Restoration Report for Ujumbe Palace, Anjouan
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D R A F T
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Ujumbe Palace:

Ujumbe Palace is a two-storey 18th-century Sultan’s Palace situated within the old medina of Mutsamudu, in Anjouan. This building is of great significance historically – it was in Ujumbe Palace that important treaties and decrees (several abolishing slavery), accords with France, and agreements with the United States, were effected.

The building possesses architectural value as it is an excellent example of the 18th-century architecture of the town. The ground floor of the building was used as the Sultan’s private residence with reception space for visitors on the upper level. A skylight running down the centre of the building allows light and ventilation into the building. Externally, the building has large lime-washed walls decorated with patterns and punctured with beautifully crafted windows. A large carved door is located at the top of the stairs to the visitors’ entrance. Internally, the building possesses many examples of the high standard of craftsmanship used on the island during this period. The banaa/boriti (timber support beams) and ceilings are beautifully painted with Arabic script from the Koran. There are niches set in many of the walls, with one whole wall on the first floor completely covered with stucco niches.

Crucially, this building also demonstrates the evolution of construction techniques, integrating modern construction materials and styles with more traditional methods. For example, the walls of the building are constructed using coral stone and mortar with timber beams used to support the floors and roof – but this local building technique has been combined with the more contemporary use of steel beams to increase the size of rooms.

Currently this building is in a precarious state of disrepair and neglect. If not attended to urgently, this hugely important building will collapse resulting in the loss of a significant part of world heritage. This project would involve the restoration of one of the most significant buildings in Anjouan. Carrying out responsible restoration of this building would provide an important model, in particular by focusing on using locally available materials and enhancing the skills of local craftspeople to retain as much of the historical integrity of the building as possible.

Ujumbe Palace-Report:

This ‘draft’ report on the required restoration work for the Ujumbe Palace was compiled after a short visit to the site in December 2010. I have been fortunate to read the structural report produced by the structural engineer Mr Giuseppe Carluccio and the UNESCO reports by Pierre Blondin, which I have based this initial report on.

I would like to thank the School of Architecture in Lille for the use of their excellent drawings of the Palace, produced by their students. I would also like to thank all the members of the Patrimoine des Comores for all their assistance and especially Fatima Boyer.

Currently I am issuing this report as a draft because of the short amount of available time to visit to Palace building. I would like to complete a study of the building before I issue this document properly.
Analysis – Building’s Current Condition

Currently the building is in danger of collapse. Due to neglect the building has fallen into a bad state of disrepair and requires urgent attention. The roof slab is in good condition with few leaks but some areas of the slab to the first floor are hazardous.

Following a structural report and on-site advice by the structural engineer Mr Giuseppe Carluccio in 2010, a lot of shoring has been positioned in order to protect the building. Some areas of the floor do not have any support beams and if it were not for the addition of this shoring these would certainly fall and in turn could perhaps cause the whole building to collapse.

A portion of the building has already collapsed. The upper level of the front façade and the roof of the entrance stairs has given way, allowing the ingress of water into the building. This leads to the continued deterioration to the structure of the building and to some of the architectural features of the Palace.

Architectural features such as the timber panelling, windows and the timber supports beams have been damaged. The openings to the Palace have also been damaged and repaired badly with cement. Rain canopies over the openings are broken or weak with some canopies requiring to be rebuilt. The windows themselves seem in relatively good condition despite the years but restoration work is still required.

Analysis – Building’s Structure

Currently, the building suffers from neglect. The following is an observation of its structural condition. For a more complete structural analysis of the building a thorough inspection of the bori poles and areas of walls will be urgently required.

Foundations
According to local knowledge, many buildings of this period and style on the island were built with almost no foundation under the walls. It is therefore logical to believe that Ujumbe Palace is similar. Further examination is required to ensure that the foundation of the Palace is in good condition.

Walls
In Anjouan, buildings are constructed with coral stone bonded together with a large amount of lime mortar. Usually, the walls of the ground floor are thicker compared to that of upper floors but an average wall thickness is 60cm. The structural condition of the Palace walls is not good. The upper level of the front façade to the Palace has already collapsed. Several other areas of wall have become damaged by water and plants have begun to take root on the walls. If left without attention it will lead to the partial collapse of the building.
Analysis – Building’s Structure

Floor Slabs
One of the most important construction techniques in Anjouan is the use of mangrove (boriti) poles to support the stone slab. Before the availability of iron materials, all buildings were constructed with mangrove poles. Boriti poles typically span a room no wider than 3 metres. In the Palace, this technology has been used with iron materials to increase the width of the room.

It is also worth noting that some of the original support beams and timbers from a section of the ceiling are no longer present. This is a serious hazard to this building and the neighbouring buildings. The floors of the rooms adjacent to the original main body of the building were constructed later using timber boarding.

