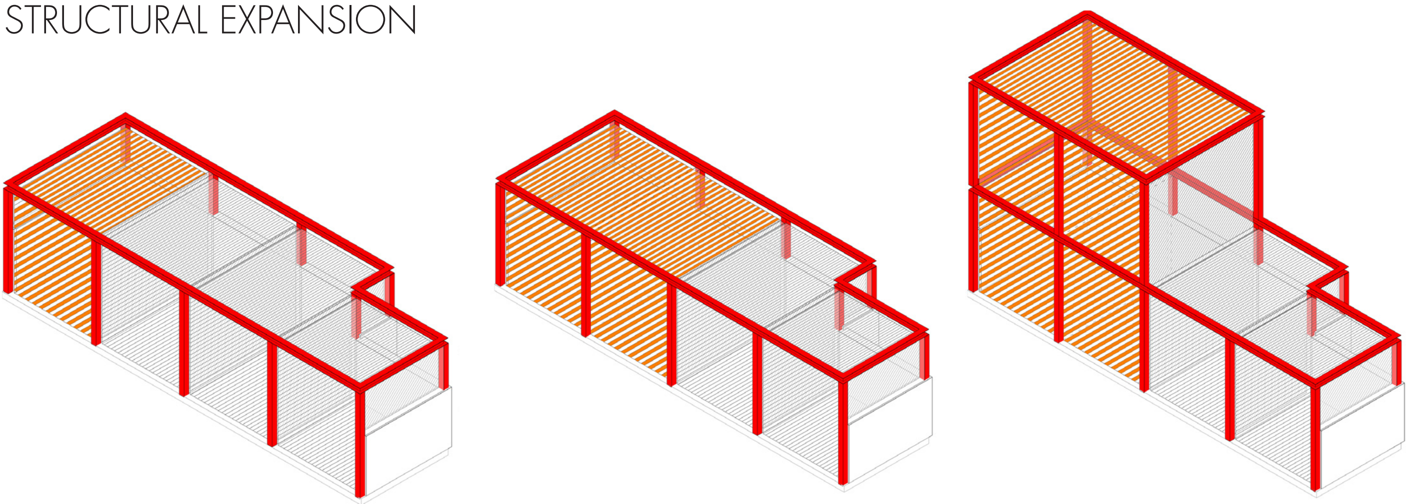
The purlins and battens is spaced at 600mm intervals to support the plasterboard ceiling and wall partitions. The plasterboard is to be 15mm 60 min fire rated gypsum board. These boards are to be used as sound absorbers where access to the roof surfaces of some of the pods is provided as it has a sound insulation reduction index of 40dB (Lafarge 2015). Sufficient space for additional personalised ceiling and wall finishes to be fixed to plasterboard is also provided. The external wall finishes will be recycled IBR metal wall sheeting.

Glazing: As the structure as a whole will not be enclosed and the pods functions as independent spaces, polycarbonate flat sheets will be used as glazing. It provides high UV protection, high heat resistance, is light weight (1/2 that of glass), high light transmittance and recyclable. It has outstanding impact resistance (250 times that of glass) that provide security and safety (Excelite 2016).

THE FLEXIBLE:

The temporary retail stalls will be constructed of standard SABS timber modules. It is a basic structure consisting of a movable timber platform. The structure should be allowed to be completed freely and be easily adjusted according to the tenants needs.

STRUCTURAL EXPANSION



A modular steel structure is used that will allow for efficient and effortless future expansion and revamps of retail spaces according to the tenants requirements.

Figure 8.12 Strutural intention of retail spaces (Author)

MATERIALITY

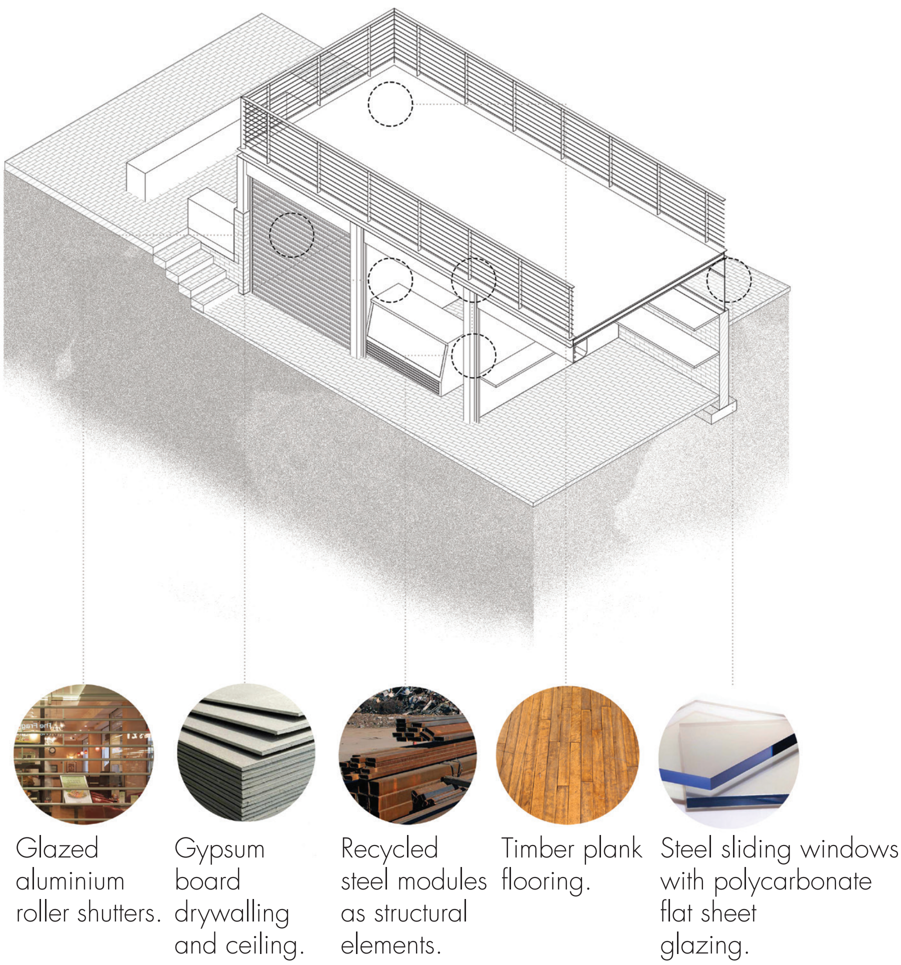


Figure 8.13 Material application of retail pods (Author)

8.6 WATER MANAGEMENT

As environmental strategy the roof as a resource, with rainwater collection as method and architectural informant, is explored. The aim is to provide water for ablution facilities throughout the year.

