*Annex 13 of the Operational Guidelines*

United Nations Educational, Scientific and Cultural Organization · World Heritage Convention

**FORMAT FOR THE SUBMISSION OF STATE OF CONSERVATION REPORTS BY THE STATES PARTIES**

***GOVERNMENT OF ETHIOPIA***

**(in compliance with Paragraph 169 of the *Operational Guidelines*)**

**Name of World Heritage property (State(s) Party(ies)) (Identification number)**

## 1. Executive Summary of the report

*[Note: each of the sections described below should be summarized. The maximum length of the executive summary is 1 page.]*

**Name of World Heritage property (State(s) Party (ies)) (Identification number)**

**Rock-Hewn Churches, Lalibela (Ethiopia)**

**Date of Inscription: 1978**

**Criteria:** (i)(ii)(iii)

**Ref:** 18

This report is submitted in response to the World Heritage Committee **Decision (44 COM 7B.118)** in its 44th regular session (Fuzhou, China/Online, 2021), which requests the State Party to submit a State of Conservation Report to the World Heritage Committee to review the Status of the Rock-hewn Churches of Lalibela world heritage property.

The State Party of Ethiopia was expected to submit (Paragraph 9) the Final Preliminary Design of the chosen architectural solution and the detailed restorations plan; and the results of the environmental and social impact study including the heritage impact assessments as well as the reports of additional studies (geotechnical, hydrological and other studies deemed necessary) based on the recommendation of the Scientific Committee.

However, the conflict in the northern part of the country together with the occupation of Lalibela for six months did not allow us to explore and deepen the studies as wished. Therefore, detailed restoration designs, proposed for the four covered churches, will be annexed to this report (see also Annex 1: Basic Pre-Project Study).

Therefore, this report contains the summary of some outstanding requests stated in the decision, submitted for considerations by the World Heritage Committee at its 45th Session to be held in 2022. The progress report further contains additional information concerning the former restoration efforts to respond to earlier concerns on the lack of previous data.

The Federal Democratic Republic of Ethiopia Ministry of Culture & Tourism Authority for Research & Conservation of Cultural Heritage

## 2. Response to the Decision of the World Heritage Committee

*[Note: The State(s) Party(ies) is/are requested to address the most recent Decision of the World Heritage Committee for this property, paragraph by paragraph.]*

**Paragraph 9. Providing the Final Preliminary Design of the canopy option and the detailed restorations planned, results of the environmental and social impact study including the Heritage Impact Assessments, and reports of the additional studies recommended by the scientific committee;**

The State Party of Ethiopia was expected to deepen the design of the shelters along with the additional studies by the Scientific Committee. Nevertheless, the conflict in the northern part of the country together with the occupation of Lalibela did not allow us to explore further studies as wished.

**However, the tender for the Environmental and Social Impact Assessment (ESIA) and the Heritage Impact Assessment (HIA) were launched and the awarded company will start its work quickly.**

The detailed restoration designs for the 4 covered churches is also attached (Annex 1: **Annex 1: Basic Pre-Project Study**) to this report for review.

**Paragraph 11. Proposed people-centred approach to preserving the property, including participatory management in the church structures' conservation-restoration, that acknowledges the active role the churches as a living heritage for the local communities;**

The already operationalized components of the Sustainable Lalibela project, detailed approaches are explained as follow. The objective of the operational "Sustainable Lalibela Project" is two-fold. On the one hand, it aims at addressing the urgent needs to restore and preserve the endangered Lalibela Churches and enhance their cultural and historical value for the future generations to continue enjoying the significance of this universal and collective heritage. On the other hand, the project intends to reinforce the local capacity to conserve, preserve and highlight the site through a comprehensive training scheme on heritage, making the process sustainable for Lalibela and replicable the result to other heritage sites in the country.

Specific objectives of the project include:

- Emergency-restoration programme with a series of 24 priority interventions to secure fragile and unstable areas. These interventions will secure the site and its users for the short-term;

- Restore the paintings and sculptures inside the churches;
- Build the capacity of Ethiopian nationals and in particular the local community to preserve, conserve and enhance heritage through training workshops and a curriculum within the newly created Institute for heritage management in Lalibela;
- Deepen the historic knowledge of the site and thus the region and increase its potential for tourism.
- Collect and archive a comprehensive digital database on Lalibela and other Ethiopian heritage.

About 50 experts from Ethiopia and France, coming from the ARCCH, Ethiopian Universities, the CNRS, Ethiopian and French Universities, the French National Institute for the Preservation of Heritage (INP) and the French School for Conservation of Written Culture (Ecole des Chartes) will be involved in the implementation of the project and the training sessions.

The activities will all be implemented in Lalibela. The training sessions and the digital center will be established is the Cultural Center of Lalibela.

➢ **Governance**

"Sustainable Lalibela" will work closely with the overall "Lalibela project" and will report and present its activities to the Task Force and the Steering Committee.

At each stage of the project, ARCCH, the Church administration of Lalibela as well as the Ethiopian Institute for advanced studies will be involved:

- selection of the Ethiopian coordinator of each component
- appointment of Ethiopian instructors and experts
- selection of candidates to be trained
- Four people from ARCCH and the local church will always be trained in each of the components, in addition to the University students (6 in number).

Each component is supervised by a Franco-Ethiopian pair, who reports directly to the project manager and the two coordinators.

➢ **Capacity building on heritage management**

**Involvement of Ethiopian counterparts:**

- Development of a curriculum with the institute for advanced studies in cultural heritage conservation and management in Lalibela, different universities and ARCCH.
- 10 persons trained selected with ARCCH and the institute for advanced studies in Lalibela. It will include experts from ARCCH, members of the local church as well as students from the Ethiopian Universities.

**Scheduled activities:**

- Selecting candidates for an academic curriculum and operational training workshops on heritage management together with ARCCH and other Ethiopian stakeholders;

**Expected results:**

- 130 nationals are trained on heritage disciplines and can work on the restoration and enhancement process of any heritage site in Ethiopia and beyond;
- The project has strengthened the newly created Lalibela Institute for heritage management, which was recently put in place by the Ethiopian Government;
- 10 educational grants are offered to the best students.

➢ **Upgrading Lalibela historic and touristic value through archaeology**

**Involvement of Ethiopian counterparts:**

- Identification of the co-director of the archaeological excavations with ARCCH.
- 10 persons trained selected with ARCCH and the Church administration in Lalibela. It will include members of the local church and experts from ARCCH, as well as students from the Ethiopian Universities.

**Scheduled activities:**

- Conducting excavation campaigns on a newly identified archaeological site near Gabriel, capitalizing on past investigations financed by the French Ministry of Foreign Affairs, and engaging Ethiopian students in archaeology through field trainings;
- Securing the archaeological site and enhancing its touristic value for visits;
- Training local guides on archeological tours in Lalibela.

**Expected results:**

- Archaeologial tours are defined on the site;
- Ruins and remains are protected and conserved;
- 50 touristic guides are trained on the historic value of the site;
- Publications and workshops are conducted to share the site's historic knowledge.

➢ **Creation of a digital resource centr" for Ethiopian heritage**

**Involvement of Ethiopian counterparts:**

- Identification of the technician in charge of the digital resource center with ARCCH and the institute for advanced studies.
- 10 persons trained selected with ARCCH and the institute for advanced studies in Lalibela. It will include experts from ARCCH, members of the local church as well as students from the Ethiopian Universities.

**Scheduled activities:**

- Purchase of digital equipment for the Resource center;
- Acquisition of 3D images and data on Lalibela and Ethiopian heritage, capitalizing on past acquisition campaign in 2019 in Lalibela with the support of the French Government;
- Digitization of artifacts and manuscripts from Lalibela;
- Creation of an exhaustive digital database on heritage in Lalibela;
- Running the Resource center;
- Training the technicians and facilitators in charge of the Resource center.

**Expected results:**

- A significant digital data base on Ethiopian heritage of the XXth and XXIst centuries is operational in Lalibela;
- 300 manuscripts are digitized;
- An IT room is operational within the Center;
- Images of the Lalibela site, which was digitized in 2019 in the framework of the Lalibela project with the support of the French Government, are available in 3D in the Center;
- 10 technicians are trained on database and archives management.

**Paragraph 13.** Operationalization of the Local Advisory Committee, according to the Reserved Area regulation, revising the 2014 Management Plan, and submission of the cadaster maps;

The State Party in the process of revising the management plan in collaboration with students from Lalibela currently studying in Institute for heritage management in Lalibela. We will update the committee on the progress of the revision of the plan in due course. The cadaster of map of the property has been submitted earlier and it is attached to this report for further review (See also annex-2: Cadaster Map of the Property). With regards to operationalizing the local Advisory Committee, training with regards to the role and responsibilities of the Committee was organized in 2021 to enable the Committee members discharge their duty.

**Paragraph 14. Vision Statement on growth and development that reflects and respects the Outstanding Universal Value of the property;**

Regarding the Vision Statement on growth and development, reflecting and respecting the Outstanding Universal Value of the property, the ARCCH is working to engage all regional and local partners and this will also be part of the operational project, as well which will have a development component.

**3. Other current conservation issues identified by the State(s) Party(ies) which may have an impact on the property's Outstanding Universal Value;**

**Other detail conservation issues that may impact the property are also stated below, which includes:-**

**1. Erosion Desquamation**

Located at the foot of monuments (due to splashing), in the form of pockets and around hard points, natural faults have often been patched with finishing mortar. They are located in line with the waterfalls of roofs or under windows (in the case of Biete Ghiorgis). But erosion mainly concerns the rocky roof when the surface hollowing encounters an underlying cavity. The most sensitive points are following the erosion already observed in certain rocky horizons, such as on Biete Qeddus Mercoreus.

However, some points that are still intact have reached a critical thinness of only a few dozen centimeters. They concern only Group 1 with the sanctuary of Biete Golgotha Mikael - Selassie Chapel, whose ceiling is practically on the same level as the courtyards. The tunnel located under the eastern trench that connects the cavities of the counterscarp of Biete Golgotha Mikael to Biete Denagel, presents the same defect. The ceiling of this corridor is very close to the floor of the trench. The risk of erosion is therefore high.

**2. Alveolization**

The poor resistance of certain horizontal rock layers defines pockets where alteration develops due to differences in the hardness of rock. This results in incremental hollows where the dusting of the rock marks the deficiencies in the surface.

**3. Viological colonization**

The churches, like the bedrock, are covered with algae and lichens, most often very dark grey. The lichens that develop on Biete Ghiorgis give it a yellow and orange colour.

## 4. Cracks

A distinction must be made between cracks resulting from the natural veining and cracks caused by breakage. The former, which are generally horizontal (figure 14), are inherent to the constitution of the rock, while the latter, sub-vertical, are acquired by material pathology.
They indicate fracture and tend to cut the churches into individualized cubes. Cracks generally affect the entire elevation. The most spectacular of these cracks cuts the church of Biete Amanuel in two, in the axis of the nave. It is worrying since the double crown in reinforced concrete used to chain the monument in 1965 is an unfinished work.

The crack is active on the roof of the monument. On Biete Medhani Alem, it is the reconstruction of the peristyle cantilever that has given grounds for reinforcement. It was cast entirely in reinforced concrete to eliminate the risk of the entablatures spreading apart. The diagonal cracks underline the ejection of the external corners. Angles pushed into the void fall. On Biete Medhani Alem, where the dimensions accentuate the phenomena, the potential instability of the two western corners of the monument was highlighted, one of which was fitted with a toroidal tie rod forming an anchor in the façade. The most prominent volumes are also the most susceptible to disorder. The west and north porches of Biete Mariam are the most altered. They had to be strapped to prevent them from falling down. The south porch has already collapsed, as have the upper four corners of the church.

The corner cracks concern a triangular portion of material proportional to the size of the monument. Thus, the corners of steps or cornices have cut off portions of a few decimetres in size. The corners of the wings of Biete Ghiorgis have cut off portions of a few decimetres. Corners of Biete Amanuel have cut off portions of a few meters, and finally, those of Biete Medhani Alem have cut off portions of about ten meters. The general shape of the parallelepipeds tends to become rounder due to the ruin of the sharp corners. This alteration phenomenon commonly affects stones exposed to the thermal stresses of a slow cycle repeated a very high number of times. It gives identical results to that caused by a short and severe episode such as a fire.

## 5. Detachments

Some fractures in the rock have resulted in zones of weakness that detach medium-sized fragments. When assessing the stability of these elements, a risk of falling could be identified. These are either blocks located in the wall in their natural state, or blocks carved into the façades. In both cases, the danger was highlighted in relation to public use. This includes interior arch fragments on Biete Amanuel, but also blocks on the exterior façade.

The faithful pilgrims are much attached to physical contact with the churches, crowd around the façades during annual festivals which increases the risk of injury. Tie rod mechanisms have been installed on Biete Abba Libanos, as well as a complete strapping system above the main strip. It plays its full role.

**6. Finishing works**

The doorframes are very well preserved. One of the doors of Biete Gabriel Raphael has been removed due to the alteration of the cavity that received its upper hinge. The pivots embedding of missing outer shutters are visible on the eastern elevation of Biete Mariam.

## 4. Additional Information

All relevant data regarding previous restoration efforts will be inventoried, archived and digitalized in the framework of the bilateral Sustainable Lalibela project. In this regard, a detailed inventory of previous conservation and restoration techniques (both traditional and modern) is presented below.

### 1. Over-digging every century

The rock-cut churches of Lalibela were carved into a basaltic scoria hill. The rock in which these churches are carved is very porous and contains a significant amount of swelling clays (Renzulli et al., 2011). Due to these intrinsic properties and exposure to the environment, the churches of Lalibela have deteriorated considerably over time.

The churches were not constructed in a traditional way but were rather hewn from the living rock of monolithic blocks. These blocks were further chiseled out, forming doors, windows, columns, various floors, roofs etc. This gigantic work was further completed with an extensive system of drainage ditches, trenches and ceremonial passages, some with openings to hermit caves and catacombs.

**Due to landslide, erosion, sedimentation process, the site transformation forced the inhabitants to over-dig (Gabriel-Rufael), adjust new facades (Golgotha), and restructure existing churches (Libanos) lowering the traffic level to protect the bases from rainfall.**

**This technique has allowed to stop the erosion issue observed but the problem was only moved and it is not a reversible technique since it changes the appearance of the monument; there is a removal and loss of material which is contradictory to the principle of heritage preservation.**

### 2. Thatched shelters

Thatched shelters as preventive conservation methods were deemed vital to reduce water ingress and thermal fluctuations. Open shelters have been used successfully to protect vulnerable structures from direct solar radiation and rain at megalithic sites. Some of the

Churches at Lalibela have been completely sheltered from the 1990s onwards to protect the structure itself and to ensure that the Churches could be used during the rainy season.

This technique was considered as non-intrusive and reversible preventive solutions protecting the buildings from further damage (solar radiation and rain). The technique was considered as sustainable due to the fact that it is natural and makes use of locally available materials and skills.

However, Thatched Shelters were not a lasting/ durable solution and was not aesthetically very compliant to the expectation of such site (by the local community) and it does not protect the surroundings areas such as the courtyards.

### 3. Plastering with mud treated with butter and animal hide

Mud collected from the surrounding area was plastered on top of 86 the roof; (2) butter was then applied on the surface of the mud plaster to reduce absorption of water into the mud; and finally (3) animal hide was put on top of this layer to serve as a mechanical protection from direct rain. This non-invasive treatment was applied before the start of the rainy season to impede the infiltration of water through the roof.

The use of hand-woven woolen carpets impregnated with butter was made by the local community mobilized by the Wagshum.

Such protection solution is non-intrusive, reversible and sustainable due to the fact that it is natural and makes use of locally available materials and skills.

However, no efforts were made to improving such traditional conservation methods, it is difficult to apply it as such in 2021 especially on a large scale such as Lalibela (Churches and courtyards).

### 4. Traditional mortars (Early 20s)

The use of mortars made from crushing stone and mixed with lime to protect the roofs during the rainy season and using cattle urine as a biocide to prevent plants growing has been reported from interviews with locals.

The use of blocks of stone and mud (the traditional construction method for houses in the Lasta region) were also inventoried as efforts to rebuild damaged parts by replacing it.

There is sustainability due to the fact that it is natural and made use of locally available materials and skills non-intrusive and reversible.

However, such solutions tend to be repetitive if the site is not supplemented by a cover and this would affect the Churches in the long term (similar modern techniques were used by the

WMF and one or two rainy seasons would easily affect those techniques). Such techniques need to be improved to be fully owned by conservators.

### 5. Porches restoration and plastering with cement in 1920s

The first international intervention to conserve the Lalibela Churches was not registered. Although, the sources are not well documented, from the local community oral narration, it appears to be a Greek mason who came to Lalibela and restored the Church of Bete Mariam, at the invitation of Queen Zewditu:

-the porches of Bete mariam were restored (rebuilt)

-the rooftops of Bete denagel and Bete Golgota were plastered with cement

**Such technique is deemed to be aggressive.**

### 6. The use of Portland cement and red painting (Early 50s)

Among the actions in the 50s, Bete Medhanialem and Bete Amanuel are mainly concerned by the restoration work undertaken by the Italians in 1954, it mainly consisted of:

- Plastering with cement of the 5th facade: use of Portland cement to restore the roofs and the walls
- Red paintings (bituminous) and wax after plastering were used as an adhesive chemical tar
- Parts of Bete Medhane Alem's Church were rebuilt: rock structure, the north-eastern and southern pillars, as well as the ceiling arches

These techniques were aggressive generating additional cracks, creating further salt efflorescence most likely caused by the excessive use of cement: not only the restoration work didn't help to prevent the infiltration of water, but it also blocked the natural breathing of the rock.

The original stonework, shape and architecture not kept: Bete Medhane Alem's pillars were reduced to about half of their original height and rebuilt with squared stone. Even the missing moldings were rebuilt with reinforced concrete. The third window from the east was completely remade and several patches of the façade were plastered up with mortar.

## 7. Plastering and sheltering with the Ethio-Swedish Institute of Building Technology (ESIBT) restoration works in 1956

The Ethio-Swedish restoration program on Lalibela Churches focusing on plastering and sheltering the roofs:

-laid provisional rooftops of corrugated sheets on the Churches of Bete Medhanealem and Amanuel. It was the first international sheltering work on these two Churches.

-The wooden structure used to hold the iron sheet was erected on the roof of the Churches without any preliminary study;

These works were also overlaid on the old "restoration work" from 1954-1955. Again, some of the pillars were rebuilt with hewn stone.

According to the local community, it quickly appeared that the wooden scaffolding, erected on the head of the Churches, was too heavy and aggravated their vulnerability.

