A great building must begin with the immeasurable, must go through measurable means when it is being designed, and in the end must be unmeasured.
Louis Kahn (1901-1974)

7

Technical Investigation

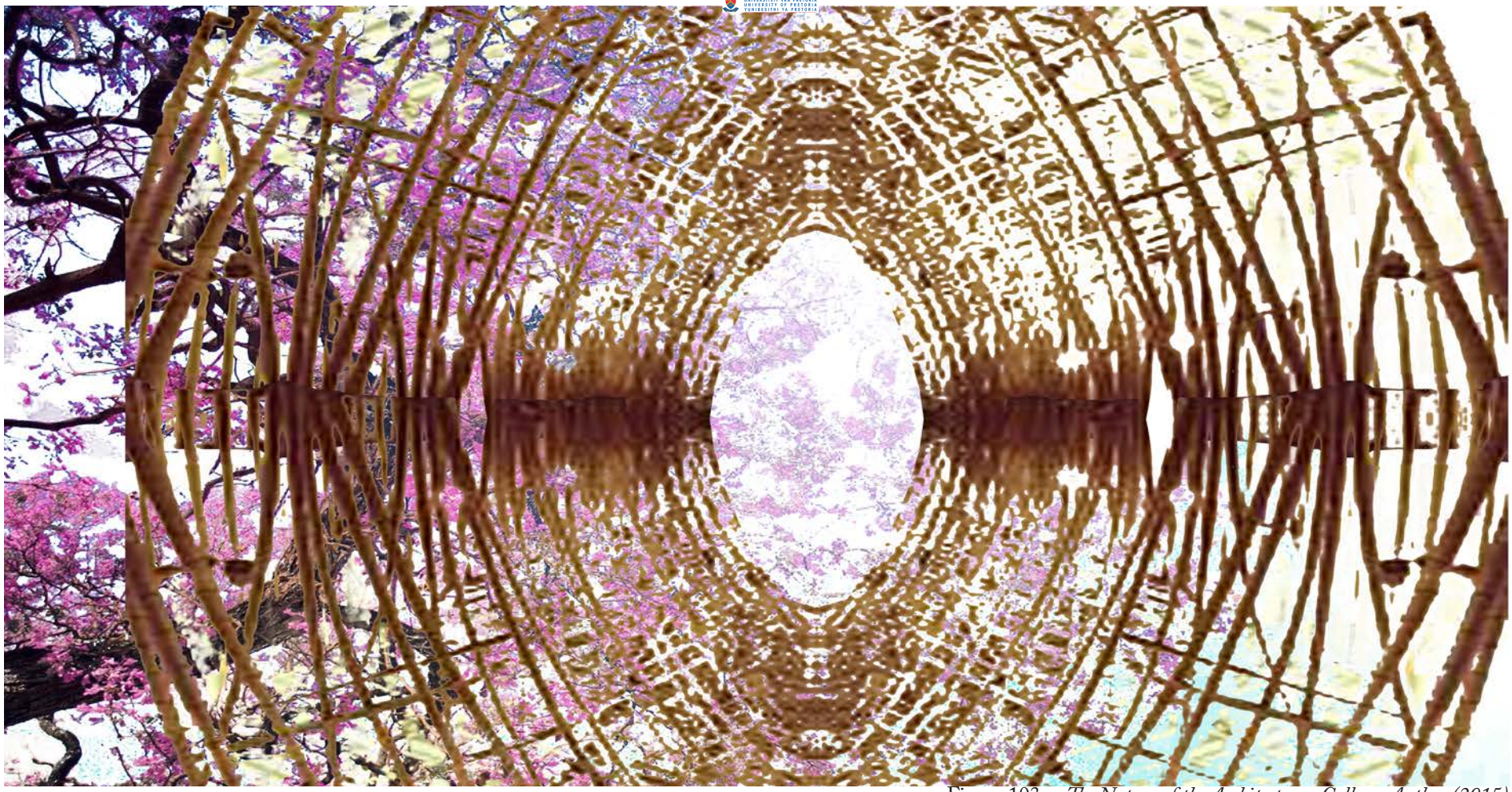


Figure 103 : *The Nature of the Architecture , Collage, Author (2015)*

7.1 Technical concept:

The technical concept was seen as an extension of the design concept. In the society of Phomolong, the communities have become earthbound by their social, cultural and economic situations. The scheme needed to reflect how the upliftment of the earthbound to the ephemeral could be achieved through architecture. Thus biophilic design attributes were introduced into the scheme. Biophilia is the reintroduction of man to nature through architecture. The biophilic lens helped to address social, cultural, economic and ecological resilience, through passive design. Passive design such as natural ventilation, daylight and natural and organic materials are promoted. This allows the structure to become an extension of the landscape and nature.

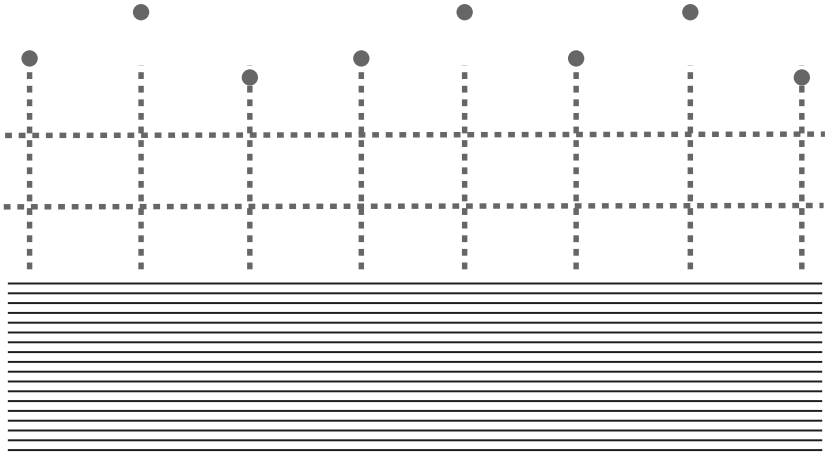


Figure 104 : *Monolothic to Transience , Diagram, Author (2015)*

7.2 Structural intention:

The structural intention was to create a safe place (Early Childhood Development Centre) along a highly public edge. The structure should meet the ground and become an extension of it. A lightweight material is proposed for the first floor, to allow the structure to merge with the sky. This symbolises how the community grows from their existing surroundings into a transient nature, to create a place which manifests a cultural identity where children can learn from the passing on of existential knowledge.

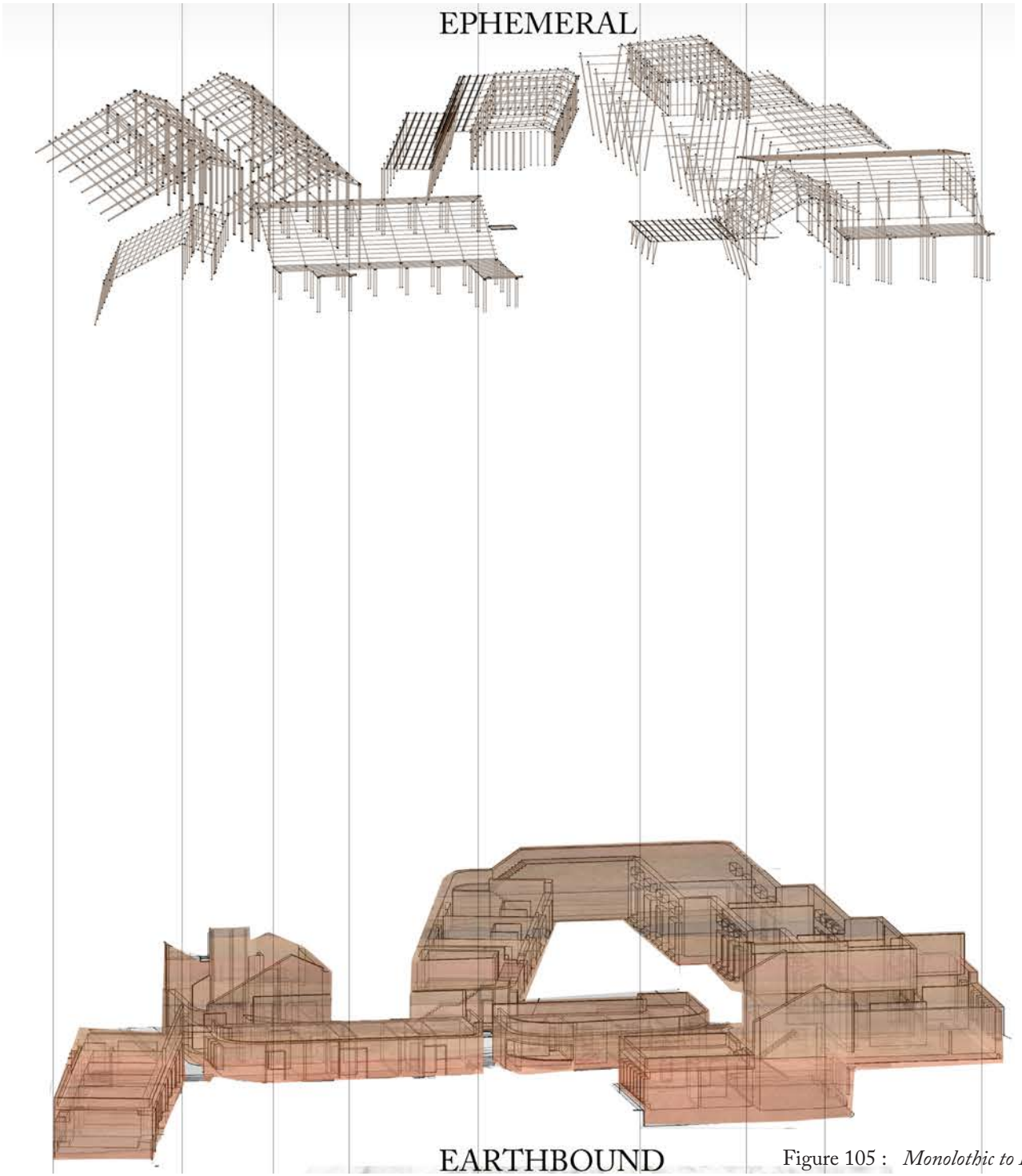


Figure 105 : *Monolothic to Ephemeral , Diagram, Author (2015)*

Figure 106 : *1:20 Model exploration , Author (2015)*

7.3 Technological intention:

As an extension of the concept rammed earth and Bamboo Balcooa were chosen. The Bamboo is proposed to be planted along green strips in the greater urban vision of the scheme. This would introduce new skills and material available to the community. The exploration of the materials and their characteristics become combined to create different conditions and spaces. Looking at the connection between the man-made and natural elements, and natural to natural elements, the fixing of the materials was explored on detail level, to also express the concept.

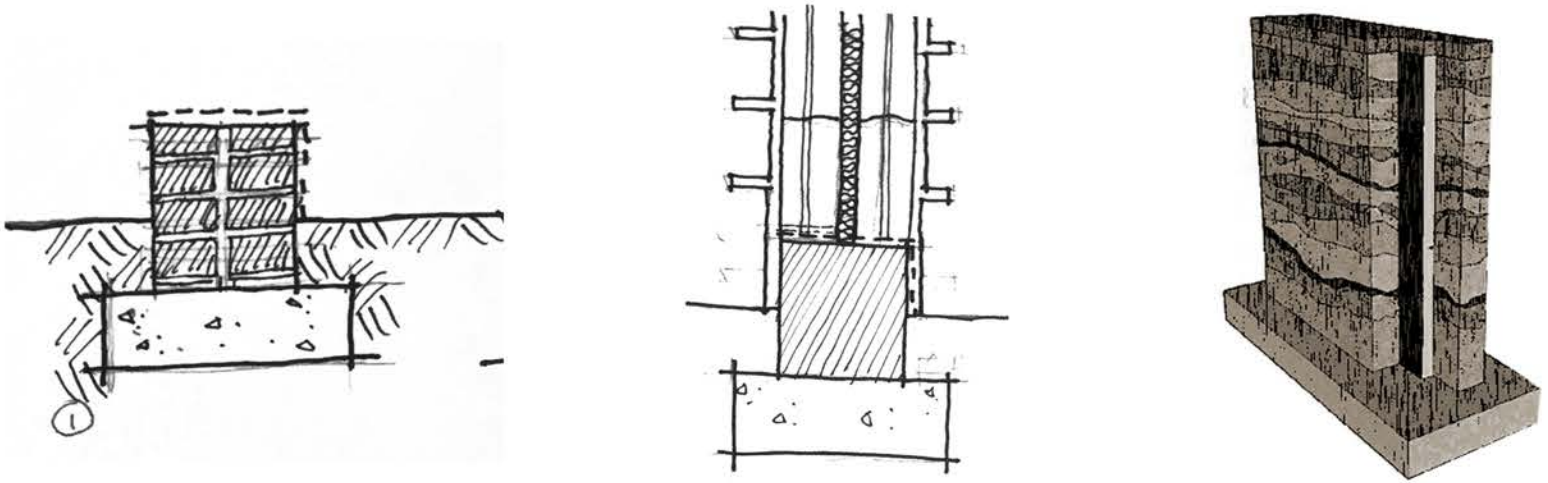


Figure 107 : *Rammed Earth investigation, Sketches, Author (2015)*

7.4.1 Rammed Earth:

Rammed earth is a mixture of sand, gravel, clay and concrete. Rammed earth construction has a long history of being used especially during economically challenging times.

Rammed earth has many advantages, including its's high thermal mass, low embodied energy, temperature regulation, fire resistance, strength and load bearing qualities and pest deterrence *(Edmonds 2015)*. The addition of Portland cement (6-10%) (adding to surface hardness), damp proof course and concrete or masonry footings and plinths and the addition of water based silicon water repellent, adds to the durability and low maintenance of rammed earth walls *(Madehow.com 2015)*.

With the silane/siloxane aqueous based waterproofing admixture *(Techdry.com 2015)* minimises water penetration and eliminates using external waterproofing coatings and future surface maintenance the rammed earth walls do not need any added finishes, but could be plastered and painted similar to any other masonry wall *(Motherearthnews.com 2015)*. Electrical conduits and other services can be built into the walls with proper planning during the design process *(Earthstructuresgroup.com 2015)*.

Steel reinforcement is often used in the foundations and walls for extra strength. Plywood is usually used as formwork and can be used on other sites as well.

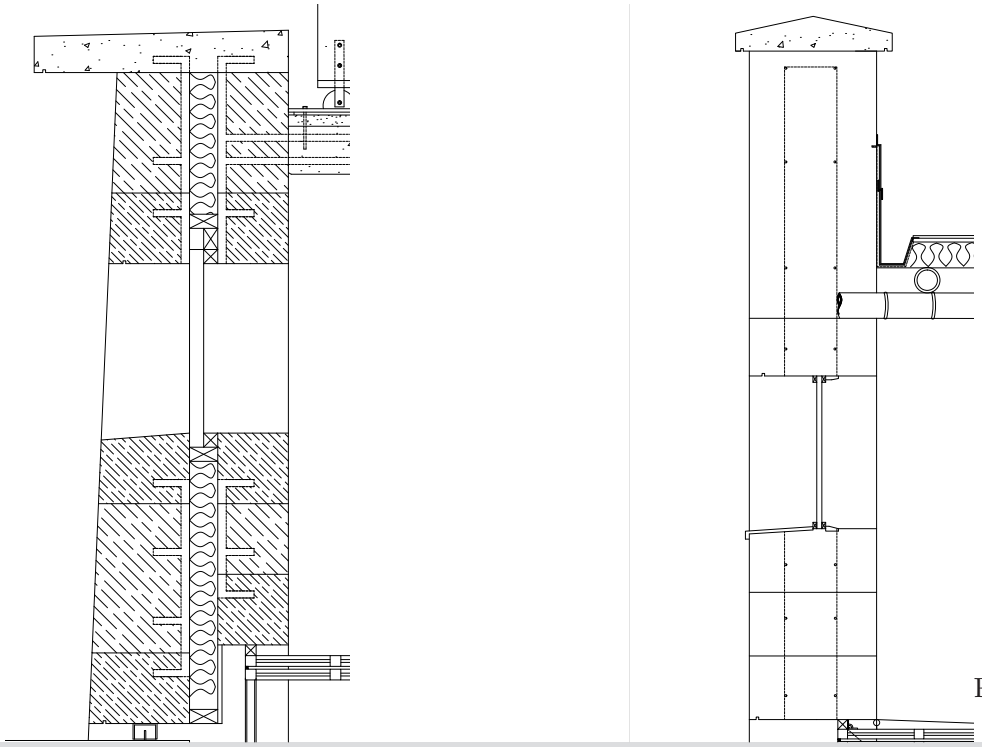


Figure 108 : *Rammed Earth investigation, Details, Author (2015)*

Three types of construction methods are used in modern day practice *(Rammed earth constructions 2015)*:

- Stabilised rammed earth, with 300-400mm thick walls.
- Insulated stabilized earth wall panels, where the walls are 400mm thick with 50mm insulation (usually Styrofoam panels). This is ideally used for Western facing walls requiring a higher R-value.
- Elevated stabilized earth wall panels of 300mm thick and are similar to precast concrete panels, which can be elevated into difficult locations *(Rammed earth constructions 2015)*.

