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06 TECHNICAL INVESTIGATION

06.01 BUILDING STRUCTURE

06.01.1 Structural Timber Frames (Timber Roof Structure)

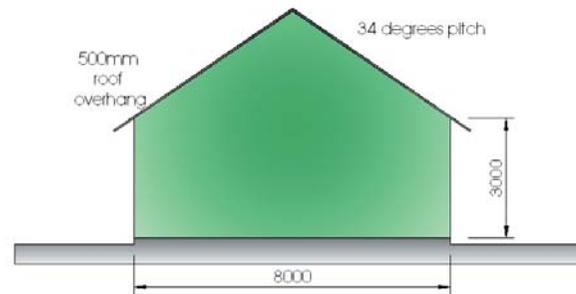


Fig.06.01

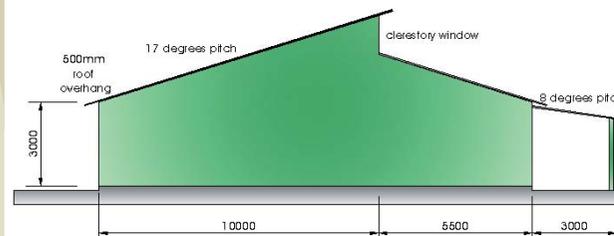


Fig.06.02



Fig.06.03

The main concept throughout the design, in terms of building structures and frames, is to keep the overall construction as simple as possible and to standardize elements. This makes the development economically viable where limitations on local labour and skills were important considerations. After a prolonged design exploration of possible solutions, the end result is extremely simple and viable within the scope of the project, as it resembles the simplicity and honesty that are evident in the rest of the project. The solution stipulates that the entire development of the main area is based on only two structural timber frames, each with its own set of sectional dimensions that can be added onto individual buildings. The construction procedures are thus greatly simplified, while no limit is placed on acceptable lengths of the various buildings. As these timber structural frames support the roof, walls are simply used as infill and are placed either in or outside the timber structure, depending on the building's function.

The first solution is a simple 34 degree pitched roof placed over an 8 meter span (figure 06.01), while the second is more complicated, with 17 degree pitched roofs that include clerestory windows with a structure that allows for spans between 5,5 and 10 meters (figure 06.02). Doors and windows are custom made with eucalyptus saligna and sizes are standardized with only 4 variations, depending on the function of a particular space. Sizes are subject to limitations placed on spacing, because of straw bale construction. These variations include:

1. standard single door – 813 x 2100 / 2500 mm
2. double door – 1626 x 2500 mm
3. standard window – 813 x 700 / 1400 / 2100 / 2500 mm
4. custom-made doors – 2100 x 2100 mm

06.01.2 Foundations

The construction of foundations is based on techniques used by a professional green architect, Etienne Bruwer. (KNOLL, C. 1998 p.19) Foundations comprise of timber shutters placed vertically on top of each other, into which stone is then poured with 500-1000mm steel reinforcing bars at 800mm spacing. The top 100mm of these bars are exposed, onto which the first layer of straw bales can be secured (figure 06.03). A concrete and lime mix is then poured into the shuttering to settle and reach full strength. After the foundation has settled, the exposed part of each foundation will be carefully finished off with neatly cut stones so as to add to the overall aesthetic quality of the development. (see details 10 & 11)

06.02 SEWAGE SYSTEMS (SEPTIC TANK)

Figure 06.04 represents the route along which sewage is discharged. Ultimately, all sewage is led to a central septic tank that overflows into a French drain.

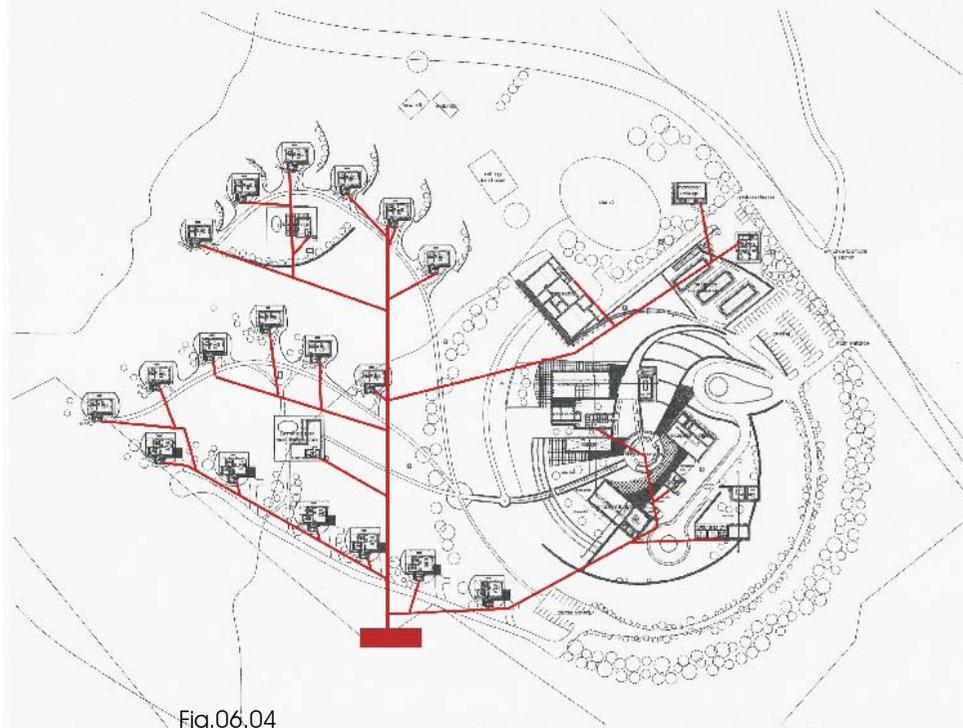


Fig.06.04

06.03 BUILDING MATERIALS

06.03.1 Straw Bales

06.03.1.1 Straw Bale Dimensions

It is important that the design uses the same straw bale dimensions from the outset to be able to create a modular design solution. The local bale machine produces bales 900mm long, 460mm wide and 360mm high. It is necessary that these bales are checked on site and trimmed to the exact size.

06.03.1.2 Construction

The design will make use of the **post and beam** method to construct the buildings. This method combines a vertical load-bearing timber frame with the bale wall (See figures 06.05 and 06.06). Straw bales can be used as **infill** between the panels of vertical support, or as **fabric** (Mushroom growing rooms) where the continuous bale wall runs alongside the exposed timber frame. (Lecture notes) These construction methods have the advantage that the roof frame can be erected first and protect the bale walls as they are raised. The use of bale as **fabric** has the additional advantage of providing the walls with more architectural freedom of movement. Using straw bales as infill allows for greater design flexibility, irregular and gable roof designs, taller one-and-a-half storey buildings, complex floor plans, different amounts of glazing on different orientations and requires smaller framing members.

(www.BuildingGreen.com)

06.03.1.3 Height & width limits

For unbraced bale walls, the recommended height/width ratio should be 5,6:1 and length/width ratio 13:1. (Lecture notes) Therefore, when using 460x360x900mm bales, the unbraced load-bearing straw bale walls can only be taken up to a height of about 3 metres or 7 layers of straw bales, which are 6 metres long. If the building requires a second storey, the walls need to be discontinued after 3 metres and should be topped with the second floor which, in turn, provides the base for the next 7 layers of straw of the second storey. Maximum wall heights can be increased through incorporating external bracing or 'baskets' into the construction of walls (see detail 10), thus making it possible to extend walls of the more complicated structures of Mkhonda Lodge where large interior spaces need to be ventilated and where natural sunlight penetration through clerestory windows is essential. In these situations, gable walls should be designed with great care and all straw bale layers that are placed additionally on top of the initial 7 layers should be wrapped in wire before being finished off with rammed earth plaster.

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Fig.06.05

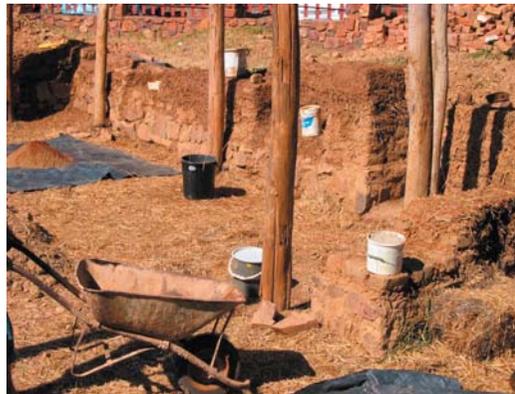


Fig.06.06

06.03.1.4 Strengthened straw bale walls

A combination of bales together with cob, timber, etc is used for a stronger composite structure. Walls that need additional strength will be braced by means of exterior ribbing-stiffened baskets. These baskets consist of 38 x 38mm vertical timber laths spaced at 600mm centres, tied to each other on opposite sides of the bale wall and then covered by chicken wire mesh. For additional strength, larger laths can be used which are horizontally braced through the bale walls and vertically braced to laths on the same side of the wall. (see detail 10)

06.03.1.5 Protection against moisture

The importance of keeping continuous moisture away from walls cannot be stressed enough. Walls with a moisture content of more than 20% (about 80% relative humidity) will support fungal growth and begin to decompose. Wise use of materials, good architectural detailing and regular maintenance generally keep the moisture content of straw below the decay threshold. Conventional frame construction often relies on a plastic film, vapor retardant paint, or other vapor diffusion retardant to help keep moisture out of walls. Most straw-bale building proponents recommend leaving walls relatively permeable to moisture diffusion, ensuring that moisture in the bales are able to escape. The following principles will secure a moisture resistant straw-bale building:

1. Exposed window ledges require flashing and care should be taken to protect horizontal surfaces and drip edges on windows and walls should lead water away from the walls
2. Sloping the ground plane from the building and foundations
3. Installing a good capillary break between the foundation and bale walls.
4. Door and window flashing
5. A skin of good weathering plaster
6. Provide a 'toe-up' on the inside of a straw bale wall to protect it in case of interior flooding
7. A watertight roof with large overhanging eaves - the roof design should preferably incorporate wide eaves of 0.5 to 1 metre in order to shed rain and protect earthen plasters from erosion.
8. Flat roofs and parapet walls are not recommended, as they tend to eventually leak
9. Good window detailing is also critical to avoid moisture infiltration – commonly, glass is set all the way up to the outside of an opening, creating a window-seat on the inside and leaving a minimum surface that needs to be protected from the weather outside.