## 8. Mortars and Plastering with Consoli's restauration in 1958

This project remained almost unrecorded. The only existing record was collected from Angelini's archives. Besides Angelini, some inhabitants also remembered this restoration work. According to oral sources, the work was undertaken on three Churches: Bete Maryam, Bete Medhanealem, and Bete Amanuel. Some mortar works were carried out on the ceilings and on the rooftops of Bete Amanuel and Bete Medhanalem. The chapel of Bete Mariam was plastered with cement. According to local witnesses, these restoration works damaged the rock.

## 9. Angelini's restoration works (60s)

Comparatively, the works conducted by **Angelini** appears to be the first scientific restoration campaign in the history of Lalibela Churches' restoration.

Restorations by Sandro Angelini and WMF (1967-1970) aimed to safeguard the Churches from further deterioration, to remove false addition, and to re-establish the monolithic form and character of the structures. They consisted on:

- The use of sacrificial mortar layers on the roofs;
- Sealing the cracks on the Church roofs;
- The use of water repellent solutions sprayed on vulnerable facades to prevent further damage of the walls of the Churches;
- The removal of elements, altering the original surface and material, added over time;

- iron sheets from the rooftops of Bete Medhanealem and Bete Amanuel,
- Paintings, the concrete and cement plastering in most of the Churches;
- Stone blocks reducing doorways' inside some of the Churches and in rooms dug into the trenches. Also, at the southern entrance of the second group of Churches, the access stairway with its side parapets was removed as it covered the original stairway with large steps;

These techniques were temporary, reversible and have no impact on the surrounding area. They were coherent and respected the authenticity and integrity of the site. However, very destructive methods were employed to remove previous restorations not compatible aesthetically or physically to the original surface and material.

The recommended solutions tend to make use of redundant actions on the heritage if the site is not covered and this would affect the Churches in the long term in addition to prevent the rock from breathing.

### 10. Temporary corrugated iron sheet shelters by the Authority for Research and Conservation of Cultural Heritage (1986)

In 1986, the **ARCCH** built corrugated iron sheet shelter to prevent the rainwater infiltration problem on the roof of Bete Maryam with eucalyptus wooden scaffolding. This shelter protected the Church from the infiltration of rain water. -It was functional until the European union shelter project applied on the site. Thus, it was a **temporary solution protecting the Churches' roofs from further damage by rain**.

### 11. Shelters with iron sheet and scaffolding (90s) by the Tarija project of the Finish (FINNIDA)

The Finland Cooperation Agency signed an agreement with the Regional Bureau of Culture and Information in the 1990's. The Finish project started in 1994 and was officially entitled "Environmental rehabilitation and upgrading of the historic site of Lalibela". Finland funded the construction of a protecting roof for the severely eroded and leaking Church of Bete Medhanealem. It was the first time that the Bete Medhanealem was covered by iron EGA sheet with iron scaffolding. (1996)

**Again this was a temporary solution to protect the Churches' roofs from further damage by rain**.

### 12. Current EU's temporary shelters

The use of four shelters made of translucent Tevlar burlap panels and secured by steel cables and anchored by pillars over five of the shelters:

These four protective shelters were completed in 2008 with the understanding that they would protect the Churches from further weathering (in particular water infiltration through the roofs) and that were put in place temporarily to allow conservation and repairs to be carried out.

Thus, they are temporary, reversible solution with no impact on the surrounding area and they reduce the amount of solar radiation while limiting the diurnal range of relative humidity.

Given that the shelters are raised several meters above the ground and allow for air to circulate freely, the relative humidity will not vary hugely between the sheltered and unsheltered Churches. It is, therefore, very unlikely that the rock walls would be much drier than their 'normal' (pre-intervention) state.

However, the growing frustrations and fears among the local community due to vibrations and extreme noise caused by the shelters under wind pressure have led to question the stability of those structures not to mention the aesthetic issues, industrial and very heavy.

In addition to that, the fact that these shelters are only erected to protect the churches makes it difficult to slow down the chemical weathering and bio deterioration affecting the rock. The challenges in limiting a directionally dependent heating and cooling of the walls (due to the fact that the current shelters cover one or two Churches and not the courtyards) persist.

### 13. Plastering

Based on traditional techniques, the WMF applied the second "permanent" restoration project on the church of Bete Gabriel Rufael and Bete Golgota Mikael ended up not being a failure: its colour and texture was not appropriate, all plastered applied as part of the WMF project deteriorated and damaged the Churches' facades after a couple of years.

This solution seems to be efficient for waterproofing but does not respect the aesthetic aspect. The coating is easily removed over 2 rainy seasons, which makes the action repetitive and harmful. Furthermore, it does not protect the courtyards/ the whole site and cannot be applied on sculpted roofs.

## 5. Public access to the state of Conservation report.

The State Party of Ethiopia is willingly sharing this state of Conservation Report to be open for public access.

## 6. Signature of the Authority

**Name** Abebaw Ayalew, Director General

**Signature** ____________

**Date** 01/04/2022

The Federal Democratic Republic of Ethiopia Ministry of Culture & Tourism Authority for Research & Cultural Heritage

Annexes:

1. **Annex 1: Basic Pre-Project Study**).
2. **Annex 2: Cadaster Map of the Property).**

# Restoration of Churches

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# 5.1. SAFEGUARDING WORKS (PRIORITY WORKS)

The first step to restoring the churches is to ensure they are covered along with their courtyards, thus avoiding repetititive restoration works . Shelters are key elements. However, the critical nature of some works could not await the final conclusion of the feasibility study. In this regard, a list of 22 urgent and safety interventions of the rock-hewn churches of Lalibela have been proposed and validated by the Steering and Scientific Committees in June 2020. They are a first step towards res-toration efforts. The aim is to preserve the churches and safeguard them from imminent danger such asprotecting them from vibrations, restoring and bettering the bridges on site.

## 5.1.1. STONE DETACHMENTS

The particular points of precariousness and medium-sized blocks detachment in regard to the public will be treated in priority. In a region of known seismicity, an episode, even of a low-am-plitude, can trigger the fall of blocks precarious for many centuries. This will be done either by purging, in the case of fragilities on unworked façades, or by pinning in the case of worked façades (figure 82).

Figure 82: Rocky roof of Biete Amanuel – Detachment of a precarious block on a crack

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## 5.1.2. BRIDGES

The two access bridges to the Biete Gabriel Raphael site will have to be dismantled. Care will be taken not to place wood, which is subject to weathering, under a concrete deck, as is currently the case. A seal will be interposed between the two materials.

## 5.1.3. TIE RODS

The already old straps of the Biete Mariam porches are no longer in perfect contact with the mineral substrate due to its desquamation. To improve their functionality, it would be necessary to insert a flexible joint between the metal of the straps and the rock.

## 5.1.4. EROSION OF THRESHOLDS

The issue of the weakened bearing capacity of the bedrock in front of, and under the Biete Golgotha Mikael lodge was raised (figure 83). In some places, the existing ceiling between the Biete Selassie room and the Biete Mariam courtyard is no more than a dozen centimeters in thickness. This weakness is all the more problematic as it lies outside the protection of shelter A. A proposal to reinforce the floor will be considered in the area where the celebrations are taking place. A project for a metal platform had been developed in 2018. This solution, which had been temporarily ruled out, could retain its legitimacy. The presence of metal in the religious enclosure had not been accepted. But a wooden cladding could remove this reluctance.

Figure 83: Biete Golgotha Mikael

## 5.1.5. INTERIOR STONE PAVING

The clergy's request to regularizethe interior floors of churches would be addressed by offering levelled pavings. Such work has already been done previously at Biete Mariam for example (figure 84). The use of a traditional stone paving, with dry joints, laid on sand, will enable the delivery of a regular levelling without modifying the existing profiles or creating an irreversible structure.

Figure 84: Biete Mariam – Floor tiles in the North porch

# 5.2. FINAL RESTORATION

## 5.2.1. GENERAL RESTORATION STRATEGY

The restoration strategy must be adapted to the context, but it must also take into account international deontology and the texts in effect on conservation. The techniques implemented will be chosen according to the local means available and will lead to training support in the conservation professions.

The previous interventions were carried out within a specific framework: considering that the shelters were temporary, and that no permanent protection was foreseeable, the whole conservation strategy was oriented towards permanent maintenance. This implied a planned repetition of inter-ventions with the awareness of having to repair in a cyclical and committed way an epidermis con-sidered to be sacrificial. In principle, this approach consists in valorising the action of the restorer before that of the curator. This theory of intangible heritage as defined in the NARA document (1994) is acceptable if one considers that the layer sacrificed periodically is renewable without damaging the characteristics of the monument, and that its renewal is in conformity with the original procedures. This is the case of the Japanese temples ritually rebuilt every twenty years, or that of the earthen mosques of Djenné in Mali, because they are reproduced in the same materials and with the same techniques. Otherwise, the intervention must be reversible. This is the case with the waterproofing carried out on Biete Gabriel Raphael.It is assumed that, when it reaches the end of its lifespan, this modern protection could indeed be removed without too much damage to the bedrock it covered, to be replaced by another waterproofing, if necessary improved in accordance with the technique available at the time (figure 85).

Figure 85: Biete Gabriel Raphael –
Laying waterproof layer on roof
Stephen BATTLE June 2016 World Monuments Fund: « Preservation at the Rock Hewn Churches of Lalibela, Ethiopia »(S-LMAQM-12-GR-022-A001)

However, this reasoning, which is appropriate for a rocky roof invisible from the surroundings, is not sustainable when dealing with a surface that can be walked on, a carved surface or a surface that can be seen from above (figure 86). This is the case for ten of the eleven main churches on the site. This principle cannot therefore be extended to the other churches, nor to the immediate surround-ings made up of the excavated courtyards and their counterscarps.

The sacrificial repair experimentally applied on Biete Golgotha Mikael does not meet the criteria for sustainable renewal, because it is carried out with a mortar or stone substitution technique com-pletely foreign to that of the original monument, on the one hand, and because it causes irreversible damage on the other hand. It has not been able to prevent alterations to the untreated parts, which continue to deteriorate. The continued process of decomposition of the rock by wetting and internal expansion of Natrolite crystals causes the lifting of the repaired surfaces as well as the untreated surfaces. It accentuates the difference in weathering between the zones (figures 87 and 88).

Figure 86: Biete Amanuel – detachment cracks

Figure 87: Biete Golgotha Mikael

Figure 88: Biete Debre Sina

The repetition of this type of intervention would eventually lead to the successive erasing of authentic rocky horizons, bearing vestiges. This can easily be imagined in a standard building where the destroyed stone is replaced by a new one, but this is impossible in Lalibela because the churches are not built but carved out. Any destruction of material is therefore irreversible, as history shows, and to a large extent, the very reason for the evolution of the excavations. For example, the recon-structed façades in dressed stone could never replace the collapsed monolithic peristyles of Biete Medhani Alem. The carved rock of the churches of Lalibela is irreplaceable, both literally and figuratively.

In this very particular case, to consider a periodic renewal of the surface would be to support an erosion that is accepted as inevitable and, by accepting this loss, to agree to the implicit dissolution of its form. This process would change the very nature of the monument. It is likely to end for future generations the interest that led to its protection as a World Heritage site. Moreover, periodic repair is not only a threat to the surface. It represents a material and undeniable danger for the un-derlying underground works, as it does not provide any means of reducing or controlling infiltration. The preservation of the painted decorations and the structural strength of the ceilings is not guaranteed in such a configuration.

In ethical terms, the restoration of a historic monument must remain an exception. This is the meaning of article 9 of the INTERNATIONAL CHARTER ON THE CONSERVATION AND RESTORATION OF MONUMENTS AND SITES (the so-called VENICE CHARTER) adopted by ICOMOS in 1964: "Restoration is an operation which must retain its exceptional character. Its aim is to conserve and reveal the aesthetic and historical values of the monument and is based on respect for the ancient substance (...)". As such, even if they are reversible, the repairs must have an intrinsic durability. It is not possible to consider that periodic repair of materials is a matter of maintenance.

The restoration proposals we make in the feasibility study are reversible and can remain light. They will be long-lasting, as they will be protected from the weather by an exogenous protection (alternative shelters). We want to promote a single restoration, and restrict the cyclical maintenance know-how to the shelter system.

**No quality restoration can take place without prior sheltering.**

## 5.2.2. DRAINAGE

The main sanitary measure involves the creation of a seasonal or permanent protective umbrella, which ensures effective waterproofing during the rainy season. The aim is to prevent the humidity level from reaching values that re-mobilise the process of swelling and splitting of the stone. This precaution applies to the introduction of water from the top. However, it has been demonstrated that infiltration from the ground is also the cause of similar damage. For the most part, the exca-
vation of the peripheral trenches was carried out within an altimetry that carefully preserves the underground structures from all the effects of runoff. However, the percolation of water from the hillside is beyond human control and may flow diffusely inside the cavities. It is practically impossi-ble to locate them with precision and also to channel them. Fortunately, this phenomenon remains very marginal. On the other hand, it is necessary to focus on the management of surface water whose flow is located at a level higher than the structures. This is the case for flows from the natural slope above the façade of a Hypogeum church such as Biete Abba Libanos. In this example, the overall protection of the top of the hill will solve the problem. But upstream of the counterscarps of Biete Medhani Alem and Biete Amanuel mainly (figure 89), it is necessary to clear or deepen the gullies dug forming a dam and then diverting the water. These flows are sufficiently scattered and

shallow that they do not require significant above-ground works. However, they periodically overflow the canals when they are undersized and pour into the courses (figure 90).

The North West outer trench of the first group is a special case. The water flow is directed to the west. After almost three quarters of its path in a particularly narrow route (figure 91), it still reaches above the ground level of the underground church of Biete Golgotha Mikael (figure 92). This elevated position of the water channel causes infiltrations that destroy the basement and the carved sculpture of the northern wall (figure 93 and 94).

Figure 89: Surroundings of Biete Amanuel – Surface Stream Collection Channel

Figure 90: Biete Medhani Alem – East Contrescarp

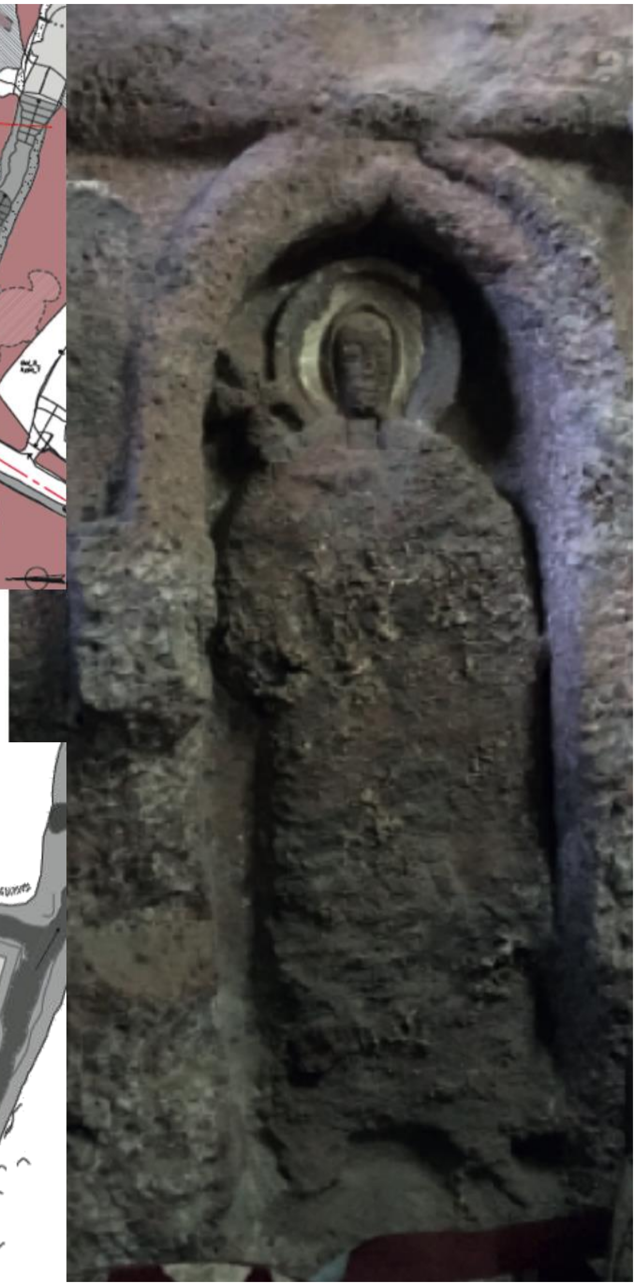

Figure 92: Biete Golgotha Mikael, Biete Selassie –
Migration of water from the northern trench

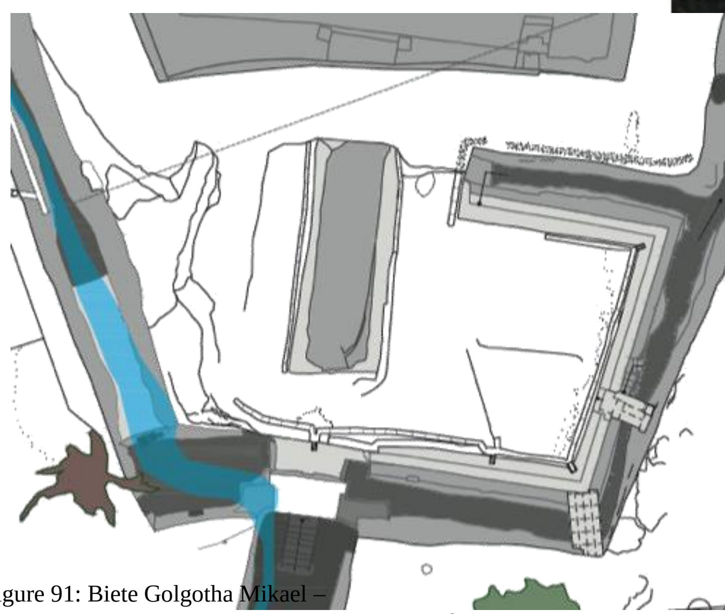

Figure 91: Biete Golgotha Mikael –
Statuary integrated into the wall in the process of
Figure 93: Biete Golgotha Mikael, Biete Debre Sina alteration

Figure 94: Biete Golgotha Mikael

It is impossible to create a capillary barrier in the rock. It is not possible to seal the bottom of the trench or to dig it up to lower its level below that of the church. The only solution is to limit the water collected by this trench as much as possible. All the rainwater that currently passes through this trench will have to be diverted upstream. The shape of the umbrellas to be made will have to incorporate the covering of the trench and the inversion of the roof slopes towards the South. The runoff from the northern entrance to the site will be diverted so that it no longer flows into the drain.

The positioning and architecture of these protections will be the subject of a specific chapter.

## 5.2.3. STRUCTURAL STABILITY OF THE ROCK

It is futile to attempt to contain the effects of seismic activity, dilatation or desiccation because of the magnitude of the forces involved. The architect Angelinni understood this when he avoided placing the tie rods in tension, which he brought back in 1965.