Precautions to take when working with rammed earth:

- The base of the wall should be raised a minimum of 50mm above the Natural ground level.
- If insulation is used a weep hole should be provided to prevent condensation of the insulation material.
- The top surfaces of the wall require capping.
- A rock drain should be provided for water back splash from the pavement.
- If a sealant isn't used a minimum overhang of 300mm should be provided.

Construction method:

1. Foundation footing and brick plinth is constructed.
2. DPC placed between brick plinth and first layer of rammed earth wall.
3. A reinforced plywood frame is constructed.
4. A layer of moist earth is poured in.
5. The layer gets compressed and compacted.
6. The next layer gets poured in.
7. Puddled earth lintels are placed at window and door heights.
8. A standard size concrete capping with a drip is placed on a puddled earth lintel.

Rammed earth and Bamboo both have a history of being a traditional and alternative method of construction, and the combination of the two materials can be seen as a reinterpretation of the traditional Wattle-an-Daub construction.

Rammed earth is used in the design to convey the concept of the Earthbound. A monolithic element to withstand the changing context and giving rise to the Ephemeral light tectonic Bamboo structure on the first floor level. Both elements add to the creation of a unique place for the *Forgotten* and marginalised networks in Phomolong. An ode to their collective memory.

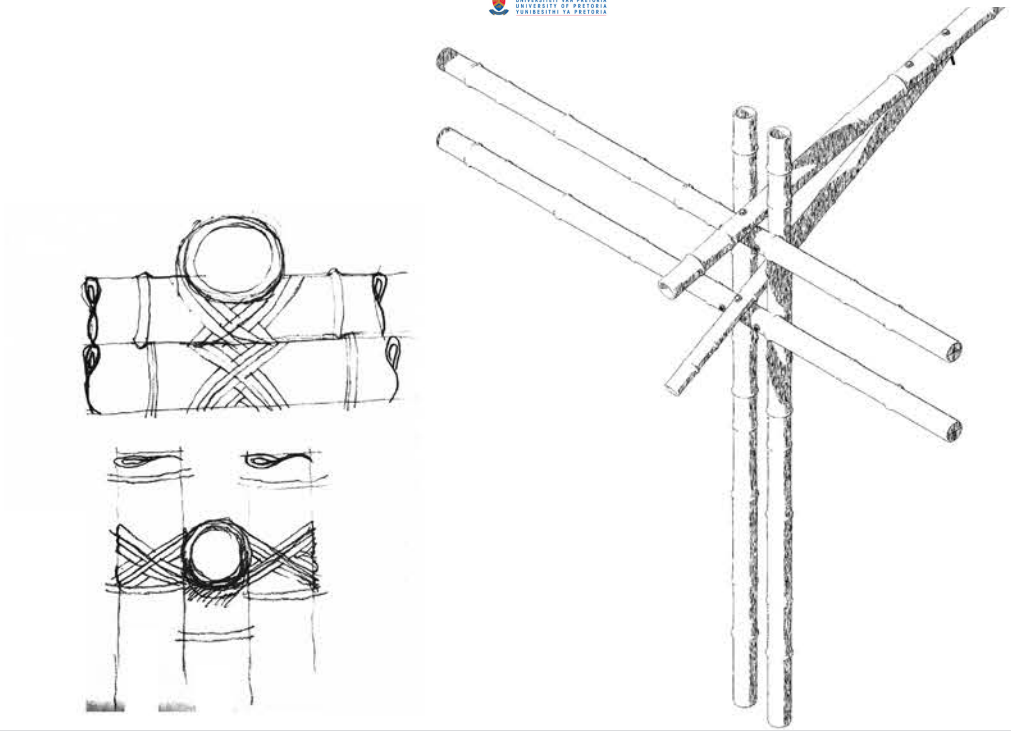


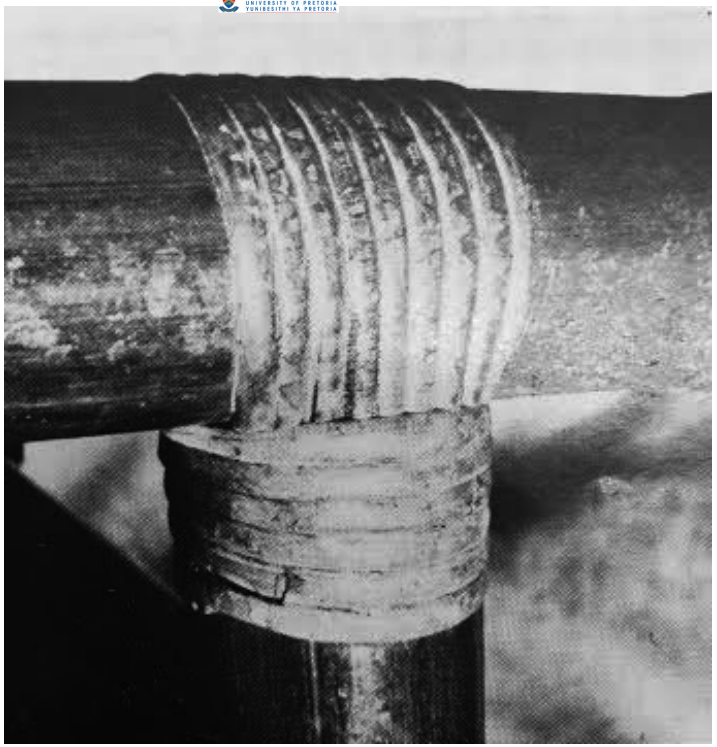
Figure 109 : *Bamboo lashed joints investigation, Sketches, Author (2015)*

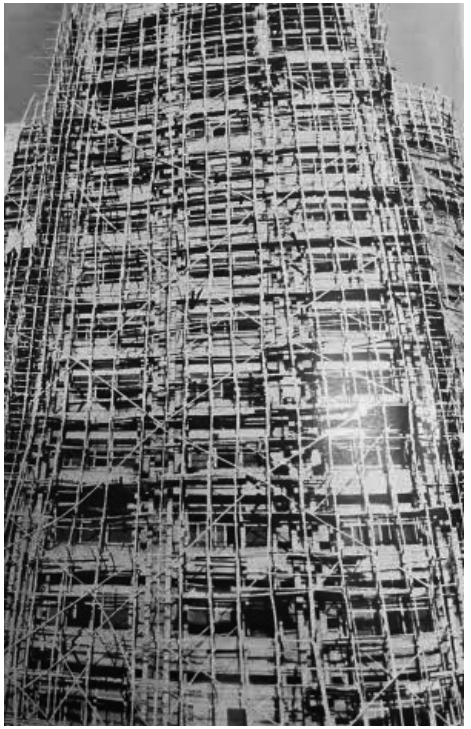
7.4.2 Bamboo:

Bamboo is the world's fastest and strongest growing woody plant *(Afribam 2015)*. Bamboo is classified as a grass species *(de Vos 2010)*. Bamboo is proposed as a rural development and climate change mitigation crop for Phomolong.

Types of bamboo viable for South Africa:

Only one species, Thamnocalamus tessellatus, is truly indigenous to South Africa (it grows in the high Drakensberg) (UP Repository 2014).
Sacred Venda bamboo:
The Venda people grow Oxytenanthera abyssinica for ceremonial purposes, this species is appropriately named the Holy Venda bamboo and is thought to have been introduced by the ancestors of the Venda from further north in Africa. (UP Repository 2014).
Bamboo Balcooa *(Afribam 2015)*: Erect with very thick walls
Height of 15–20m
Diameter of 15-20cm
Average weight (dried) 30kg
African alpine bamboo: Commonly found in Ethiopia and Kenya *(Afribam 2015)*.





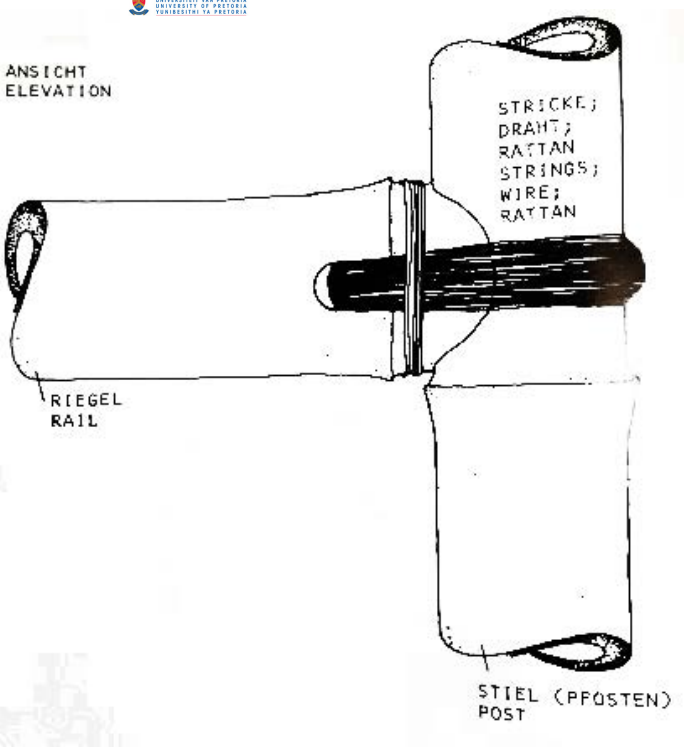
Potential of Bamboo in South Africa:

The South African climate requires Bamboo plants to first be hardened to the conditions, before it can be planted *(Sutton 2013)*. Hence a strategy of the seedlings developing in greenhouses for an incubation period, then being moved outside under shading nets and then they are able to be planted in normal conditions. These tissue cultured bamboos develop a well-developed root system for planting elsewhere and have a greater chance of surviving in the natural conditions due to their exposure to the climate at different stages. The hardened plants then allow for a greater yield per hectare due to their better field establishment.

Currently there are Bamboo plantations in the Eastern Cape and in Leandra in Mpumalanga *(Sutton 2013)*.

Bamboo is a good substitute for timber, due to its versatility and the speed at which the plan regrows (4 years as opposed to 8 to 15 year tree life cycle.) Bamboo culms grow their full height and girth within 3-4 months, yet take 3 years to mature and start to decay after 5 years. Bamboo culms can be continually harvested annually for the duration of the plant's life span of 40 to 120 years *(Afribam 2015)*.

Bamboo can be used for construction, furniture, and paper pulp, charcoal and can be processed to become laminate bamboo used for floors and structural beams as well as the bamboo shoots being edible *(Afribam 2015)*.



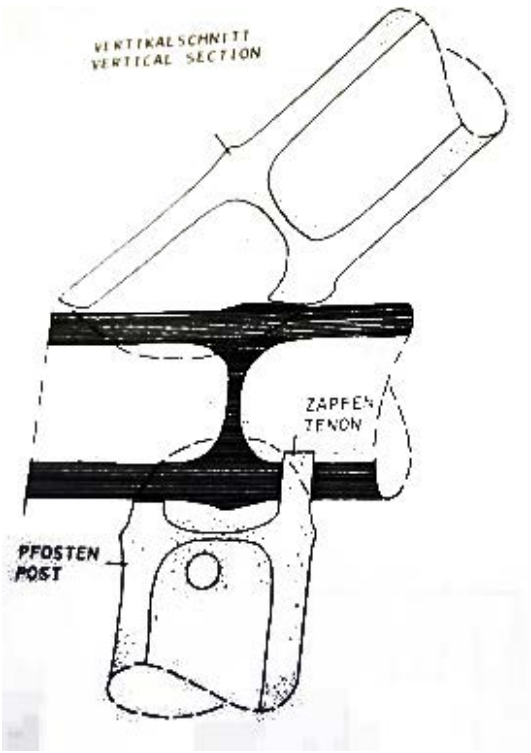


Figure 110 : *Bamboo lashed joints, Photograph, Dunkleberg (1985)*
Figure 111 : *Bamboo lashed joints, Photograph, Dunkleberg (1985)*
Figure 112 : *Bamboo Scaffolding, Photograph, Dunkleberg (1985)*
Figure 113 : *Bamboo lashed joints, Photograph, Dunkleberg (1985)*
Figure 114 : *Bamboo lashed joints, Detail, Dunkleberg (1985)*
Figure 115 : *Bamboo lashed joints, Detail, Dunkleberg (1985)*

Bamboo advantages over tree species:

Bamboo biomass and carbon production and retention are higher, and produce 35% more oxygen when compared to wood *(Blumrick 2014)*. Bamboo has a dense root system (60cm deep) which is anchored in topsoil and does not impact the lower water table; hence it is very effective for erosion control *(Janssen 2000)*. The rapid growth enables the absorption of surplus nitrogen, phosphorous and heavy metals found in sewage and polluted water.

Bamboo mulch is extremely rich in moisture and nutrients; together with the rapid decomposition of the material it adds an enriching layer to its surrounding soil conditions *(Afribam 2015)*. Bamboo yields 6 times more biomass than pine, and is classified as one of the strongest building materials, due to its high tensile strength (28 000 psi) the equivalent of mild steel. If used as firewood it burns longer and creates less ash than hardwood *(Afribam 2015)*.

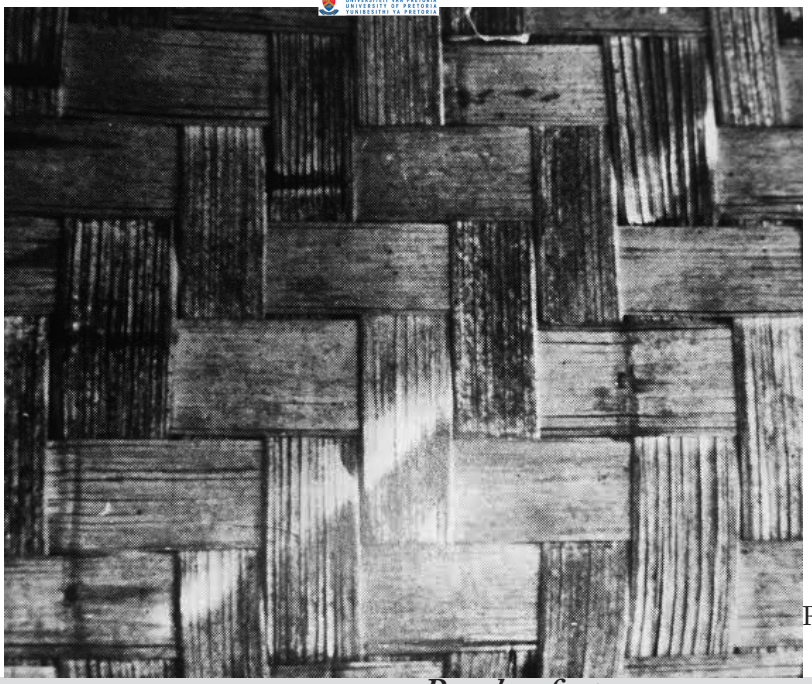


Figure 116 : *Woven bamboo, Photograph, Dunkleberg (1985)*

Composition of material:

Bamboo has long fibers, which adds to the tensile strength. It is highly elastic and can be formed during growth or before being dried. The hollow cores add to the lightness of the material, making it easy for a person to carry it *(Afribam 2015)*.