(KENNEDY, J.F., SMITH, M.G., WANEK, C. 2002 p.190)

As the moisture content within the mushroom cultivation buildings will be very high, it will be impractical to construct these buildings with straw bales only, as they are very sensitive to moisture in general. However, straw bales can be of high insulation value to keep temperatures within these buildings constant and will be used as wrapping around a brick inner shell. In this way, the laboratory and growing rooms become extra insulated, assuring optimal growing conditions.

06.03.1.6 Joining straw bales with other materials

Since straw bales are unconventional building materials, new techniques have to be developed so as to join different building materials with straw bales. The idea would be to separate the different types of structures and fill in the gaps with a softwood spacer or cob mixture that is relatively high in clay content. Each structure within the design should be self-supportive, displaying its inherent qualities. Ideally, two different types of walls should be joined by using brick forcing in the construction of walls and ensuring that the layers of reinforcement in each wall overlap and join to add to the overall structural stability of both walls. (see detail 9)

06.03.2 Stone

Solid stone walls are strong in compression but not in tension and for this reason it is necessary to provide walls with additional reinforcement. Pre-cast reinforced concrete beams can be built into the wall at the base and top of the wall to add to the structural stability of stone walls. Where stone walls need to be at least 3 metres high, a third beam can be built into the wall at mid-height. The stone wall will be built using a mortar mix of sand, lime and clay to bind stones to each other.

06.03.3 Wood

TIMBER TREATMENT

The poles used in the design of Mkhonda have to be treated to ensure maximum lifespan. Poles used in outside areas, where they will be exposed to a range of harsh weather conditions and those in contact with the ground have to be treated with Totim-B (a non-toxic, mammal-friendly timber preservative), which keeps the wood's natural colour. Structural poles not exposed to weather conditions will be treated with Flambor for increased fire resistance. (Flambor is a product consisting bore and a flame retardant, making the timber more fire resistant). Poles used in the interior spaces as non-structural elements will be treated with borax in order to keep insects out. Borax poses no threat to the environment.

TIMBER POLES

Types of poles used in construction vary according to the specific design needs. Straight, graded poles are used where the structure needs to carry a large and intricate load (figure 06.07), for example the complex roof structures of the larger buildings, whereas naturally rough or uneven poles will be used to carry lighter structures such as lattice work or small roof spans. Warped poles are used in especially outdoor areas add to the idea of using materials as close as possible to its natural state, blending into its surroundings. The poles can therefore be sourced and treated locally, reducing transportation costs while promoting local job creation.

TIMBER LATTICE WORK

Elements are designed to have maximum protection through incorporating sheltering, overhangs, flashings etc. into the design, which will facilitate quick drying of various components of the lattice structure. Top ends of vertical elements are cut at an angle to shed water and are held with a wall plate to prevent splitting.



Fig.06.07

06.03.4 Cordwood walls

The cob mix used between logs consists of sand, lime and sawdust (soaked in water overnight). Lime makes the mix more workable and adds strength.

(KENNEDY, J.F., SMITH, M.G., WANEK, C. 2002 p.143-148)

Precaution measures when building a cordwood wall:

1. Use only sound wood with the bark removed
2. Do not allow log ends to touch each other to prevent the entrapment of moisture
3. A roof overhang of at least 500mm is necessary
4. Cordwood masonry should be at least 100mm above ground level and placed on a moisture-proof stone foundation.

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06.03.5 Earthen plasters and floors

06.03.5.1 Plasters

The straw bale walls need to be plastered with a mixture of sand, clay and straw, also known as a 'cob' mixture. The mixture is site-specific and tests need to be done beforehand on each individual site to determine the natural composition of the soil. Generally, the cob mixture consists 1 wheelbarrow local sand, 2 buckets river sand, 1 bucket red building sand, ½ bucket clay, a few handfuls of straw (or bran, depending on the type of finish required) and water. It is important not to add cement to the cob mixture, as cement's moisture content is higher (15%) than that of cob (5-8%). Thus with cement, moisture is retained within the wall to form a damp mass that gradually moves down along the cement barrier within the wall until it reaches the bottom to cause major cracks and damage after a few years. This is not the case with cob walls, as they are able to 'breathe' and let moisture through.

PLASTERING STRAW BALES

First, a thin layer of cob with large clay content is spread onto the straw bales that have been covered with chicken wire mesh and locks into the bales to provide a surface to which the next layer can stick. A thicker layer containing more straw is then applied to this layer, which is worked off roughly to once again provide a surface for the next layer. The final layer of cob wall plaster uses fibre in stead of straw so as to provide a much smoother finish to the walls.

06.03.5.2 Floors

CONSTRUCTION OF EARTHEN FLOORS

The ground on which the floor will be placed needs to be well-compacted and dry prior construction. A drainage layer of 250mm coarse sand or gravel should be incorporated. This will stop the upward movement of moisture. The sub-floor, constructed on top of gravel, consists of 50mm moistened sandy soil with enough clay to assure the necessary bonding. This floor serves as a working surface during construction and only after all heavy construction has been completed, should the finished floor be installed. The finished floor consists of two thin (25mm) layers. The first layer could be left rough and the second layer should be applied while the first layer is still damp. Once the floor is completely dry, it needs to be sealed to make it resistant to dust and water damage. This is done by using boiled linseed oil, which is mixed with odourless, which penetrates deeply into the earthen floor. Four layers of this mix should be applied.

(KENNEDY, J.F., SMITH, M.G., WANEK, C. 2002 p.113-117)

06.04 TECHNICAL EXPLORATION OF PROPOSED BUILDINGS

The design of Mkhonda Lodge focuses on the use of locally available materials as close as possible to their natural state. Construction techniques are simple but unconventional, thus posing a challenge on a technical level to be able to come up with alternative technologies. Particular care is taken in clothing interior spaces with natural elements and materials, as they add to the overall rustic feel of the buildings. Certain details and finishes recur throughout the various buildings to create an integrated design.

The project only focuses on the detail design of buildings contained within the main development area and thus excludes the detail design of the Private Lounge, Semi-public swimming area, Farm Factory, Manager's cottage and cottages in the private section of Mkhonda Lodge. The buildings that will be discussed in detail in following segment include: Cottages of type C, D and E; Offices and Reception; Composting Area; Restaurant and Kitchen; Lounge; Conference Facility and Meeting room; Staff Quarters; courtyard and landscaping. The basic design of the Mushroom Cultivation Area is also included in the discussion.

06.04.1 COTTAGES (Units C,D and E)

The design of the cottages reiterates most of the design and construction techniques used in the rest of the development. Therefore, the proper resolving of technical aspects within the cottages is extremely valuable to the rest of the development.

COTTAGES IN PRIVATE SECTION OF DEVELOPMENT

The cottages in the private section of Mkhonda Lodge (Units A and B) are designed using the same materials and construction methods of the cottages in the main development area. However, the cottages in the kloof will be more diverse in terms of shape and functions, for the natural landscape and existing trees have to be incorporated into the design. The layout of the various cottages is therefore site-specific and not standard as with the main development. The private cottages are furthermore not supplied with electricity and therefore make use of gas stoves for cooking, candles for lighting and a solar geyser without an electrical booster to heat water. Since the cottages are less exposed to sunlight, a backup water heating system is essential, thus the use of an outside direct-fired water heater.



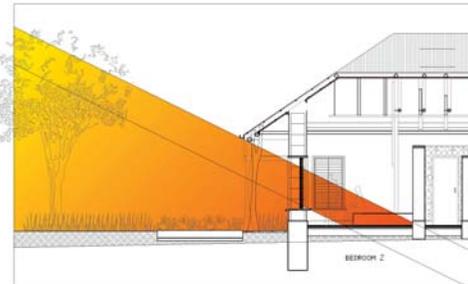
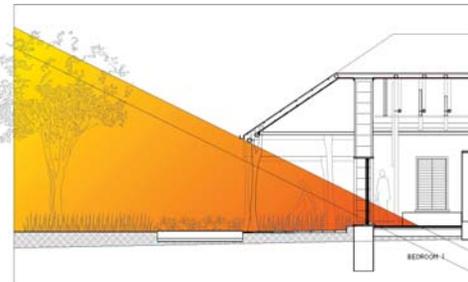
Fig.06.08