Roof Slab
The thickness of the roof slab is 80cm as several additional layers of coral and mortar were built one upon another. This is an extremely heavy load for the building to be supporting.

Openings
There are two types of openings in the building – openings for doors and for windows. Door and window openings have been damaged by weathering and neglect. There are no vaults or arches with the building.

Work urgently required to secure the Palace from collapse:

- Removal and reconstruction of the roof deck
- Rebuilding of masonry to front façade
- Introduction of a ring beam to tie existing structure
- Upgrade of the wall coatings (internal & external)
Restoration of the Palace Structure
Restoration Work:

This restoration project should be considered in three parts:

- securing the Palace from collapse
- restoration of the Palace
- application of the proposed function

The condition of some areas within the Palace especially at the rear of the building is unknown, and a more extensive study must be done. For this reason and the fact that the building is in such a state of disrepair, unforeseen problems may occur. Because structural problems and water damage can be hidden initially, the restoration of old buildings is typically difficult to anticipate.

Many architectural details and features that existed within the original Palace have been damaged or destroyed and therefore need to be restored or replaced. Any existing information regarding the Palace building, photographs, drawings or text need to be studied so that the restoration is in keeping with the original Palace architecture. Studies of similar buildings and architecture on the islands and elsewhere should add to the general understanding.

Several architectural features within the Palace must be protected during the restoration work so that any further damage to these features can be prevented. Features such as the stucco niches and the painted timber panelling must be protected.

Input from the structural engineer is very important, especially at the beginning of the project. On-site advice and recommendations need to be discussed with the engineer prior to each new trade.

No machine tools should be used on site. This may change over the course of the restoration but due to the vibrations caused, these tools are too dangerous to use. This will also be in keeping with the type of construction methods originally used.

Prior to each new trade or section, a meeting will be held between parties involved to discuss how best to approach this. The logistics of the process need to be discussed, with regard to the storage and handling of the building materials, construction methods/techniques involved and the tools required.

The craftspeople working on the restoration of the Palace must have an appreciation for the work they are doing and must follow the instructions of the architect, engineer and site supervisor involved.

Environmental issues, such as the dumping of waste rubble and the sourcing of suitable timber need to be resolved. Contractors involved with the project must submit all documentation proving the source of certain materials. Also their intentions, for example, on where they intend to dump waste from the project need to be agreed. Mutsamudu has some problems with the amount of rubbish being currently dumped on the island and the project should not add to this growing issue.

The restoration of the Palace should also include a redesign of the stairway to the Friday Mosque so as to create more space between the buildings. This will also provide more suitable access to the mosque.

Clarification should be sought from UNESCO regarding certain parts of the restoration to ensure the correct method and materials are being used. For structural reasons it is no longer advisable to restore the Palace using solely traditional techniques. Structural stability needs to be reintroduced into the building but the architectural style and character of the Palace should still be evident.
**Ground Floor:**

- Face of walls badly damaged, cracks in showing structure.
- Planting has taken root within walls.
- Lime mortar is badly damaged.
- Niches to be protected during restoration works of structure.
- Area between the Palace and the Friday Mosque to be redesigned to allow space for each building.

**First Floor:**

- Front façade wall to be rebuilt.
- Face of wall badly damaged, cracks in showing structure.
- Planting has taken root within walls.
- No protection to top of the wall from weather.
- Lime mortar is badly damaged.
- Niches to be protected during restoration works of structure.
- Timber carved entrance door requires restoration.
- Existing windows need to be restored and replaced where required.
- New windows to be manufactured for new front façade - windows to match existing.

Entrance to site to be secured.

Entrance to site to be secured.

Facade has collapsed and requires to be rebuilt.

Remove door and store prior to repair.

Repair existing timber windows to this facade.

Shaded area covered with asphalt - to be removed. New finish with slope to be applied to this area.

Niches to be protected during restoration works of structure.

Niches to be protected during restoration works of structure.

Side entrance.

Area between the Friday Mosque and the Palace needs to be re-designed.

Niches to be protected during restoration works of structure.
Ground Floor-Reflected Ceiling Plan:
The current condition of the timber beams [banaa] to be surveyed and a number of the support beams replaced if required.

First Floor-Reflected Ceiling Plan:
Timber beams [banaa] do not exist in 2 areas. Timber beams and slab to be replaced in these locations.
Ground Floor Plan:

- Face of walls badly damaged.
- Planting has taken root within walls.
- No protection to top of the wall from weather.
- Lime mortar badly damaged.
First Floor Plan:

- Front façade collapsed-needs to be rebuilt.
- Face of walls badly damaged, cracks showing in structure.
- Planting has taken root within walls.
- No protection to top of the wall from weather.
- Lime mortar and pattern feature are badly damaged.
- Timber carved entrance door requires restoration.