Uses:

Plant

- Soil stabilizer
- Soil remediation
- Cultivation of marginal lands.
- Wind breaker, sound and visual screens.

Material:

- Wood, paper and chemical industry.
- Construction
- Furniture, weaving and carving
- Food industry
- Charcoal
- Laminated Bamboo (Lamboo)

Bamboo facts:

- *Tensile Strength: with members of the same weight, bamboo has a tensile strength of almost 200 kN/mm² where steel only has a tensile strength of 150 kN/mm² (Davey, 2010).*
- *Allowable Force: with members of the same weight, bamboo has a allowable force of 25.6 KN and steel 27.6 KN (Davey, 2010).*
- *Can substitute steel: bamboo can replace steel (and timber) completely as scaffolding, trusses or space frames. Current research and design indicate that multistory buildings with only bamboo as vertical structural element can reach up to 3 levels, or 12-15 meters (Davey, 2010).*

Figure 117 : *Harvested Bamboo week 1, Photograph, Author (2015)*
Figure 118 : *Harvested Bamboo week 2, Photograph, Author (2015)*

Harvesting and planting data:

The clumping root systems seen in Bamboo Balcooa allows for an average of 5 culms per clump after 6 years. This gives average 1500-2500 culms per hectare per year to be harvested *(Afribam 2015)*.

Bamboo as an Energy Crop:

The heating power of bamboo is 4600cal/g, thus it can be used for power generation, cooking (charcoal) and heating *(Blumrick 2014)*.
Because of the high biomass yield, biomass gasification and biofuels are a possibility.

Optimal soil conditions and climate can yield 30 Tons/ha annually. Thus 1 ha can provide fuel for 55 households. Afribam has initiated collaboration with NGO's to promote Bamboo education in rural development because of its possibilities as a resource. As a utility crop bamboo has the highest potential to deliver a sustainable balance between habitat and community *(Blumrick 2014)*.

Figure 119 : *Harvesting Bamboo, Collection of Photographs, Author (2015)*

7.4.3 Personal experience with harvesting Bamboo:

On October 3 2015, the author went to a farm in Mpumalanga on the Highveld, where a cluster of Bamboo has been growing. Standing unhindered with no recollection from the owner of the farm as to who might have planted it. The cluster of Bamboo stood at about 12m in height, tapering towards the top. Fallen leaves had formed mulch around the stems.
Through observation it was derived that the Bamboo had a clumping root system with about 7 culms per clump. A range of tools were used and the following was found:
Panga's and hatchets work best for quick felling of the culms, however, a saw gave a cleaner cut, for the panga and hatchet caused the bamboo to splinter on impact, causing the loss of about 30cm of material each time. Branches were easily removed with the panga with no damage done to the proposed structural culm.

It must be noted that the felling of the Bamboo was done with unskilled labor and the skills were easily learned. As well as that if Bamboo is harvested safety goggles and gloves would be proposed to be used (from the recent experience).

Figure 120 : *Harvesting Bamboo, Collection of Photographs, Author (2015)*

For ease of transport the culms were cleaned and cut into 3m segments. It was still easy to carry 3 culms per person, and was found to be lightweight. The greener culms, were heavier, and it is speculated that this is due to a higher moisture content. There were also dried culms on the site, and it was experienced that these culms were lighter to carry but more difficult to cut, they were harder. The bamboo culms have a thick inner wall of about 15mm and the nodal diaphragms were solid. After transport the culms ends were placed in a plastic container with water for 2 days. This was to prevent splitting because of the dry circumstances in the Highveld. One culm was left outside in the sun to see the impact upon it. After one day in direct sunlight the culm had started to burst and crack from node to node.

After 2 days in the water, the culms are to be moved to an enclosed garage structure which gets Western sun and is thus extremely warm. The culms are to be packed on pallets raised from the ground, and misted once a day for a week to help the drying process to not happen too rapidly. The culms will also be sawn neatly before being stacked for drying. After 2 weeks of drying the culms will be treated with a varnish and then used for details and examples during the final presentation and examination.

The impromptu harvesting experience, helped greatly for the authors understanding of the material.

BAMBOO PLANTING AND HARVESTING STRATEGY:

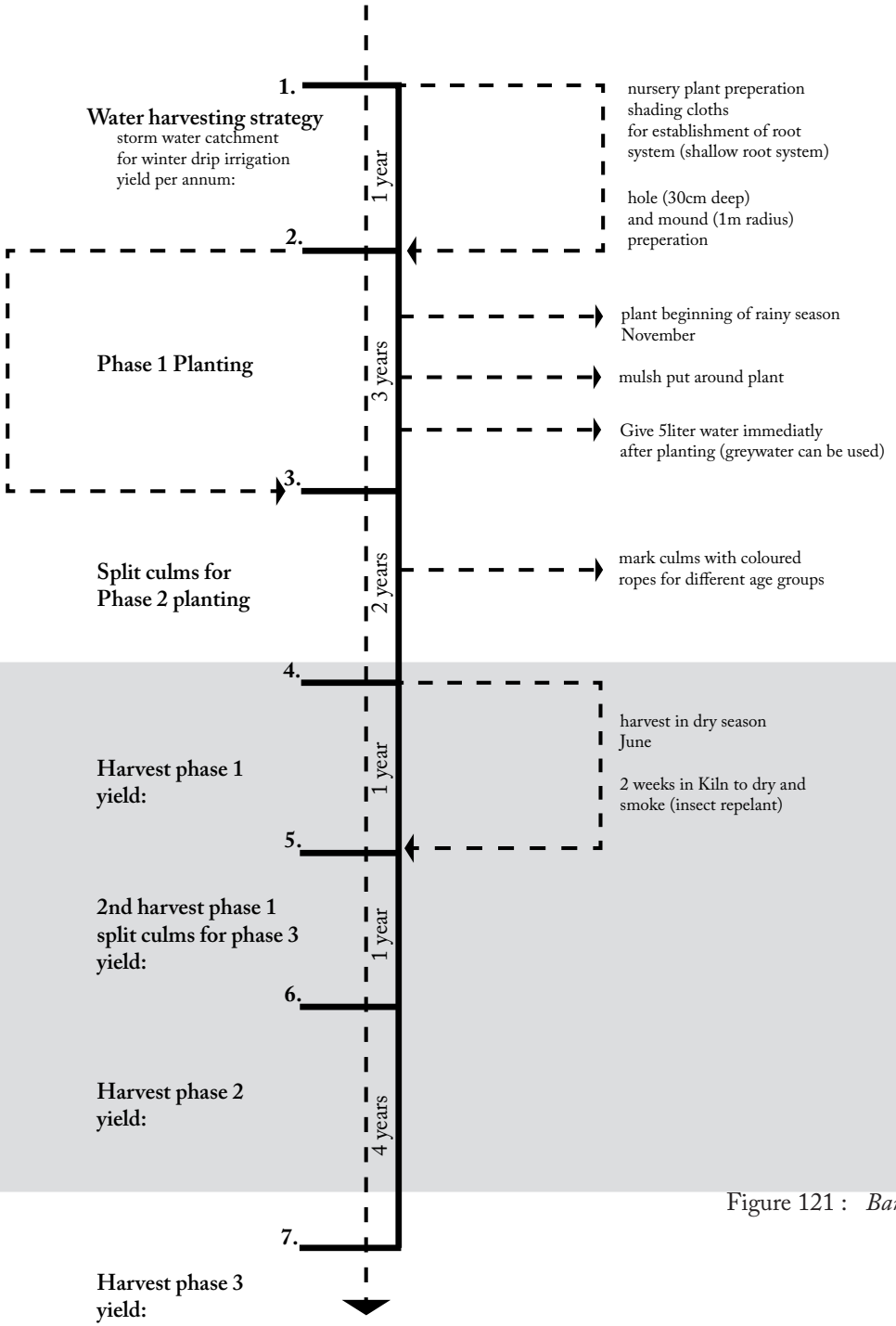


Figure 121 : *Bamboo Planting Strategy , Diagram, Author (2015)*

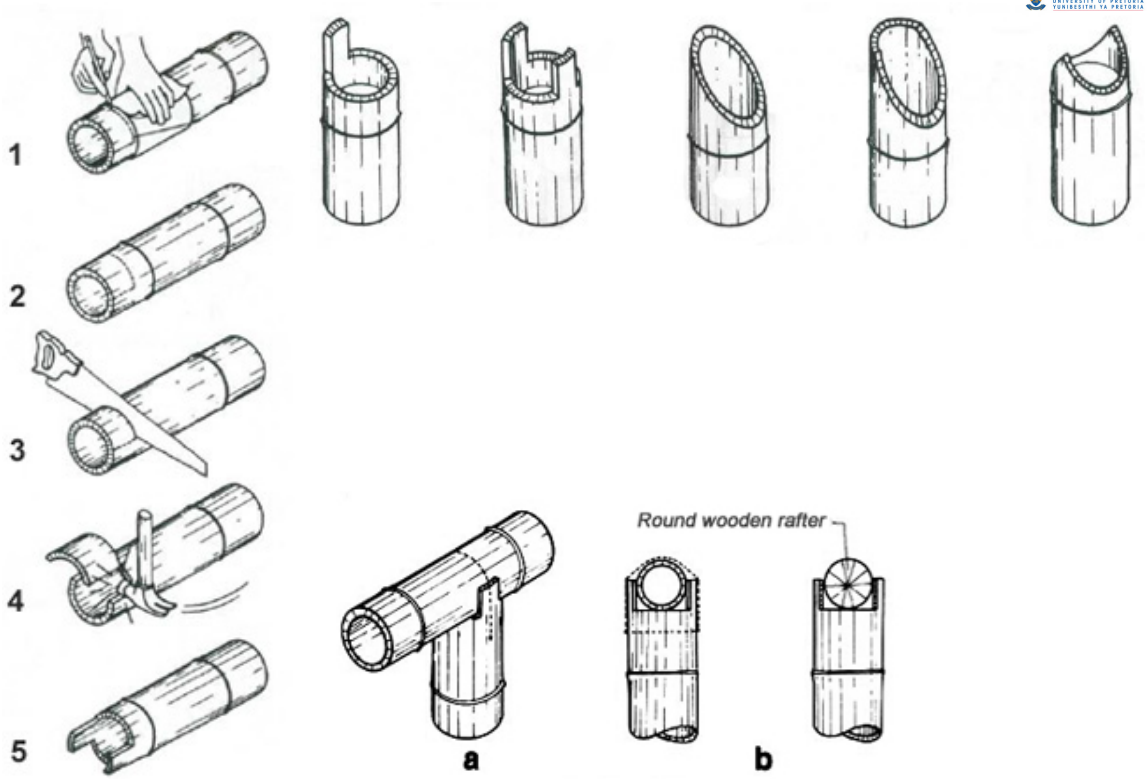
Figure 122 : *1:20 Model exploration , Author (2015)*

Investigation justification:

The propsed design will make use of a variant of Bamboo joinery. Proposing traditional and contemporary methods of joinery to be used, it was important for the Author to experiment with the material in real life to gain an understanding of the material and its characteristics.

Secondly, the Author has no previous experience in these types of construction and it is beneficial to be able to prove that unskilled labour can easily be taught the above mentioned methods of construction and harvesting techniques to be able to use in the context of Phomolong.

The different typesof joinery also relate back to the tectonic concept of how man-made and natural elements (contemporay method) are joined as well as how natural and natural elements are joined (traditional method).



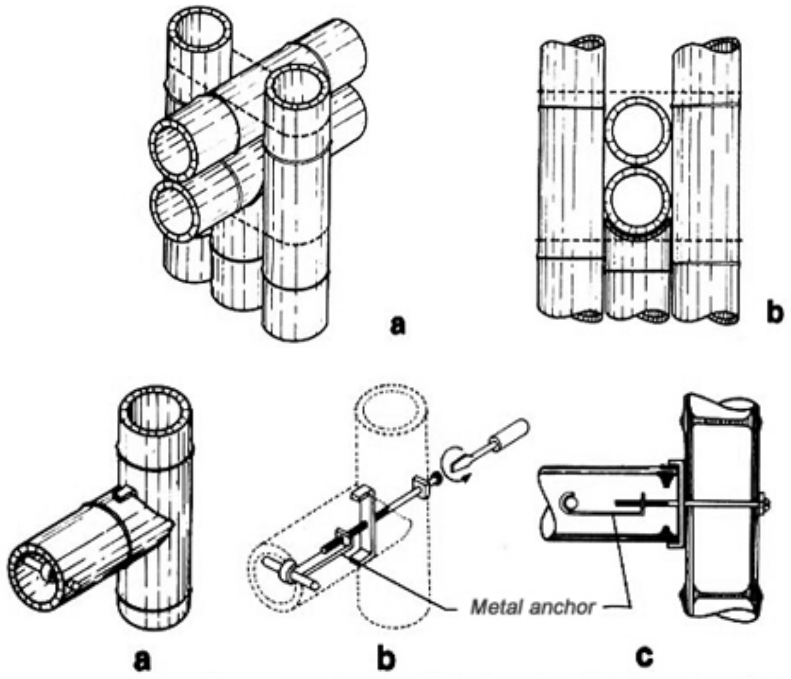


Figure 123 : *Cutting and joining methods of bamboo , Diagrams, Schröder (2009)*

Traditional methods of joining Bamboo connections:

Traditionally and in modern scaffolding technology, Bamboo would be joined through the use of string, wire or rattan with lashed joints.

Bamboo skin can also be used as string and the advantage of the use of Bamboo string is that it has the same expansion ratio as the Bamboo culms. Thus it shrinks and expands in unison with the rest of the joints. Bamboo string would be wetted and then tied, when the string dries it shrinks and tightens the joints further. The bamboo lashing has the same strength as zinc wire.

Bamboo or timber pegs are also used for as a joining method, where a hole is drilled and the peg inserted to prohibit any movement, this method might cause splitting of the culm.

If there is cut into the Bamboo culm it must be between two nodes and not cut into a node directly, this would influence the structural integrity of the material.