TECHNICAL INVESTIGATION

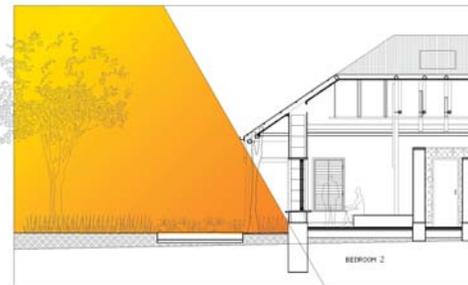
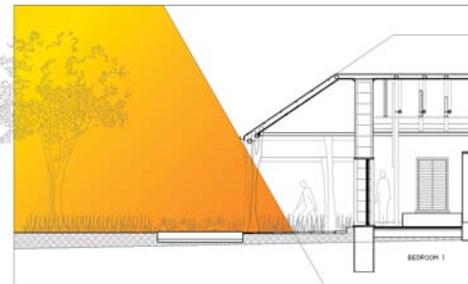
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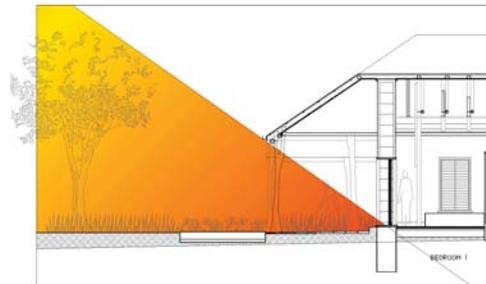
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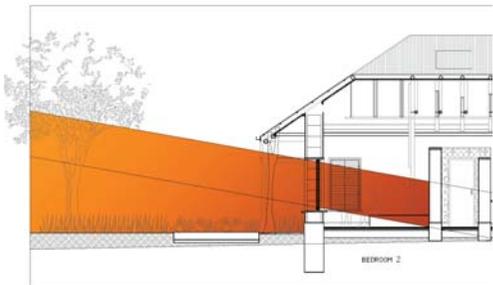
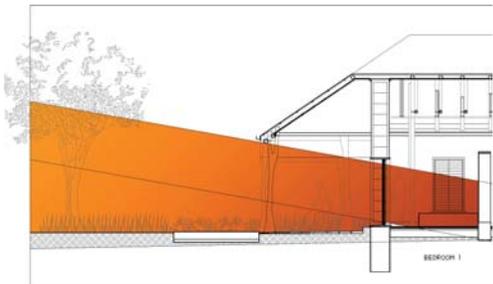
21 march - 16h00



22 nov / 22 des / 21 jan - 14h00



22 nov / 22 des / 21 jan - 16h00



22 nov / 22 des / 21 jan - 18h00

This project focuses on the detail design of units C, D and E only.

COTTAGES – UNITS C, D and E

Cottages are designed to ensure continuous contact between the user and the immediate environment. In effect, interior spaces reach out to the surrounding natural elements through the use of building materials, finishes and detailing, incorporating gardens around each cottage and the strategic placement of openings to maximize views. For example, each bedroom overlooks a private garden and the mountain. As with the rest of the design, buildings are mitigated and merged into the landscape through the use of circular natural elements that surround each cottage, for example the circular lines of planted gardens, timber partitions which screen off outside showers and stone walls in type C units.

In order to protect the straw bale walls against rain, the northwestern and eastern facades of each cottage are provided with a sufficient roof overhang, which lessens the impact of a rainstorm.

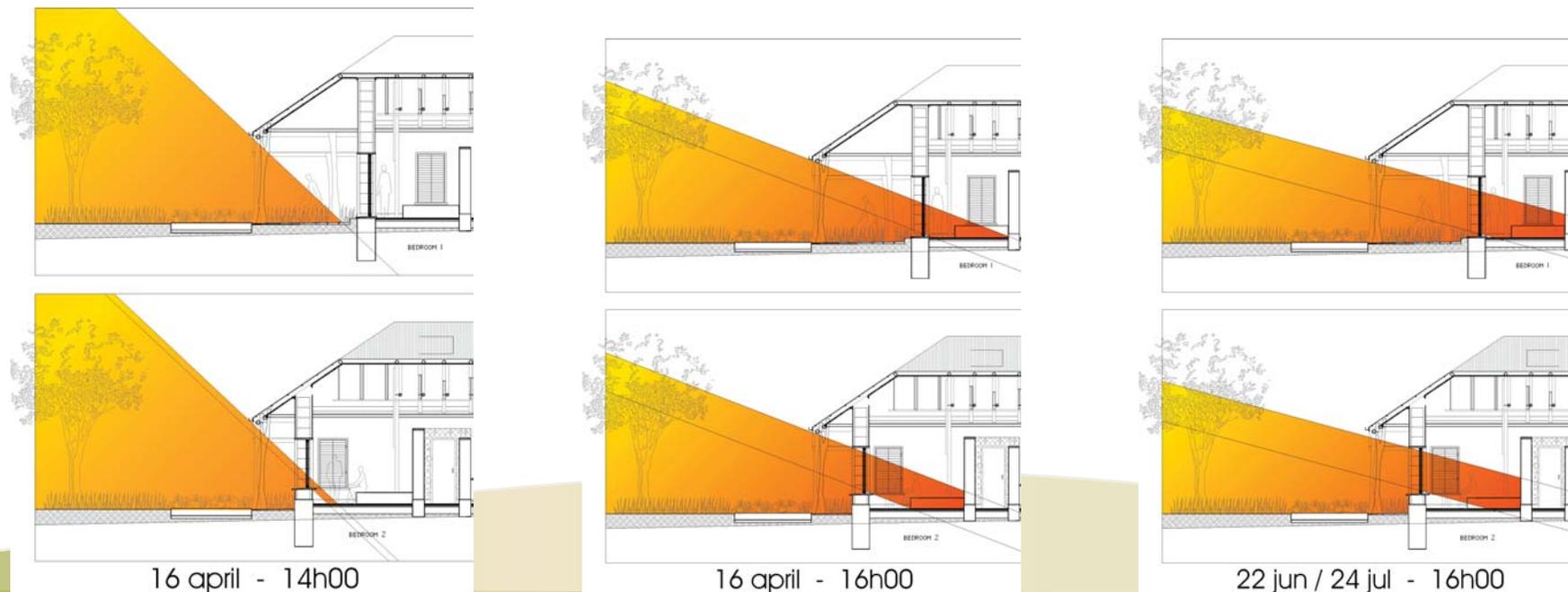
Cottages are smaller entities and therefore the heating effect of the sun will be more concentrated on them than on the larger buildings on site. To be able to minimize thermal heat gain through the straw bale walls and the penetration of western sun into the bedrooms of each cottage, it was necessary to reduce the

Fig.06.09

total area of **exposed western facades** and to provide them with a large **roof overhang** of 500 - 1500mm. Roof overhangs are accompanied by strips of grass and vegetation around the cottage to prevent the surface from heating up too much. Additionally, timber shutters were incorporated into the window design, which enables the user to manually regulate interior temperatures.

Only family units or type E units have an additional bedroom on the western end of each cottage, as opposed to units of types C and D, which have only one bedroom that faces both north and west. The design of the bedrooms within unit types C and D will therefore be approached in the same way as the main bedroom of family unit type E. The main bedroom of unit E faces north and west simultaneously and is recessed to have a larger roof overhang than the second bedroom on the southern end of the cottage. By recessing the main bedroom, the secondary bedroom is provided with a small northern window. During daytime, the northern sides of the cottages are more exposed to natural sunlight and therefore tend to build up heat as the day progress, as opposed to the southern facades, which are less exposed. Thus, at the time when the western sun reaches each cottage, the northern part of the cottage will be warmer than the southern part. The main bedroom will therefore need the most protection against harsh western sunrays and requires a larger roof

overhang than the secondary bedroom. By providing each cottage with the same gable or clerestory roof design used in the buildings within the main development, a larger structural design where western and southern sides of each cottage are considerably exposed to sunrays occurs. To be able to prevent this, each cottage will need additional shading and a larger roof structure on the western façade, which will have an effect on the overall building costs. However, the cottages need to be placed within a certain defined area on site, which means that providing maximum privacy between adjacent cottages is already a fairly difficult task to achieve. Cottages with larger shading devices and substantial roof structures require an even larger building footprint and will increase visual impact. This will, in effect, lessen the overall privacy of the accommodation. The solution is therefore to integrate the shading device into the actual roof structure in order to save costs and space and, for this reason, hipped roofs, where the corrugated iron roof sheeting is simply extended to the required length of roof overhang, are used. These are refined and less bulky structures, which will enhance the existing visual quality of a subtle landscape.



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Hipped roofs require a relatively intricate roof design where a combination of materials needs to be used in order to join the large amount of timber poles at the two opposite top ends of each roof. To provide the efficient structural stability, vertical load-bearing poles (which aid in overall load distribution) were additionally bolted to each end truss.

Roof trusses are made on site and while the roof structure is being raised. Different poles are joined using 16 to 20mm diameter metal bolts. Generally, **timber poles** are not consistent in thickness and therefore to ensure a perfect join, the connecting area between two or more poles requires the adequate leveling of these separate irregular surfaces. Timber poles are embedded for 1 meter into the ground after which it is secured with well-compacted backfill. A concrete collar is added at the top of the foundation for additional support. A drainage layer is placed at the bottom of the pole to cater for proper drainage through the pole. All the poles are obtained on site and are preserved with a non-toxic boron-based treatment.

An independent **timber pole structure** not supported or fixed to a wall or any stable element, tends to move outwards because of the forces working in on the vertical supporting elements of the roof structure. It is therefore essential to have **lateral bracing** that counteracts this likely movement of a timber structure. As the straw bale walls are only used as infill, the roof structure cannot be fixed to these walls, for they do not provide sufficient stability. The use of bracing elements to connect timber roof poles and trusses with the vertical supporting elements is thus essential to secure the entire roof structure. The bracing elements are visible in interior spaces and are therefore adjusted to adhere to the specific functions of the various spaces.

The top ends of straw bale walls are encapsulated by an unconventional **wall plate** so as to completely seal off and protect the end of the wall. These wall plates are fixed to the vertical bracing elements that form part of the overall construction of the straw bale walls and for certain parts of the wall length provide a base onto which various 400mm high strip windows can be fixed. These narrow **strip windows** are incorporated to emphasize the fact that the straw bale walls are non-load bearing structures that do not carry the roof structure and in addition allows natural light into the interior. Where strip windows are excluded from the design, wall plates will be replaced by extending the top insulating layer of cob at the top of the straw bale walls up to corrugated iron roof sheeting level.

The design of the cottage includes the use of **timber windows and doors** that are built on site. Specific doors incorporate glass panels for views from interior spaces, for example the bathroom door, which opens onto the outside shower and western- and northern-orientated doors, which capture the surrounding views. Each window and door is provided with timber shutters that fit into the thick straw bale wall, thus displaying the efficient use and practical considerations of these walls.