Except, of course, in the case of the seismic factors, we rather seek to reduce the causes. It is possible to significantly influence the evolution of disorders by regulating temperature and humidity.

It is therefore essential to gain precise knowledge of these phenomena, which interact with the natural rock. For this reason, fissurometers combined with temperature and humidity measurements were installed at the most sensitive points. The positioning near the sensors placed by Angelinni allowed verification by comparison (figure 95).

The study, combined with the temperature and humidity readings, provided reliable indications of the evolution of the monument.

The measurements carried out by Sébastien Clabaud between October 2019 and September 2020 showed that the churches to be stable (see 1strumesure study September 2020 in the appendix)

Maintaining the churches out of water will contribute to limiting the variations in hygrometry and temperature, which is favourable to the stability of the cracks, but it is also necessary to ensure that the acquired fragilities do not generate collateral disorders.

Figure 95: Biete Mariam – Fissurometer West façade

## 5.2.4. REINFORCEMENT

In line with the works of Angelinni, it will be proposed to install tie rods on the north-western corner of Biete Medhani Alem and to complete with a strapping the existing device on its south-western corner.

The nave of Biete Amanuel, which is split lengthwise, requires reinforcement to prevent the crack from extending. A chain-link system had begun to be implemented before 1968. It consisted of restoring the modenature of the bands that had disappeared from the façade, in order to insert a reinforced concrete chain-link intended to prevent a gap.

The Angelini fund kept at the Biblioteca Civica in Bergamo (Italy) specifies the proposal of 15/05/1953:

It describes the following interventions:

1. Removal of unstable rock at the foot of the façade and installation of a stone cladding (punctual anchoring with dowelled hooks in the rock)
2. Demolition and reconstruction in traditional masonry, over the entire width, of a section of the north-west corner elevation
3. Purging the cladding and applying a reinforced coating between the last two upper bands
4. Cleaning with a wire brush of the claddings and applying a cement coating on the most damaged parts (edges and bands)
5. Creation of a perimetral reinforced concrete wall chain in the place of the fascia below the upper windows
6. Creation of a perimeter reinforced concrete wall chain under the upper fascia that precedes the part forming the roof.
7. Repairs to the steps at the right of the entrances (cement sealing)
8. Installation of wooden window frames with anti bird metal grills on the windows
9. Grouting of all cracks with cement mortar

This proposal was only partially implemented and was revived in 1967.

The document (figure 96) of 27/12/1967 planned by Sandro Angelini foresaw the installation of three “catene” (chains):

1. Tie rod 1 to the west
2. Tie bar 2 to the east
3. The peripheral reinforced concrete chaining (shown in plan only) corresponds to point 6 of the 1953 project, not yet completed.

Of the three proposed tie rods, only one is visible, that of the west (figures 97 and 98). The central one, which would pass through the middle of the nave, has not been installed. The third one in the east would be located in the inaccessible shrine area.

Figure 97

98

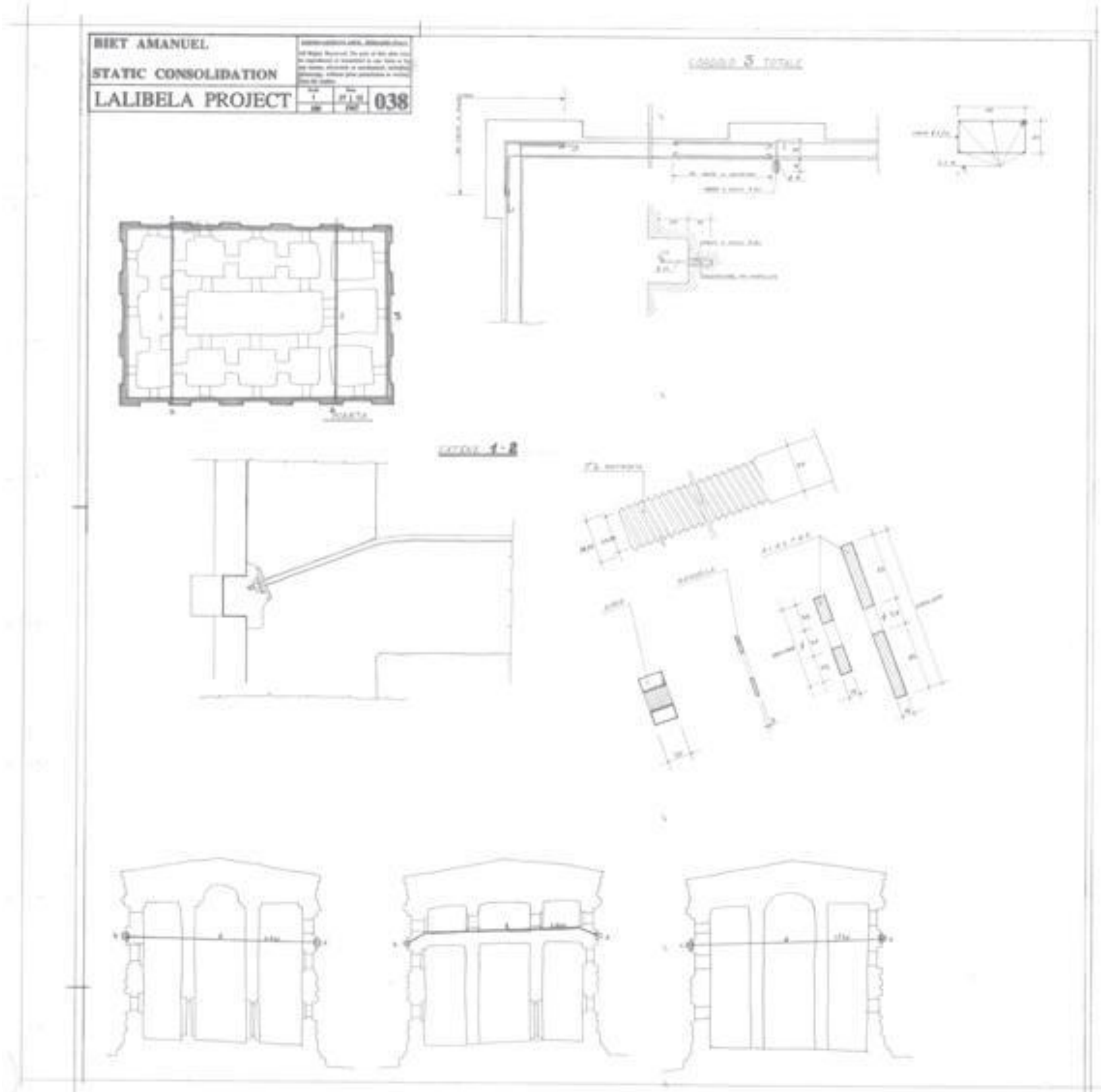


Figure 96: Sandro Angelini, static consolidation Biete Amanuel 27 December 1967


Figure 98: Biete Amanuel – Presence of the transversal tie rod in the western gallery

We propose to pursue and complete this chaining solution, which is elegant in its appearance and efficient in its choices (figure 99). The upper band of the projecting cornice with redent has not been completed in the north and south longans, probably because of the greater erosion of the wall. However, it is possible to complete it, provided that the outer bare wall is refilled as a result of the loss of material (figures 100 and 101). We propose to improve Angelini's project by closing the belt but also by placing the transversal tie rods at the level of the upper chaining. This positioning allows for the avoidance of intrusion of the interior volume into the church. The three tie rods will be drilled into the heart of the stone cap, and linked to the peripheral band (figure 102). The concrete used will be formulated on the basis of mortar filled with local stone powder. A decoupling film will be applied at the interface between the wall ties and the monument to avoid raising the swelling clays and to avoid contamination of the supports. The chaining will be reinforced in accordance with the calculations of the design office.

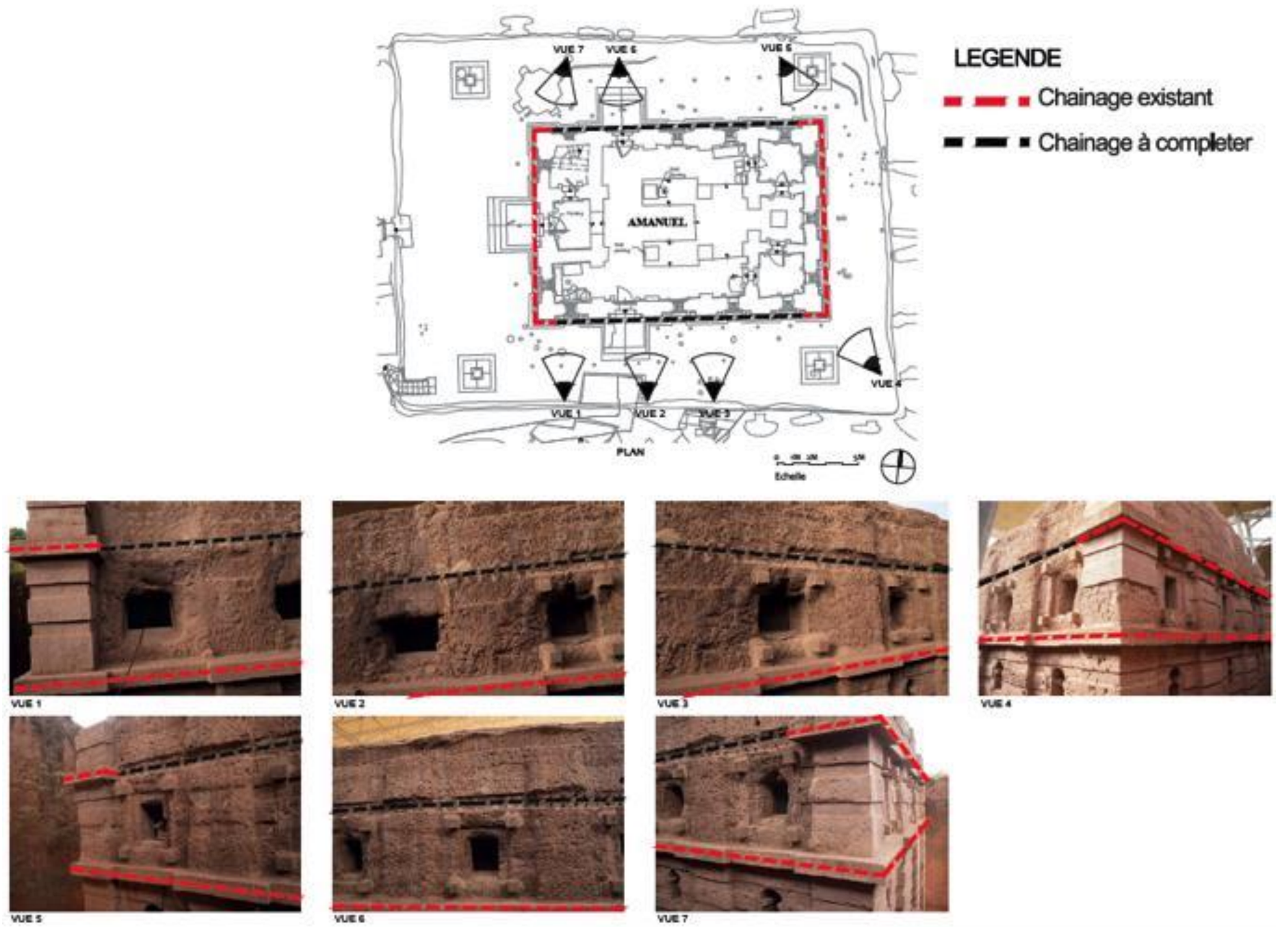


Figure 99: proposal of reinforced concrete chaining

Figure 100: Biete Amanuel – Before chaining works

Figure 101: Biete Amanuel – After chaining works

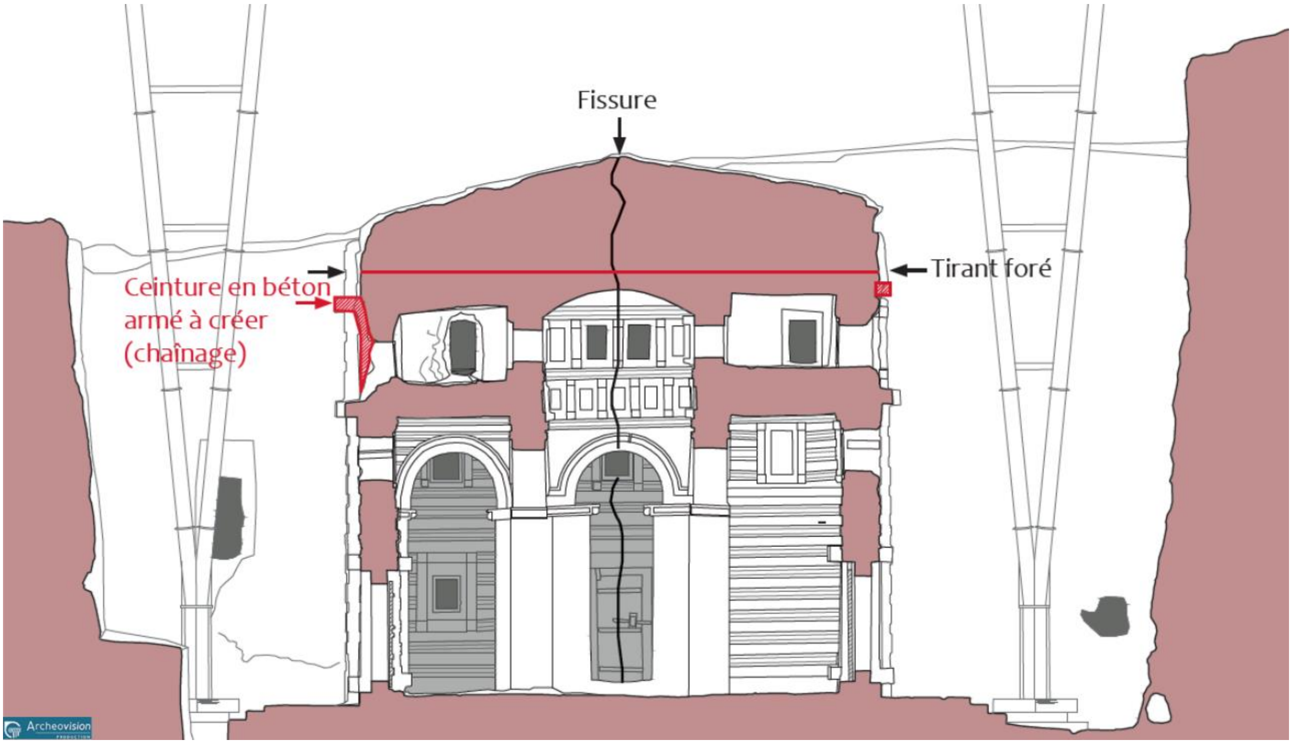


Figure 102: Biete Amanuel

## 5.2.5. CLEANING OF LICHENS

The cleaning of lichens is a seemingly harmless operation, but it is delicate in its implementation (figure 103). Mechanical brushing of the living organisms will not reach the roots that nestle in the micro-cracks of the rock. And superficial scraping would cause the organic matter to spread and the lichens to re-seed.

The first step is the application of a lichenicide that acts in a completely dry atmosphere and support. Only after complete desiccation and the demise of the organisms, can a soft brushing be considered. This process has the potential to restart the colonisation if the surfaces are exposed to weather conditions. To avoid periodically repeating this cleaning, it is therefore essential to place shelters that protect the monuments from humidity.

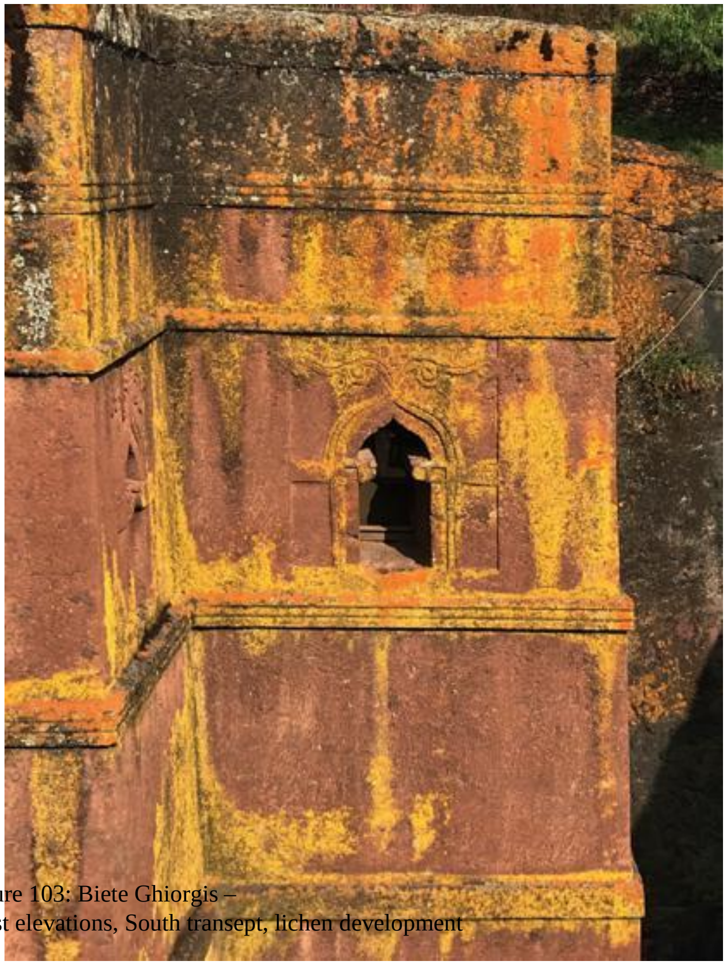

Figure 103: Biete Ghiorgis –
West elevations, South transept, lichen development

## 5.2.5. CLEANING OF STAINS

The cleaning of the façades is necessary due to the accumulation of dust, eroded surface material and organic waste (figure 104). It is intended to reduce the impact of the traces left on the facade by the run-off from the gargoyles (figure 105). The operations will be carried out exclusively in the dry to avoid mobilising hygroscopic salts, crystallisation of Natrolites and expansion of clay inclusions.

The epidermis will be gently brushed with suction to eliminate the alteration products. Depending on the result, harmonisation patinas can be applied as part of the enhancement operation.