- Restore canopies above windows to East facade.
- Restore timber windows to East facade.
- Dotted lines indicate position of skylight.
- Façade has collapsed and requires to be rebuilt.
- Replace timber windows to new facade.
- Front Façade to be rebuilt following collapse.
Roof Plan:

Roof over entrance stairs do not exist.
Roof thickness = 80cm. Dangerously heavy for structure.
Parapet wall is badly constructed-reconstruction required
Ring beam needed to tie building together.
The ingress of rain-water has damaged the building’s structure. Portion of wall on first floor to be reconstructed. Plants and algae on the building’s walls to be killed and removed. Lime mortar finish to walls is badly damaged and needs to be removed and a new finish re-applied.

Façade has collapsed and requires to be rebuilt.

Parapet wall to be removed and rebuilt.

Area between the Friday Mosque and the Palace needs to be re-designed with new stairs to the mosque.
**South Elevation:**

The roof thickness is approximately 80cm and therefore extremely heavy. This is the result of additional layers of mortar and stone being added over the years.

For structural reasons this roof slab should be removed from the Palace. This will require dividing the roof into sections and breaking the roof slab one section at a time. When one section is broken the rubble removed. If the complete roof is broken at the same time this could cause the building to collapse. When one section is removed that portion of roof is constructed. This will continue until the complete roof is replaced.

This is difficult work and will require to be carefully completed so as to ensure that the work is structurally satisfactory.

It will also require that the work be carried out and completed in a safe manner. Some of this rubble may be possible to be used elsewhere in the restoration, but the remainder will be required to be removed from site. This will involve the removal of large amounts of rubble through the medina. A suitable location for this rubble to be dumped will need to be chosen so that there are no environmental issues with completing this restoration.

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Roof area showing the skylight running down the center of the Palace, the thickness of the roof slab and the later addition to the Palace on the left of the picture.

The construction of this later addition of the main body of the Palace building was completed 19???. This portion of the building is badly constructed and should be removed. This will also allow for greater access to the roof during the reconstruction of this roof slab. It will also allow for the scaffolding to be positioned closer to the main body of the building.
West Elevation:

Face of wall badly damaged, cracks in structure require to be filled.
Plants and algae on the building’s walls to be killed and removed.
No protection to top of the wall from weather.
Lime mortar is badly damaged
Timber carved entrance door requires restoration.

Walls badly damaged from cracks and poor repairs. Parapet wall should be removed and rebuilt at the original height.

Remove door and store prior to repair.

Entrance to site to be secured.

West Elevation
East Elevation:

Portion of wall on first floor to be rebuilt.
Parapet will require to be removed and rebuilt.
Cracks showing in structure of wall require to be filled.
Openings require restoration following previous repairs using cement.
Timber windows require restoration. 1 no. window missing.
Plants and algae on the building’s walls to be killed and removed.
Lime mortar finish to walls is badly damaged and needs to be
removed and a new finish reapplied.
Patterns visible in mortar require restoration work.

Walls badly damaged from cracks, salts and poor repairs. Parapet wall
should be removed and rebuilt at the original height.

Restore existing timber windows and canopies above.
Cement plaster around windows to be removed and lime mortar finish applied to
wall.

Existing patterns on face of wall to be repaired.

Façade has collapsed and requires to be rebuilt.
New windows to front façade to be drawn and manufactured to match existing.
Vertical crack requires to be tied together with horizontal stitching.
Area covered with asphalt - to be removed. New finish with slope
to be applied to this area.
Vertical crack requires to be tied together with horizontal stitching.

Wall with visible crack and cement render finish.
Restoration of the Palace floors
Procedure for replacing boriti

The task of replacement is a difficult one as it is necessary to fit the pole between its two neighbours. To obtain the maximum length, the pole is offered up diagonally between the ones either side. It is then straightened into a position parallel with its neighbours and a small amount at each end located in the wall. Replacing poles in this way inevitably causes the new poles to be significantly shorter than the originals. As more poles are replaced so the quality of available restraint diminishes.

It is very important that as more boriti are replaced restraint is not lost. Although it is not possible to fit poles any longer than the diagonal between the ones on each side, it is possible to artificially increase the quality of restraint afforded by short poles. This is done by fitting specially manufactured brackets to the ends of replacement boriti.

\[
\begin{align*}
A &= \text{Length of original boriti.} \\
B &= \text{Maximum length of new boriti.}
\end{align*}
\]
Procedure for replacing floor slabs

It is not safe to remove the complete slab at one time. Floor slab must be removed & replaced in sections. Each new section should have a male or female dovetailed key cast into it so that it locks into the next section when it is cast. It is best if sections are not removed and replaced one after another all along the floor, instead replace them on a rotational basis. This will allow freshly cast sections to cure slightly before the one next to it is removed. This approach will avoid areas of weakness developing.
Reconstruction of Roof, Floor-slab & Front Façade
Existing Roof Slab

The existing roof slab thickness is 80cm. This is because several layers of coral and mortar have been added to the roof slab over the years increasing the thickness. Unfortunately this has become very heavy and therefore structurally dangerous.