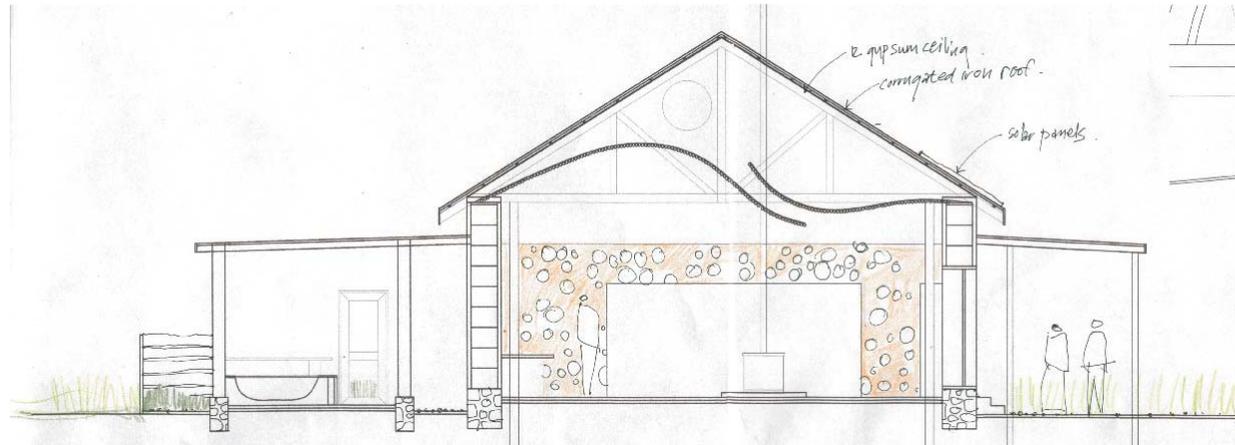


Fig.06.10a



Fig.06.10b

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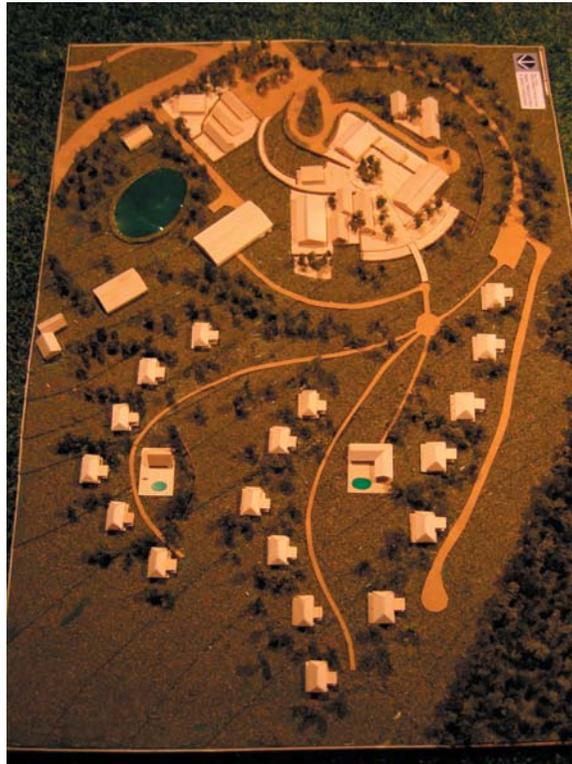


Fig.06.10e

The design of the shutters is repeated throughout the whole development and therefore principles that pertain to windows and doors within the cottages can be applied throughout the rest of the design. Generally, shutters are placed both in and outside of windows and doors, depending on the desired outcome. Shutters placed outside buildings are constantly exposed to harsh weather conditions and therefore needs to be treated with Totim-B and Flambor, as well as being finished off with a few coats of varnish. Interior shutters need only be varnished as to enhance the natural wood quality of the shutters. At the western windows, glazing is recessed and shutters are placed on the outside of the windows to prevent early-morning sunrays from penetrating interior spaces, thus heating the cottages. (see detail 8) The design of northern, southern and eastern windows also incorporates the use of shutters. These shutters contribute to the privacy of each cottage and additionally they are placed on the inside of windows and doors for ease of use. In this case, shutters fold up inwardly to allow windows to open up to the outside, which improves natural wind flow into the cottage. North-facing glazed doors open up onto the shaded verandah and it is therefore not necessary to have shutters outside, but rather on the inside. The extended corrugated iron roof above the verandah keeps out harsh summer sunrays while still allowing the low winter sun to penetrate and heat interior spaces.

Solar panels are fixed to the galvanized corrugated iron roof sheeting at an angle of 34 degrees and are connected to a solar geyser (with an additional electrical booster) and covered with a suspended ceiling of wattle slats. To eventually provide the sink and external wet core area with warm water, pipes are fixed at ceiling level and along the top of the straw bale walls.

The design incorporates curved ceilings, which resemble the circular patterns in the landscape. The actual buildings make use of simple rectangular straw bale construction with uncomplicated layouts, but strive to incorporate nature into the design through clothing interior spaces with natural shapes and elements. These ceilings are represented in different ways through using a variety of materials, depending on the function and other interior finishes of each space. (see detail 12)

Within each cottage, the bathroom's ceiling is manufactured from wattle slats closely fit so as to properly cover the entire ceiling area, whilst ceilings in the rest of the cottage are from 6mm gypsum ceiling board fixed to the timber poles, trusses and laths. Adequate fiberglass insulation is placed between the gypsum boards and metal roof sheeting to enhance the thermal insulation qualities of straw bales. Suspended ceilings are used in the bedroom areas for warmer and more intimate spaces. These curved ceilings are made from 50mm diameter wattle slats that are individually fixed to a bended steel frame, which, in turn, is fixed to the timber roof structure. The entire roof is properly insulated with 75mm of 'Isotherm' polyester blanket. (see detail 2)

Cordwood walls are included in the design to symbolize the local context, as it uses timber off-cuts. These walls add warmth and texture to the interior of the cottage and are only used as non-structural space dividers. Cordwood walls enhance the aesthetic quality of the bedrooms and lounge in that they contrast with the natural colours and smooth finishes of the plastered straw bale walls and rammed earth floors. The walls differ in height, depending on the type of unit. (see detail 3) The family unit type E includes walls that are 2 500mm high, providing the necessary privacy within the two bedrooms. Unit type D is a semi-private unit needing less privacy and therefore a wall height of 2000mm is sufficient. The remaining unit type C is an enclosed cottage situated in the private end of the main development and therefore the wall need only be 1 400mm high to separate the bed from the central coal stove. Cordwood walls are constructed from timber poles obtained through the trimming of local poplar forests cut into logs of 400mm, which they are laid on top of each other in a bonding mixture of cob. Walls are stabilized through incorporating brick forcing into the construction of the wall at every 1000mm of wall height. This brick forcing is then continued to the adjacent cordwood or straw bale wall and aids in providing a proper connection between individual walls to improve the overall

stability of walls. Softwood spacers, which allows for the thermal movement of walls, are placed to seal off the gap between different walls, which are then finished off by covering the joints with timber strips.

The recycling of grey water in each cottage is done through channeling the water discharged by both handwash basins into a geopipe placed under the garden surface. This allows for the slow release of water, which could irrigate the garden. The design of the outside shower includes a slightly sloping base, thus allowing grey water to simply flow from the shower base to the adjacent garden. Walls that are exposed to water from the outside shower are finished off with pebbles laid in waterproofed mortar. Grey water from the bath joins black water from the water closet so as to ensure the efficient flushing away of solids.

In winter, the cottage is heated by means of a centrally placed wood stove placed on a stone platform. The users will therefore be able adjust interior temperatures according to their wishes.

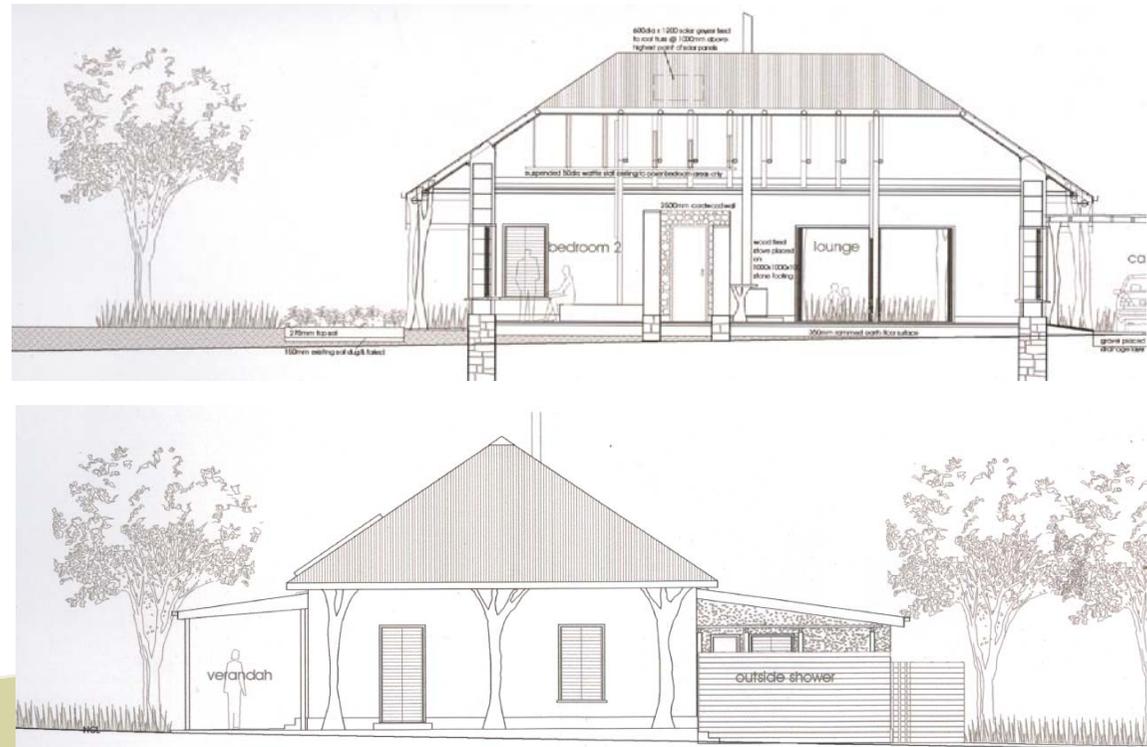


Fig.06.10c,d

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06.04.2 CONFERENCE FACILITY

The Conference facility consists of a large main function hall, service kitchen and storage building, as well as a separate building with the public toilets.