WATER DEMAND:
To determine the water requirements for ablution facilities, the SANS 10400 document was consulted. According to part A of SANS 10400 the building falls under the classification F1: Large Shopping Space. The population allowance should thus be one person for every ten square metres. As the floor area of the building is 2940m2, daily provision is made for 300 people. The annual domestic demand is set at 1029m3. Taking into consideration the yield in Pretoria and the available roof area, there will be sufficient water catchment to use in ablution facilities. However, water for cooking spaces will be provided through municipal connections, while irrigation will be supplied by pumping water from Moreleta Spruit.

FILTERING SYSTEM:
As for the filtering system, a natural flow though filtration system will be used. The water is collected through gutters and is transferred to the filtering system by chain downspouts. The water is then naturally filtered through landscaped reservoirs that collect filter and infiltrate water run-off allowing pollutants to settle and filter out as water peculates through the planter soil before being piped to its downstream destination. Planters should be a minimum width of 750mm for optimum sufficiency. An overflow needs to be provided at a minimum of 75mm below top of planter wall to allow for emergency discharge (Oregan State University 2010). As water will also be used for showers and hand wash basins, the water will also be pumped through UV filters as a safety precaution.

TANK SIZE:
The maximum domestic demand for the structure is 93m3 per month. To effectively plan for the worst case scenario and to make sure that the tank remains to required capacity throughout the year, a minimum tank size of 300m3 is required. Eight 4000mm diameter corrugated steel tanks with a height of 3000mm will be placed on the roof of the ablution facility. This will provide sufficient water supply throughout the year and allow water to be supplied to ablutions.

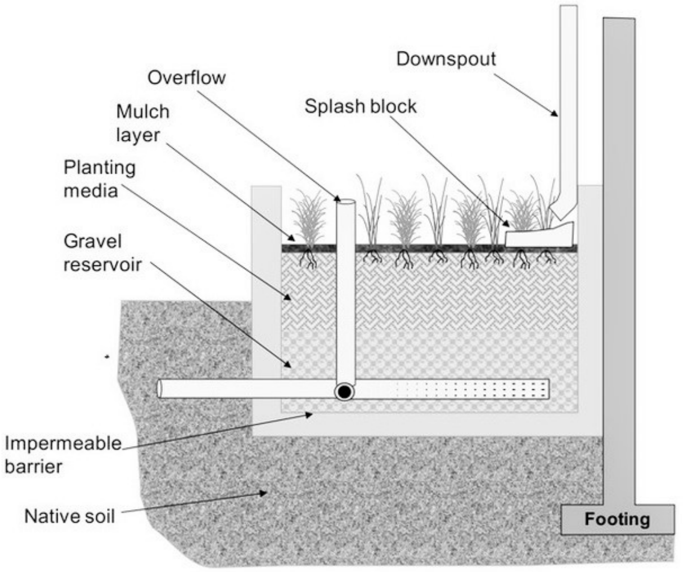
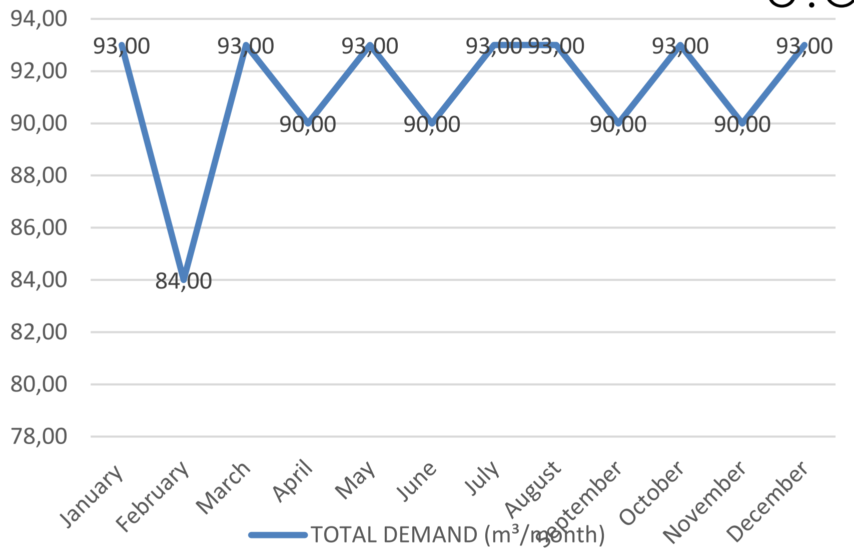
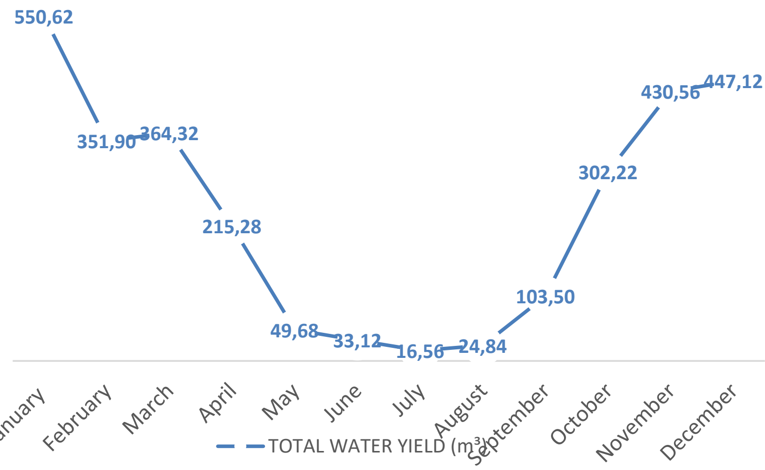