This roof should be carefully removed and replaced with a lighter RC roof slab which would also give extra structural stability to the building.
Reconstruction of Roof Area

The existing roof thickness is 80cm and therefore very heavy for the original structure. The roof of the Palace will require to be replaced. This can be constructed with a much lighter roof of RC concrete poured on a traditional construction of timber support beams with coral stone laid between.

This new re-enforced concrete roof will connect to a ring beam running around the entire perimeter of the main body of the Palace building. This will provide strength to the existing structure of the building. An up-stand beam will form the side of the skylight. Visually the appearance of the completed roof and ceiling will look correct.
Reconstruction of Front Façade

The front façade of the Palace requires to be rebuilt. Due to the difficulties of tying the new and old structure together, re-enforced concrete must be used. A concrete beam will be cast at the base of the new wall with concrete columns used to tie the structure together. Between the concrete columns the traditional wall construction of coral and mortar can be used and a lime wash mortar applied to the complete face of the wall.
Reconstruction of the floor slab

The first floor slab will need to be replaced in areas. This can be reconstructed using concrete, on the traditional construction of timber support beams with coral stone laid between.
Reconstruction of Front Facade

Existing coral and clay wall construction.

Exterior

Floor Level

Section

Floor Level

Section
Reconstruction of Front Façade

The front façade of the Palace requires to be rebuilt. As there are no existing drawings of this façade, these drawings will require to be prepared prior to construction.
Reconstruction of Front Façade

Re-enforced concrete columns used to add strength to the structure. Between the concrete columns the traditional wall construction of coral and mortar can be used and a lime wash mortar applied to the complete face of the wall.
Reconstruction of Front Façade

At the top of the front façade a ring beam will wrap around the existing perimeter of the structure. The roof over the visitor stairs will require to be replace.

PROPOSED FRONT FACADE - ROOF PLAN
Restoration of existing walls
Method for grouting cracks in walls:

1. **Setting-up:**
   Mark out a 30 x 50 cm grid on the wall. Starting at one end of the bottom line in the grid, begin to drill neat holes approx. 2 cm in diameter.

2. **Cleaning:**
   Flush free the holes of debris by pouring in water. It is important that flushing is thorough as small fragments of mortar and stone can easily block access to smaller parts of the void. Grout is poured through a simple piece of equipment made from a large funnel and piece of hosepipe.

3. **Pouring:**
   Pouring begins in the second level of holes and ideally continues in the one site until grout comes out from the hole beneath. In reality, void systems can be complicated such that grout may begin to flow from a site many metres from the point of entry. It is essential that entry points are kept open and do not become obstructed, preventing the ingress of further grouting material.

4. **Sealing:**
   To keep the grouting hole open it is necessary to pour only small amounts of grout followed immediately by an almost equal amount of water. Pouring should not be continuous, short pauses are taken to allow air to escape and allow grout to spread. If the weight of liquid grout within the wall becomes too great there is a danger of damage. Grouting should continue from each site until refusal, at which time the hole is sealed and work begun on the next. Occasionally a slightly higher pressure is required to force grout into fine or remote cracks. Sufficient pressure will be generated by erecting a scaffold and pouring the grout from a height of four or five metres.

   Once the wall is grouted it should be left to cure for two weeks.

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Section of wall showing internal cracks and voids. These can be filled and the wall strengthened by fillings these spaces with grout. This is done using simple equipment made from a funnel and a piece of hosepipe.
Restoration of Lime Mortar Finish

It is likely that the wall will be contaminated with salts, in which case rendering the without treating the problem, the repair work would quickly fail. To re-render externally without first renewing or repairing gutters and down-pipes would also be a mistake as gutters and down pipes protect the render.

Testing is a very simple matter. The surface is lightly tapped with a small section of iron rod. If the sound produced is hollow the bonding between coats is poor. If there are only isolated areas that sound like this, the render is in good condition and can be kept. If, on the other hand it sounds hollow all over, it would be best to replace it.

If the wall surface is very badly eaten away, it will need more than just re-rendering; some attempt must be made to desalinate it as it will be contaminated with salt.
Desalination:

The only sure way to remove salt is to remove as much as possible of the material that contains it.

1. The first step is to cut away all the damaged render right back to the large corals forming the walls. If the mortar between the corals is not firm and solid, this should also be removed.