The main function hall is a large building requiring a complicated roof design, as natural sunlight penetration and ventilation is essential for comfortable interior temperature levels. The building hence makes use of the proposed clerestory roof design. (see detail 1) This is the same for all the other larger structures within the main development and includes the main function hall of the conference facility; offices and reception, as well as the restaurant and kitchen.

In each instance, the walls used in conjunction with these roof structures need special design attention, as the end gable walls reach a maximum height of 6 metres. Laterally braced straw bale walls can safely be taken up to a height of only 5 meters and therefore the solution lies in elevating the entire straw bale wall construction with an additional 1 metre above ground level. Typically, the stone foundation wall is extended to a height of 300mm above natural ground level to protect the base of straw bale walls against water penetration, which means that the total stone foundation wall height is 700mm. By extending the wall with an additional 1 metre, the total exposed stone wall area will be 1300mm high, which affects interior finishes within the various buildings. However, this portrays the honesty of adjusted design methods and construction techniques that accompany buildings assembled using straw bales.

As the building faces west to embrace the main view, exposure to western sunrays once again becomes an important design consideration. In late afternoons, the western sun might cause a certain level of discomfort in the outdoor space, but can be resolved through the planting of evergreen indigenous trees and through providing the verandah with a dense timber lattice work. The outdoor space is enclosed by a stone wall, which gradually slopes from 1500mm to a minimum height of 450mm to serve as seating. Through lowering the wall, natural airflow is permitted, thus enhancing ventilation within the exterior space.

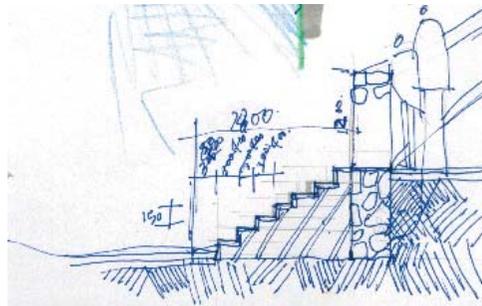


Fig.06.11a

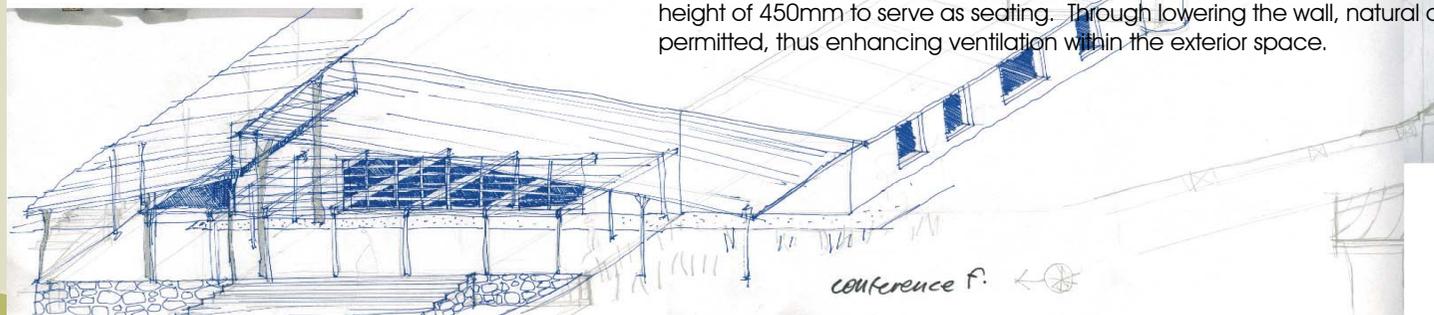


Fig.06.11b

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As with the cottages, the design incorporates curves, which blend buildings with the natural landscape. In the landscape, the natural curves are represented in the stone walls used for the retention of soil. In the interior use of curves are evident in the ceilings of the main conference hall and public toilets. Materials and finishes used to construct the ceilings vary, but the notion remains the same. These ceiling materials and finishes include: 50mm dia wattle slats, 6mm gypsum board and 25x150mm timber planks. The gypsum curved ceiling is constructed by cutting the boards into narrow panels that are fixed to the curved steel frames. These are in turn fixed to timber trusses.

Ponds have been placed at the northern facade of the conference facility to allow sunlight to reflect into the interior spaces. The roof design includes two types of ceilings with the northern half made from gypsum board, painted white. In this way, light initially reflected off the water surface, is reflected for a second time, thus creating a magical effect.

The eastern wall of the conference facility is constructed of stone to contribute to the stone corridor between the conference facility and the meeting room. The eastern walls of the public toilets and lounge and the western wall of the meeting room are therefore also from stone. Outdoor steps at the conference facility will be finished off with selected stone laid on a brick base.

Rainwater collection tanks are incorporated into the design of the service area of the conference facility, as well as at the kitchen. Corrugated iron roof sheets lead water along a corrugated iron gutter connected to the collectors to harvest rainwater, which will be used in both the kitchens and public toilet buildings.

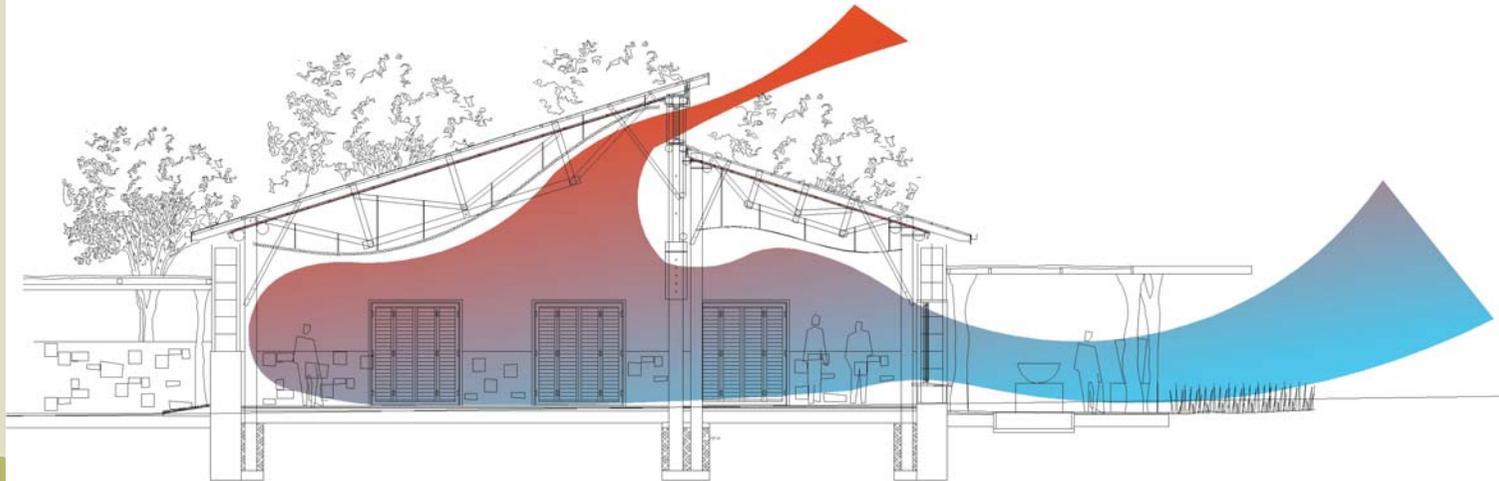


Fig.06.13



WINTER

Fig.06.12b



SUMMER

Fig.06.12c

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06.04.3 MEETING ROOM

The western wall of the meeting room is made from stone as to complete the 'stone corridor', while the rest of the walls comprise of straw bales.

The two main interior requirements within the meeting room deals with glare and ventilation aspects. The use of projectors may be necessary at times and therefore each window will include a timber shutter that can be opened and closed from the inside, depending on the lighting requirements. The shutters only need to prevent unwanted glare and not heat buildup, as the conference facility blocks out western sun. Since people using the meeting room will need to maintain high levels of concentration, efficient natural ventilation is an important design guideline and windows are therefore aligned to ensure maximum ventilation. The boardroom table will be constructed from eucalyptus saligna on site to fit around the central timber structural poles.



Fig.06.14a



Fig.06.14b

06.04.4 COMPOSTING AREA

Guests will be able to overlook the composting area from the central courtyard through glass panels built into a stone wall. Special care needs to be taken in making those components in contact with the compost heap completely water-resistant. This means that timber window elements need to be separated from the compost heap by sufficient glazing, thereby strengthening the glass to resist pressure from the heap. (see detail 7) The design thus uses 12mm clear laminated safety glass. In constructing the stone wall, stones are placed in mortar to keep them from shifting and to prevent the passage of air, water and small creatures. The mortar mix consist of sand, clay and lime putty which slows down the setting of mortar, thus making the mix workable over a longer time period; it also reduces the mortar's brittleness. (KENNEDY, J.F. 2002 p.186) Spaces and gaps between stones of different rows are filled with mortar and small stones.