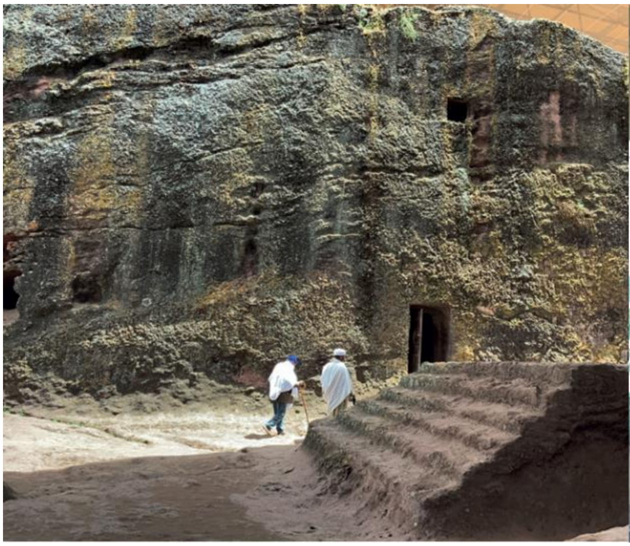

Figure 104: East counterscarp at the top of Biete Mariam – filled and vegetated reliefs

Figure 105: North façade of Biete Mariam – Vertical guttering under the gargoyle

# 5.3. ENHANCEMENT

## 5.3.1. FURTHER INFORMATION ON FAILINGS

Whatever destroys the integrity of a carved church is irreversible. Repairs can profoundly distort the understanding of the monument if they call upon the techniques of a builder, for they are precisely not built. This is the case of the dressed stone reconstructions of the Biete Medhani Alem peristyle recorded in 1954, (figure 106) and of the South porch of Biete Mariam. This is also the case when replacing the infill of windows (figure 107) or creating artificial pillars. On Biete Golgotha Mikael, the last restoration work placed masonry extensions on the outskirts of the church designed to channel rainwater to the sewer (figure 108). This process, which is contrary to all conservation ethics, transforms the silhouette of the monument, concentrates the water falls, and creates further damages in the areas affected by the splashing. It should be removed because it distorts the archaeo-logical perception of the churches, modifies the hydric impact on the rock and introduces an apoc-ryphal vocabulary (figure 109). The waterproofing of the churches by means of a general protection of the churches will allow these unfortunate additions to be removed.

For the complements, we will favor all substitution practices, which retain the monolithic aspect, even artificially. This method has been used successfully to restore the mullion of a window in the southern façade of Biete Golgotha Mikael. Large-scale dressed stone is a possibility, but it requires finding off-site quarrying areas to supply suitable blocks.

Concretes formulated on the basis of local crushed stone pits may also be suitable. In this case, the surface finishing should be worked with a tool. Wherever the reintegration of monolithic blocks from the monuments can be implemented, it should be favoured. It is regrettable that small veneer claddings have replaced in elevation the cyclopean fragments of the northern cornice of Biete Medhani Alem that remained on the ground (figure 110).

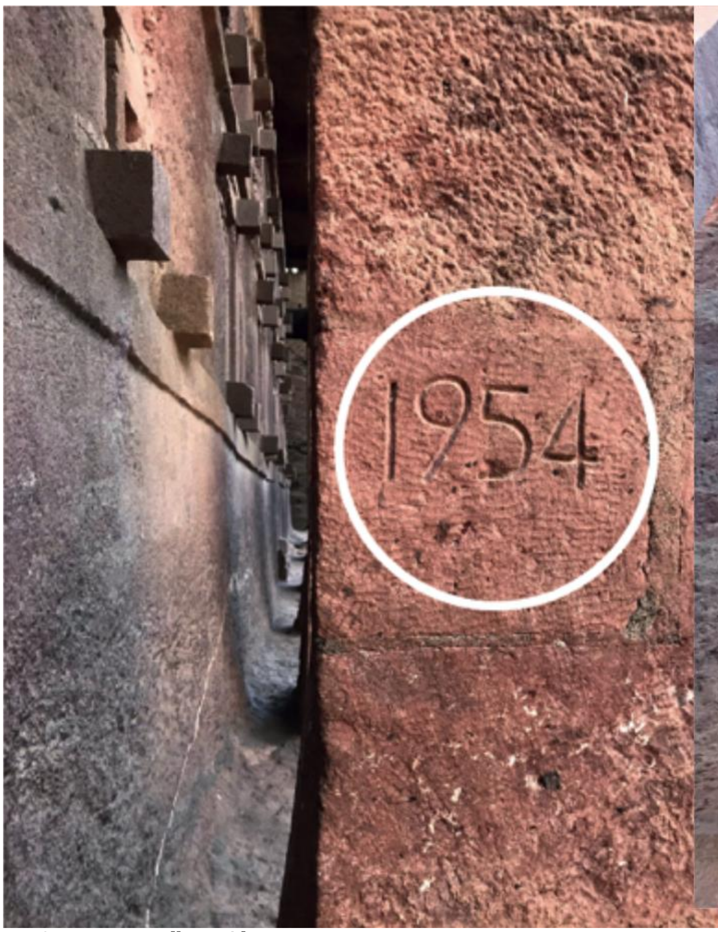


Figure 107: Biete Medhani Alem –
Figure 106: Biete Medhani Alem – Reconstruction of peristyle

Window restoration

Figure 108: Biete Golgotha Mikael – Reconstruction of peristyle

Figure 110: Biete Medhani Alem –
Remains of the northern cornice

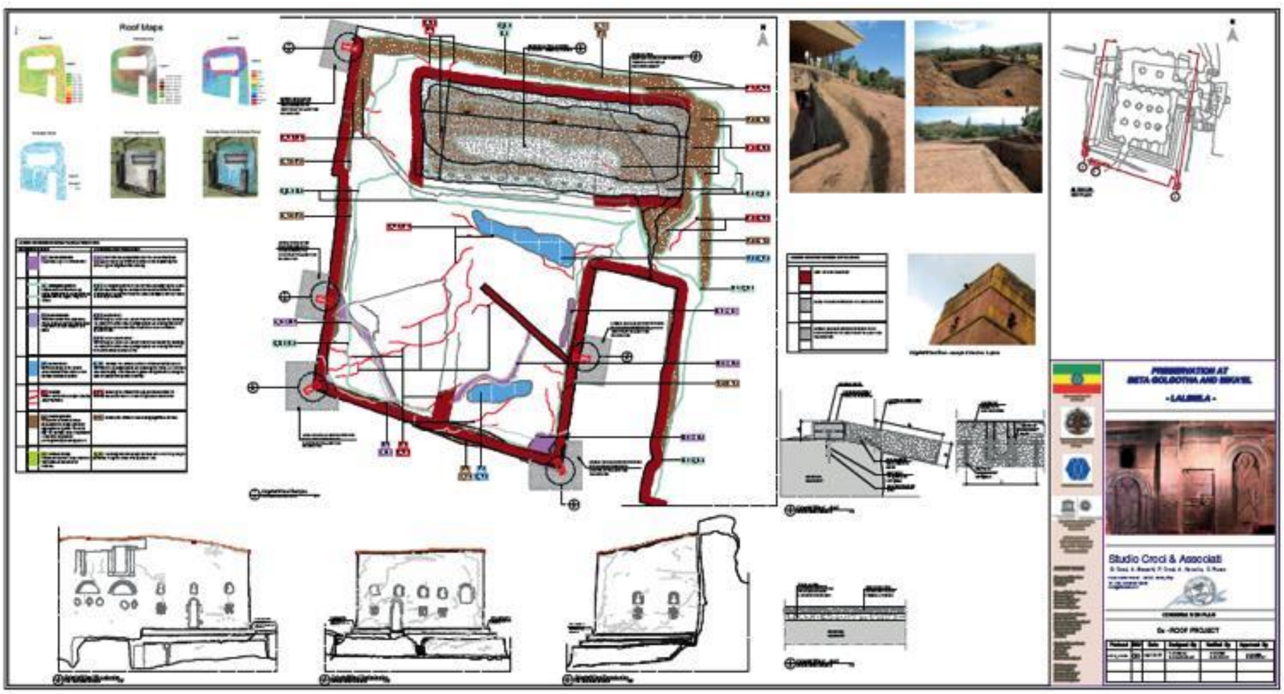

Figure 109: Studio CROCI & Associati Roof Project Preservation plan at Beta GOLGOTA and MIKA'EL 6 November 2017

## 5.3.2. PURGING

A de-restoration of the supperficial repairs of Biete Golgotha Mikael carried out in 2016 will be necessary for the most important parts forming continuous plasters. This is particularly the case for the traffic-prone floors where the difference in hardness between the natural floors and the interven-tions are apparent in the form of patchworks (figure 111).

In elevation, a light purging of the affected areas will be carried out by removing with a wooden spatula or a soft chisel for the most adherent parts. When the repairs are not desquamation, their removal may result in loss of substrate material. In this case, they can be kept in place and a har-monising patina can be applied.

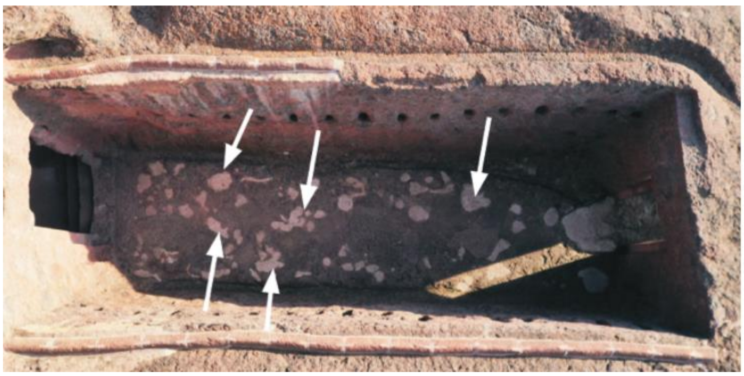

Figure 112: Biete Abba Libanos – Cracks on the western façade

Figure 111: Biete Golgotha Mikael – Mortar patching on the floor

## 5.3.3. PATCHING MORTAR

Façade cracks are a detrimental defect in the perception of monuments (figure 112). Although the durability of the building is not at stake, their appearance gives a counterproductive image of precariousness. Once stability is assured, an integration solution is possible. It consists, after having removed the dust accumulated in the crevices by blowing compressed air, in making injection grouts. The composition will be formulated on the basis of the physico-chemical compatibility of the different rock horizons in relation to the conclusions of the report on the rock's pathology. The fluidity and texture of the grout will depend on the width and depth of the cracks. For fine faults and indurated supports, it is preferable to use light solutions with high dilution and low pressure by syringe or mini-compressor.

For larger cracks and on soft substrates, the application can be done using a mortar blowing bath, with vents, and preferably by gravitational means. Temporary sealing should be carried out in front of the fractures, with a flashing or a swallow's nest introduction bowl. Cannulas connected to an expansion vessel are introduced into the crack. After removal of the temporary filling, a levelling mortar is applied to ensure continuity with the rock surface.

## 5.3.4. SURFACING

When erosion or destruction of the rock have caused irreversible losses of material, it is necessary to consider prior consolidation with reinforcement strips before reconstructing the gaps with solins (figure 113). The process was successfully tested and completed for the largest gaps during the 2016 campaign on Biete Gabriel Raphael courses. It consists of filling the deep pockets (figure 114) with a rubble stone, finish with lime mortar (figure 115). The finishing layer is smoothed in the manner of a plaster. The finish can be scraped, but more commonly it is re-cut to imitate the original surfaces, using stonecutters' tools. This process has given very satisfactory aesthetic and technical results during the repair work on the southern façade of Biete Maskal (figure 116). However, an adjustment of the hardness of the lime and its hydraulic properties will have to be made to match the different porosity of the rock depending on the locations.

Levelling coatings will be proposed exclusively on the appearance façades. The process developed by Angelinni can serve as a model. It is a coating made of lime and rock decomposition brasier. Its relative firmness allows working the surface finish with a hand tool, as one would do with natural stone. The best examples of this can be found on the foundations of Biete Amanuel, and on the northern side of Biete Mariam. If some fragments did not reveal some concrete bars, one could be mistaken about the authenticity of certain façades treated in this way (figure 117) as the tradition of direct stone cutting is well preserved in Lalibela to this day (figure 118).


Figure 113: South Façade Biete Maskal – Textured plaster finishing on repairs

Figure 114: Biete Abba Libanos – Alveolisation of the courtyard walls


Figure 115: Filling of gaps with mortar-filled rubble (before finishing plaster) Stephen BATTLE June 2016 World Monuments Fund: « Preservation at the Rock Hewn Churches of Lalibela, Ethiopia» (S-LMAQM-12-GR-022-A001)

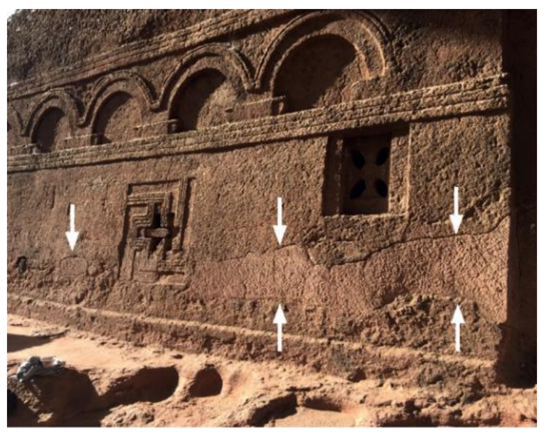

Figure 116: South Façade Biete Maskal – Textured plaster finishing on repairs

Figure 117: North Porch Biete Mariam – Pilar rebuilt with mortar

Figure 118: Stonecutters in Lalibela

The aim is to create a cladding that is in perfect continuity of texture, form and colour with the existing.

This illusion is only intended for remote viewing and for the easy integration of the restorations by the public. The close view should allow the specialists to identify the perimeter of the intervention at a glance. The boundary may be indicated by a slight shade of material or a millimetre hollow joint cut with a fine tool into the material surface.
The latest restorations carried out in the courtyards of Biete Gabriel Raphael yield satisfactory results in elevation (figures 119 and 120).

We refer to the description of the operations carried out in the final report of Stephen BATTLE on 30 June 2016 for the World Monuments Fund: "Preservation at the Rock Hewn Churches of Lalibela, Ethiopia" (S-LMAQM-12-GR-022-A001). This methodology and its implementation can be pursued and extended to the overall site.



Figure 120: Biete Gabriel Raphael –
South courtyard after works (Stephen BATTLE Juin 2016 World Monuments Fund: « Preservation at the Rock Hewn Churches of Lalibela, Ethiopia »
Figure 119: Biete Gabriel Raphael – South courtyard before works (S-LMAQM-12-GR-022-A001))

## 5.3.5. COATING

When reconstructions have been made in coloured and textured concrete, the finish is acceptable because it is well suited to the site and to the monolithic character of the churches (figures 121 and 122). This is not the case if the reconstructions have been done in dressed stone (figure 123), as the sight of the joints disrupts the understanding and the character of the restored volumes. In close view, this aspect could be corrected by a plaster coating of the same type as that of the patches. An archaeological procedure of discreet marking of the restored part can be envisaged.

This project could concern the projecting porches of the three entrances to Biete Mariam (figure 124) in connection with the extremely weakened original claddings, which will be repaired. Some of the renderings already done in the same manner have not lasted and are desquamating due to dis-placement. The non-adherent mortars need to be removed to renew the surface layer, as is the case on the ceilings of the porches of Bite Mariam (figure 125).

**Same corner after removal of incongruous additions but before restoration to monolithic form and appearance.**

Figure 121: Photo by Sandro Angelini

**A corner of Biet Mariam reconstructed with modern brick and cement**

Figure 122: Photo by Sandro Angelini


Figure 123: Biete Mariam – West Elevation

Figure 125: Biete Mariam –
desquamation of the plaster under the ceilings of the north porch

Figure 124: South porch side elevation of Biete Mariam – Dressed stone cladding restored following collapse

## 5.3.6. WHITEWASH EXTERIOR AND PATINAS

Numerous remains indicate the presence of architectural paintings, most often in relation to the openings (figure 126). These decorations are of great importance in the perception of the site and are generally unreadable due to the erosion of the support and the loss of maintenance practices. They also cover the window infills with ribbed and geometric decoration.

We suggest restoring this whitewash using natural lime or plaster paste. After identifying the sometimes-irregular contours, purging and consolidating the epidermis, one or more coats of whitewash will be applied with a brush or a broom in a rustic manner similar to the existing one, or smoothed on the splayings.

In order to unify old concrete repairs with authentic substrates (figure 127) and recent patches, it may be necessary to apply harmonising whitewashes. These limewashes, applied with a spalter or a soft brush in thin and transparent layers, will be tinted in the colour of the churches by means of natural ochre pigments or a brazier of rock powder taken from the quarry waste. Their application is intended to soften the interfaces between the areas of intervention, but also to partially erase the rock inclusions whose colour contrasts with the plain façades (figure 128). The whitewashes also have the capacity to nourish and consolidate the sides weakened by the natural porosity of the rock.
Alum salts can be used in diluted form as natural fixatives.

Figure 126: Biete Maskal – South entrances   Figure 127: Biete Gabriel Raphael – Contrast of light-coloured mortar patching on the basement

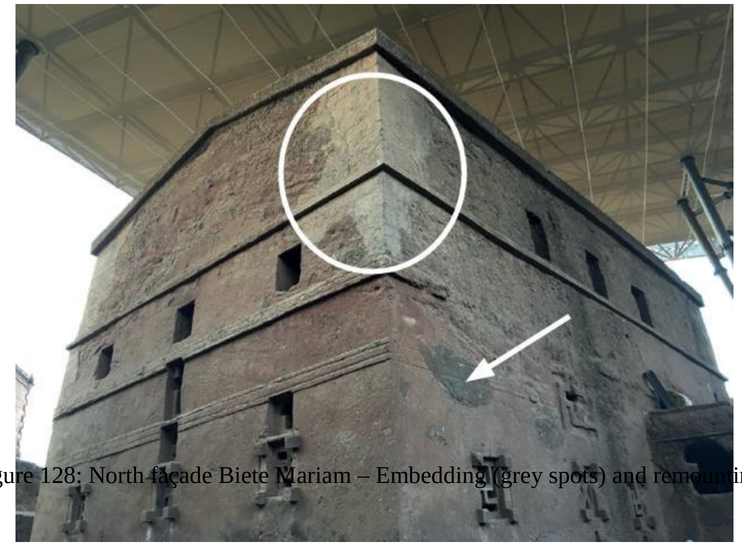

Figure 128: North façade Biete Mariam – Embedding (grey spots) and remounting (light spot)

## 5.3.7. FLOORS

A distinction must be made between two types of floor restoration The first type concerns interior floorings of dressed stone slabs. The carved floors of churches can be perfectly regular when the bedrock is of good quality (figure 129). But they can also be very irregular due to the discontinuities of the veins, and create holes that are unfavourable to the circulation of the faithful (figure 130). This inconvenience has been corrected more or less by the mats sometimes laid in multiple layers on the floors. This inconvenience has been corrected more or less by the mats sometimes laid in multiple layers on the floors. We propose to apply mortar patching to the weakest defects, and to continue with the use of stone slabs to compensate for them, as has already been done on the most critical points (figure 131). A prefiguration will be carried out on Biete Mariam in the programme “Sustainable-Lalibela” with the safety works. This experiment could be extended to include all the churches if it is successful (figure 132).