2. The surface of the wall is next saturated with clean drinking water and apply a rough render whilst the wall is still wet. A rough render consists of a coarsely broken porous aggregate mixed with a lime binder. The traditional mix of 1:3 is normally used. It is not necessary to use expensive good quality lime; ordinary hydrated lime will do. The aggregate can be any broken up coral with a good range of particle sizes. The mix is quite wet and should be thrown against the wall to ensure contact.

3. It is the job of the rough render to draw salts out of the masonry. The water applied to the wall will soak into it and on its way, dissolve much of the salt in its path. As it does so, it will carry its charge of salts along with it. The rough render will act as an extension to the wall and the water and salt will move on through it to the surface. There, the salts will be concentrated.

4. When quite dry, the salt infested render is removed and cleared away from the site. It is important that the rough render does not get wet after it has dried and before it is removed. If rainfall is allowed to saturate it, there is a danger that salts contained in it will be washed back into the wall.

5. When the process is completed the salt content within the masonry should be much reduced. If rising moisture is not present the treatment should be a permanent cure, assuming the re-rendering is well done and when complete is maintained.
**Wall Coatings:**

The work to remove the existing old plaster from the walls is very important and must be completed correctly so that the newly applied finish will grip the existing wall construction. This coating will be a lime plaster which will allow the wall to breathe. The finish is to be applied in 2 coats. The first coat averaging 5-10mm thick whilst the finishing coat between 20-30mm.

In areas where the wall has been damaged from salts due to water ingress, these salts should be properly removed first and then the finish can be applied.

All cement plaster should be removed from the walls.

**Internal wall finish:**

The existing lime mortar finish applied to the walls should be removed. It is badly damaged by water ingress and any crack can be clearly seen and repaired. Examples of the finish must be prepared and approved by the site supervisor before completing the process.

**External wall finish:**

The existing lime mortar finish applied to the walls should be removed. It is badly damaged and a more consistent finish is possible. Also, a better understanding of the wall structure is possible as any crack etc. can be clearly seen and repaired confidently.

A patterned frieze that can be seen on the East façade must be restored so as to continue around the building. Examples of this process must be prepared and approved by the site supervisor before starting on the Palace walls.

The mixture of pigment with plaster will produce a coloured plaster which may be the material used to the East façade. Tests will need to be done and the final colour agreed.

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**Removal of rusting iron, etc.**

The size and extent of the metalwork will dictate the precise details of removal but regardless of size, the principles will remain the same.

As far as possible, the fitting should be drilled out using a non-percussion drill so as to avoid vibration damage to the delicate bond between coats of render and masonry substrate. Holes are drilled at close centres around the outside of the metal, it is then gently tapped with a light hammer and gradually worked free. Should the feature be set deeply, it may be necessary to continue excavating the holes begun with the drill by hand. For this purpose a special chisel called a *quirk* is useful. The special fish tail shape of the tool will permit very deep excavations with no damage to surrounding work. Once the metalwork is removed, the cavity in the wall is filled with mortar and small stones to the wall surface. When all shrinkage has ceased, the patch repair may proceed.
Protection of Architectural Features: Timber
Timber Beams:

A lot of the restoration work is required for the existing timber beams. Internally a lot of the timber beams are damaged due to the ingress of water and humidity. These will require to be replaced.

Raised roof providing light and ventilation to the building.

Painted timber beams. Some of these beams have been damaged by the ingress of water and humidity. These will need to be replaced.

Exposed painted timber lintels above internal openings. Some of these lintels may require to be replaced.
Timber Repairs:

In historic buildings, it is always better to retain as much of the original historic timber as possible. Where the original is covered in fine carvings, the reason for this is obvious. But even if the timber piece is quite plain, it will have a character that comes from age, which is impossible to reproduce.

Similar timbers:

It is best to determine the species of the timber to be repaired and to use the same species for the replacement piece. Never use softwoods such as cypress to repair hardwoods. The repair will always fail.

Appearance:

If the timber element is to be finished with a clear finish such as teak or linseed oil, an effort should be made to match the appearance of the new timber piece (e.g. colour, grain pattern, etc.) with the original.

Grain:

When carrying out repairs by plugging, or repairs that in any other way involve letting-in and mating pieces of new timber to original joinery items, it is essential that the direction of the grain of the repair is the same as the direction of the grain of the surrounding original timber. When making new members for joinery items, the grain direction of the new member must be the same as the original member.

Strength:

The strength or rigidity of a joint must not be altered in any way as a result of a repair. Where joints have originally been left open to allow for movement, or fixed without glue or mechanical fastening, these must not be strengthened during the course of the repair by the addition of glue, mechanical fixings such as screws, or by any other method. Generally, care should be taken to make joints that are not too rigid or strong, as movement is inevitable, and if a joint is inflexible, the stresses will be transferred to the timber, which, if old and brittle, may crack.