Figure 8.14 Example of water planted filtering system (Oregan State 2010)

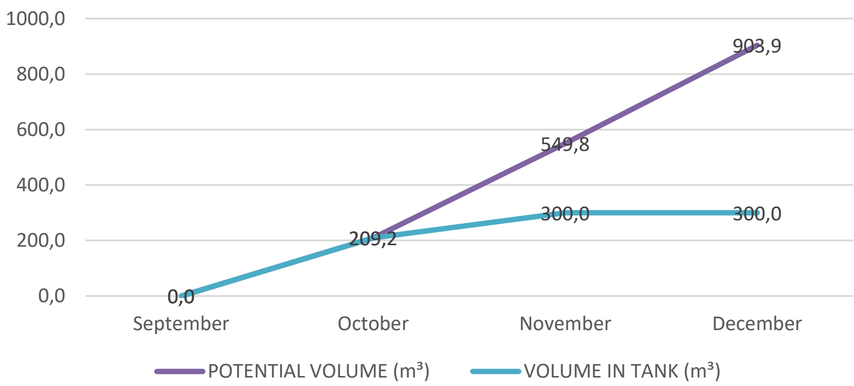
WATER YIELD FROM CATCHMENT AREA



WATER DEMAND



WATER TANK INITIATION PHASE



WATER TANK OPERATIONAL PHASE

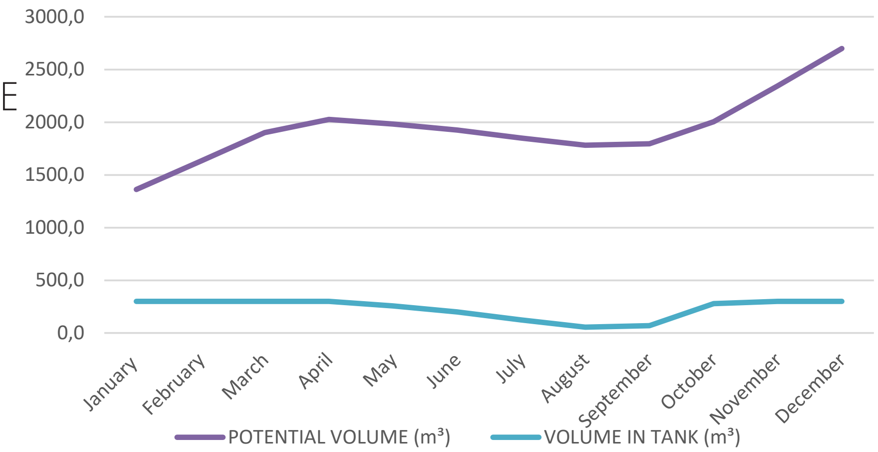


Figure 8.15 Water catchment calculations (Author)

8.7 ENVIRONMENTAL STRATEGIES

Apart from water catchment, temperature comfort, daylighting and solar harvesting is also explored and iterated. The aim will be to produce a comfort temperature beneath the roof structure. To achieve this, methods of natural ventilation, shading and insulation is explored. The roof manipulated to allow the maximum amount of daylighting in the space below the roof as well as the interior of the retail spaces.

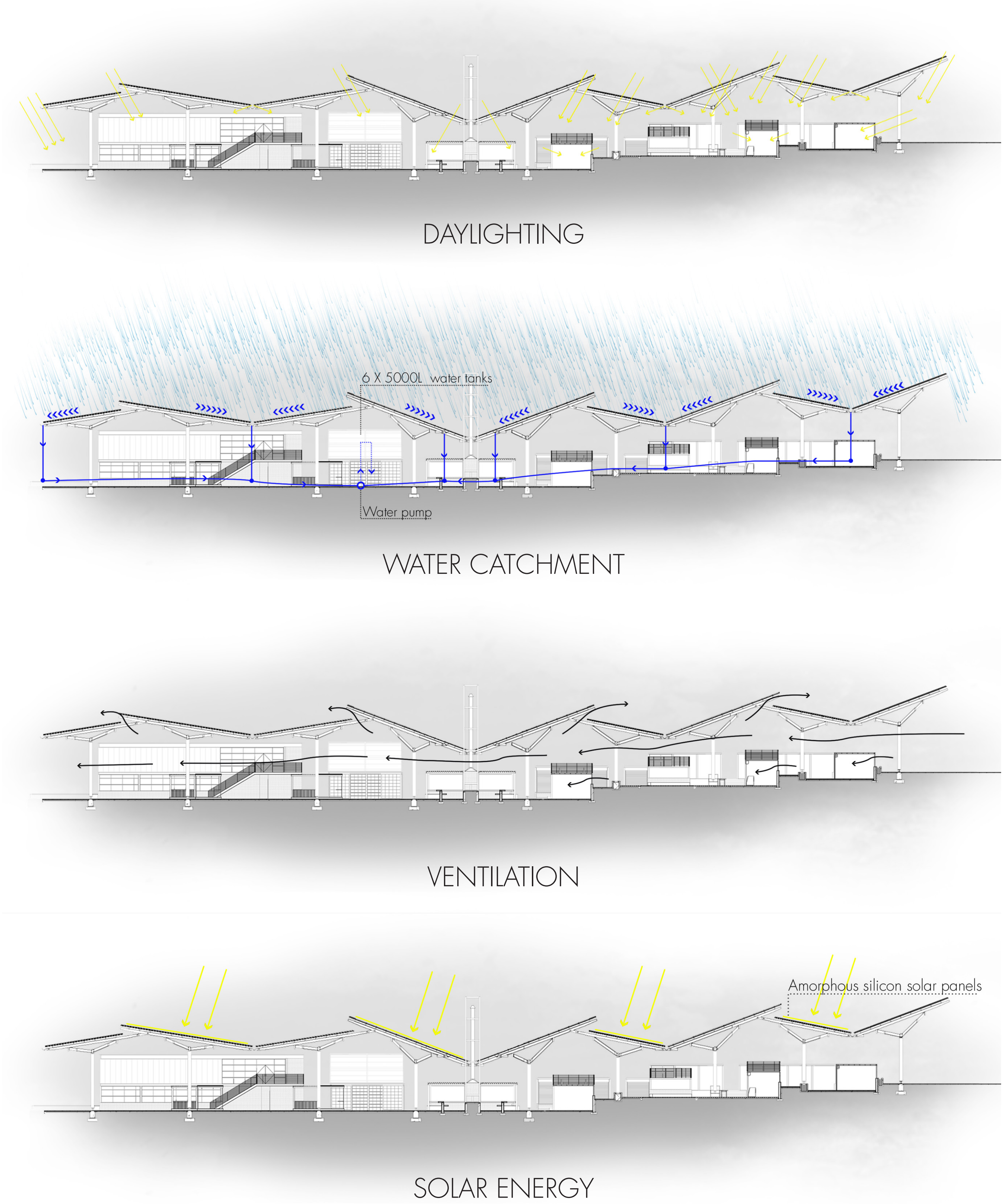
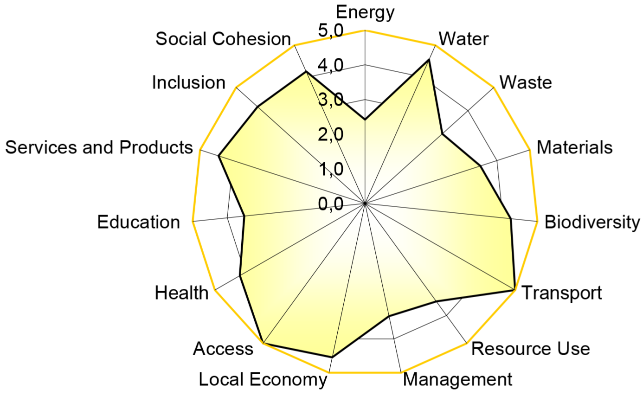