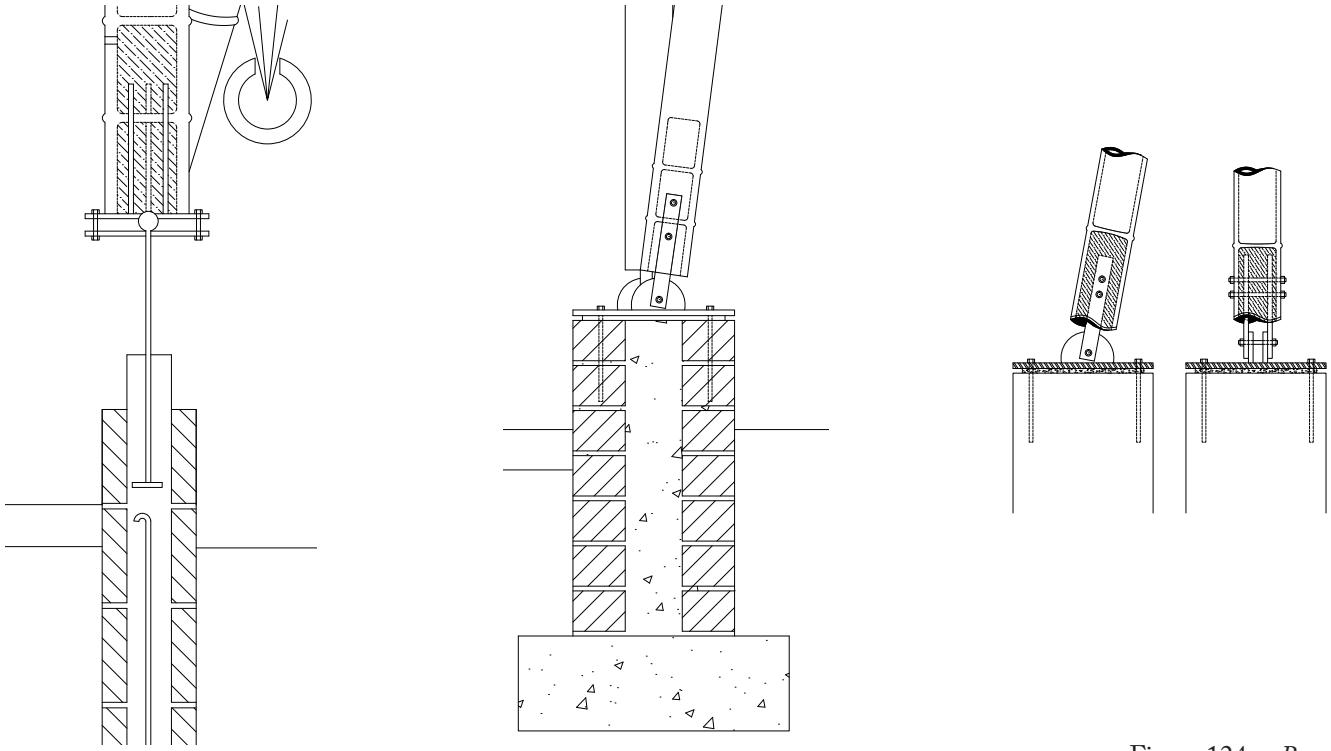


Figure 124 : *Bamboo detail development , Author (2015)*

Contemporary methods of joining Bamboo connections:

In contemporary Bamboo construction, modern techniques such as steel bolts and mortar infill is used for example : *Threaded bolt tightened with mortar and Steal mounting link with mortared bolt* as used in the ZERI Pavilion 2000 *(Bamboo Connections 2002)*
These techniques have certain considerations which might influence the structural integrity of the material.

If a hole is drilled it should not be drilled straight through the culm, always mark the holes and drill from opposite sides of the culm *(Schröder 2009).* Splintering often happens when the drill passes from the interior towards the exterior of the culm.

Mortar is often used as an infill for the hollow core between two nodes where the joint is, for example where a threaded steel rod is placed. Mortar however has a high alkalinity and this will eat away at the organic material of the Bamboo (*Minke 2012*).

Thus an alternative to stabilise the rod in the hollow core is proposed, such as an epoxy resin or expanding urethane foam. This adds the extra stability in the core for the steel rods or bolts.

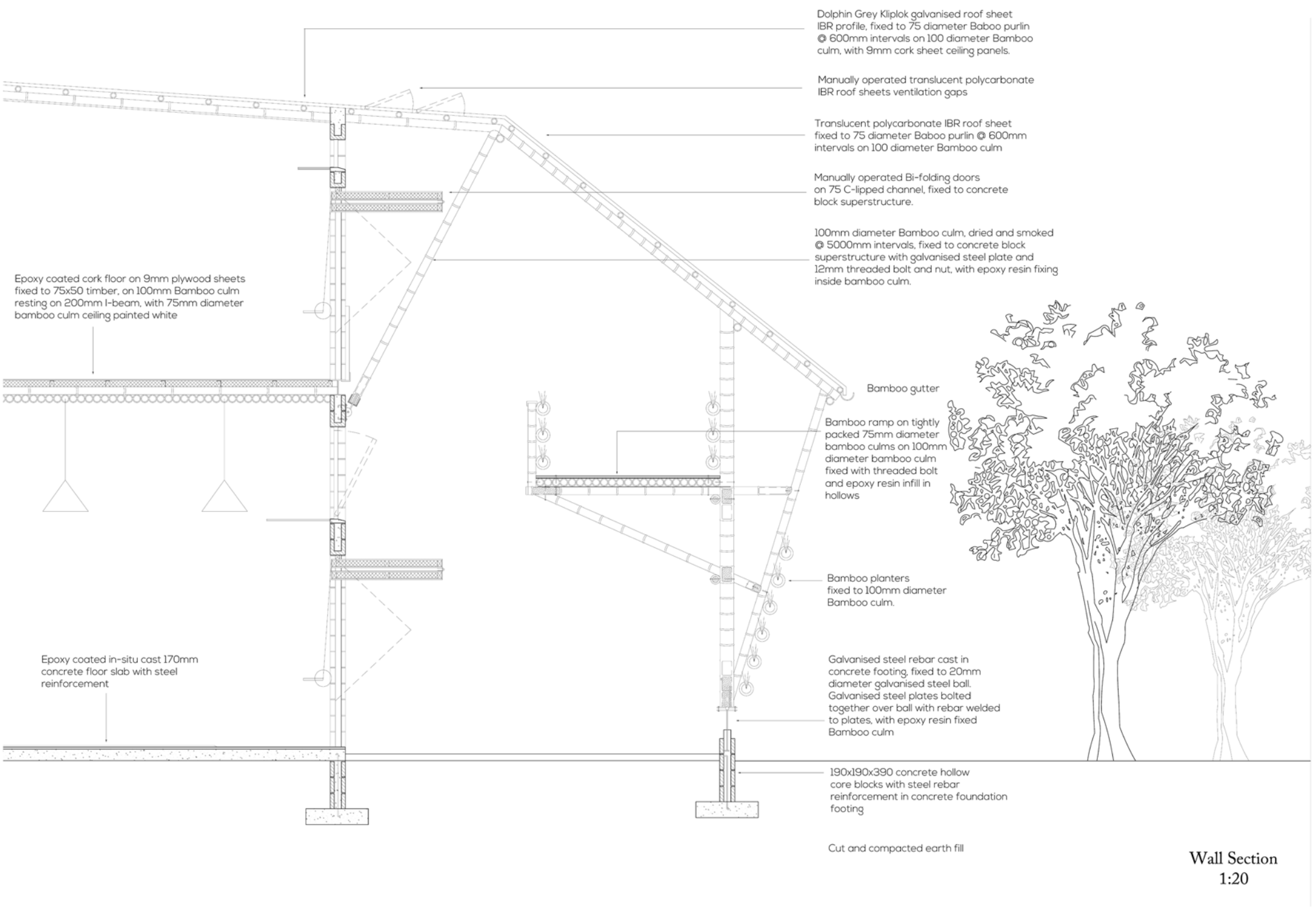


Figure 125 : *1:20 Section development , Author (2015)*

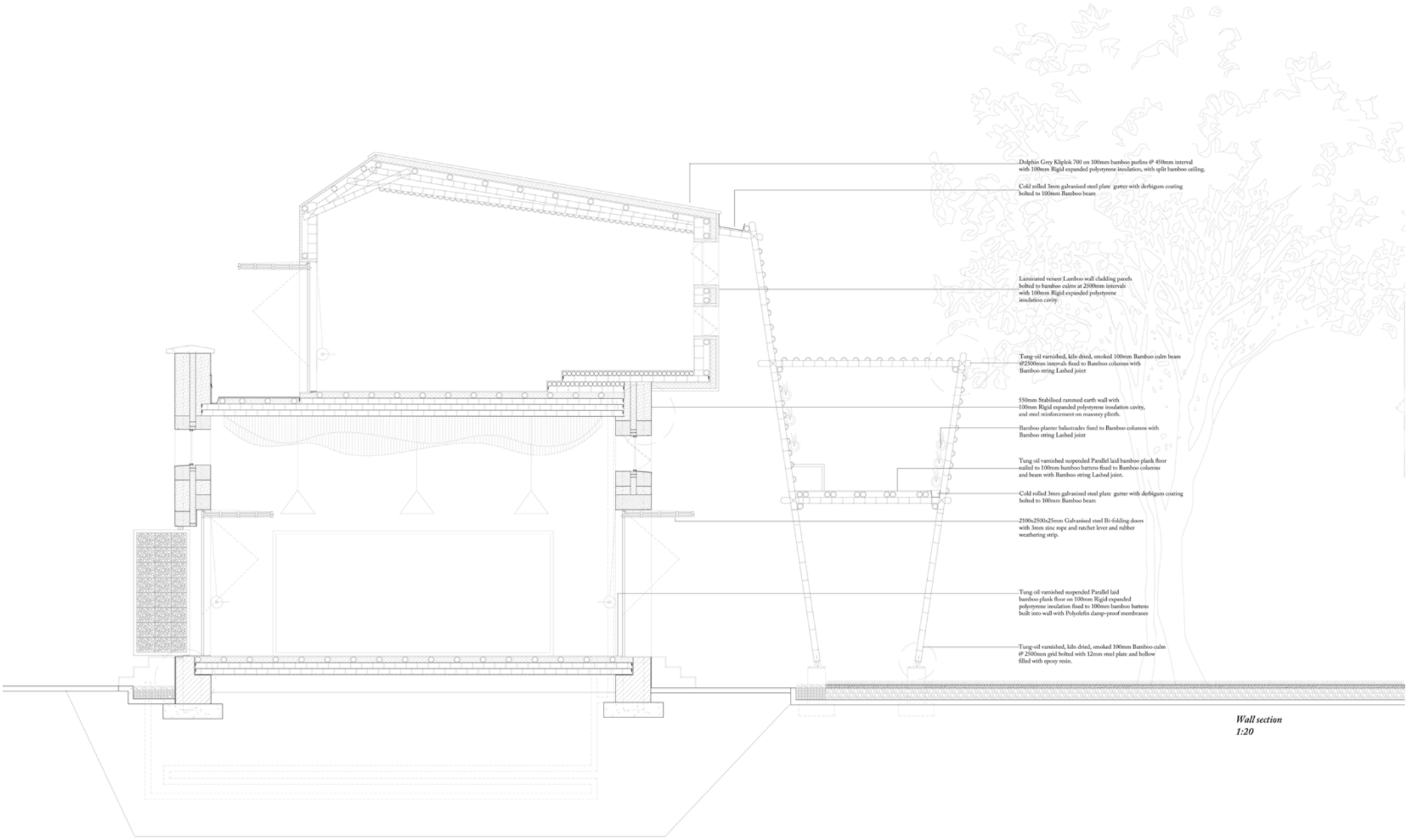


Figure 126 : *1:20 Section development , Author (2015)*

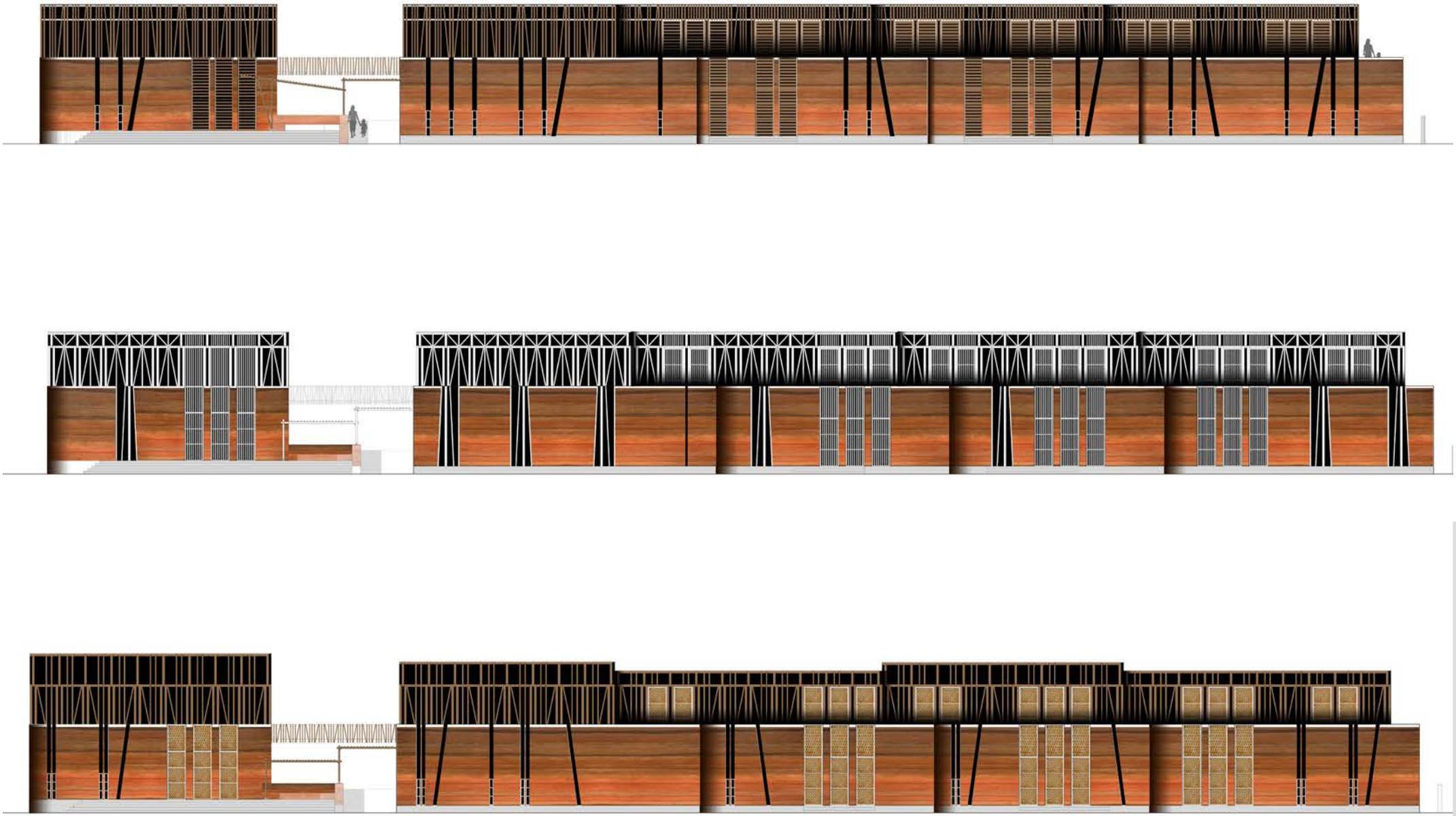
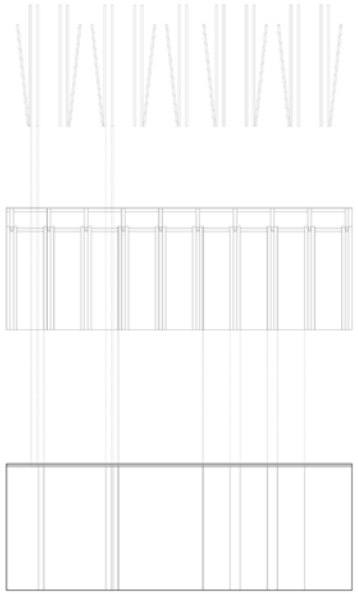


Figure 127 : *Elevation development , Author (2015)*



Elevation development and iterations:

The exploration of the elevation was found be of great value in the design process, yet only became possible after a greater understanding of the materials had been achieved. This allowed the designer to explore the monolithic condition of the rammed earth walls and how the structural rhythm of the Bamboo related to the monolithic through door and window openings.

Rhythm A: The structural bamboo elements, representing the light tectonic classrooms of the ephemeral on the first floor, consists of 150mm diameter bamboo culms spaced at 1200mm intervals. This was applied to the monolithic Rhythm C to determine openings.

Rhythm B: 75mm Bamboo culms to act as extra bracing and celebrate the dynamic vertical qualities of Bamboo as a material. The spacings inbetween again informed the window and glazed openings of the Monolithic Rhythm C.

Diagonal slits are proposed to be relief elements to announce a change in programme of the internal spaces.