Repair in-situ:

It is generally better to carry out repairs to timber in situ, or in other words, whilst the timber element remains in its original position. This is because removal usually results in more unnecessary damage both to the timber and to the buildings around, and if an element is disassembled for repair, reassembly once the repair is complete is very difficult and usually shows. When carrying out structural repairs, the same principle applies, although great care must be taken to ensure that the structure is properly supported and prevented from collapse before repairs begin.
Timber Doors & Windows:

There is a large Swahili type door to the entrance of the building. This door is in a bad state of disrepair and should be removed from site and stored elsewhere. Once removed from the building it is easier to restore the existing door.

There are a number of existing timber windows situated to the East façade of the building. These are beautifully made and should be carefully restored.

Externally the rain canopies above the windows are damaged. The timber fretwork to the windows appear in relatively good condition but will require some restoration work.

Large carved timber entrance door.
Replacing boriti lintels:

Boriti lintels are weak and prone to rot and bend. As this occurs, the masonry in the wall above subsides and cracks. This type of action can give rise to knock-on effects in neighbouring parts of the building. These features are very important and must be preserved. They must not be replaced in concrete because they add a great deal of character to rooms and are part of the historic structural system.

Placing boriti and building the arch:

With the wall supported, and defective masonry and rotted boriti removed, reconstruction and installation of the arch can begin.

1. New boriti should be selected and fitted in the same location as the originals. They should match as closely as possible in terms of size and general shape. New boritis should be firmly bedded on a 1:3 lime mortar and the spaces between bridged with small pieces of coral and mortar in the traditional way. Allow two or three days for the mortar to harden and construct a simple centring immediately on top of the boriti.

2. The centring is the formwork around which the arch is constructed. It is required because the arch will not stand until it is in compression and at least one ring or layer of stones or bricks is completed.

3. The cheapest and simplest way to form the centre is to use pieces of very light white coral to form a segmental shape. This should resemble the top of a very large circle. For an opening 2m wide the hump should be about 400mm tall in the middle. The centring is constructed along the full length of the lintels. It is important that the stones or bricks in the arch are not seated on the boritis. The arch, when complete must rest at either end on masonry. If it sits on the timber it will fail if the timber rots.

4. Once the centre is in place the arch is built around it. Although it is possible to build the arch in coral it is easier and will involve less labour to use fired brick. The bricks or coral, should be arranged around the centre by adding a course to each side alternately. They are laid in a bed of 1:3 lime mortar and the last bricks to go in should be in the middle and the joint vertical. If bricks are used they should be arranged as headers set on their sides, as this will minimise joint thickness. A minimum of four rings is required to protect a two-metre opening. When complete, the arch must be left for as long as is practical before continuing construction above it. The centring remains in place and forms an in-fill between the timber lintel and arch. When the arch is complete it will carry all of the weight of the wall above the opening.

Expressed timber lintel to internal door opening.

Centring formed by using light coral pieces on new boriti.

Bricks or coral are arranged around the centre adding a course to each side alternately. Bricks are laid in a bed of 1:3 lime mortar. The last bricks should be in the middle of the vertical joint.
ADHESIVES FOR JOINERY WORK

External (Joinery exposed to moisture)  
**Aerolite 306**, manufactured by The Kenya Swiss Chemical Company, E. Africa (Nairobi).

Internal  
**Ponal-3**, manufactured by Heinkel, E. Africa (Nairobi).

ADHESIVES FOR STRUCTURAL TIMBER

External & Internal  
All adhesives used for load-bearing structural timber work, to be Urea-formaldehyde type, to BS 1204 PART 1;

- **Aerolite 306**, manufactured by The Kenya Swiss Chemical Company, E. Africa (Nairobi)
- **Resorcincol**, available in Nairobi
- **Aerodux 185** by Ciba-Geigy (Novartis)

**Urea-formaldehyde** glues are both strong and highly resistant to moisture, but they are also expensive, and so it is recommended that they be only used where a joint is load bearing or is likely to be in contact with moisture, and lower specification glue used elsewhere. It should be noted that Urea-formaldehyde glues are usually two-pack, which means that the two ingredients must be mixed up on site in order to make the adhesive. Once mixed, two-pack adhesives must be used immediately, and cannot be stored in its mixed state.

**Note:** We do not recommend the use of organic wood glues (e.g., casein glue which is milky-white in colour), as these tend to quickly deteriorate when exposed to moisture. A wood glue called Woodfix is commonly; however, our tests showed that this glue failed when saturated. In particular, NEVER use casein glues such as Woodfix for structural repairs.
Timber Panelling:

Painted timber panelling exists between the beams supporting the floors. This panelling contains Arabic script from the Koran. The panelling has been discoloured and damaged over time. The correct patterns and colours need to be appreciated prior to the restoration of the features.