Figure 8.16 Environmental strategies (Author)

SBAT ANALYSIS



Environmental, Social and Economic Performance

Environmental	3,5
Economic	4,3
Social	4,1
SBAT Rating	4,0

SB5 EF and HDI Factors

EF Factor	3,7
HDI Factor	4,1

SB6 Targets

Environmental	71
Economic	86
Social	82

Figure 8.17 Summary of SBAT analysis of project

8.8 TECTONIC EXPLORATION

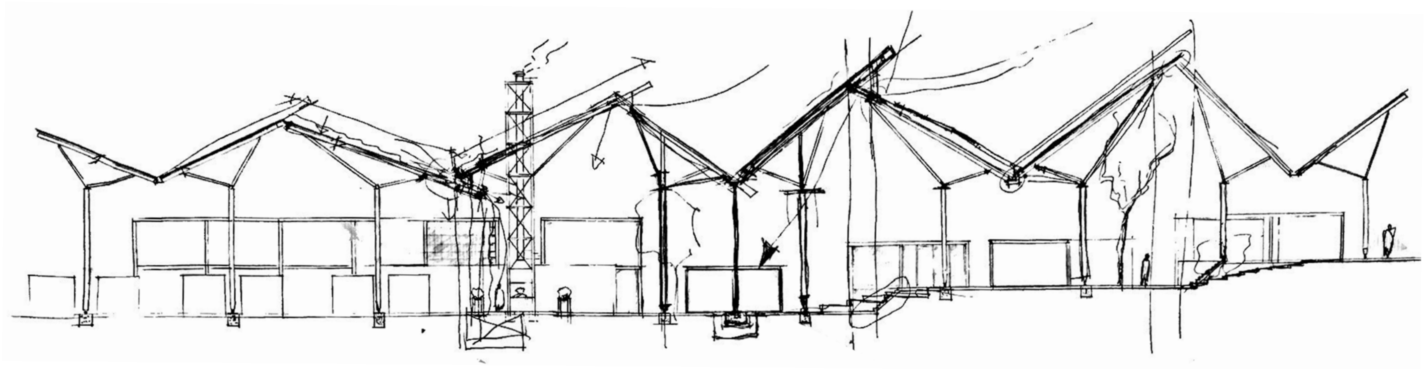


Figure 8.18 Section exploration A (Author)

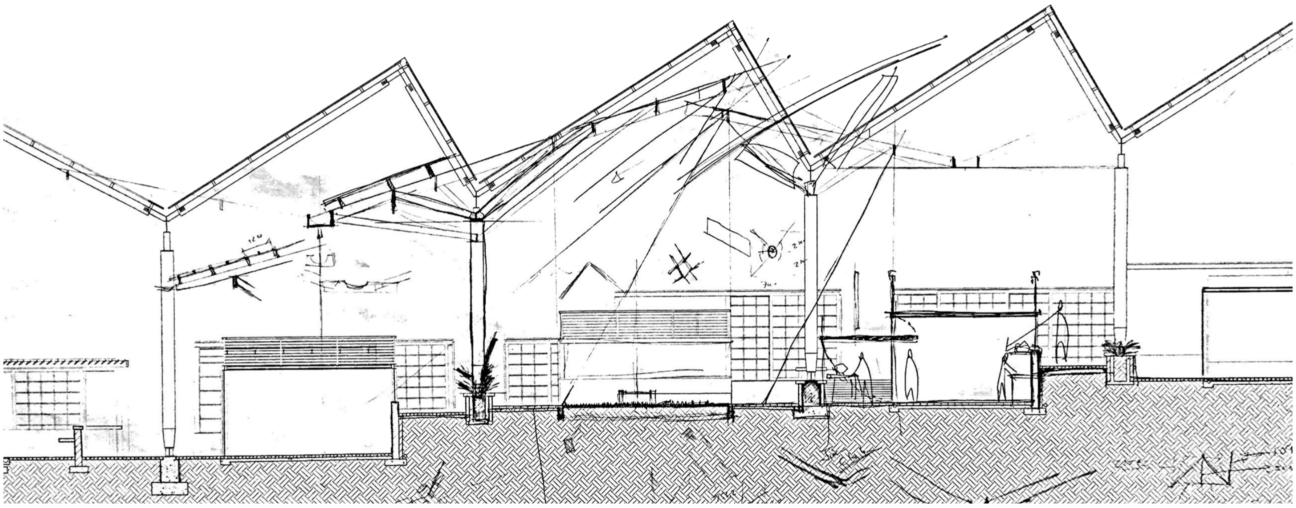


Figure 8.19 Section exploration B (Author)