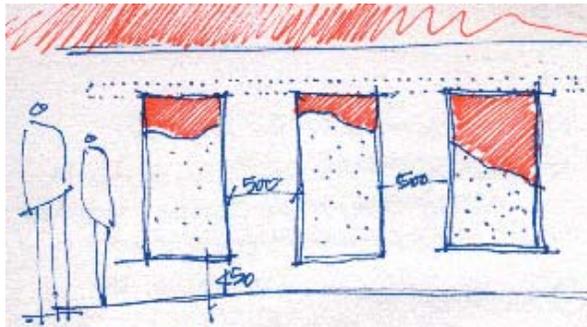


Fig.06.15a

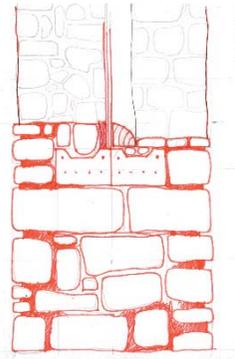


Fig.06.15b

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06.04.5 OFFICES AND RECEPTION

Upon entering the reception area, the visitor is introduced to main design elements that define the architectural language throughout the rest of the design. These elements include: stone walls; terraced gardens; rammed earth floors; straw bale walls; cordwood walls; curved ceilings; and the timber pole roof structure. Openings in walls are aligned to create a visual link between the individual and his or her natural environment. An exposed straw bale wall of which only the one side has been left unplastered is placed next to the reception counter to inform guests of exactly how a straw bale wall is constructed. The timber roof structure is a direct application of the design solution used in the main function hall of the conference facility.



Fig.06.16

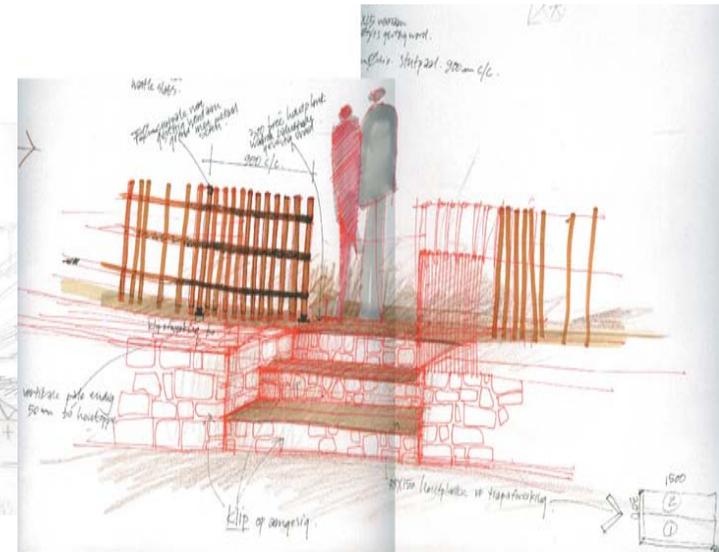


Fig.06.17a

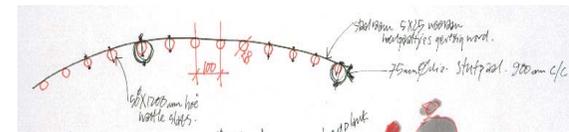


Fig.06.17b

06.04.6 RESTAURANT AND KITCHEN

The area surrounding the restaurant compliments local food preparation. The outdoor dining area overlooks the vegetable gardens, latticework displays the growing of tomatoes and other vegetables and the herb garden next to the dining area forms a green backdrop to a series of window openings included in the northern façade of the restaurant. Additionally, clay ovens overlook the outdoor dining area and therefore guests will witness traditional bread making. The ovens are wood fired which will lessen electricity costs considerably. Ovens are built using a combination of local bricks and cob.

The timber roof structure allows for clerestory windows. This change in roof shape is complimented by a change in floor levels inside the restaurant. The change in level is supported by a stone wall and the conventional balustrade replaced with planters. A fireplace is centrally located in the dining area and is constructed in the same way as the fireplace in the Lounge.

The kitchen is linked to a service road for delivery purposes. The roof design allows hot air to escape through the high clerestory windows. Grey water discharged by the kitchen and hand wash basins of the adjacent public toilets are led to geopipes underneath the vegetable gardens.

Both the freezer and cooler rooms in the kitchen are custom made on site. The interior walls are made from modular isowall panels of varying widths, up to 1200mm. The cooler room needs to maintain a temperature of around 1-4 °C and therefore requires a panel thickness of 100mm, while the freezer room requires panels of 150mm thick to maintain the required temperature of -8°C. The isowall is sealed off completely and enclosed by an additional layer of insulating straw bales. Since the cooler and freezer rooms face west, this additional layer of straw bale insulation helps to maintain the required interior temperatures. Additionally, the western facade is planted with trees to keep out direct western sun.



Fig.06.18

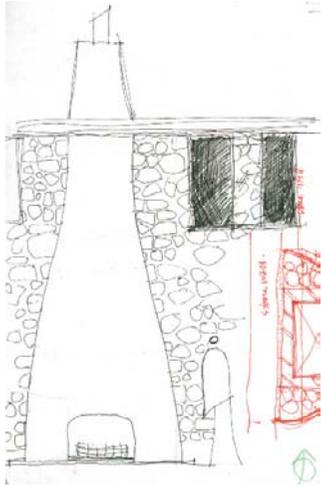


Fig.06.21a

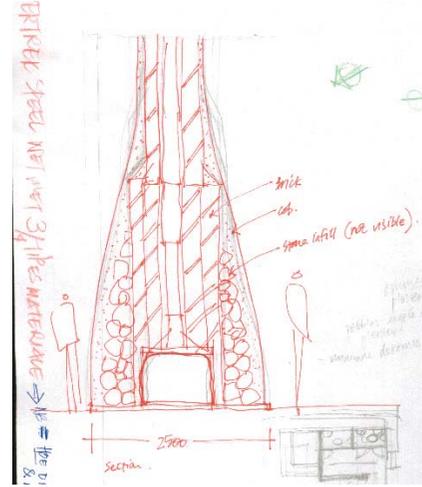


Fig.06.21b

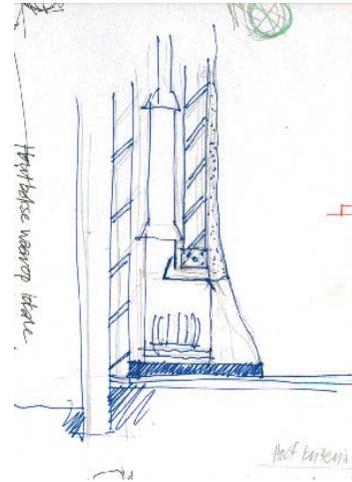


Fig.06.21c

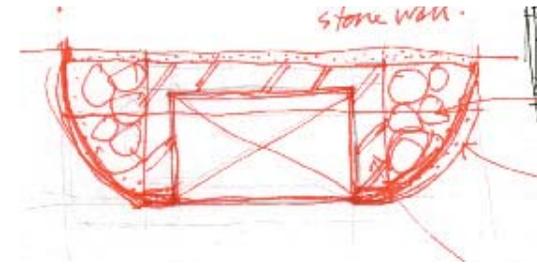


Fig.06.21d

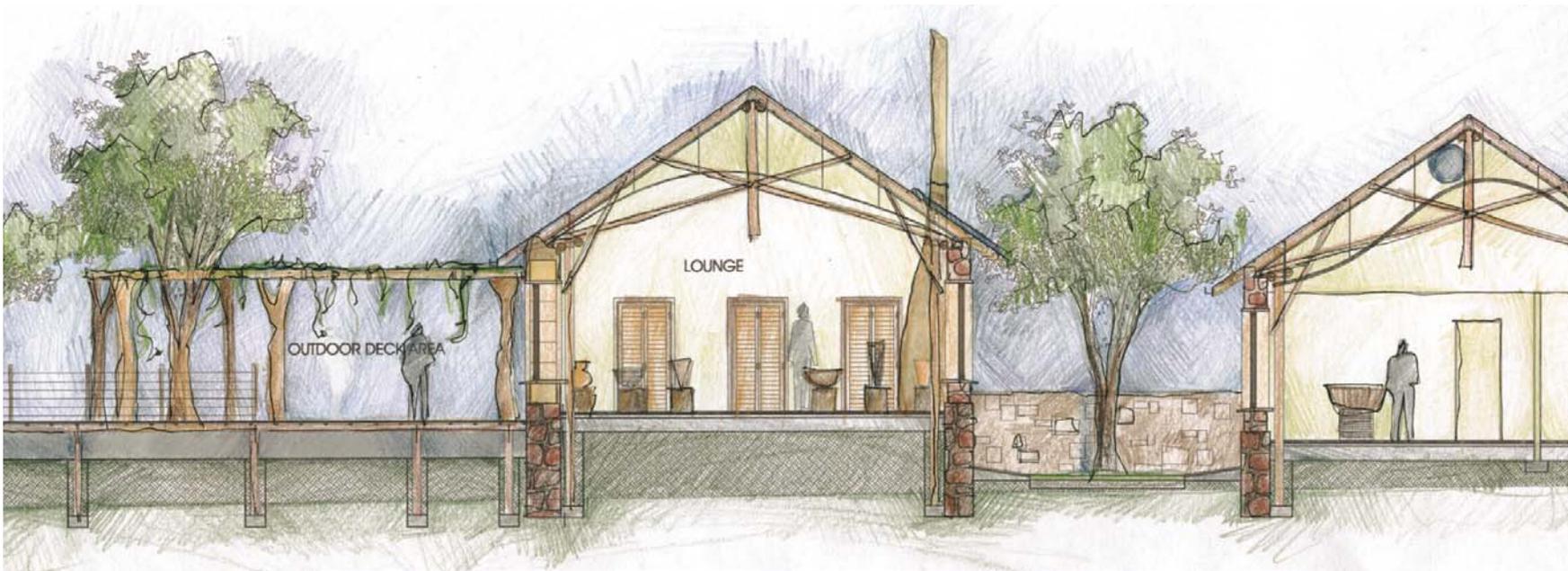


Fig.06.22

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06.04.8 TIMBER DECKING

Treated timber decking is used for a large part of outdoor areas and will sustain a considerable amount of traffic. The decking areas will in effect be an extension of functions within the lounge and restaurant to, weather permitting, host events outside. Good detailing therefore becomes important in terms of durability and sufficient drainage. Design specifications include:

1. Narrow timber planks to facilitate repair and add strength
2. Double galvanized screws and bolts
3. Minimum final decking board spacing of 6mm to allow for drainage
4. All joints are self-draining and receive maximum amount of natural ventilation
5. End grain of each timber element is designed for minimal exposure to weather conditions
6. Top surfaces are slightly sloped to shed water
7. Bollards and posts are chamfered to reduce the tendency to splinter

06.04.9 COURTYARD AND LANDSCAPING

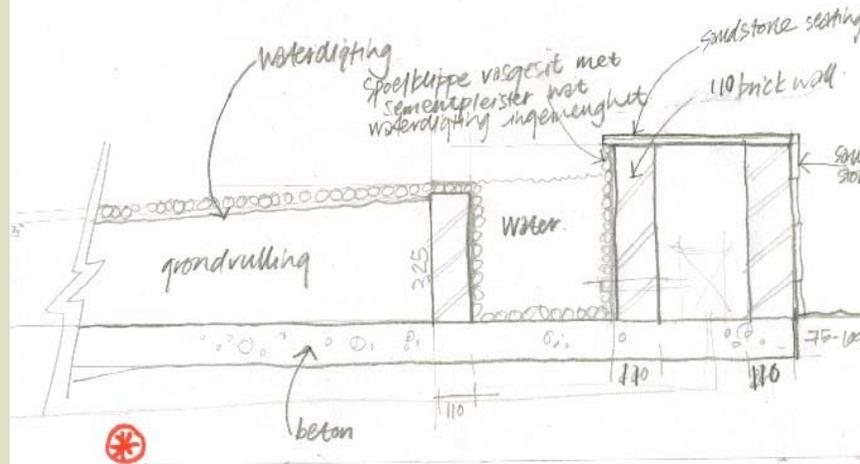


Fig.06.23a

The most central point of the main development is a courtyard linked to three other formal courtyards by means of a clearly defined walkway. These courtyards expand into a number of less formal courtyards as one moves away from the centre and diverts from the main line of movement.

The central courtyard is a perfect circle consisting of a water feature, planted grass and a hard surface of rammed earth. (see detail 4) The grass is formally arranged along the inside of the water feature so as to portray the idea of nature being trapped by man-made structures and human activities. However, through sensitive design nature is 'freed' as we learn to work with instead of against nature. Buildings and elements should be designed to blend into nature and form part of it. This idea of nature being freed becomes evident as the courtyards become less formal towards the outer edges of the main development area and vegetation becomes more

loosely arranged around circular lines and courtyards until it eventually breaks away from the stringent circular lines on site and is not trapped within strict courtyard layouts.

The prominence of the six terraces within the main development area makes it an important visual element. These terraces will be planted with cultivated annuals, providing an ever changing backdrop of colours.

Gabions will be used to contain the soil of each terrace in the landscape. Throughout, gabion wall heights do not exceed 2000mm. Gabion sizes used include 1m x 1m x 2m and 0,5m x 0,5m x 2m. The base on which the structure is founded should be leveled and compacted. Each gabion should be braced with at least 4 bracing wires per square meter of gabion, as figure 06.29 indicates. Rocks placed in the gabion structure should be clean, durable and graded between 100 – 250mm. When filling the gabions, the void ratio should be approximately 0,3. Water collected at the back of each gabion structure is channeled away by means of a geopipe embedded in a compacted layer of gravel, as the sketch indicates. (see detail 6)

Geotextiles prevent the loss of fine particles from the soil behind the gabion structure through the rockfill and simultaneously negate the buildup of any water pressure behind the wall. Geotextiles must be placed at each soil-gabion interface and a minimum overlap of 300mm should be maintained.

Trees planted in public areas are provided with a grid supporting frame which is incorporated into the design of timber decks. This allows for necessary and protection. (Dimensions of these grids are 1510 x 1510mm, central circular opening of 600mm in diameter, 125mm overall depth.)

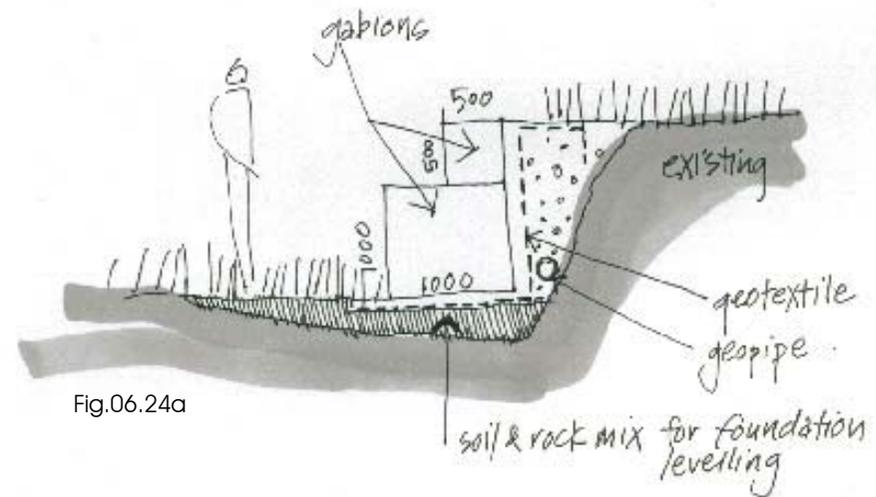


Fig.06.24a

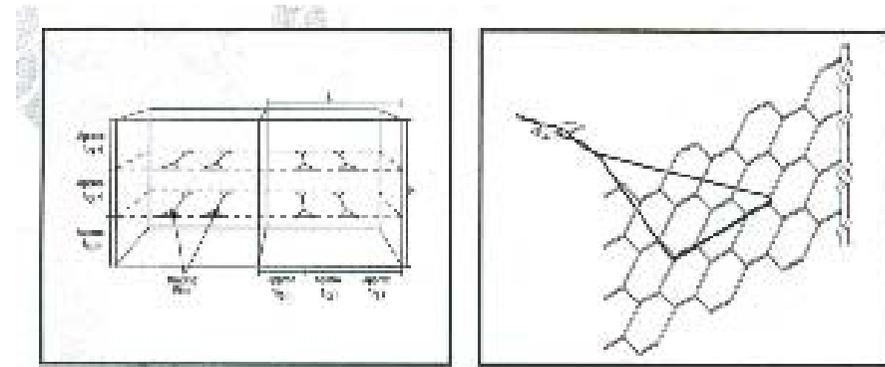


Fig.06.24b

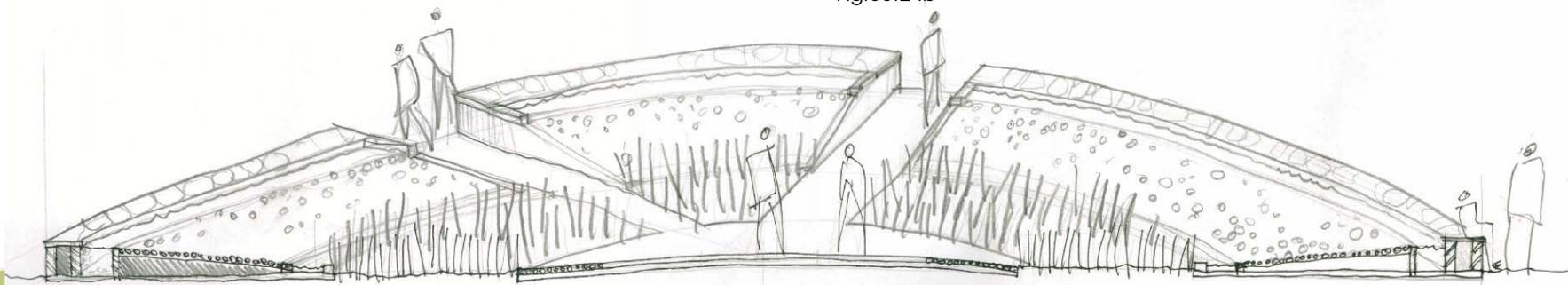


Fig.06.23b

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06.04.10 STAFF QUARTERS & LAUNDRY

The Staff quarters and Laundry are enclosed by stone walls and spill out onto an inner courtyard. The buildings comprise of mainly stone and as they are partly situated away from the other buildings it helps to integrate them into the landscape. Each of the 4 bedrooms has north facing doors and windows, and has smaller southern windows to facilitate natural airflow through the bedroom. The design makes use of the gable end (with 34 degrees pitch) roof structure to cover the total span of 8 meters.