As it is required to replace some of these panels and because of existing damage, this script will require to be replaced. There will be a mixture of newly replaced panels and re-worked existing panels there is a requirement that some of the work will need to be completed in position. This work will require a specialist.

The complete painted ceiling will require to be carefully photographed first, to ensure the new painting will replicate the existing. A better understanding of this designs, colours and script used, should be determined with ‘test’ examples of the panels produced and examined first.
Protection of Architectural Features: Wall details
East Facade: Detail of window.

- **Existing rain canopies to be repaired or restored depending on damage.**
- **Wall to be rebuilt using the traditional method of coral stone and mortar.**
- **Repair existing timber windows.**
- **New windows to front façade to be manufactured to match existing.**
- **Cement repairs around window to be removed and a lime mortar finish applied to complete wall.**
- **Pattern on wall to be repaired and restored.**
- **Existing timber windows to be measured and drawn so as to re-produce these windows for the new front facade.**
- **Pattern on wall to be repaired and restored.**
- **All plants to be killed and then removed from structure of building.**
Wall Details:

Stucco: In the past, plaster was also used to decorate walls with intricate patterns and designs. When used in this way mortar is called stucco. Some of the walls to the Palace building contain excellent examples of stucco niches. Some of these have become damaged, by the ingress of water, from fire and neglect. These niches will require to be restored to their original condition. This is specialist work and if done incorrectly can cause a lot of damage to these existing features.

Patterns on the internal wall finish: Details of these needs to be photographed and protected during the restorations work. There are also wall details and patterns that have been lost and no longer exist in the Palace currently and therefore need to be replaced. Studies of similar buildings and architecture on the islands and elsewhere should add to the general understanding of the Palace.
Workshops and required information
Workshops & Specialists:

Workshops showing restoration techniques are required so that locals can be trained in the skills required to complete this type of work. Contact has already been made with ‘fundis’ in Stone Town, Zanzibar and depending on funds, a variety of workshops can be organised.

A workshop in the restoration of timber and the use of lime mortar are required. These should include the restoration of the timber beams, panels, windows and doors. These workshops must be carefully organised so that the people involved get the most out of the time and also are in a position to teach other. Some parts of the workshops should filmed so as to be discussed or kept for future reference.

These workshops should also include an understanding of the architecture and construction techniques used so that there is an overall appreciation for the building by those working on the restoration.

Specialist work is required for certain elements within the building. The painted script to the timber ceiling is one area that will require a specialist.

Test examples of certain parts of the restoration will be required. ‘Mock-ups’ of area and details to show and test materials, finish and strength of materials.

Drawings & Information:

Prior to starting on-site

- A survey of the existing building will be required to be prepared. Following this, a complete set of construction drawings will be required for the entire building.
- Accurate drawings showing the positions of windows and door openings, size and position of supports and levels of of floors need to be prepared and checked.
- Construction Details: eg. lintels to existing windows and proposed beams to slab.
- Drawings of the new windows to match existing windows.
- Programme of works showing the order and expected date of the different trades.
- Tender packages for different parts of the restoration will be required.
- Research into a variety of different materials and techniques will be required.

At a later date

- Drainage layout drawings will be required for the Palace.
- Electrical layout drawings for the building.
Specification Document:

A specification document should be prepared for this restoration project. Due to the complexity of the restoration, the limited space on site and the requirement for safety to those working on site, this document must include these items.

- Safety of Personnel
- Cleanliness on site
- Delays to the project
- Quality of the completed works
- Environment
- Removal of waste from the site
- Protection of the building and the workers from the weather
- Preparation of examples.

Tenders:

The restoration will be split up into different packages so that for each section of the restoration, a tender submission will be required.

Tenders must include a break-down of all costs for materials used and a programme of time to complete the works. A tender submission without this information will not be considered.

Tenders must be confidential and must be submitted on time or else it cannot be considered.

The contractor involved should provide examples of completed construction or restoration work that can visited.

Conservation and Maintenance Plan:

The Conservation and Maintenance Plan identifies the requirements for the conservation of the project and sets guidance for the continued maintenance of the building.

For the plan to be sustainable, it needs its own financial mechanism. For this reason, the idea of establishing commercial spaces and services in the building to generate funds for its future maintenance might be advantageous.

It is for this same objective that the idea of creating a management team for maintenance is proposed.
Comments & Notes on the Palace Project
Site Preparation:

Prior to any reconstruction work to commence, a temporary structure should be constructed to protect the building. The structure must provide adequate protection of the Palace from water etc. A drainage system should be incorporated into its design to ensure that the rainwater can be directed away from the building.

The building will require to be be secured so entrance to the building is only by those working on the restoration.

Storage facilities for the materials is required as there is very limited space on-site.

Health & Safety:

Helmets [hard-hats] must be worn on site at all times. This is the responsibility of the contractor to ensure that his workers have the proper protection to do the work required safely.