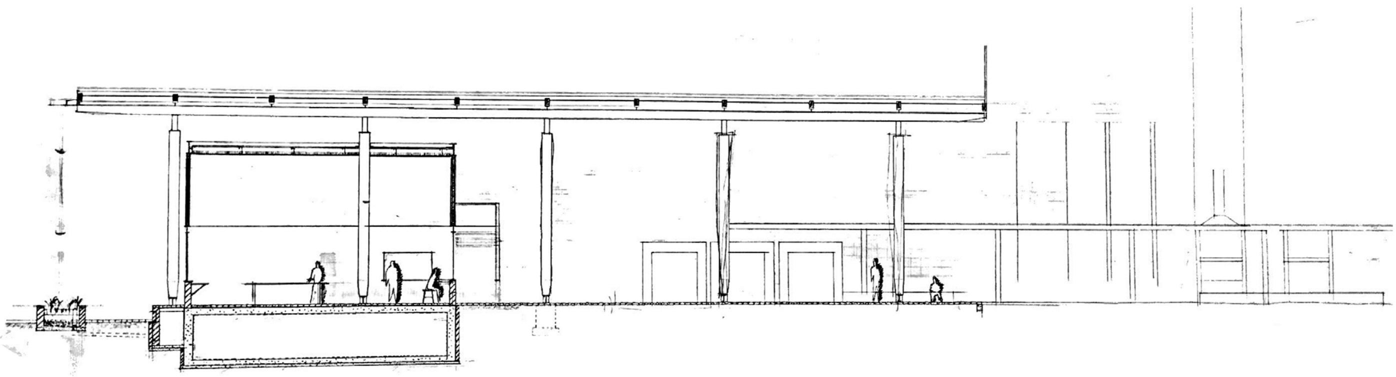


Figure 8.20 Section exploration C (Author)

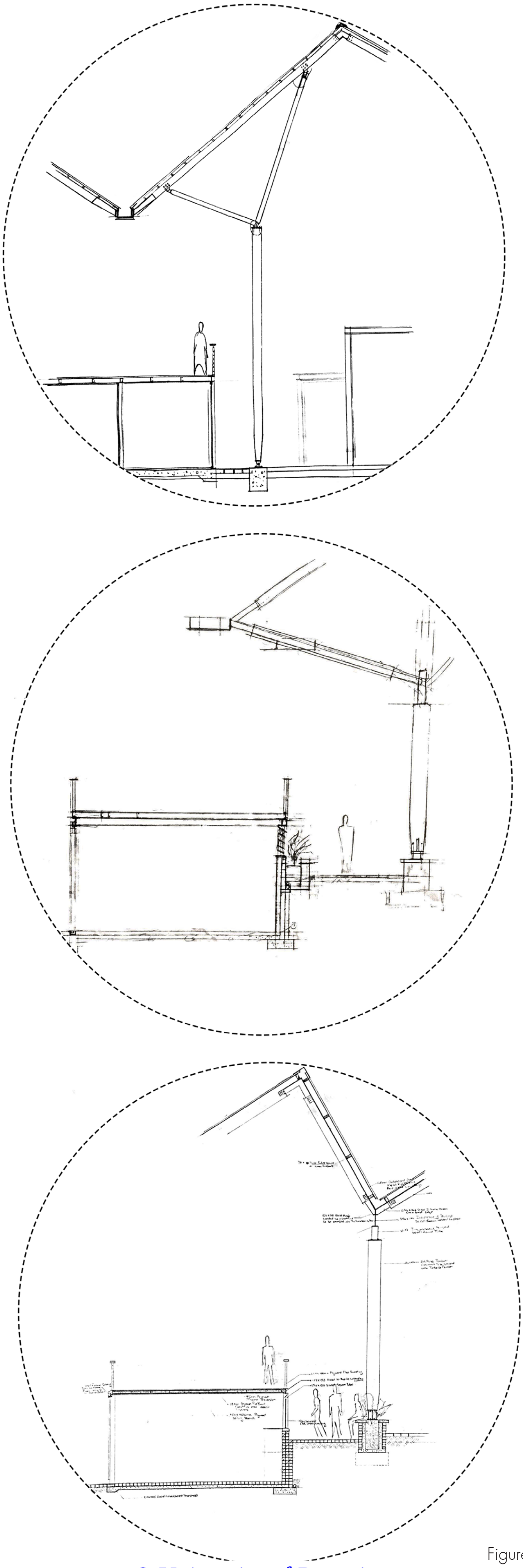


Figure 8.21 Detail section development (Author)

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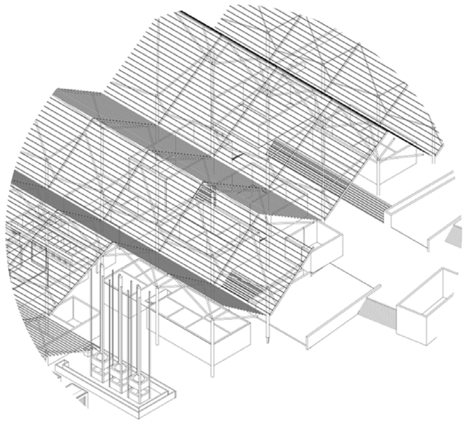
ROOF STRUCTURE EXPLORATION