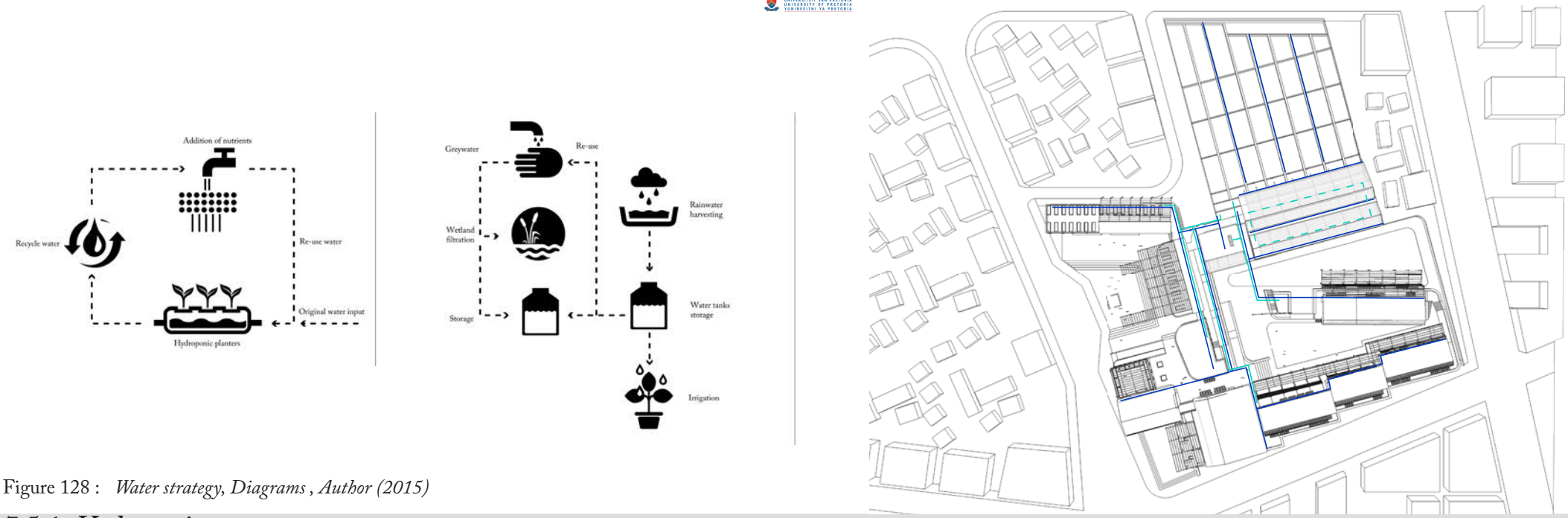


Figure 128 : *Water strategy, Diagrams , Author (2015)*

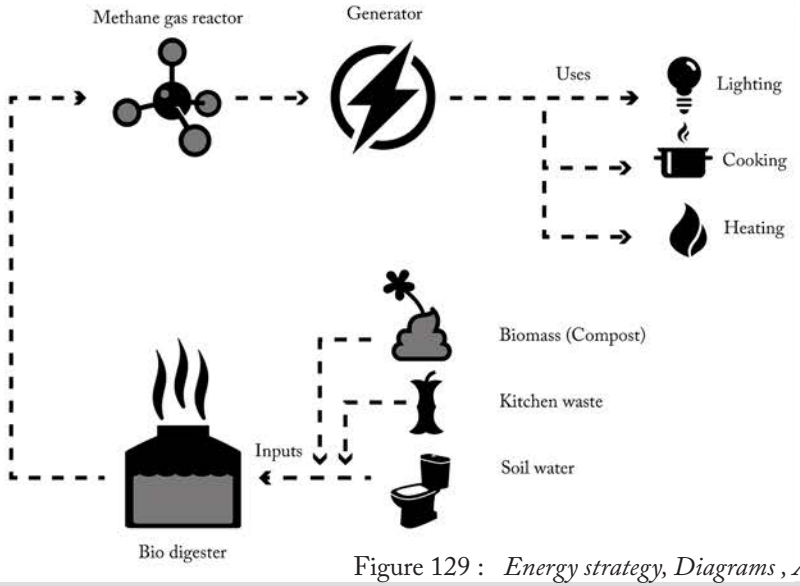
7.5.1 Hydroponics:

Hydroponics is a branch of agriculture where plants are grown without the use of soil (Full Bloom Hydroponics 2015).
The use of Hydroponics and water harvesting strategy, is to aid in the introduction of Biophilic design and to reduce the project and it's users dependency on the municipal water supply.

Nutrients are dissolved in water and plant roots are in contact with the solution. Plant root systems are supported by alternative mediums to soil, such as Rockwool or Perlite *(Full Bloom Hydroponics 2015)*. Thus the plant root systems come into contact with more oxygen and nutrients, improving the growth rate (by 25%), quantity (by 30%) and growth quality of the plants *(Turner 2015)*.

Because the plants are grown in a closed system, evaporation and loss of water is less than water used for soil planted crops *(Turner 2015)*.
The proposed system to be used in the project would make use of the Nutrient Film Technique. NFT has a continuous flow of nutrient solution over the plant roots. The planters are at a slight incline to make use of gravity for flow to take place *(Simply Hydro 2015)*.

<u>Considerations when working with hydroponic systems:</u> *(Turner 2015)*
- It is recommended that the nutrient solution in the reservoir gets changed every 2 to 3 weeks.
- The water temperature should be regulated through heating or cooling.
- The nutrient solution should be aerated with use of an air pump.
- The pH balance of the nutrient solution must be regulated *(Full Bloom Hydroponics 2015)*.



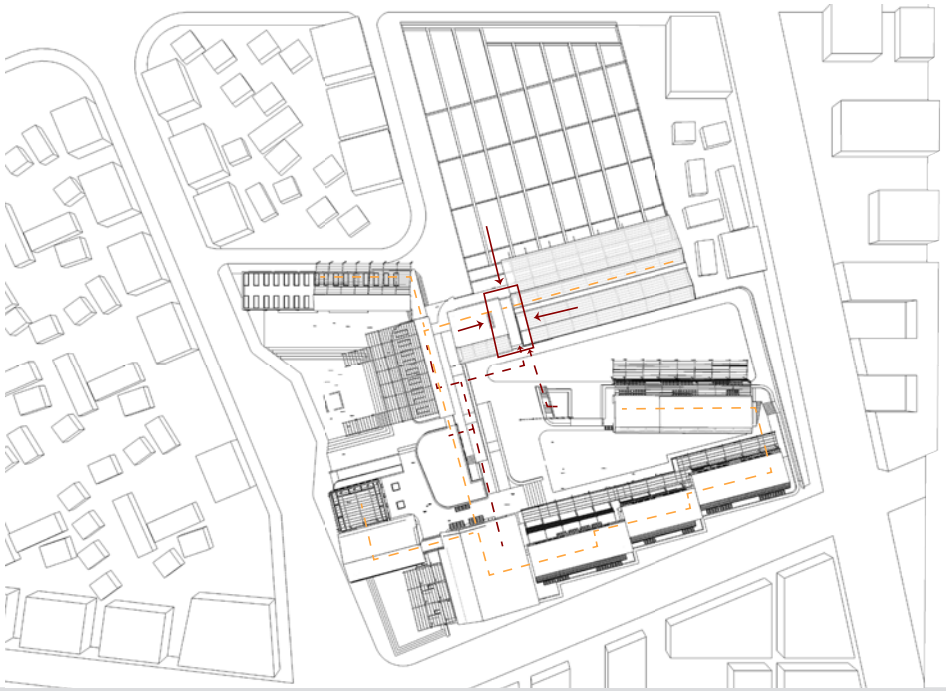


Figure 129 : *Energy strategy, Diagrams , Author (2015)*

7.5.2 Biodigester:

Biodigesters allow for a self-sustaining alternative energy generating process, which would empower the users by reducing their dependency on grid electricity. Thus adding to the layer of a sustainable and empowering structure in the context of Phomolong.

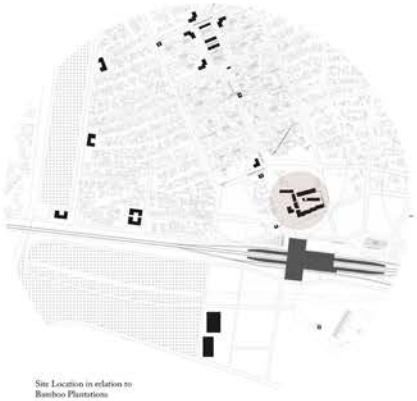
Biodigesters decompose organic material through the use of bacteria in an anaerobic environment. The process produces a mixture of methane and carbon dioxide, called biogas. Biogas can be used as a renewable energy source, as well as bi-products which are produced can be used as fertilizer *(SRC.sk.ca 2015)(Simgas 2015)*.

Biodigesters can be fed any organic material including sewage water, though some materials have a higher biomass quantity which releases more energy during decomposition *(SRC.sk.ca 2015) (Simgas 2015)*.

Biogas can be used in a methane generator to generate electricity for cooking and heating, allowing for a sustainable alternative to grid electricity *(SRC.sk.ca 2015) (Simgas 2015)*.

Final Presentation

Context and Site Location



Site Location in relation to
Bamboo Plantations

Site Location in relation to
Greenview Station

Existing fabric of site

Networks

The daily exodus: The faceless masses

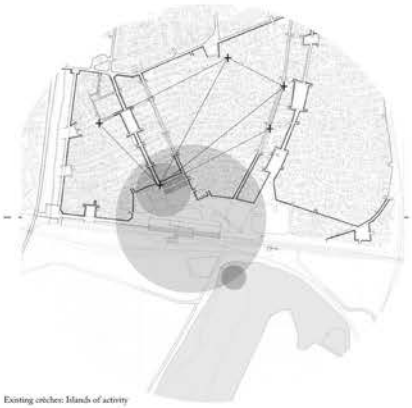
Network identification: The 3 generations

The Forgotten: Children and Elderly dependents

Issues

Networks that are left behind

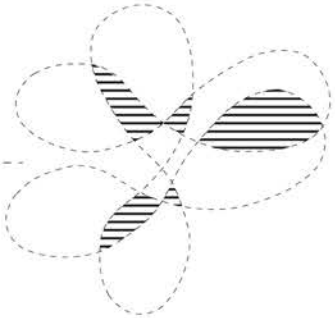
The disconnection between the formal
and informal



Existing crèches: Islands of activity

Intentions

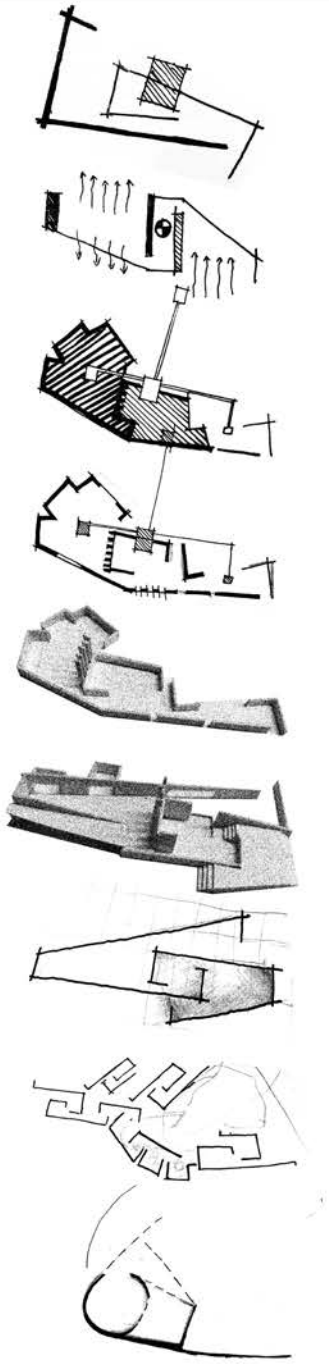
Create a place for the Collective



Make allowance for different social econoes
and networks to overlap, reconnecting the community

Finding a gap in the self-made fence

Diagrammatic development and approach



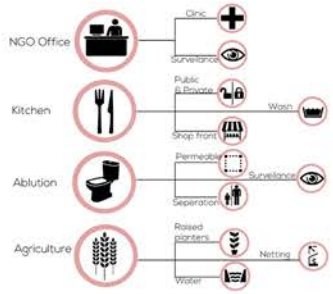
Existential knowledge as an approach

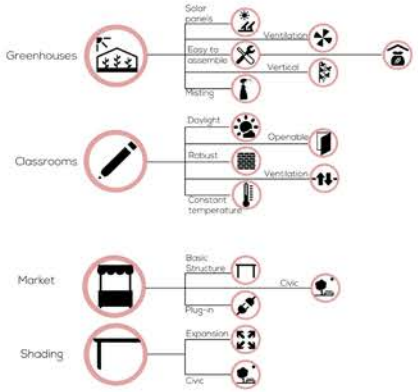
Existential knowledge through listening

Existential knowledge through observation

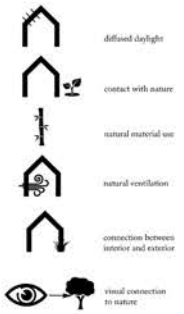
Existential knowledge through participation

Programmatic approach





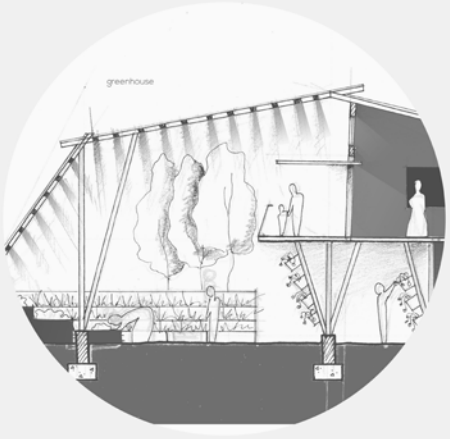
Biophilic and sustainable approach



Design Iteration 1

Movement and spatial intention diagrams

Ground floor plan



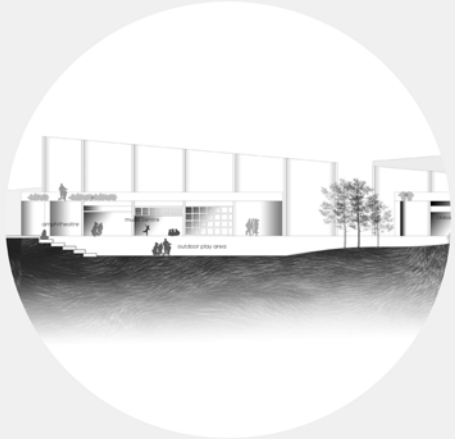
Section

The design focused on the collective space where Catharsis could take place, a greenhouse structure on the Western edge with a pool of reflection, introducing the concept of Biophilia to the public, with a route of remembrance which would exit into the public park. The Western edge showed control but however lacked permeability. There was a lack of attention paid to the permanent users, the children and the elderly caretakers and their daily rituals and routes.
The design considered a control point and the public realm as one leg of the design and the crèche as another leg of the design, separating the two. There was however a lack of control over the edges and response to context.

Design Iteration 2

Movement and spatial intention diagrams

Ground floor plan



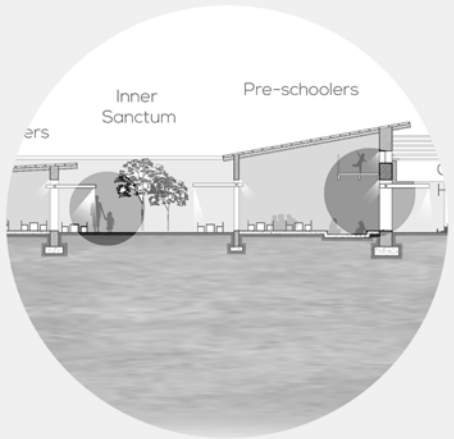
Section

The design tried to further develop the matriarchal space, yet it lacked control and spaces were too dispersed for children to be able to navigate successfully.
The proposed classrooms, offered interesting spaces for the children and were inserted into the greenhouse structures as a method of introducing the children to natural spaces, which made it a forced and uncomfortable solution, with no clear hierarchy of space.
The exaggerated greenhouse structures were dominating and foreign. The circular structures were merely extrusions of the plan and were not designed volumetrically.