The second concerns the external surfaces. We have seen that the floors of the courtyards included baptismal basins, traces of pillars being pulled out, of the installation of wooden poles, of consecutive levels of digging, of slopes and drainage channels. These precious remains of recent archaeology continued to be eroded by the weather. Hydraulic mortar coatings were applied to natural faults (figure 133) or to particular points of wear (figure 134) or to attempt to reduce water infiltration into the underground works. Once the installation of comprehensive protections frees the ground from the constraints of waterproofing, it becomes possible to remove the mortar screeds that were altering the appearance of the floors (figure 135). It will thus be possible to recover the subtlety of the significant reliefs of the bedrock.

Conversely, areas of fragility defined on rocky ceilings that have become thin, could receive a semi-thick consolidation slab intended to preserve them from accidental collapse (figure 136). This is the case for the floor of the Biete Mariam courtyard located in front of the underground sanctuary of Biete Selassie where a temporary platform solution has been proposed. The condi-tions for acceptability of a top-laid slab are: its reversibility, the absence of dividing joints, a flexible profile in harmony with the existing structure, and lastly a texture and colour identical to that of the surrounding area. The installation of such a coating should be done with the interposition of a separating film ensuring its independence from the remains. The substance of the slab must not be too hard; otherwise it will have a polished finish that is not in line with that of the façades. This is a defect that has been observed on contemporary artificial floors. The sacrificial nature of this work should be considered as a guarantee of its mattness. The surface film is likely to erode and the weathering dust to be evacuated periodically by the sweeping of the site or the wind. The mortar must therefore be homogeneous in its composition and colour. We propose to use a mixture of mi-cro-fibred low hydraulic lime which avoids cracking and expansion joints. The aggregate and sand load will be of the same local origin as that of the coatings.


Figure 129: South side of Biete Medhani Alem – Figure 130: Biete Medhani Alem – South entrance The carved surface is regular and of high quality

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Figure 131: Western entrance to Biete Mariam –
Figure 132: Example of stone paving from Lalibela

Remain cladding of old stone under the carpets

Figure 133: Biete Gabriel Raphael – Crack filling with mortar

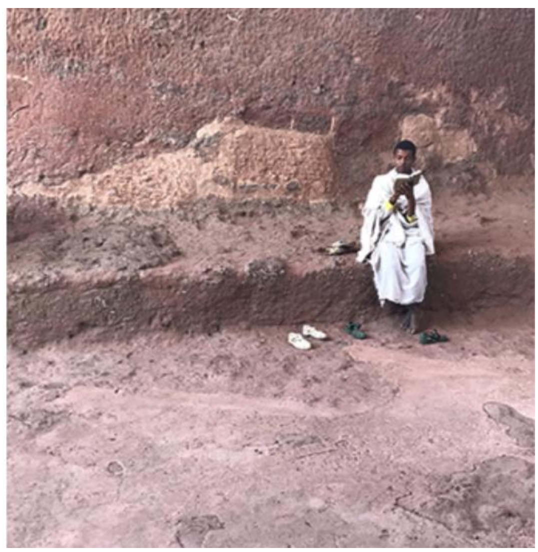


Figure 134

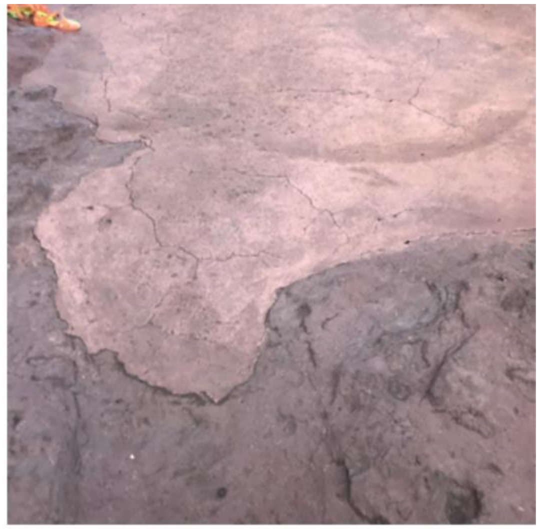


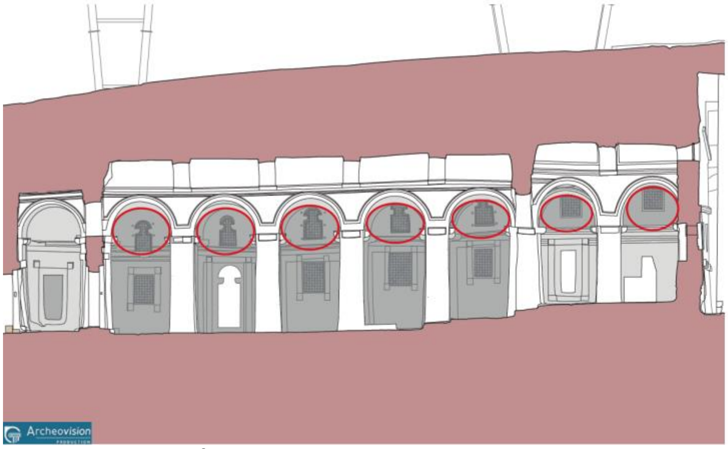
Figure 136: Biete Golgotha Mikael, Biete Selassie –
Figure 135: Biete Qeddus Mercoreus – Mortar screed above the church

Screed in the courtyard of Bieta Mariam

## 5.3.8. FINISHING WORK

The window frames associated with the churches have preserved a good level of authenticity. Most of the door and window frames are made of solid wood with only one or two pieces. This gives them a particular solidity and resistance. This one-piece character of the doors must not be distorted by scattered attachments. Intervention should be avoided as much as possible. The South door of Biete Gabriel Raphael calls for intervention. Its reinstallation requires the creation of a strap to be sealed in the upper part to avoid stressing the broached lintel once more.

In order to limit the thermal exchange between the exterior and the interior, it would be desirable to install glass in the plaster clerestory of churches. For a similar reason, exterior shutters should be put back into place on the eastern windows of Biete Mariam.
The clerestories are fragile and remarkable elements that are crucial for the finishing of churches. Some of those that have been destroyed can be recreated based on the remains that have survived (figure 137). They require a delicate restoration using traditional gypsum techniques. A careful con-servation intervention will allow the restoration of the remains and the filling of structural gaps to re-establish the continuity of the walls (figure 138).



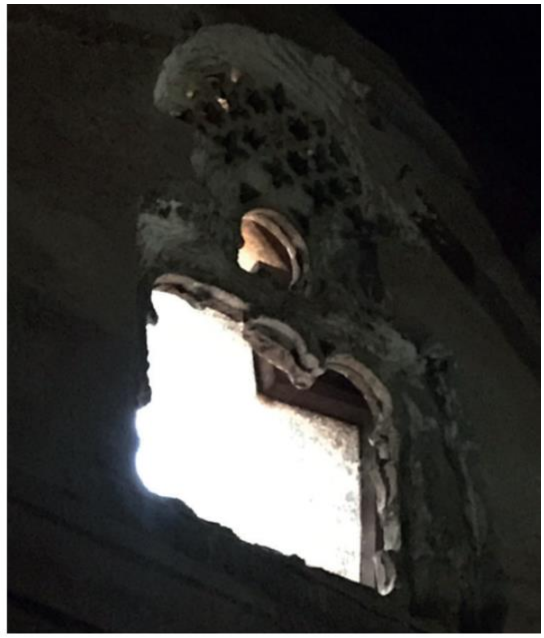



Figure 138: North wall of Biete Medhani Alem –
Figure 137: Biete Medhani Alem – Position of the claustras

Remains of plaster clautras

## 5.3.9. PROTECTION FROM BIRDS

There are two types of protection to be considered: the nesting, which concerns the resting areas on the facades, and the entry into the churches. In the first case, it is possible to use chemically sealed wires stretched over pins. In the second case, the windows currently closed with wire mesh of all sizes (figure 139) will be fitted with homogeneous wire mesh placed on rails whose contour conforms to the sinuous nature of the openings.

Figure 139: Biete Medhani Alem – Protective mesh over windows

## 6.1. GRIEVANCE TOWARD EXISTING SHELTERS

The main criticism of the existing installation is its alleged vulnerability. The faithful instinctively fear the shelters will fall down and the churches will be lost. We have seen that the shelters do not have any design or aging defects that could raise concerns about their fragility, but only a ballast defect.

The break in scale and vocabulary with the monument is then stressed. This defect is cited as much by Ethiopians as by foreign tourists who are disappointed to find the installations are not well integrated into a site that they thought to be preserved in the authenticity of a natural setting (figure 140).

From the conversations held with affectees and managers, a few key points are clear:

- The temporary labelling of the structure is not well perceived. Some feel that a precarious protection does not suit the idea of eternity that shrines convey.
- Metal should not be part of an ideal perception of supports. This material is deemed incompatible with the mineral aspect of the site.
- The wind blowing into the platform structure creates resonance with the shelters and causes noise pollution on the site.
- More recently, waterproofing defects in the roof membrane have been seen as signs of pending inefficiency. But the stability and durability of the structures in place remains the main concern raised by critics of the installation.

Figure 140: Biete Amanuel – Installation of a support in the courtyard

## 6.2. EXISTING SHELTERS CONDITION

The four temporary shelters erected in 2008 were examined in detail and modelled in 3D during the October 2019 mission (BMI report of January 3rd, 2020 see appendix). They are currently in a suitable state of preservation. Their effectiveness is proven. With regular upgrading and main-tenance, they could last another fifty years, with the exception of the Biete Abba Libanos shelter, which is affected only by the weakness of its foundation (figures 141, 142 and 143). Shortcomings have been reported out in its supports, which require shoring.

At the request of local stakeholders, an inspection was carried out to check the condition of structures located in the plenum of the platforms in September 2020 by Sébastien Clabaud (figure 144) see appendix. This inspection did not reveal any construction defects or aging pathologies. During the technical study carried out in 2018 by ARCCH (Ethiopian Ministry of Culture), Essayas Gebre Youhannes demonstrated the instability of shelters to wind conditions. Following the terrain category II reference, agreed by both the Ethiopian experts and the BMI design office, during the scientific committee of 27th October, 2020, the initial stability study (N ° 19- 147 of December 2019) was revised to conclude that there was insufficient ballast on several shelters bases leading to a risk of sliding over a return period of 50 years (Study 20-154 A of 9/12/2020, see appendix). The durability of the shelter bases in their current configuration will require either an increase in ballast height or safety anchorages.

In conclusion, the limit state stability of existing shelters is not guaranteed in view of the wind uplift calculations. A monitoring to assess the risks of uplift was carried out. Its installation on the bases of the structures initially planned for March 2020 was completed in September 2020 due to COVID-19.

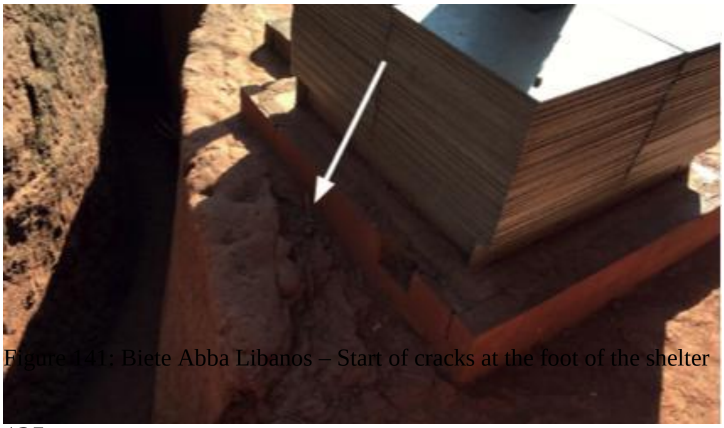


Figure 141: Biete Abba Libanos – Start of cracks at the foot of the shelter

125

Figure 142: Biete Abba Libanos –
Erosion of the foundation at the foot of the shelter

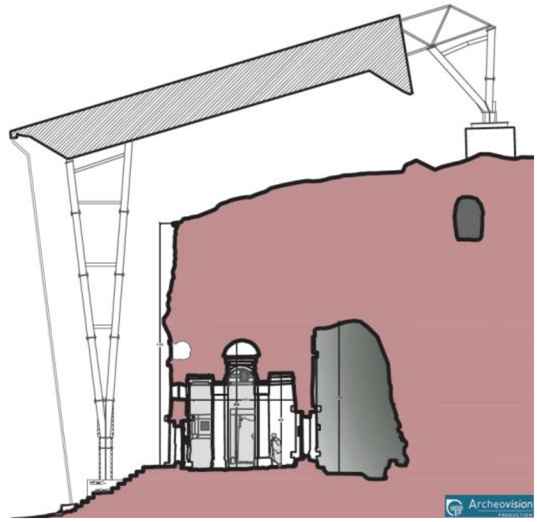



Figure 143: Biete Abba Libanos
– Installation of shelter

Figure 144: Group 1

## 6.3. EXTENDED PROTECTION

We have shown in chapter 3.8. that protection was the sine qua none condition of safeguarding churches. It is therefore necessary to maintain or replace the protection of churches already covered, regardless of their form, and extend to those, which do not yet have an adequate coverage.

The four existing shelters represent a surface area of 4,019m², which can be broken down as follows:

Biete Mariam - Shelter A
30.5m x 34.5m = 1,052m²

Biete Medhani Alam - Shelter B
45.6m x 40m = 1,824m²
(Groupe 1: 2,876 m2)

Biete Abba Libanos - Shelter C
24.7m x 19m = 469m²

Biete Amanuel - Shelter D
27.4m x 24.6m = 674m²
(Groupe 2: 1,143 m2)

A fifth shelter exists on Biete Lehem. It is traditional, made of sheet metal and eucalyptus poles and covers a surface area of approximately 50m².

In order to cater to conservation needs, the total surface area of the shelters should be increased from 4,070m² to 15,600 m², which is almost four times the current surface area. This extension will include new creations for Biete Ghiogis, Biete Qeddus Mercoreus, Biete Gabriel Raphael, Biete Denagel, and Biete Golgotha Mikael, which lack such structures, a replacement or an extension for Biete Lehem, Biete Amanuel, Biete Mariam, Biete Medhani Alem, and a reduction for Biete Abba Libanos. On the case of the latter church, the covered surface had been increased by the need for supports in the courtyard, well in front of the façade. The new type of protection should be limited to a more modest overhang.

# 6.4. PROTECTION TYPE

## 6.4.1. DISMANTLING AND CREATION OF NEW PROTECTIONS AT THE SITE LEVEL

The question of the alternative to existing shelters is prompted by the socio-cultural inadequacy of the existing installation on the one hand (rejected by population and stakeholders) and by the need to safeguard churches and their immediate surroundings (courtyards), on the other hand. It will therefore be necessary to create new protections to replace the four existing shelters and to extend the protection to churches that still lack it. This heavy solution calls for a new architectural design. The terms of reference will be defined according to the site constraints in a technical specifi-cations document (see chapter 7).

It is difficult to consider a global approach to protection because of the spans to be covered (figure 145), unless one considers monumental structures such as the Eden Project in the United Kingdom (figure 146) which evoke contemporary facilites which are very connotative and more importantly out of scale. The use of intermediate supports can be envisaged to reduce the impact of structur-al elements. However, they should not be located in the courtyards so as to avoid any impact on religious celebrations and public attendance.

Figure 146: Eden project (UK)

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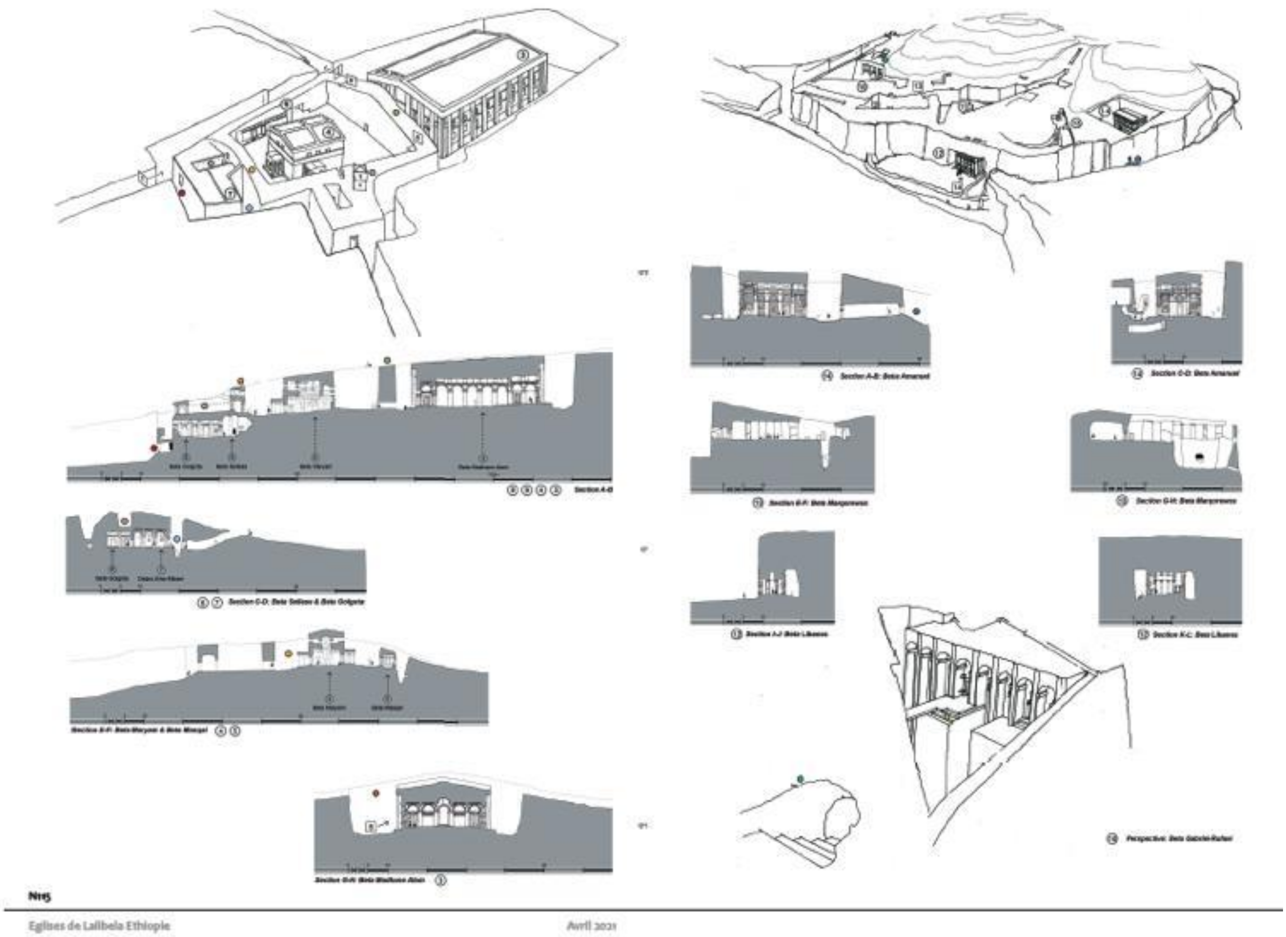



Figure 145

The need to keep the crests of the counterscarps clear was stressed. Indeed, during major cer-emonies, a connection exists between the clergy who ascend to the upper parts (figure 147) and the faithful who alternately occupy the counterscarps of the courtyards of Groups 1 and 3 (figure 148), or of Biete Amanuel. The mapping of occupancies for the main ceremonies of the religious calendar gives an idea of the space required both on the ground and in terms of viewpoints (figure 149).