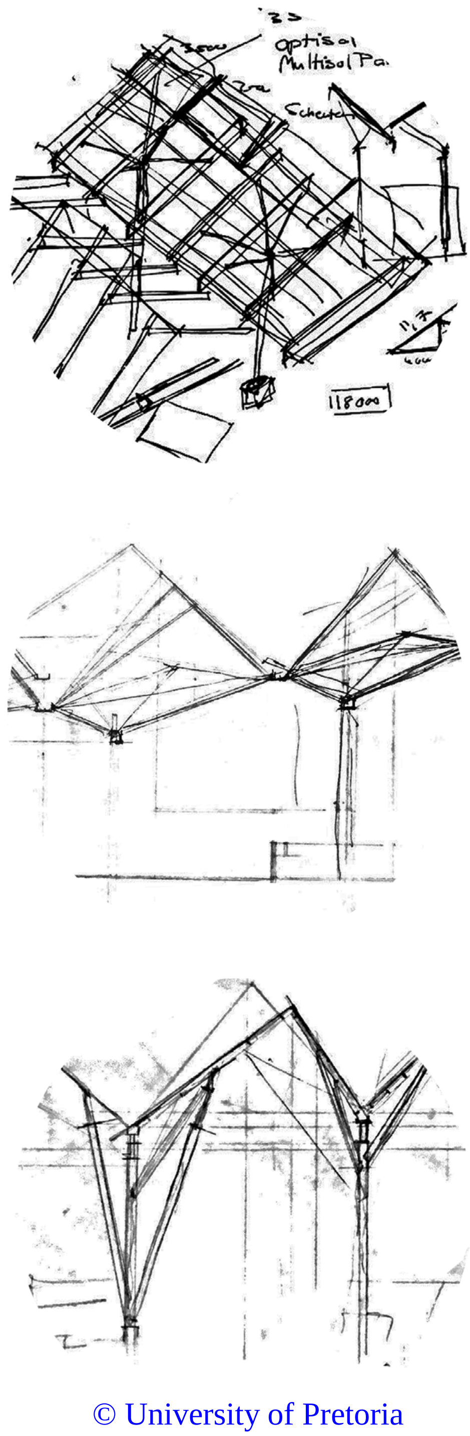


Figure 8.22 Roof structural exploration (Author)

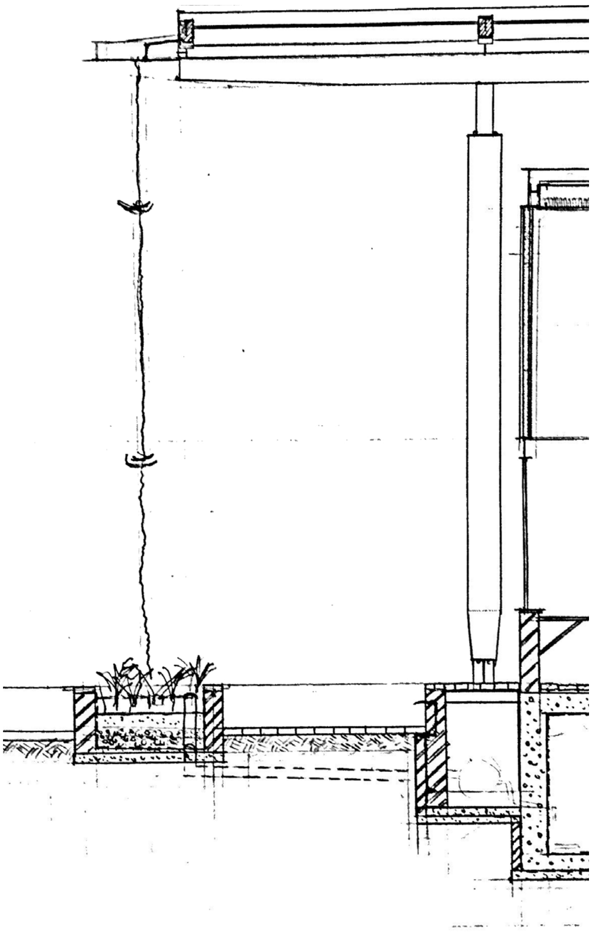


Figure 8.23 Rain chain and water catchment detail exploration (Author)

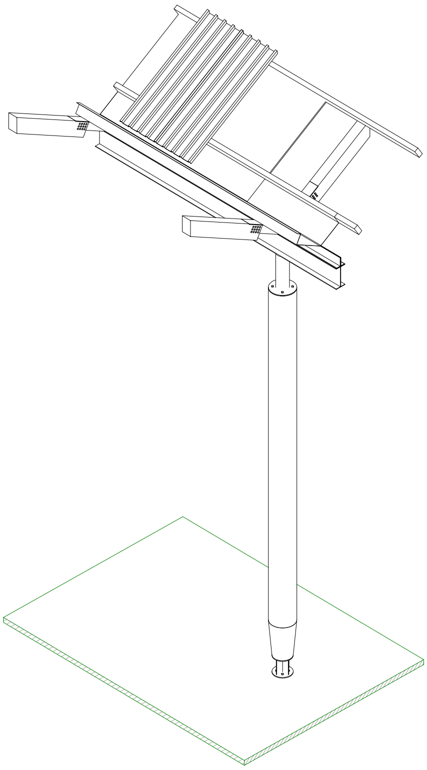


Figure 8.24 Column and gutter detail exploration (Author)

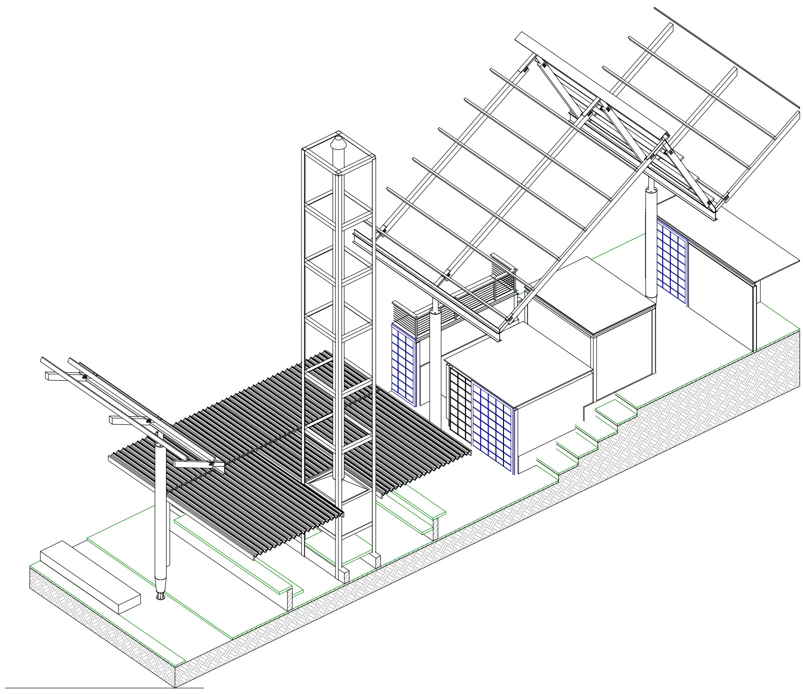


Figure 8.25 Tectonic exploration of "social core" (Author)