Design Iteration 3

Movement and spatial intention diagrams

Ground floor plan



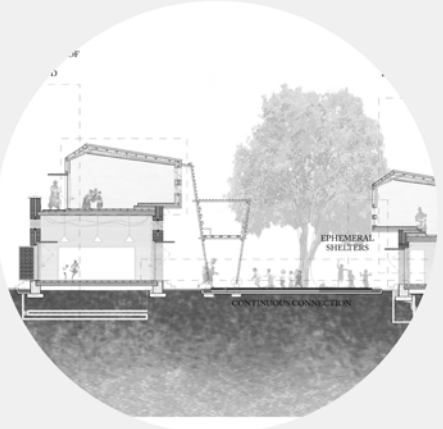
Section

During this iteration, the proposed context was adapted and the movement through space became the main driver of the design. The investigation led to the different thresholds and social spaces, thus the definition between Public, semi-private and private realm started to become more controlled. The design started to consider architecture as a flow of social systems creating ecotones and the public square started to become more controlled.

Design Iteration 4

Movement and spatial intention diagrams

Ground floor plan

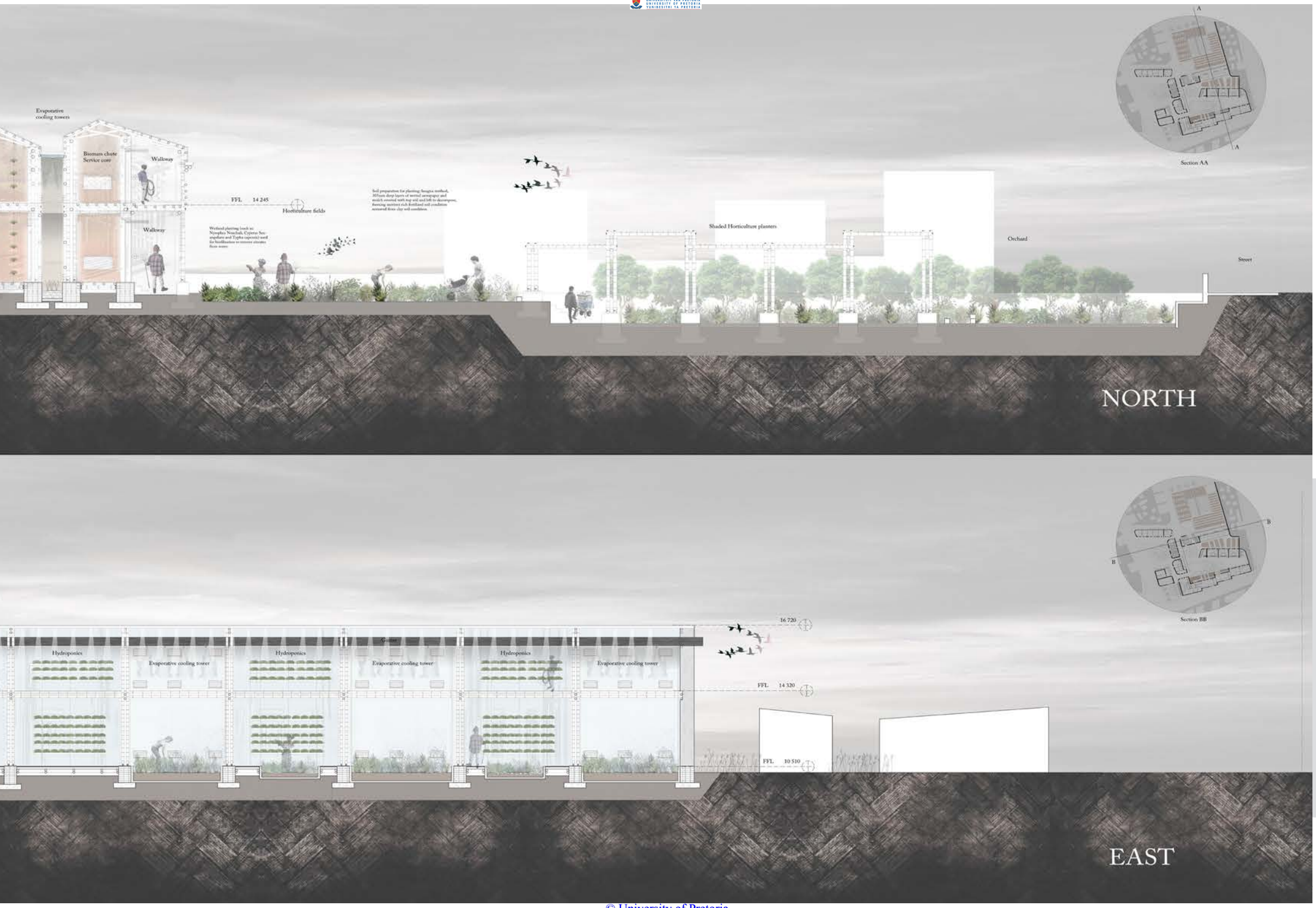


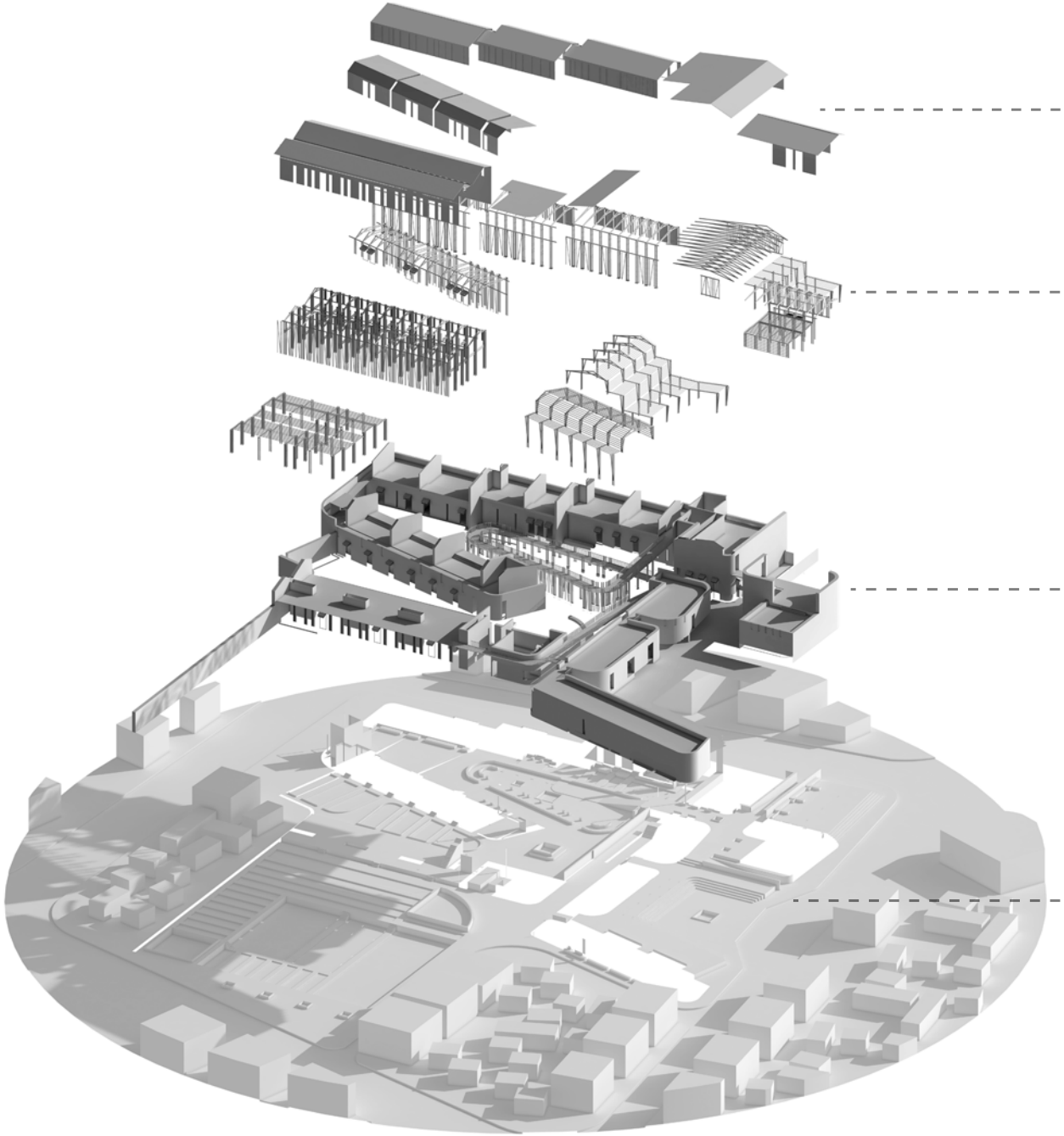
Section

A new meeting place with enough resonance (memory) of the types of shops surrounding the previous meeting space (the Apollo light). The square becomes the public interface of the scheme. Areas of passive surveillance include the shop owners, and the kitchen area from the public space. The public user's route becomes a celebrated edge condition, where one can buy fresh produce, commute and interact with other residents on a daily basis. Hence a communal place is created, which has the possibility to strengthen the collective memory.

GROUND FLOOR PLAN
1:200

FIRST FLOOR PLAN
1:200





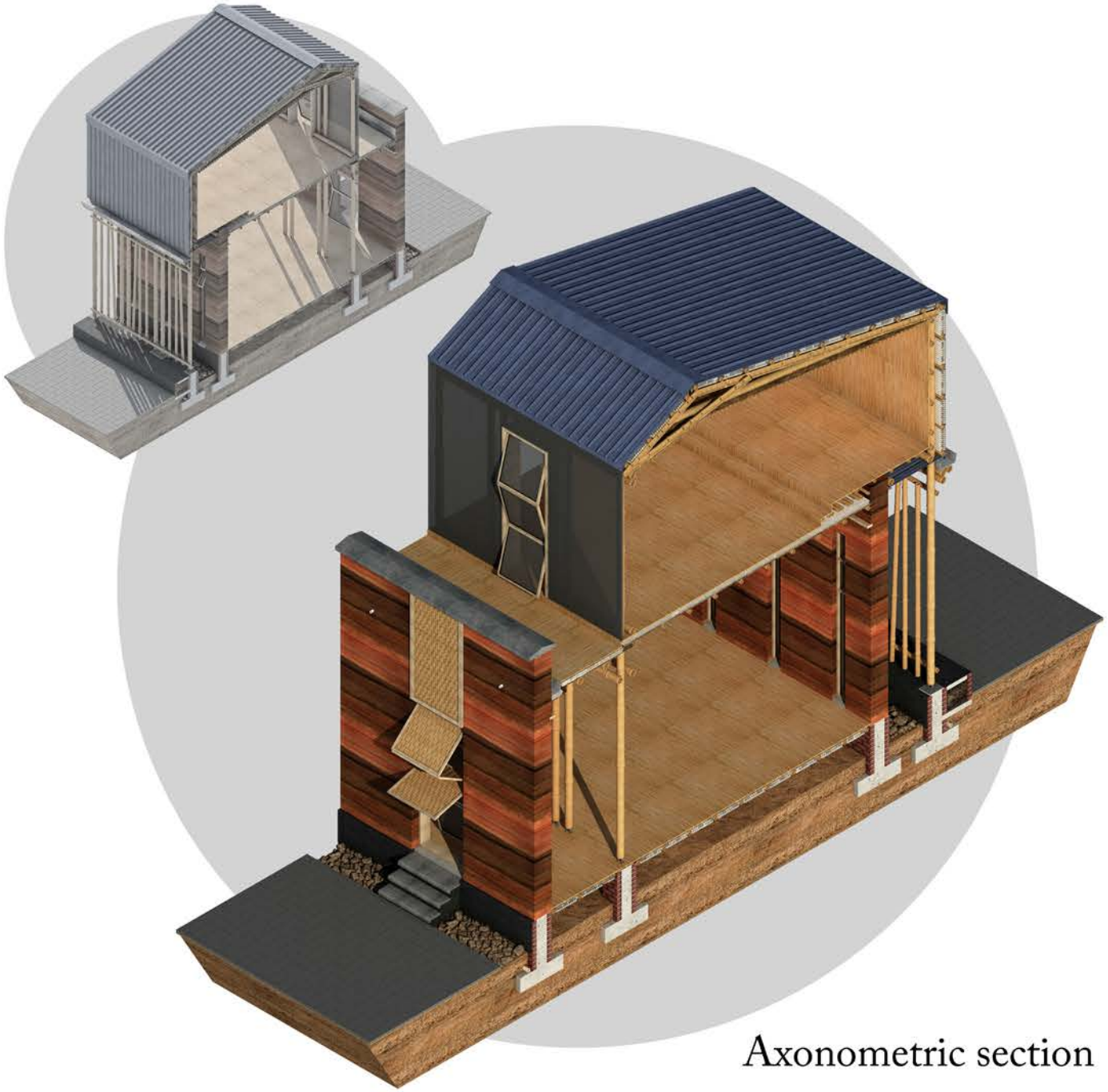
Roof and structural envelope:
Polycarbonate sheeting and KlipTite

Light Ephemeral structures
(First floor, doors and windows and pergola structures) :
Bamboo Balcooa
Houses classrooms, study centre and allows for informal trade

Earthbound structure:
Rammed earth
Permanence in informality, shops, authority programmes and toddler play areas

Ground manipulation:
Horticulture fields and urban edge
Level differences for dynamic spaces of interaction

Structural and programmatic layering



Axonometric section


Section iteration 1


Section iteration 2

General Specifications:

All Bamboo used to be of species Bamboo Balcooa, Kiln dried and smoked with steel cable ties fastened around open ends of culm for reinforcement and to prevent splitting. Open ends to be sealed with Entropy Resin or SuperSap.

Harvested stormwater collected from surface and roof runoff cleansed through wetland filtration.

Opal Twin-wall 1200x3500x16 Multiwall polycarbonate sheet fixed to purlin with purlin clip at 1200mm intervals.

Tung oil finished non-slip grooved 178x1850x20mm MOSO® Bamboo X-treme® decking fixed at 1500 intervals with clip-in MOSO® fasteners min fill 1-2 .

KLIP-TITE Galvanized roof sheeting with Chromadeck coating with concealed fixings at 600mm intervals.

100mm Expanded polystyrene rigid board insulation between 75 Bamboo purlins at 600mm intervals.

7500x150 bamboo scissor truss at 1500mm intervals on 100 bamboo horizontal joist.

Tung oil treated 3500x1200x40mm Tri-folding Lamboo door frame and 4mm glazing panel infill with ratchet lever and 6mm steel cable to detail.

75 Bamboo halves ceiling nailed to Bamboo Plywood, fixed to truss

Tung oil finished flat surface 178x1850x20mm MOSO® Bamboo X-treme® decking fixed at 1500 intervals with clip-in MOSO® fasteners.

1220x2440x21mm Waterproof Bamboo plywood used as substrate fixed at 1200mm intervals with timber screws.

750x300x3mm galvanized steel cold-rolled gutter bolted to Bamboo column and 100mm bamboo beams lashed to column at 1200mm intervals

250x400mm puddled earth lintel with 10% Portland cement add-mixture

Tung oil treated 3500x1200x40mm Tri-folding Lamboo door frame and woven bamboo screen infill with ratchet lever and 6mm steel cable to detail.

400mm Rammed earth wall with 6% Portland cement add mixture and steel rebar reinforcement on plastered masonry plinth foundation footing to engineer's specs.

Tung oil finished 3500x300x40 Double hung awning Lamboo window

2x4500x150 Bamboo support column at 1500mm intervals with galvanized 300x30x3 galvanised steel support imbedded in nodal hollow bolted through with 2xM12 threaded steel bolts and Bio-resin infill.