Some contradictions need to be resolved. The allottees would be in favor of seasonal protections considering that the rainy season is marginal throughout the year. To this it must be argued that the protection is not only intended to protect the monuments from rainfall, but also from the effects of heat and their exposure to the sun. The most vulnerable monuments must therefore be permanently protected even during the dry season. On the other hand, the permanent nature of the installation may seem contradictory to the mobility of the protection, and hardly compatible with long spans, particularly due to the constraints related to the effects of the wind. The installation must be revers-ible but not temporary with the potential exception for Group 3, which is a special case.

One of the challenges of the feasibility is the possibility of using anchorage points in the bedrock beyond the trenches, to ensure the stability of the shelters. It is necessary to precisely locate the cavities that need to be avoided in the rocky horizon of the counterscarp. The point cloud estab-lished by Archéovision offers this possibility. The anchors can be done in the ground and in any case, outside the perimeter of the churches. The technique of drilling with sealing will be proposed according to its capacity. Tensile tests at pullout should be carried out before sizing and determining the number of anchorages required.

The design, and above all the maintenance of the new protection, must be compatible with the means and know-how of the local workforce, so that the construction constitutes by means of a transfer of skills, a training course of professionals and youth from the region. The idea of a training worksite appeals to the local authorities. This approach will facilitate the appropriation of shelters and will allow field workers to carry out routine maintenance, modifications, and adapta-tions that may be necessary for the functioning of the churches. In the context of the dismantling of the existing shelters, consideration must be given to the future and possible recycling of parts of the existing structure. For the good management of the site, it is indeed preferable that the dismantled materials can be reused, because their state of conservation is overall satisfactory.

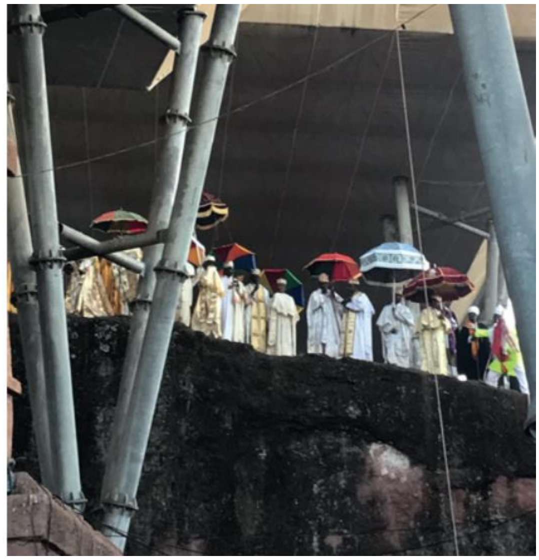


Figure 148: Biete Mariam –
Feast of the Nativity, occupation of the counterscarp ridges

Figure 147

Figure 149

## 6.4.2. RENEWAL OF EXISTING ARCHITECTURAL PLAN

The mistrust caused by current shelters is not necessarily linked to their architecture. It can be argued that it is the very principle of protection, which is the focus of rejection.

Reconstruction of the existing shelters cannot be considered even with substantial improvements to the supports and finish, as their aesthetics and design of a temporary nature still give them a low degree of acceptability. Furthermore, calculations have demonstrated insufficient ballast on the bases of three of the four shelters (figure 150). This obstacle cannot be overcome by redesigning the appearance of the existing poles. Additional ballast could be added with the existing platforms preserved in their original design.

| Libanos | | | | | | | |
|---|---|---|---|---|---|---|---|
| Pillier C1 | | Pillier C2 | | Pillier C3 | | Pillier C4 | |
| Socle béton | 169 KN | Socle béton | 150 KN | Socle béton | 186 KN | Socle béton | 153 KN |
| UPN | 4 KN | UPN | 4 KN | UPN | 4 KN | UPN | 4 KN |
| Plaque | 6 KN | Plaque | 6 KN | Plaque | 6 KN | Plaque | 6 KN |
| Lest | 153 KN | Lest | 4 KN | Lest | 4 KN | Lest | 151 KN |
| Total | **332 KN** | Total | **164 KN** | Total | **200 KN** | Total | **314 KN** |

*Figure 12 – Poids permanent aux pieds des 4 piles du Shelter de l'église Beta Libanos*

| Amanuel | | | | | | | |
|---|---|---|---|---|---|---|---|
| Pilier D1 | | Pilier D2 | | Pilier D3 | | Pilier D4 | |
| Socle béton | 101 KN | Socle béton | 111 KN | Socle béton | 92 KN | Socle béton | 82 KN |
| UPN | 4 KN | UPN | 4 KN | UPN | 4 KN | UPN | 4 KN |
| Plaque | 6 KN | Plaque | 6 KN | Plaque | 5 KN | Plaque | 6 KN |
| Lest | 58 KN | Lest | 58 KN | Lest | 58 KN | Lest | 58 KN |
| Total | **169 KN** | Total | **178 KN** | Total | **159 KN** | Total | **150 KN** |

*Figure 14 – Poids permanent aux pieds des 4 piles du Shelter de l'église Beta Amanuel*

| Maryam | | | | | | | |
|---|---|---|---|---|---|---|---|
| Pilier A1 | | Pilier A2 | | Pilier A3 | | Pilier A4 | |
| Socle béton | 76 KN | Socle béton | 63 KN | Socle béton | 132 KN | Socle béton | 151 KN |
| UPN | 4 KN | UPN | 4 KN | UPN | 4 KN | UPN | 4 KN |
| Plaque | 6 KN | Plaque | 6 KN | Plaque | 6 KN | Plaque | 6 KN |
| Lest | 13 KN | Lest | 13 KN | Lest | 128 KN | Lest | 130 KN |
| Total | **99 KN** | Total | **86 KN** | Total | **270 KN** | Total | **292 KN** |

*Figure 13 – Poids permanent aux pieds des 4 piles du Shelter de l'église Beta Maryam*

| Madhane | | | | | | | |
|---|---|---|---|---|---|---|---|
| Pilier B1 | | Pilier B2 | | Pilier B3 | | Pilier B4 | |
| Socle béton | 80 KN | Socle béton | 75 KN | Socle béton | 103 KN | Socle béton | 69 KN |
| UPN | 4 KN | UPN | 4 KN | UPN | 4 KN | UPN | 4 KN |
| Plaque | 6 KN | Plaque | 6 KN | Plaque | 6 KN | Plaque | 6 KN |
| Lest | 13 KN | Lest | 13 KN | Lest | 13 KN | Lest | 13 KN |
| Total | **103 KN** | Total | **98 KN** | Total | **126 KN** | Total | **91 KN** |

*Figure 15 – Poids permanent aux pieds des 4 piles du Shelter de l'église Beta Madhane Alam*

Figure 150: Permanent weight at the feet of the 4 shelter pillars of the churches Biete Abba Libanos, Biete Mariam, Biete Amanuel, Biete Medhani Alem.

# Technical Specifications for Alternative Shelters

Shelters must have a unity of style. The multiplicity of forms must be avoided without excluding flexibility and adaptation to the terrain. The project aims to blend shapes with the landscape. The sites are different in size. They must therefore be provided with shelters fitting their purpose. The major aesthetic defect of the existing shelters steemed from an isolated perception of each church (figure 151). An overall design at the scale of the site would allow to compose the covers in relation to one another and to create quality ambiances and interstitial volumes. The area of protection should create close links, even continuity between churches. The area to be covered for the entire Group 2, for example, is approximately 5,491 $m_2$.

The topography of the site, with its hidden cavities, combined with the uses including the open and frequented trenches (figure 152) and the sacred character of the monuments, draws a map of the positioning constraints.

Moreover, the positioning of the crowds during the most important ceremonies of the year is perfectly codified. The faithful gather both in the immediate vicinity on the counterscarps and in the courtyards along an unchanging geography (figure 153). The clergy stand in line on the crests around Biete Mariam (figure 154). By default, this results in a potential support layout.

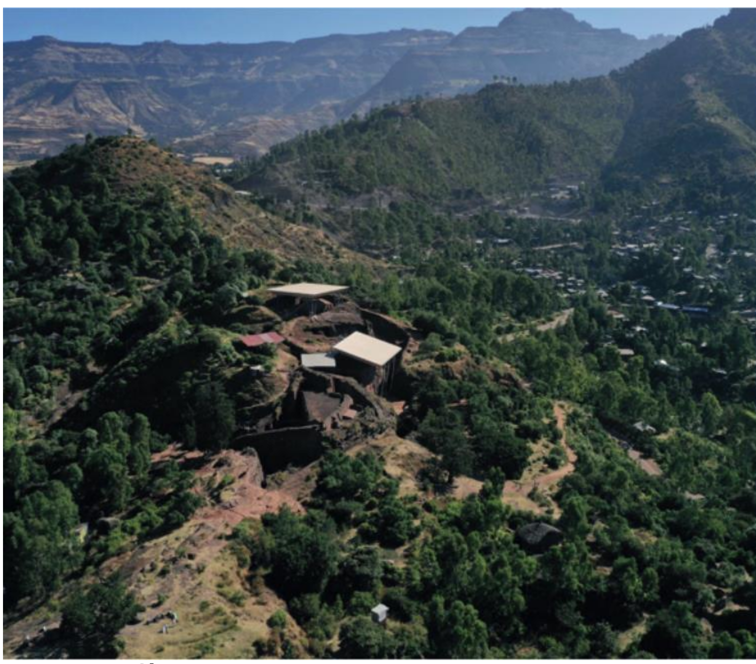


Figure 152: Biete Ghiorgis –
Figure 151: Group 2 – Existing shelters

Access trench leading to the church

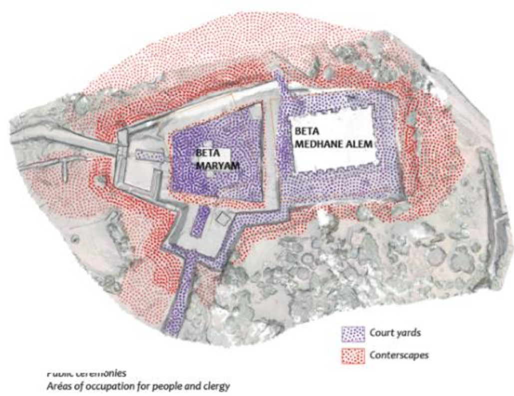
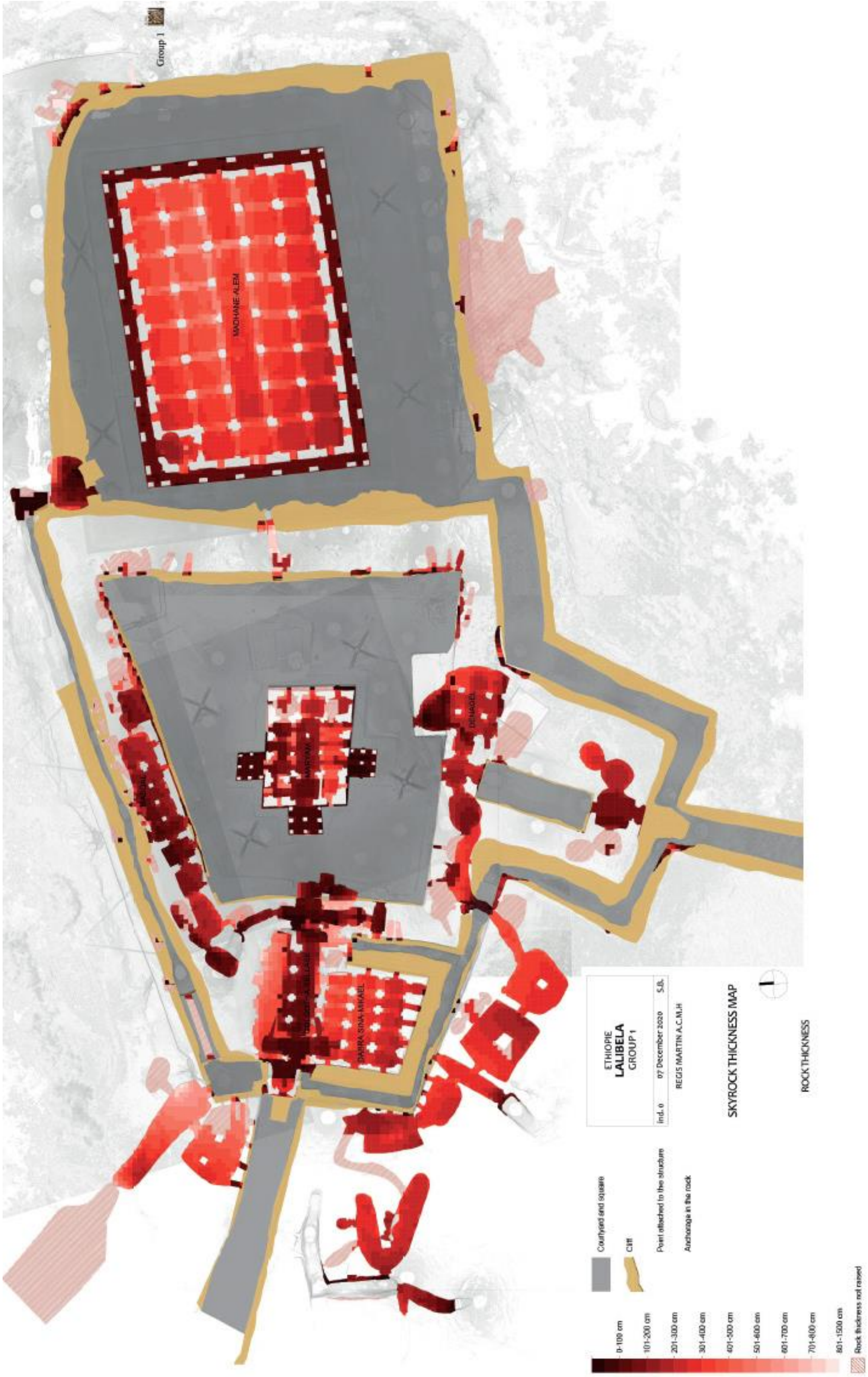



Figure 154: Group 1, public ceremonies, areas of
Figure 153
occupation for the faithful and the clergy

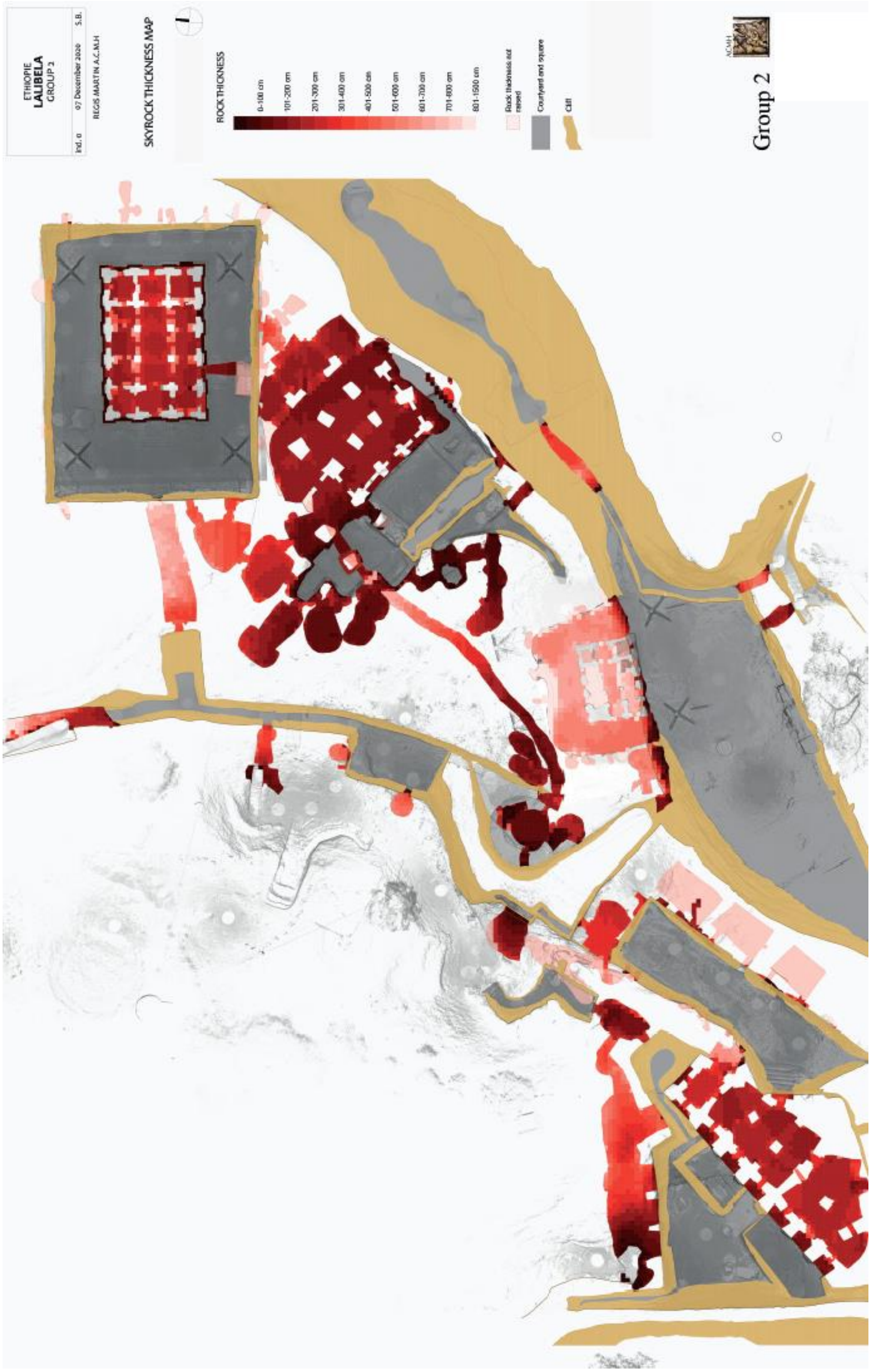
## 7.1. LAYOUT

From the three-dimensional point cloud produced by Archéovision in fall 2019, a map of the three church groups (figures 155 and 156) was extracted to designate the thicknesses of rocky roofs. A legend has been applied which indicates in gray the courtyards and trenches, in yellow the cliffs and ravines, and in a gradient of red and black the base rock fronts. The darkest is the thinnest. The fairest is the thickest. In white is a surface available for solid supports.