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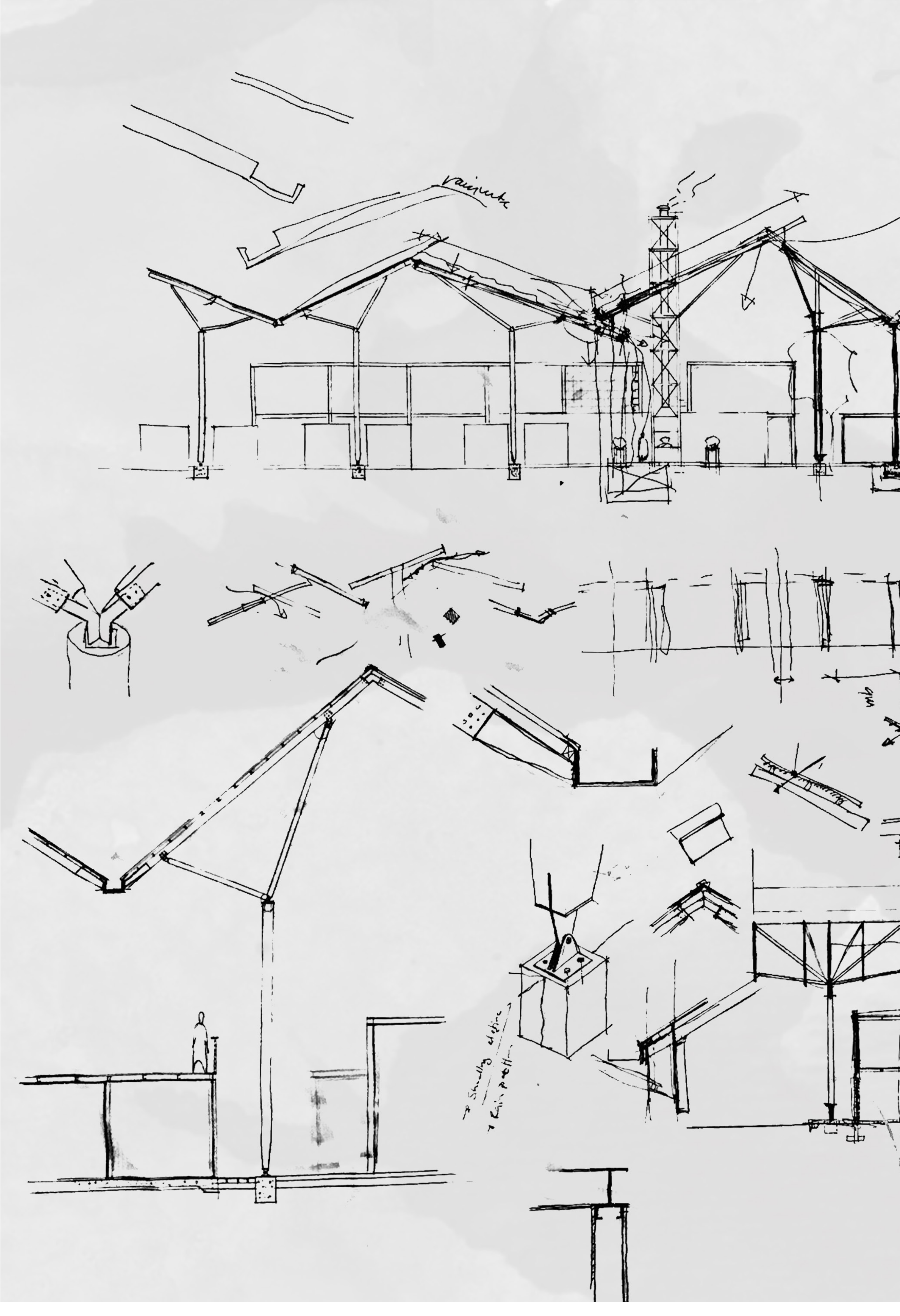