2x7680x150 Bamboo columns at 1500mm intervals with 75 horizontal bamboo purlins fixed with untreated bamboo string lashed joints at 1200mm intervals.

100 bamboo floor joists on 2x5200x150 Bamboo culms suspended floor beams at 1500mm intervals 440mm above NGL

460x510mm masonry foundation plinth with airbrick at 1500mm intervals and galvanized steel cover.

NGL under suspended floor covered with 300 micron Polyethylene DPM Radon barrier with 150mm overlaps and 30mm Neccbond sealant.

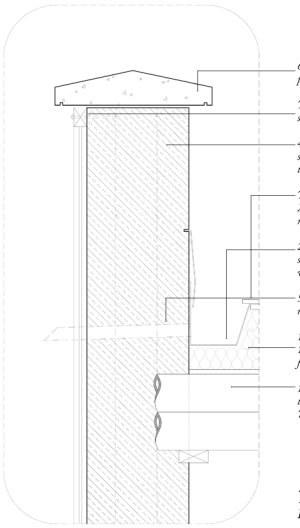
100mm pvc geopipe to wetland storage

Geotextile layer to prevent weed growth and contains fine gravel.

Compacted earth fill in min. 150mm layers

7800x100mm Earth tube at 3000mm depth with inlet on southern side.

1:20 SECTION



600x136 tapered precast concrete wall cap with drips on both edges on puddled earth lintel with non-shrink mortar.

Tung oil finished 2190x1200x40mm Lamboo frame with woven bamboo screen bolted to rammed earth wall, over door openings.

400mm Rammed earth wall with 6% Portland cement add mixture and steel rebar reinforcement on plastered masonry plinth foundation footing to engineer's specs.

Tung oil finished non-slip grooved 178x1850x20mm MOSO® Bamboo X-treme® decking fixed at 1500 intervals with clip-in MOSO® fasteners min fall 1-2 .

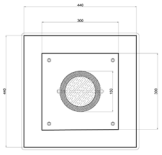
250x200x3mm galvanized steel cold-rolled gutter with 3mm galvanized steel flashing with 50mm overlap and 20mm built into rammed earth wall.

500x25mm galvanized steel overflow spouts at 1500 intervals built into rammed earth wall.

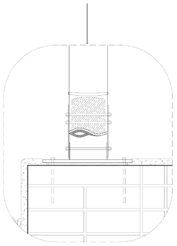
100mm Expanded polystyrene rigid board insulation on 1220x2440x21mm Waterproof Bamboo plywood used as ceiling panel fixed at 1200mm intervals with timber screws

150 Bamboo floor joists at 600mm intervals lashed at 1200mm intervals to 2x7500x150 Bamboo floor beams built into rammed earth walls with 75x50 timber rail.

1:10 DETAIL A :
Parapet balustrade and walkway gutter

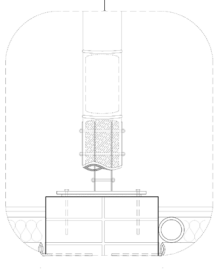


2x7680x150 Bamboo support column at 1500mm intervals with galvanized 300x30x3 galvanised steel support fixed externally nodal hollow bolted through with 2xM12 threaded steel bolts and Bio-resin infill



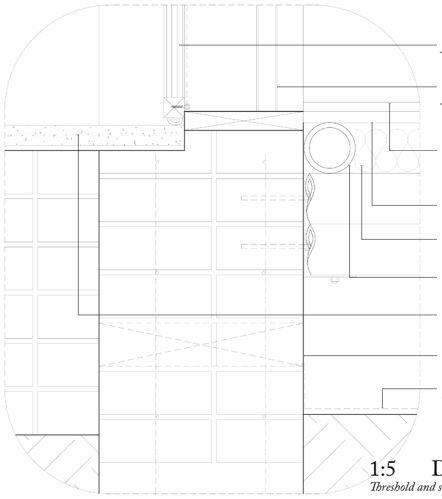
1:10 DETAIL E :
External column footing with pivot

2x4500x150 Bamboo support column at 1500mm intervals with galvanized 300x30x3 galvanised steel support imbedded in nodal hollow bolted through with 2xM12 threaded steel bolts and Bio-resin infill.



1:10 DETAIL C :
Internal fixed column footing

General specification:
All open joints to have steel cable tie or similar reinforcement to prevent splitting



Tung oil treated 3500x1200x40mm Tri-folding Lamboo door frame and 4mm glazing panel infill with ratchet lever and 6mm steel cable to detail.

Tung oil treated 3500x1200x40mm Tri-folding Lamboo door frame and woven bamboo screen infill with ratchet lever and 6mm steel cable to detail.

Tung oil finished flat surface 178x1850x20mm MOSO® Bamboo X-treme® decking fixed at 1500 intervals with clip-in MOSO® fasteners.

1220x2440x21mm Waterproof Bamboo plywood used as sub-strate fixed at 1200mm intervals with timber screws.

100mm Expanded polystyrene rigid board insulation between 100 Bamboo floor joists.

100 bamboo floor joists on 2x5200x150 Bamboo culms suspend-ed floor beams at 1500mm intervals 440mm above NGL.

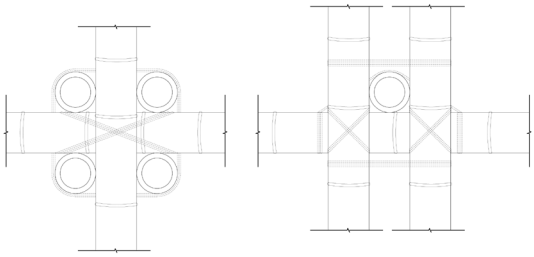
25mm plastered masonry stairs with Charcoal Surefoot 150x300x50mm concrete copings.

460x510mm masonry foundation plinth with airbrick at 1500mm intervals and galvanized steel cover.

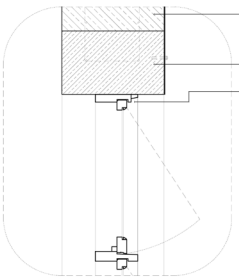
NGL under suspended floor covered with 300 micron Polyethyl-ene DPM Radon barrier with 150mm overlaps and 30mm Ne-cobond sealant.

1:5 DETAIL B :
Threshold and suspended floor connection

Typical materials used for lashing of joints:
Rattan, bamboo skin string and zinc or galvanized steel wire



1:10 DETAIL F :
Typical lashed joint between column and floor beam



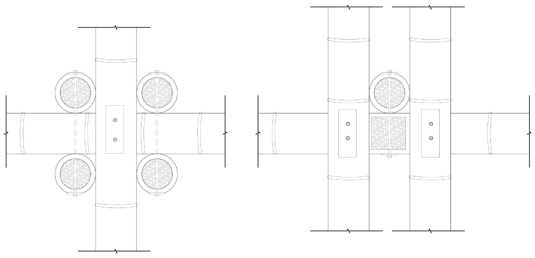
400mm Rammed earth wall with 6% Portland cement add mixture and steel rebar reinforcement on plastered masonry plinth foundation footing to engineer's specs.

250x400mm puddled earth lintel with 10% Portland cement add-mixture

Tung oil finished 3500x300x40 Double hung awning Lamboo window

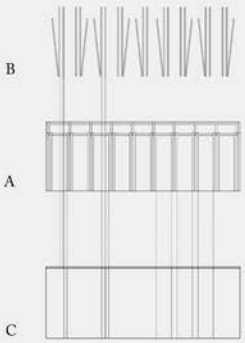
1:10 DETAIL D :
Window and lintel connection

Alternatives to epoxy resin as infill for inter-nodal hollows:
Poly-urethane foam
Bio-resin (Starch based)
Steel tube inserts
PVC pipe inserts



1:10 DETAIL G :
Bolted column and floor beam connection

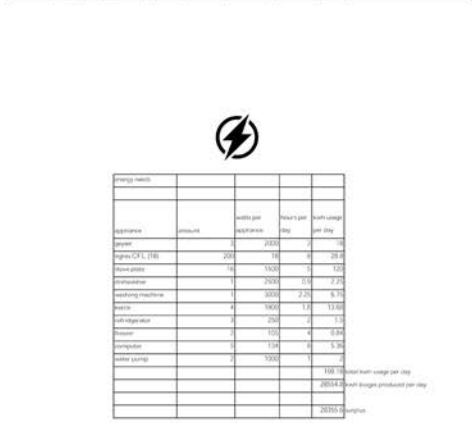
Elevation design



Rhythm A: The structural bamboo elements, representing the light tectonic classrooms of the ephemeral on the first floor, consists of 150mm diameter bamboo culms spaced at 1200mm intervals. This was applied to the monolithic Rhythm C to determine openings.

Rhythm B: 75mm Bamboo culms to act as catra bracing and celebrate the dynamic vertical qualities of Bamboo as a material. The spacings inbetween again informed the window and glazed openings of the Monolithic Rhythm C.

Calculations



energy needs				
appliance	amount	watts per appliance	hours per day	kwh usage per day
geyser	1	2000	2	16
lights CFL (18)	200	18	8	28.8
stove plate	16	1500	1	1.01
dishwasher	1	2100	0.5	2.73
washing machine	1	3000	2.25	6.75
metro	4	1800	1.9	13.68
soft refgerator	4	250	7	1.1
freezer	1	100	6	0.84
computer	1	134	6	5.36
water pump	2	1000	1	2
				108.19 total kwh usage per day
				2854.8 kwh biogas produced per day
				26355.6 kwh/yrs

	Surplus from previous month	Rain yield	Greywater used	Greywater yield	Agriculture demand	Left over in tank
January	0	571.3	170	170	222.2	348.1
February	348.1	566.3	160.8	160.8	160.8	724.4
March	724.4	418.6	170	170	167	956.3
April	956.3	221.6	172	172	157.4	1020.5
May	1020.5	98.3	170	170	157.4	957.6
June	957.6	49.2	172	172	129.6	897.2
July	897.2	24.6	170	170	111.1	794.7
August	794.7	14.8	170	170	129.6	679.9
September	679.9	108.3	172	172	185.2	665
October	665	349.6	170	170	185.2	757.4
November	757.4	541.7	172	172	212.9	1096.2
December	1096.2	541.7	170	170	222.2	1415.7

Tank size 1500L

Rammed earth:

Data:

Mixture of sand, gravel, clay and concrete. (stabilised rammed earth)
250mm rammed earth, 100mm insulation, 250mm rammed earth
wall has a combined R-value of 3.2 m2·K/W

Precautions to take when working with rammed earth:
Rammed earth wall should be built on a plinth at a min. of 225mm above the NGL.
Steel reinforcement should be used
A weep hole should be provided for the cavity insulation
a min. 300mm overhang should be provided for the external wall face
A rock drain should be provided for water back splash from the pavement

Construction method:

1. Foundation footing and brick plinth is constructed
2. DPC placed between brick plinth and first layer of earth.
3. A reinforced plywood frame is constructed.
4. A layer of moist earth mixture is poured in.
5. The layer gets compressed and compacted.
6. Next layer is poured and compacted.
7. Puddled earth lintels are placed at window heigth.
8. A standard size concrete capping with a drip is placed on a puddled earth lintel.

Polycarbonate sheeting:

Perspex® Polygal (Multiwall Polycarbonate)

Data:

- Lets in natural light
- Thermal properties provide insulation, saving on electricity
- Can withstand harsh weather
- Creates a sense of openness and flow while maintaining stability and strength
- Durable and flexible (allows cold bending)
- Available as sheets or as a system solution
- Polycarbonate Glazing accessories also available to compliment the Multiwall sheeting
- Can be screen printed directly onto the sheet allowing limitless options for creating unique spaces
- UV protected to withstand harsh African climate
- 10 year warranty
- Polycarbonate is self-extinguishing

Bamboo Traditional:

Data:

Bamboo Balcoa
Diameter between 100 - 200mm
Height of 15-20 meters
Hollow cores devided by diaphrams on nodal intersections
Tensile strength of mild steel

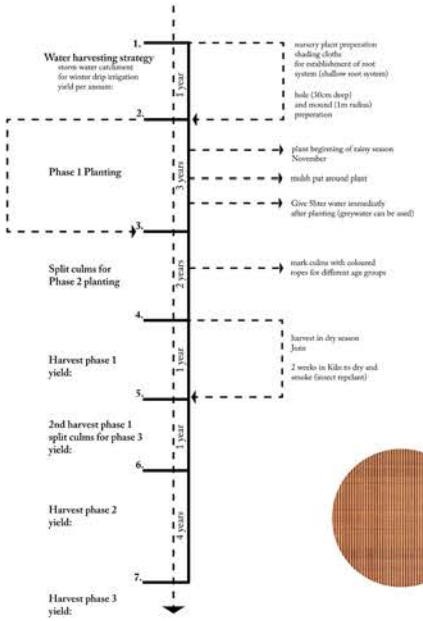
Needs to be dried and smoked for external resin to become distateful to insects
Culms should not be in direct cantact with ground.
Cut below nodes and openings should be reinforced and sealed to prohibit splitting.
Bamboo stalk strings used to tie bamboo culms to one another.
Bamboo pegs used as 'bolts'
Waterproofing is lime wash
Wet bamboo stalk string, tie around culms and as it dies the string will shrink and tighten, string as same strength as zinc cord.

Bamboo contemporary:

Contemporary connections often incorporate threaded bolts.
To stabalise the bolt in the hollow core, it is common practise to fill the hollow with mortar. The alkalinity of mortar however eats away at organic material over time.
Thus an epoxy resin is a better option.

To prevent the cut edge from splitting the epoxy resin will seal and plug the open end.

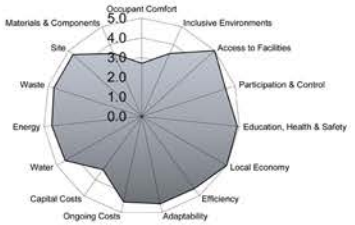
Other options are galvanised steel caps or cable ties.