As a general rule and with few exceptions, supports on churches should be avoided. Supports in the courtyards should be removed in any event, as they are considered invasive and disruptive to the worship service (figure 157). Supports in the peripheral trenches are to be excluded due to the obstacle they could create for the fluidity of flows or the movement of people.


Group 1
MADHANE ALEM
ETHIOPIE
LALIBELA
GROUP 1
07 December 2020
REGIS MARTIN A.C.M.H
SKYROCK THICKNESS MAP
ROCK THICKNESS
Courtyard and square
Cliff
Point attached to the structure
Anchorage in the rock
0-100 cm
101-200 cm
201-300 cm
301-400 cm
401-500 cm
501-600 cm
601-700 cm
701-800 cm
801-1500 cm
Rock thickness not raised

138


ETHIOPIE
LALIBELA
GROUP 2
Ind. 0
07 December 2020
S.B.
REGIS MARTIN A.C.M.H
SKYROCK THICKNESS MAP
ROCK THICKNESS
0-100 cm
101-200 cm
201-300 cm
301-400 cm
401-500 cm
501-600 cm
601-700 cm
701-800 cm
801-1500 cm
Courtyard and square
Cliff
Group 2

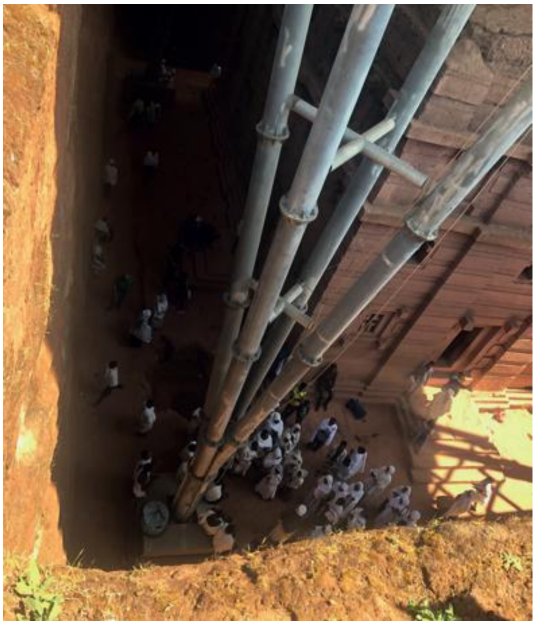


Figure 157

## 7.1.1. BIETE QEDDUS MERCOREUS (HOUSE OF ST. MERCOREOS)
**(Figures 158 and 159)**

The case of this church is one of the most delicate, since the rock is very altered not only on the churches themselves, but also in the surroundings. The positioning of supports is therefore a matter of great precision. In order to limit the span, it is possible to find a support on the ceiling of the closed church itself, provided that the load is well distributed. The protection can be extended along two slopes. East/West anchorages could be placed in the interstitial areas with Biete Abba Libanos and Biete Amanuel.

## 7.1.2. BIETE ABBA LIBANOS (HOUSE OF ABBOT LIBANOS)
**(Figures 160 and 161)**

The fragility of the hypogeum of Biete Abba Libanos is not related to the ceiling, as it is thick and stable. The risk of weathering is due to the water flowing from the rocky plateau to the façade. The project will establish a protection covering the upper platform to avoid infiltrations and create an overhang above the cliff.


Figure 158: Biete Qeddus Mercoreus – Roof plane


Figure 159: Biete Qeddus Mercoreus – Floor plane


Figure 160: Biete Abba Libanos – Roof plane

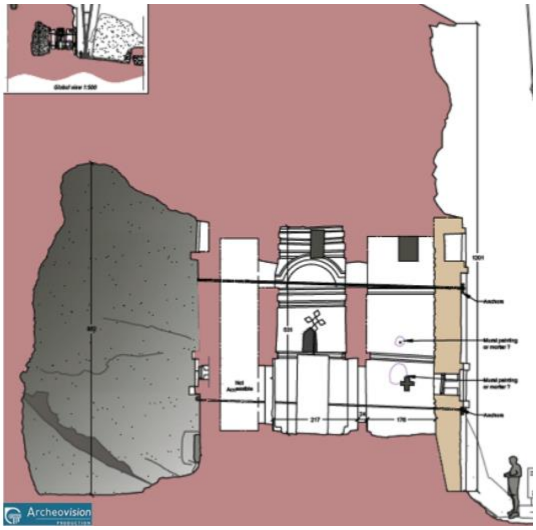



Figure 161: Biete Abba Libanos – Section

The shelter will be supported by a set of support points, spread out to form a homogeneous support at the edge of the rock. The protection will be sufficiently detached from the rock formation to allow ventilation and access to maintenance. If an anchorage is necessary, it can be done upstream on the preserved massifs of the old shelter but also over the cavities.

### 7.1.3. BIETE GABRIEL RAPHAEL (HOUSE OF GABRIEL RAPHAEL)

Part of the Biete Gabriel Raphael church was protected in 2016 without shelter, by means of a waterproofing membrane covered with an integration plaster. This coating ensures that the two main volumes are kept out of water, but does not cover the façades, whose erosion is nevertheless evident (figure 162), nor the courtyards with walls in poor condition and the annexed cavities whose roofs have partially collapsed (figure 163).

Furthermore, the degradation of the film-like layer of the coating has already started. It is necessary to create a protection that covers the front and back courtyards, resting on the longitudinal wall that separates the excavated complex in two. It is therefore a two-sided structure, of the same type as that of Biete Qeddus Mercoreus that will be installed. If necessary, the tension methods will also be mixed.


Figure 162: Biete Gabriel Raphael –
Figure 163: Collapse of the rocky roof at the entrance to the site

Erosion of façade cladding

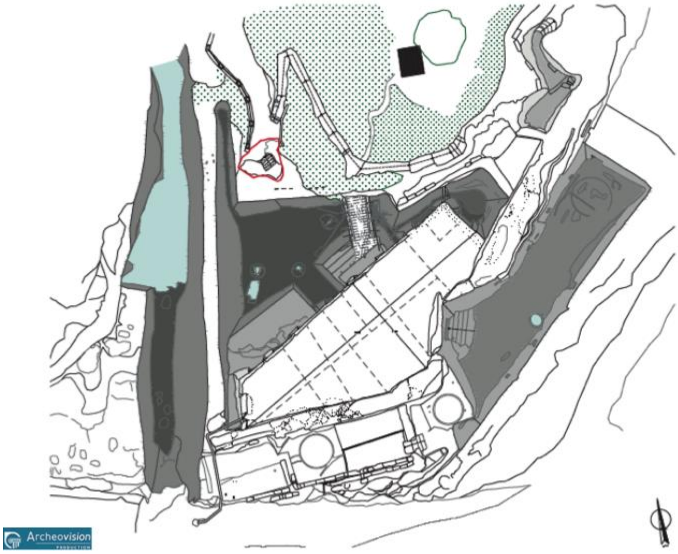


Figure 163: Biete Gabriel Raphael – Roof plane

Figure 164: Biete Gabriel Raphael – Floor plane

### 7.1.4. BIETE LEHEM (HOUSE OF HOLY BREAD) (Figure 165)

This church is the only one that still has a first generation shelter, i.e. made of eucalyptus poles mounted as scaffolding supporting a metal sheet roof. This protection is effective but fragile due to the sensitivity to pests. It is not satisfactory because the entanglement and density of timber hide most of the monument.

Due to its proximity to the previous site, the protection will be established as a direct extension of Biete Gabriel Raphael by implementing the same system.

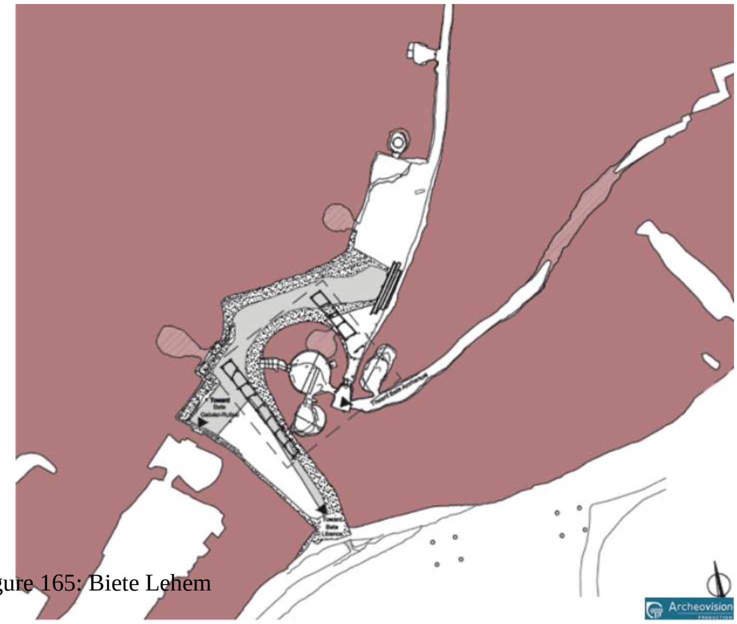



Figure 165: Biete Lehem

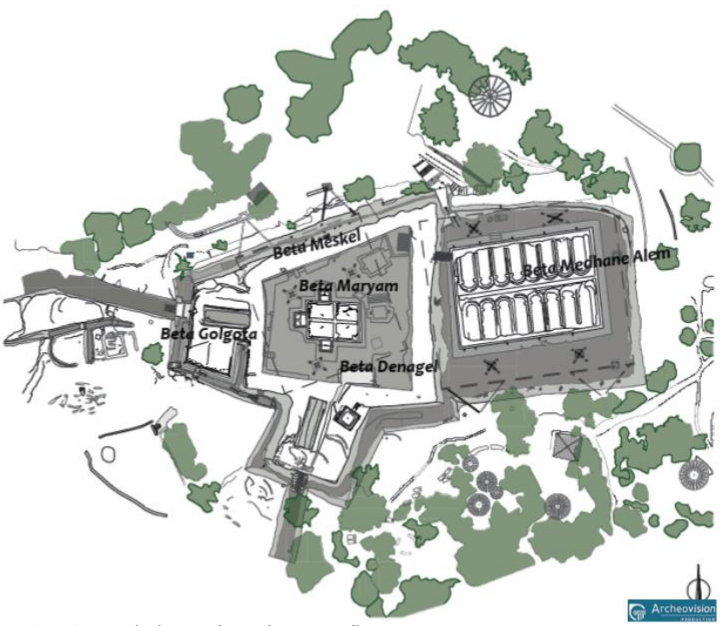




Figure 167: Ground plane of North sector floor – Aerial view

Figure 166: Ground plane of North sector – Aerial view

## 7.1.5. BIETE GOLGOTHA MIKAEL (HOUSE OF GOLGOTHA MIKAEL) (Figure 166)

The church of Biete Golgotha Mikael has been identified as the most vulnerable due to the presence of two superimposed shrines, wall paintings, the proximity to the trench drainage, and the absence of a shelter. The one for Biete Mariam only partially encroaches on its right of way (figure 167). Given the absence of a courtyard on three sides of the monument, it will be necessary to find support on the counterscarp. The difficulty of layout is compounded by the presence of under-ground cavities that cannot be seen from the surface. The mapping of these hollows prepared by the Archéovision team makes it possible to identify all the points of weakness (figure 168).

The protection of Biete Golgotha Mikael will be designed in close relation and as a direct extension of that of Biete Mariam (figure 169). Specific resting points may be considered on the northern crest of Biete Golgotha Mikael only in areas devoid of cavities. The protection of the church of Biete Golgotha Mikael, located in the lower part of the site, must not hinder the view of the ceremonies taking place on the crests of Biete Mariam. In fact, the crowd of people flock to the counterscarps to assist to them (figure 170).

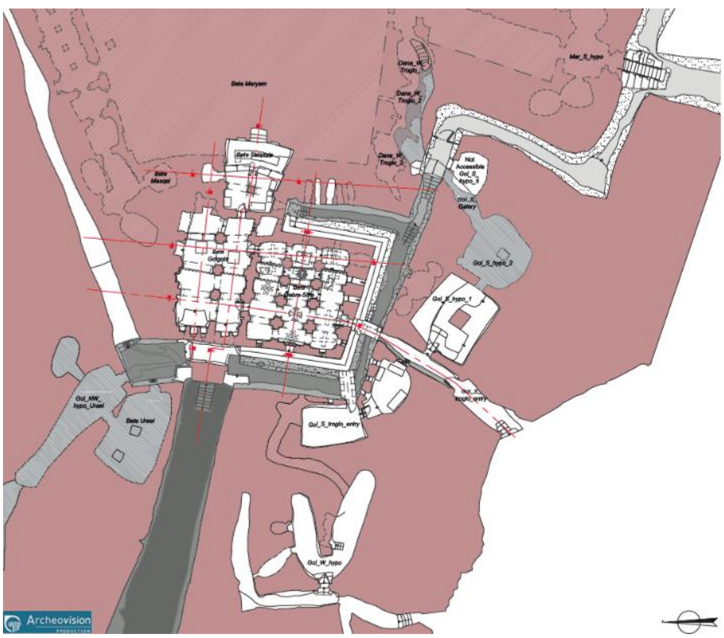



Figure 166: Biete Debre Sina


Figure 167: Biete Golgotha Mikael – Aerial view

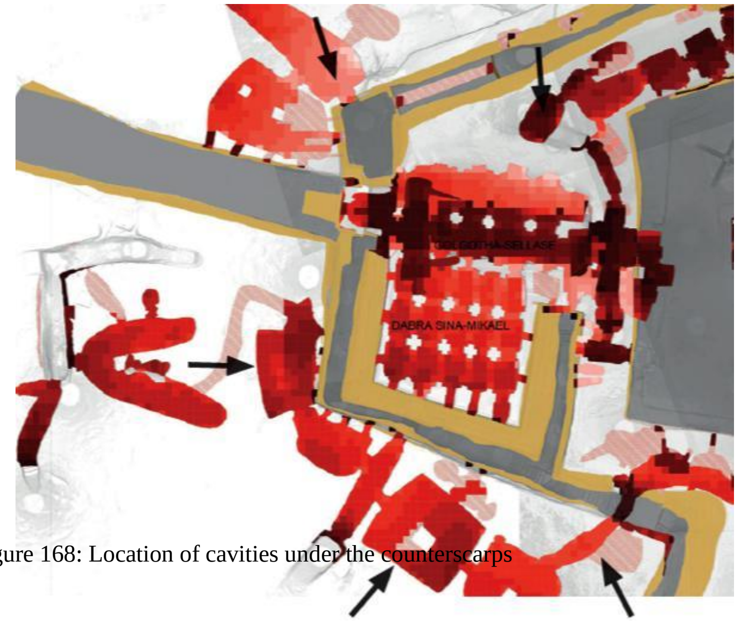



Figure 168: Location of cavities under the counterscarps

Figure 170: Biete Golgotha Mikael and Biete Debre
Figure 169: Clear southwestern edge of Biete Golgotha Mikael

Sina – Public standing in the vicinity

## 7.1.6. BIETE MEDHANI ALEM (HOUSE OF THE SAVIOUR OF THE WORLD), BIETE MARIAM (HOUSE OF MARY), BIETE MASKAL (HOUSE OF THE CROSS) (EXISTING SHELTERS)

**(Figures 171 and 172)**

For these three churches and their courtyards, which already benefit from shelters, the new pro-tection will be extended to counterscarps. The present perimeter covers only part of the exposed structures (figure 173). Shelter A does not protect the hypogeum church of Biete Denagel, located in the southern counterscarp of Biete Mariam. And the respective footprints of shelters A and B that are out of alignment with Biete Mariam and Biete Medhani Alem leave some of the courtyard spandrels unprotected.

The existing support points will not be reused. Their position in the courts is not favorable to religious practice. The distribution of the support points can be done on the adjoining wall of Biete Mariam. The principle will be the same for the three sites: supports placed on the ground will have a culminating point greater than or equal to that of the existing shelters. The shelters connected to one another without discontinuity will form a central layer.

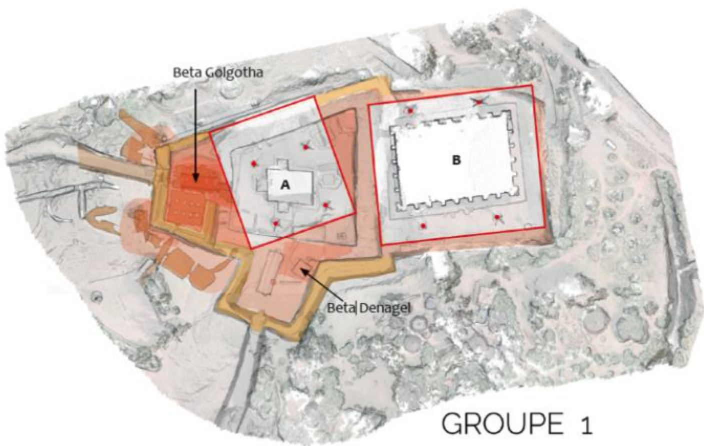



Figure 171: Group 1

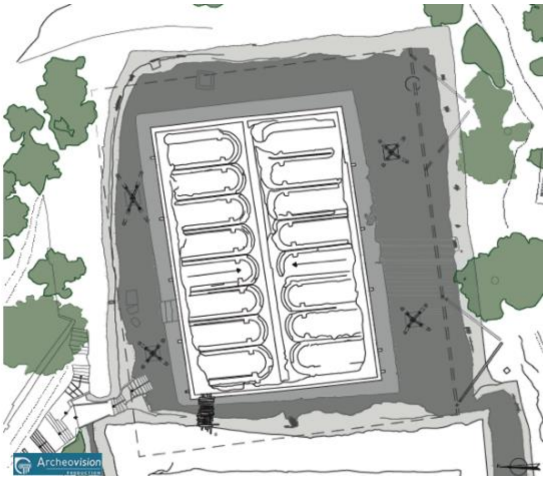



Figure 171: Biete Medhani Alem – Roof plan

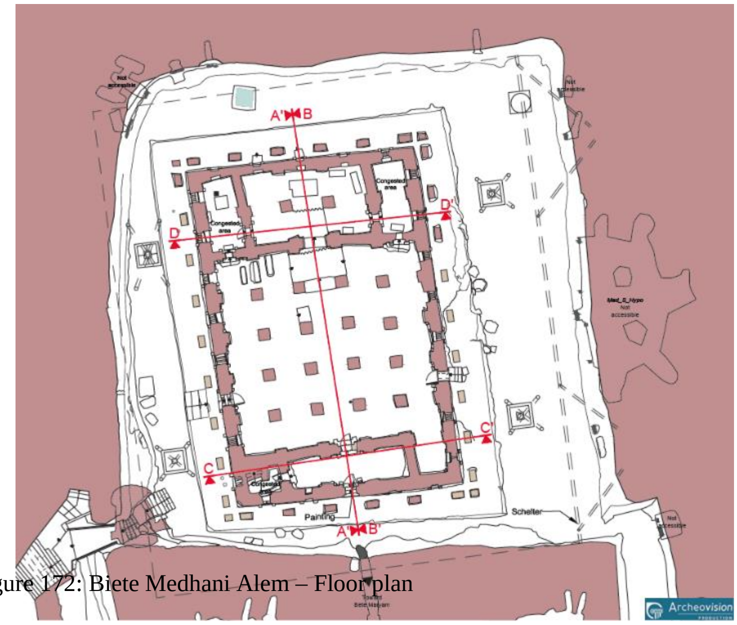



Figure 172: Biete Medhani Alem – Floor plan

## 7.1.7. BIETE DENAGEL (HOUSE OF VIRGINS)

As with Biete Golgotha Mikael, supports on the roof of the church itself are ruled out. The thickness of the rock is too thin. Support points can be considered around the edges of the trenches, including the open-air Biete Mariam courtyard entrance complex. The height of the protection should be slightly less than that of Biete Mariam, but sufficiently clear to allow for distant vision and the clergy wandering on the crests.