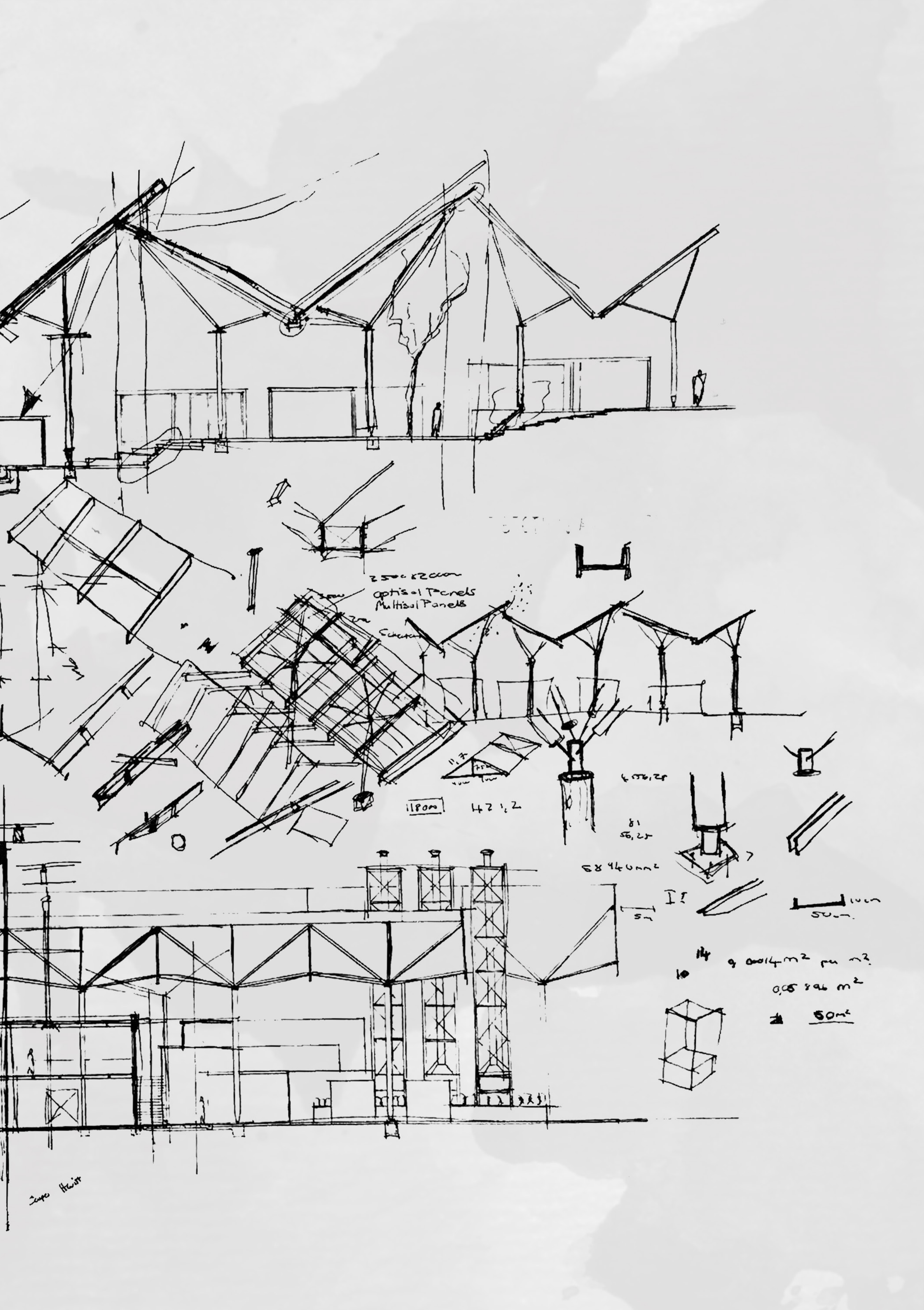

Figure 8.26 Sketches of tectonic exploration A (Author)

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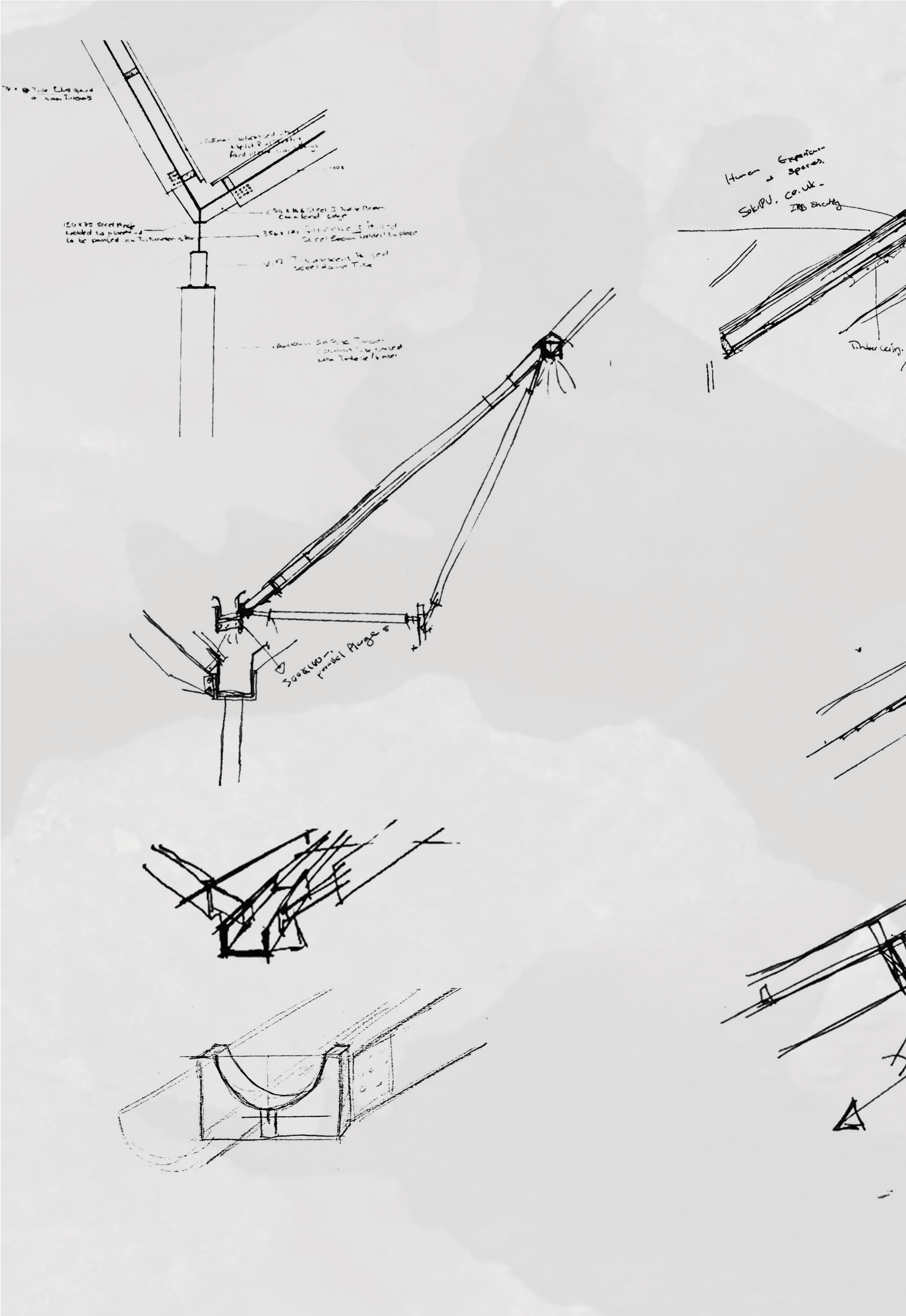

Figure 8.27 Sketches of tectonic exploration B (Author)