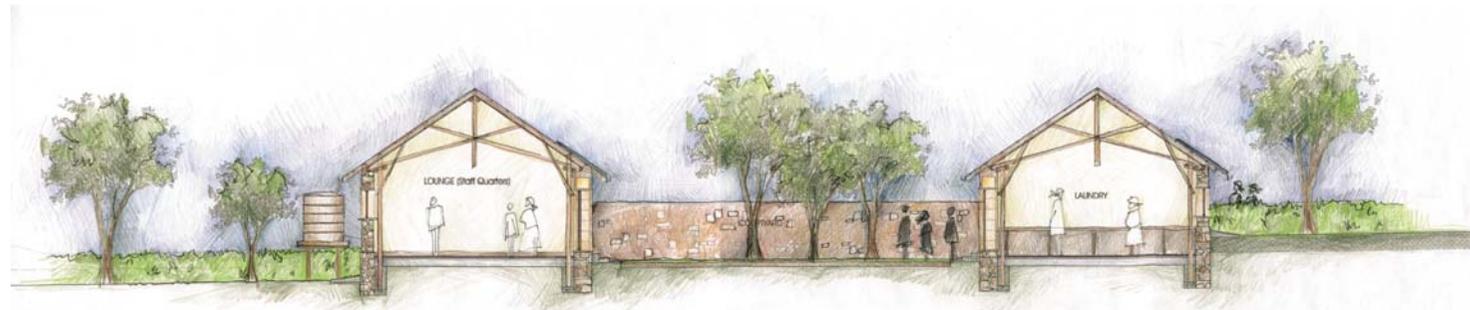


Fig.06.25

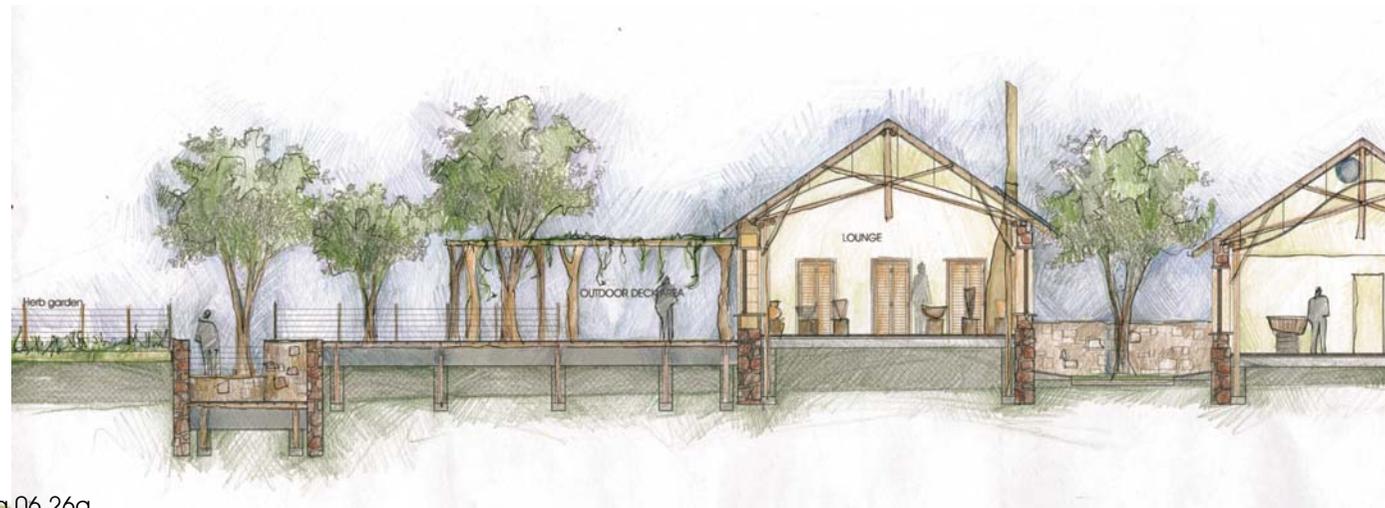


Fig.06.26a



Fig.06.26b



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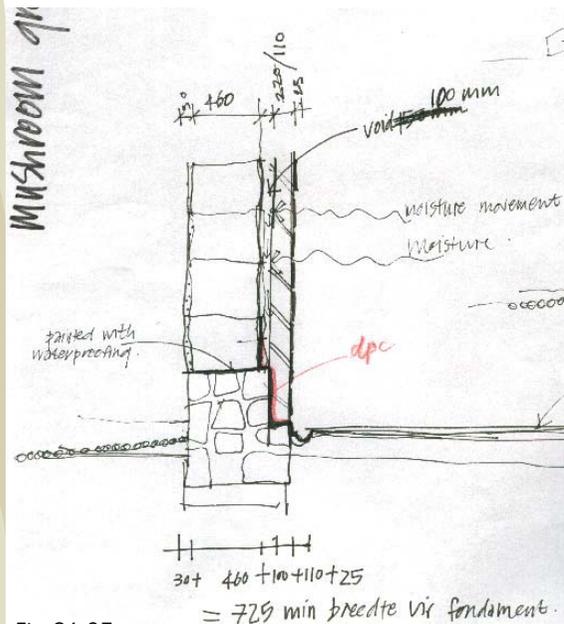


Fig.06.27

01.04.11 BASIC DESIGN OF MUSHROOM CULTIVATION AREA

The technical data required for the effective design of the various mushroom production buildings are contained within appendix xxx. The most important design aspect in terms of the actual structure of these buildings is dealing with the extremely high interior moisture content produced by the growing mycelium. Therefore, the walls and ceilings need to be constructed to be completely moisture-resistant. Conventional straw bale walls are prone to rotting when exposed to such high moisture levels. The solution is an additional brick wall placed on the inside of the straw bale walls onto which the tiles, which is the required wall finish, can be applied. A gap of 100mm is allowed for between the straw bale and brick walls to enhance the thermal insulation of the overall wall structure. Roofs are sloped to lead water away from the apex. This ensures that moisture collecting on the surface of the ceiling do not drip on growing mushrooms, but flows from the roof apex along the inside of the ceiling and brick wall until it eventually reaches the bottom of the wall where a dpc layer is carefully placed. Rammed earth floors are sloped at 2 degrees to drain water into small channels alongside the longest walls, which eventually lead water away from the buildings. Throughout, moisture makes no contact with the straw bale walls. The ceilings need to be sealed off to ensure that no moisture flows onto the straw bale walls and are therefore cut short to finish in line with the brick walls. The connection between the ceiling and wall is sealed off with a cornice and a fair amount of silicone. Another design aspect to deal with is the high level of insulation value needed within the growing rooms and laboratory. A straw bale wall has a very high U-value and is therefore an ideal insulation material. Placing an air void between the brick and straw bale walls will further increase the insulation properties of the overall wall construction.

To be able to carry the load of an additional 110mm brick wall, foundations have to be 725 - 750mm wide and stepped on the interior side of the foundation.

06.04.12 HIKING TRAILS

06.04.12.1 Mushroom trails

Various mushroom trails exist, on Madola and a number of other farms in the immediate surroundings. The availability of mushrooms on each trail is subject to weather conditions and therefore guests will be advised as to which trail to explore at certain times of the year.

06.05.12.2 Indigenous trails

The private development in the kloof area is concentrated around an indigenous arboretum. A trail is carefully planned around the 31 different indigenous species and tourists will take pleasure in visiting the individual trees. (Read in conjunction with Tabel 08.01 of Appendix 08.01.4)

06.04.12.3 Educational excursions

The development is planned to facilitate free movement between buildings and guests will be able to visit the various production areas on the farm. This includes a visit to the mushroom growing rooms and solar dryer and a guided tour through the Farm factory, where visitors will be informed exactly how farm products are manufactured, for example the manufacture of berry, mushroom and vegetable preserves, cultivation of wines and liqueurs, as well as cheese making.

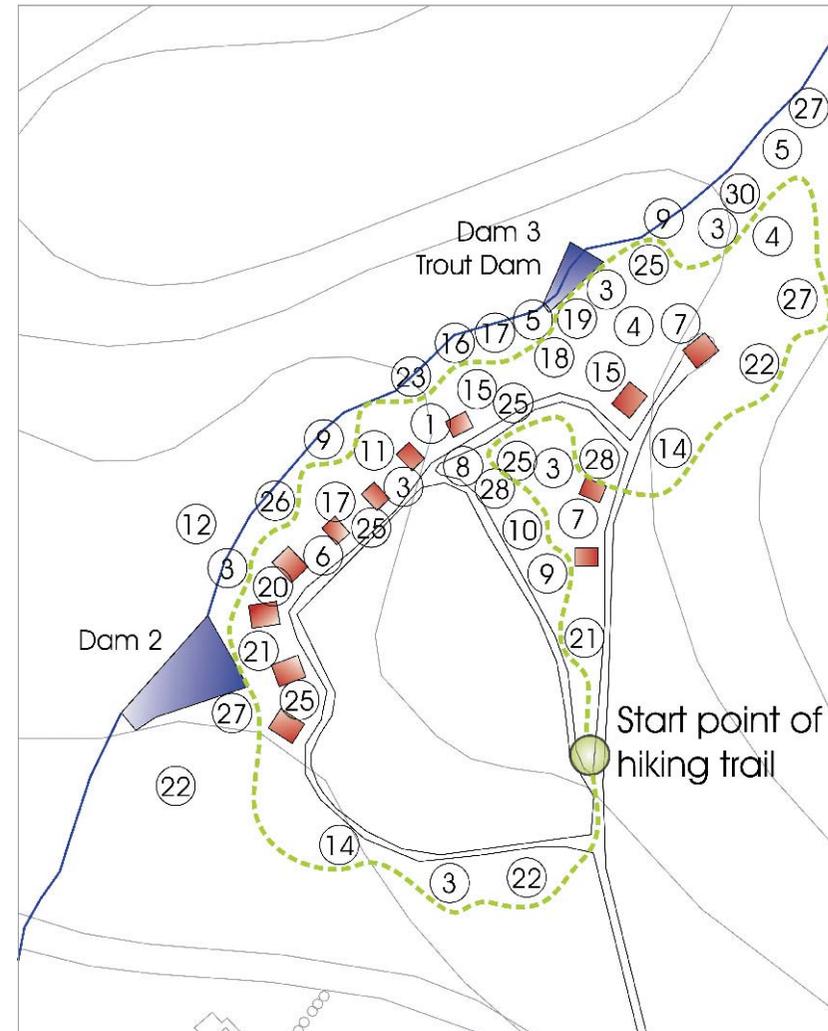


Fig.06.28