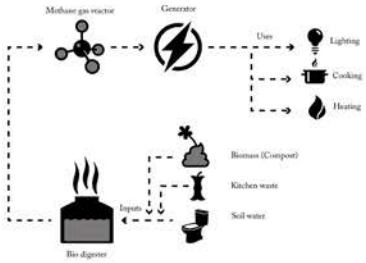


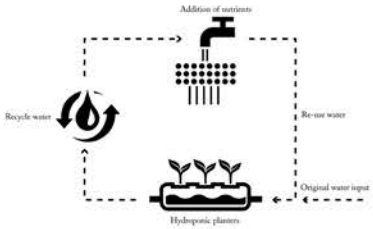
DATA:

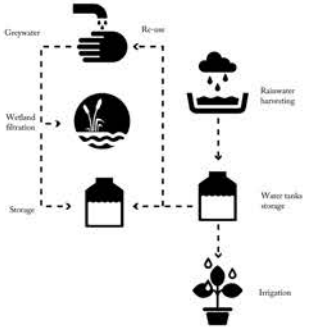
Lifespan:	50+ years with 20-40% harvest
	Bamboo balcoua clump can be harvested after 5 years
Yield:	312 plants /ha @ 20% harvest
	47.8 tons/ha
	287 tons/ha biomass per annum
Water needs:	5000l liter per clump per year
Root Systems:	clumping (non-invasive)
	running (invasive)
Viable species:	Venda sacred bamboo (clumping)
	African Alpine Bamboo (clumping)
	Balcoua Bamboua (clumping)
Strengths:	Fast growing (3-4 years per harvest)
	Lightweigth (vs steel and concrete)
	Elastic
	Multiple uses (construction material, furniture, paper, biomass, biochar)

System strategies:





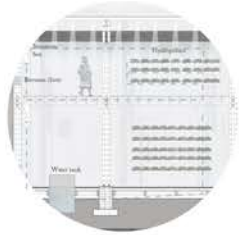




System application:

Natural ventilation assisted with evaporative cooling towers

Biodigester fed with biomass from greenhouse producing methane gas for gesserator



Recycling of water for hydroponic cultures through addition of nutrients

stormwater and roof water runoff and grey-water harvested in wetland used for irrigation

View of Horticulture fields and Grey water treatment pond

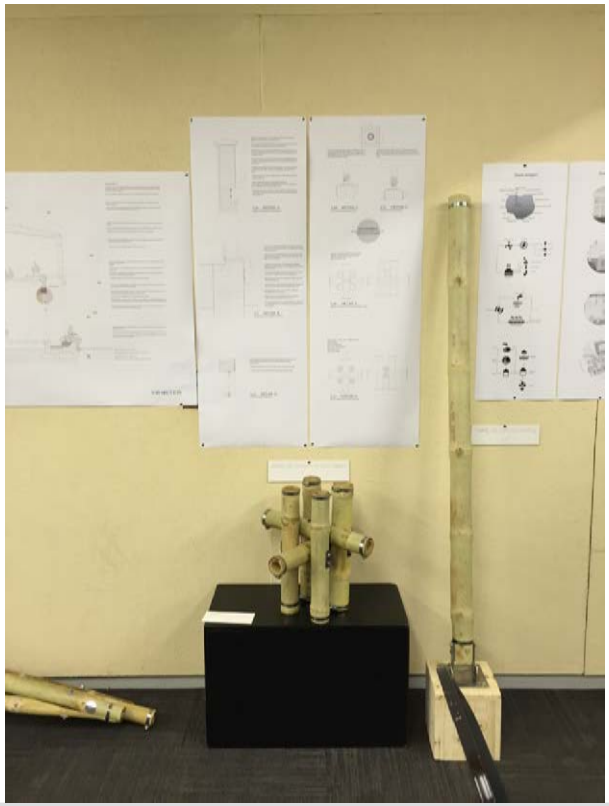
Entrance to Kindergarten

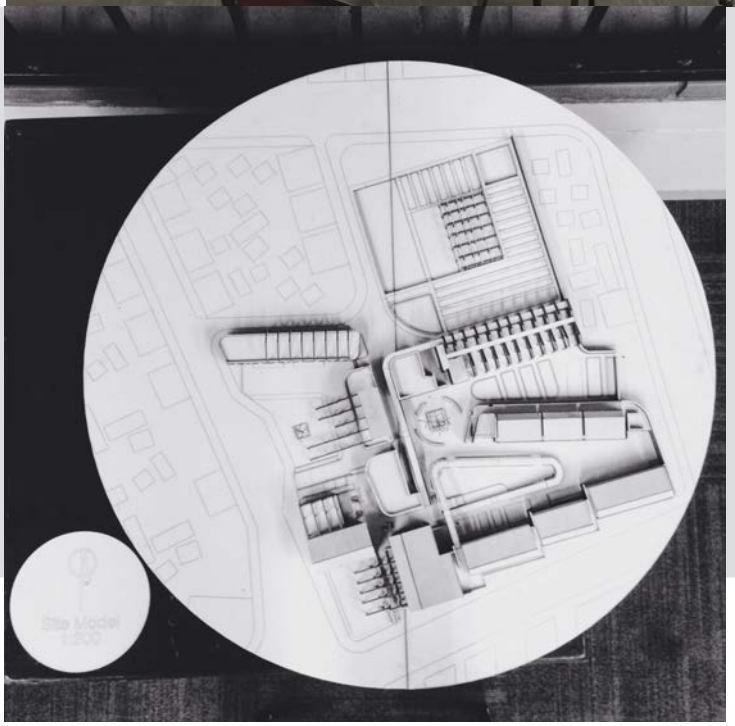
Children's dining courtyard

Public Square Daily activities

Public Library balcony

Children's Courtyard with Sandpit





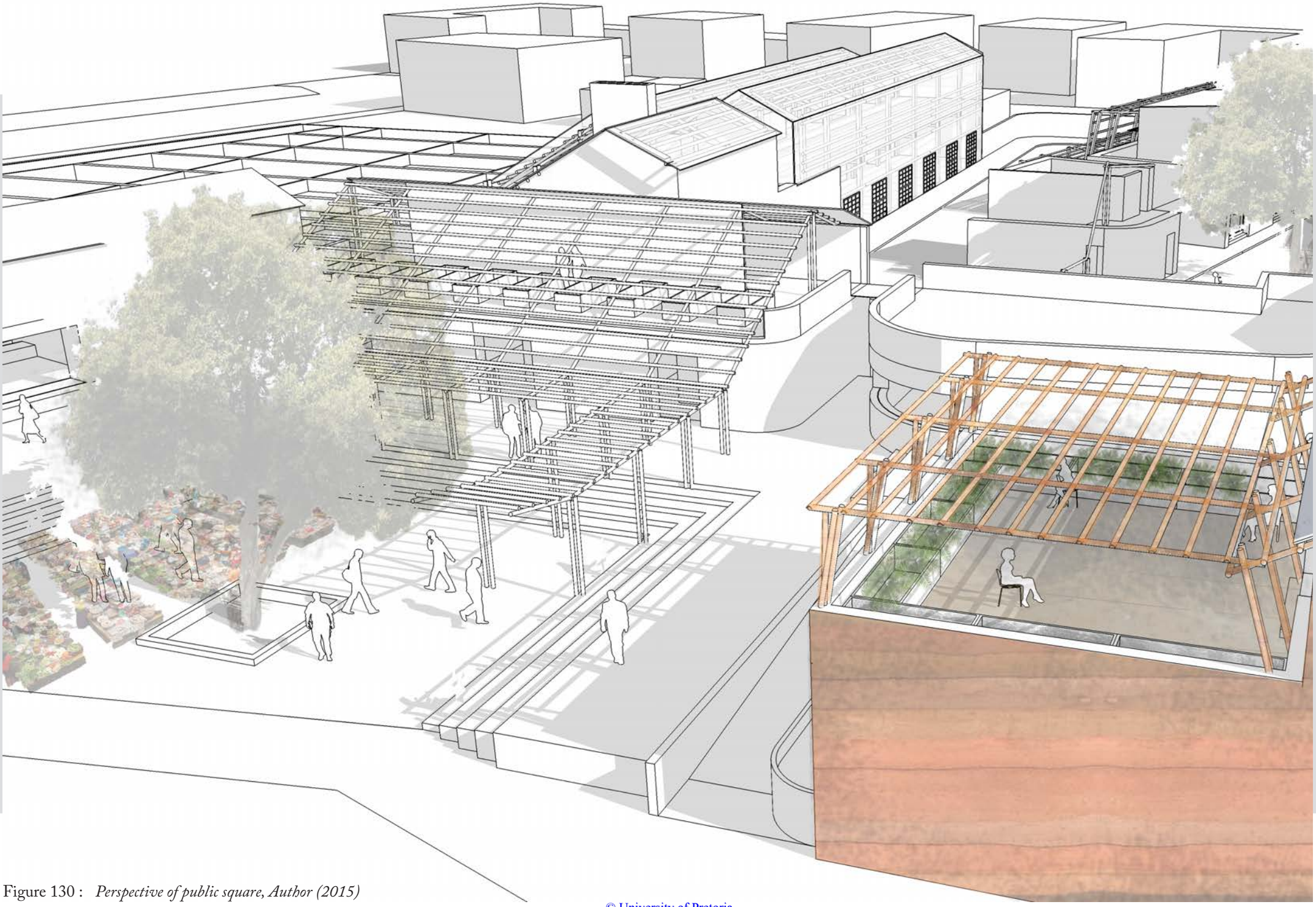


Figure 130 : *Perspective of public square, Author (2015)*

Conclusion

This dissertation was an enquiry into how architecture could aid in the re-seeding of growth of a collective cultural memory, through the creation of a place for the Forgotten networks of Phomolong. This is one of the amorphous spaces in the greater Mamelodi, which experiences the effects of the daily migration of the working class, leaving behind a network of elderly dependents and children. Through the use of a mnemonic system of social spaces, the blurring of the public and private realms aided in the architecture becoming a social system rather than an object which is removed from the collective. The proposed Early Childhood Development centre acknowledges the Forgotten networks and the daily trek of commuters, creating a centralized space from which dispersal takes place. Thereby promoting a dynamic public interface, which enhances the overlapping of social ecotones and the creation of a repository for the collective cultural activity.

The design of the proposed building allowed for an exploration of architecture where social ecotones, nurturing spaces and collective thresholds were the main drivers. It has been established that architecture could provide a platform of reintroducing man to nature through biophilic design attributes and thereby cultivating spaces which promote social activity in the amorphous area. These positive environmental changes are rooted in the physical aspects of the projects spaces on a human scale and materiality choices, creating allowance for the Forgotten networks to become co-creators of their immediate environment, thereby creating a place of empowerment for them. Consequently, every aspect of the architecture, including the construction of the space, places emphasis on the earthbound conditions and the possibility of transition taking place through the passing on of existential knowledge, skills and thereby growth of the collective.

The theoretical premise of place for the collective through mnemonic and ecotone systems, as well as the precedents investigated, indicate that social spaces, activity generators, collective interest (well-being of children) and food production could be layered to create a place for the daily rituals to become a celebrated and dynamic event. The hierarchy and transition of spaces from one another allows the users to understand, on a human scale where thresholds differ and where the public and private realms are divided. The process of growth and cultivation is a visible element which is fed back into the community and aids in the concept of collective growth and biophilia. The result is a layered compilation of different social spaces that are all related either directly or visually, thereby acknowledging the co-dependence of the collective. The building therefore operates as a social system and threshold of different programmes that would normally be separated from each other.
The awareness of changing spaces and materiality reminds the users of the process of growth and transformation.

The spaces become a beacon for the collective of transition and growth. Activated by place making, food production and the education of children, the design becomes an interface between the commuters and the Forgotten. A space of Catharsis where all can bring and take from it what is needed. For the children it is a stimulating and interactive environment, for the Elderly a space of empowerment and for the public a space of acknowledgement of their daily rituals. Through the creation of architecture, acknowledging the economic health, social equity, cultural vitality and environmental responsibility of the Forgotten networks of Phomolong.

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List of Figures

Appendix

schedule of accommodation data										
programme	m^2	Building classification	Sans 10400	users according to Sans	wc needs male	wc needs female	wc needs children	productive m^2	kg yield/m^2/day	
Formal shops	131	F2	1 person/10^m2	13						
Public space	310	A1	1 person/1^m2	310	4wc 7uri 6 hwb	11wc 6hwb				
Tavern	53	F2	1 person/10^m2	5	seen as shopping complex					
Hairdresser	41	F2	1 person/10^m2	4	seen as shopping complex					
Admin	110			4	1wc 1hwb					
Kitchen	76			7						
Hydroponics	621			5				486	1458	*(Davey (2010)* states hydroponics can yield 3kg/m^2/day)
Daycare	1241	A3	1 person/5^m2	248	*NBRI (1977)* states 1 wc per 10 children		25 wc 25hwb			
Library	323	C2	1 person/20^m2	16	1wc 2 uri 2 hwb	3 wc 2 hwb				
Agriculture	1776			10				1776	12	*(Shand (2013)* states that 36m^2 can produce 88kg/a)
Nurse and infirmary	168			5	2wc 2hwb 1 bath					
Toy Library	71	C2	1 person/20^m2	4	seen as shopping complex					
public toilets	72.6			provided	6wc 10 uri 7 hwb	12wc 7hwb				
tot	4993.6			631					1470	
									/0.3	Min personal intake of
										vegetables per day 0.4kg
									3675	*Shand (2013)*
										people can receive daily intake
										248 children and 28 staff (110.4kg per day)
										can receive food and surplus be sold

	Surplus from previous month	Rain yield	Greywater used	Greywater yield	Agriculture demand	Left over in tank
January	0	571.3	178	178	222.2	349.1
February	349.1	566.3	160.8	160.8	190.7	724.7
March	724.7	418.6	178	178	187	956.3
April	956.3	221.6	172	172	157.4	1020.5
May	1020.5	98.5	178	178	157.4	961.6
June	961.6	49.2	172	172	129.6	881.2
July	881.2	24.6	178	178	111.1	794.7
August	794.7	14.8	178	178	129.6	679.9
September	679.9	108.3	172	172	185.2	603
October	603	349.6	178	178	185.2	767.4
November	767.4	541.7	172	172	212.9	1096.2
December	1096.2	541.7	178	178	222.2	1415.7

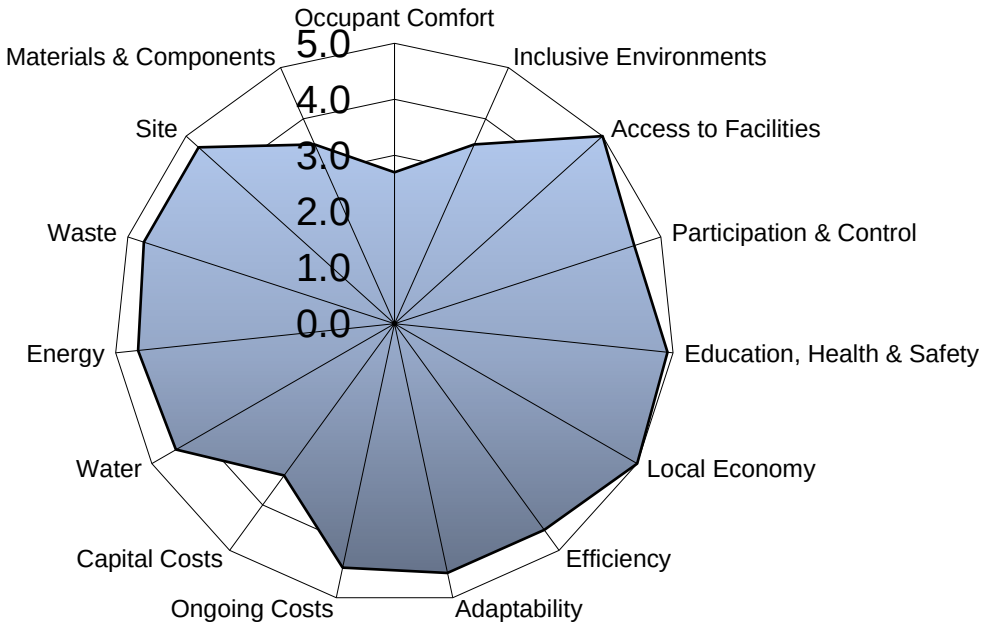
Tank size 1500L

Catchment surface	Area (m2)	Runoff coefficient we	Area of catchment weighted
Roof	2002.6	0.9	1802.34
Paving	3902.8	0.8	3122.24
Grasslands	0	0.36	0
Roads	0	0.75	0
Arena			0
Total			4924.58

energy needs					
appliance	amount	watts per appliance	hours per day	kwh usage per day	
geyser	3	2000	3	18	
lights CFL (18)	200	18	8	28.8	
stove plate	16	1500	5	120	
dishwasher	1	2500	0.9	2.25	
washing machine	1	3000	2.25	6.75	
kettle	4	1900	1.8	13.68	
refridgerator	3	250	2	1.5	
freezer	2	105	4	0.84	
computer	5	134	8	5.36	
water pump	2	1000	1	2	
				199.18	total kwh usage per day
				28554.8	kwh biogas produced per day
				28355.6	surplus

SUSTAINABLE BUILDING ASSESSMENT TOOL (SBAT- P) V1

PROJECT		ASSESSMENT	
Project title:	The Forgotten: By-products of the daily exodus	Date:	10/19/2015
Location:	Phomolong, ext. 6 Mamelodi	Undertaken by:	Ursula Kotze
Building type:	Early childhood development centre and feeding scheme	Company / organisation:	UP Architecture dept.
Internal area (m2):	636	Telephone:	Fax:
Number of users:	0	Email:	ursulakotze@gmail.com



Social	4.1	Economic	4.4	Environmental	4.4
Overall	4.3	Classification	Excellent		