Safety harnesses must be used when working at a height at an edge etc.

No structural supports or elements of shoring should be removed or changed without speaking to the engineer or site supervisor first.

No building work should continue without it being discussed and fully understood first.

Access to and around the site must be secured at all times.

Scaffolding is required for restoration work to the roof and the first floor. This must be self supporting and must not connect to the existing structure of the building.

Areas that require protection from the sun should have temporary timber structures built with canvas covers to provide shade to those working beneath. This structure must not be fixed in a way that will cause damage to the existing building.
Materials:

Getting materials to site at the correct time is very important with this project. A meeting prior to the commencement of re-construction should be held so as the availability of materials and the timescale required to get these materials to Anjouan can be discussed.

Timber:
Due to environmental protection laws hard wood will require to be imported from Dar es Salaam, United Republic of Tanzania.

The moisture content of timber is important as it will effect the ability of the timber to work in its location. All timber sourced must have the correct moisture content.

Steel:
New steel will need to be ordered from Dubai. The delivery time to get this to site will need to discussed first and a suitable location to store this material prior to installation. The grade [quality] of the steel will need to be specified depending on the use. No steel must be in contact with lime as the lime will cause the steel to degenerate.

Concrete:
Concrete will be required to be used for several area of the construction. The mix and the quality of the sand and water is essential for good strength concrete.

Coral Stone:
For environmental reasons coral stone is no longer available on the islands.

The collapse of the vestibule has recovered a large quantity of stones. The coral stone will be set aside and reserved exclusively floors. Depending on their size, the volcanic rocks serve as reserve materials needed for the restoration work. In each case, the layout of existing masonry will be studied before to make additions. The aim will be to bring the best of the existing unit, using stones of similar shape and size.

There may also be the possibility of using lime stone in areas depending on the availability of this material. For structural reasons large flat stone would be suitable.

Water:
Freshwater must be used for all construction work. Sea water is not suitable for purpose.

Lime, Lime mortar & Lime Plaster:
Lime is currently unavailable on the island and will have to be imported for the restoration work of the Palace.

A frequent source of confusion regarding lime mortar stems from the similarity of the terms hydraulic and hydrated. Hydrated lime is any lime other than quicklime, and can refer to hydraulic (hardens underwater) or non-hydraulic (doesn’t harden underwater) lime. Stored lime putty is always non-hydraulic (since hydraulic putty sets quickly after mixing) and, as the name suggests, lime putty is in the form of a putty made from just lime and water.

Non-hydraulic lime is primarily composed of calcium hydroxide (generally greater than 95%). It is produced by first heating sufficiently pure limestone (calcium carbonate) to drive off carbon dioxide to produce quicklime (or calcium oxide).

Lime mortar is made principally of lime (hydraulic, or non hydraulic), water and an aggregate such as sand.

Hydrated non-hydraulic lime can be mixed with water to form lime putty. Before use it is usually left in the absence of carbon dioxide (usually under water) to mature. Putty can be matured for 24 hours to many years, with an increased maturation time improving the quality of the putty. It is generally agreed that putty at the time of slaking is preferable as the quality of the material is better. A hydrated lime will exhibit longer carbonation periods as well as lower compressive strengths. Therefore a good material to be used as lime mortar.

Lime plaster is type of plaster composed of hydrated lime, sand and water. It is sold as 'bagged' powder or hydrated lime; or is available as lime putty. Lime putty generally being considered more suitable for pure lime application. Non-hydraulic lime is the most commonly used and known lime, also called (high) calcium lime or air lime, as it sets only by reaction with CO₂ in the air and will not set until dry. This causes limitations in construction use as the lime can remain soft for months or years. Non-hydraulic lime can only set through carbonation (re-absorption of CO₂). Hydraulic lime and hydrated lime must not be confused. Hydrated lime is merely a form in which lime can be supplied (as opposed to quicklime or lime putty); while ‘hydraulic’ refers to a water resistancy characteristic of the lime

Lime wash:
At its simplest, lime wash is very finely sieved lime putty in an excess of water. The basic wash, however, is not durable and will dust off easily. To prevent this, it is possible to add a variety of materials or binders. Unfortunately, most of them are proteins and very quickly encourage mould growth in the wash, especially on exterior walls. In tropical climates like Anjouan, it is not easy to recommend an additive that will prevent dusting and not encourage mould growth.

A very effective binder for use indoors is water in which seaweed has been boiled. The liquid is allowed to cool and form a sticky gelatinous mass. Before use, it is thinned with boiling water and put through a fine sieve. Approximately half a litre of liquid is added to 20 litres of wash. For use outside, common salt is perhaps the best choice although this must not be used if the render is of significant historic value. Approximately half a kilo of salt is added to four gallons of wash.