## 7.1.8. BIETE AMANUEL (HOUSE OF EMMANUEL)
**(Figure 175)**

The positioning of the Biete Amanuel shelter is undoubtedly the most relevant, the best sized and the most well integrated. (Figure 176) It is not possible to reuse and sustain the existing supports for the same reasons as in Group 1. However new supports can easily be found on the North, West and South counterscarps. This may prove to be a little difficult on the eastern side due to the shallow wall thickness on the trench side.



Figure 174: Ground plan of south sector floor –
Figure 173: Ground plan of south sector – Aerial view

Aerial view

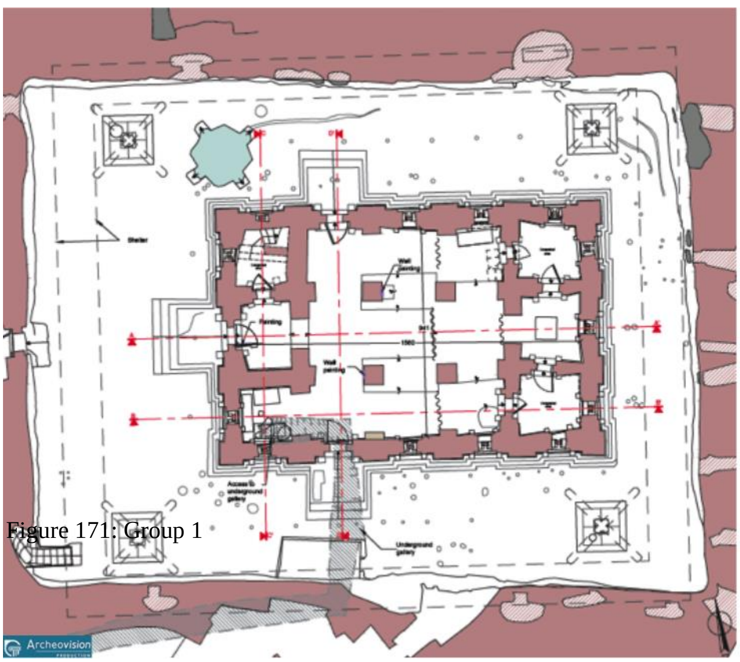



Figure 171: Group 1

Figure 175: Biete Amanuel – Floor plan

Figure 176: Biete Amanuel

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## 7.1.9. BIETE GHIORGIS (HOUSE OF ST. GEORGE)
**(Figures 178)**

The case of this isolated church is special because of its iconic character. The clear view of its cruciform roof pattern is key. It is both the best preserved monument and the one on which a permanent cover would be the most difficult to accept. The positioning of a shelter should match the centered character of the monument. A tight protection, which may be removed depending on the season, should be considered. Its movable character would require a lighter weight and a limited number of supports to overcome the constraints of the surrounding relief.

The surrounding plateau is clear and its gently sloping relief has few accidents. This feature is favorable to a temporary lateral movement of the shelter (figure 179).

The protection will be centered on the church itself. The coverage of the whole courtyard is less legitimate as the surroundings consist of bare rock inclined towards the cavity. It will not be possible to excavate the upstream part of this rock to collect run-off water. The principle of a minimal amount of rainfall entering the courtyard must be recognised.


Figure 178: Biete Ghiorgis – Floor plan

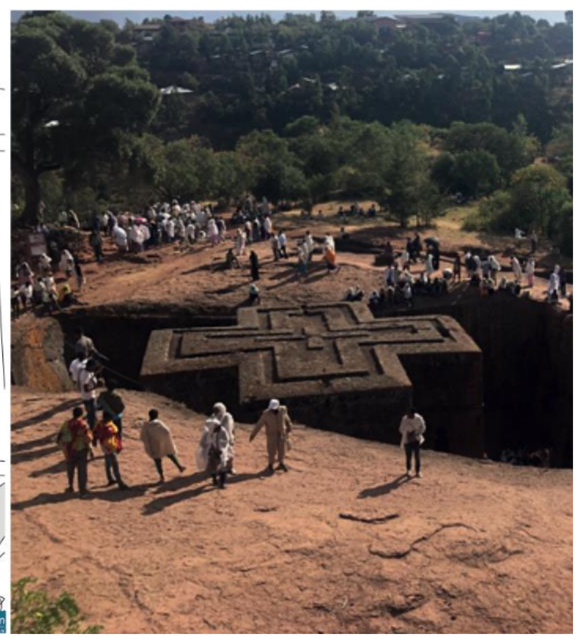
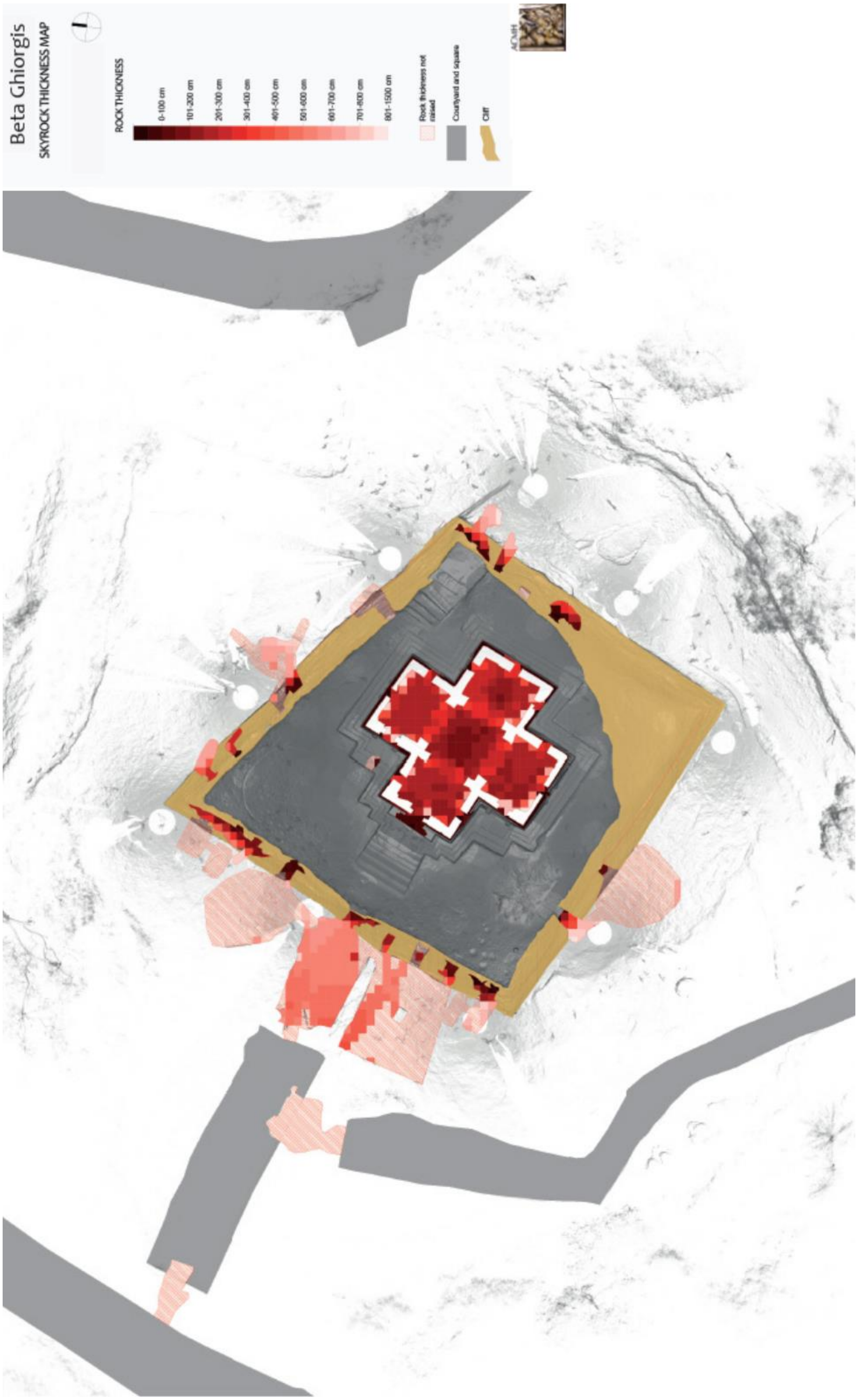


Figure 179: Biete Ghiorgis


Beta Ghiorgis
SKYROCK THICKNESS MAP
ROCK THICKNESS
0-100 cm
101-200 cm
201-300 cm
301-400 cm
401-500 cm
501-600 cm
601-700 cm
701-800 cm
801-1500 cm
Rock thickness not raised
Courtyard and square
Cliff

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## 7.2. STRUCTURE

The structures will be static and durable or renewable. The basic elements will be light or small in size so that they can be transported to the site without mechanized handling, preferably by hand due to topographical constraints and fragile access. The assemblies should be easy to reproduce and should employ artisanal or semi-industrial techniques. The material resource will be local or national. The distribution of loads will avoid punching.

The supports will be sized to withstand wind uplift stresses in line with the scales adopted by Ethiopian standards. The plannimetry of the bearing surfaces can only be obtained by the addition of material. Scouring is prohibited. For the application of base mortars, a prior decoupling by a geo-textile film will be necessary.

The design, and above all the maintenance of the new protection, must be compatible with the means and know-how of the local workforce, so that the construction constitutes by means of a transfer of skills, a training of professionals and youth from the region. The idea of a training worksite appeals to the local authorities. This approach will facilitate the appropriation of shelters and allow field workers to carry out routine maintenance, modifications, and adaptations that may be necessary for the functioning of the churches.

In the context of the dismantling of the existing shelters, consideration must be given to the future and possible recycling of parts of the existing structure. For the good management of the site, it is indeed preferable that the dismantled materials can be reused, because their state of conservation is overall satisfactory.

## 7.3. ANCHORAGE AND BALLAST

One of the challenges of the feasibility is the **possibility of creating anchorage points** in the bedrock beyond the trenches, to ensure the stability of the shelters. It is necessary to precisely locate the cavities that need to be avoided in the rocky horizon of the counterscarp. The point cloud estab-lished by Archéovision offers this possibility. The anchorages can be done in the ground and in any case, outside the perimeter of the churches. The technique of drilling with sealing will be chosen based on the tensile tests carried out at pullout.

The structure is dependent on the possibility of anchoring or not. In fact, the uplift stresses can reach up to 37.3 additional tons on a single shelter foot. These loads are such that, in the absence of anchoring in the rock, equivalent ballast must be placed on the ground. This leads to volumes that require the use of heavy materials such as reinforced concrete or steel, which are hardly compatible with the characteristics of the site. The following is an overview of the architectural proportions generated by the two techniques in the Biete Abba Libanos example (figure 181).

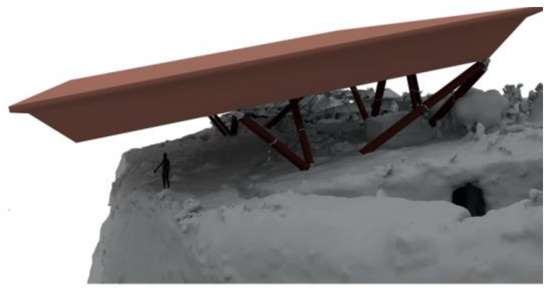
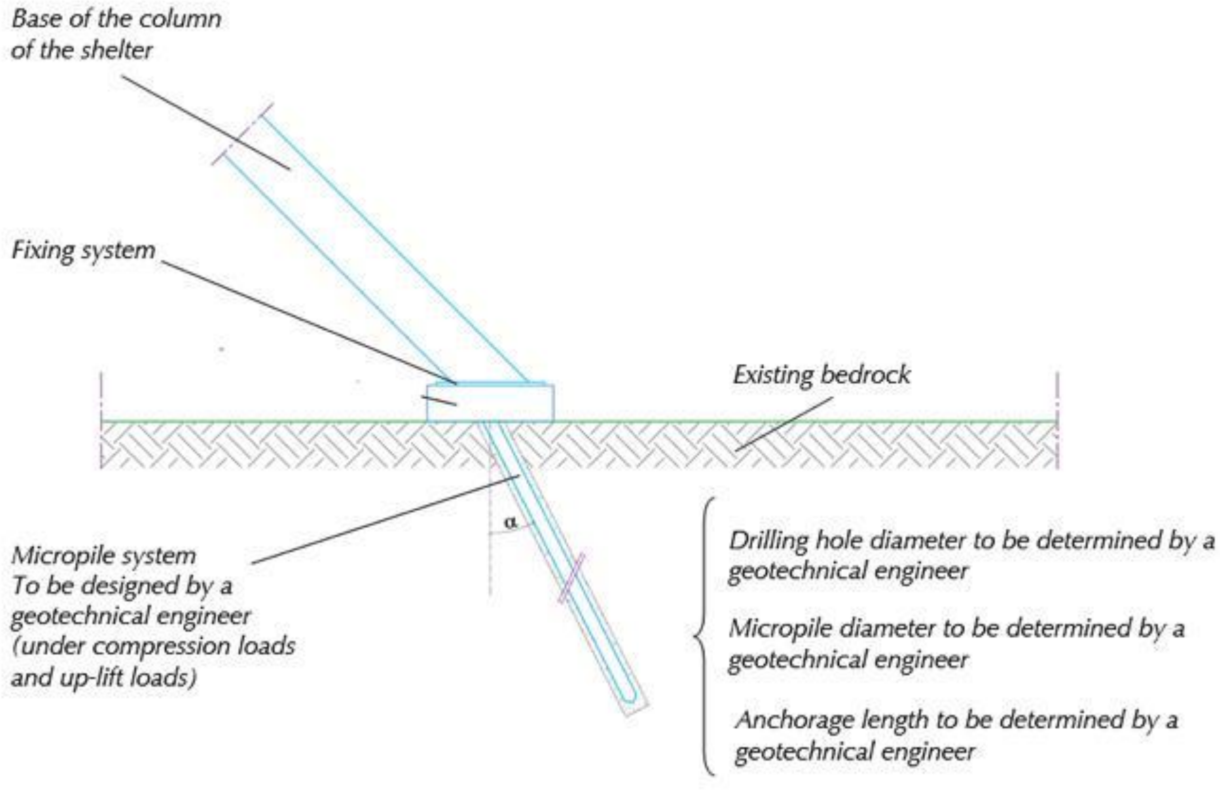


Figure 181: Biete Abba Libanos – With lest (without anchorage)

Anchorages also have an appreciable advantage in terms of compression. In the areas around a cavity or a crest of an escarpment, shifting to the bottom the very high forces generated by the weight of the supports can better control the pressure bulges in the surface rock. The risk of fragmentation and cracking of the surface rock, which was clearly demonstrated at the foot of Biete Abba Libanos, can thus be removed. Without the anchorages, heavy footings would have to be created in the open air in front of, or on top of, the historic ground.

**In order to achieve a lightness of design, anchorages are therefore more than desirable.**




The design (number, type, length, diameter, angle) of the micropiles depends on the loads to be calculated at the bases of the shelters.
Micropiles have to be designed by a geotechnical engineering office within the frame of a G5+G2AVP mission (geotechnical diagnosis + geotechnical design study in pre-project phase). On-site essays and investigations will have to be carried out by the geotechnical engineering office.
For information only, the design of the micropiles given in TEPRIN, 2001 was as followed:

- Micropile diameter: 73mm
- Drilling diameter: 160mm
- Maximum Length: 12m

Figure 182

«In order to minimize the architectural and technical impact of the shelters on the site, we plan to build anchors drilled in the bedrock. The lack of anchorage, the extent of the necessary protections, the small surfaces available to implant the supports, and the concerns of the locals associated with the wind effects, resulted in a heavy, invasive supports close to one another and not compatible with the expected visually light architecture of the shelters. Anchors would, therefore, allow well-targeted supports as well as taking advantage of the inertia of the rock. The uplift forces constraints would be compensated by the natural resistance to tearing.

This technique would enable to release the churches' courtyards from all the load bearing points/ counterweights that are currently installed inside and thus would allow to have finer columns forming wind-bracing.

The accurate mapping of the geomorphology shows the thickness of the rock at all points of the site. It gives an overview which defines in negative all the residual spaces available for the supports' installation. This tool, which is quite a landscape scan, provides excellent visibility on the location of cavities dug over the years. It is extracted from a 3D group of dots and allows implants to be placed in the rock with no risk of ever encountering hand-crafted work.

The technology uses diamond-headed rotary drilling without damaging vibration without water depending on the nature of the holes. Beyond a certain depth, it is possible to encounter stronger basaltic horizons and therefore a better anchoring capacity. The diameter will depend on the depth of the drilling and the efforts to be resumed. No lateral pull-out stress is envisaged due to the nature of the surface rock (scoriaceous basalt). All anchors will be calculated to work on friction according to their axis. The inclination will be defined according to this principle, and taking into account a safety bulb at a distance from the cavities. The length and diameter of the anchors will be limited as much as possible so that they are as minimally invasive as possible.

The number of drillings for a shelter would be on average 8 units. The number of shelters is estimated at a dozen in the long term.

Some tearing (pull-out) resistance tests will be required before implantation, these tests will have to be carried out as part of a geotechnical G5-G2 pre-project mission (geotechnical diagnosis and geotechnical study at a pre-project level). This geotechnical study will allow the prestressed ground anchors solution to be presized following the forces on the foot of the structures calculated by the structural engineering firm.

The issue of the invasive nature of the anchors is, in my opinion, legitimate, more for heritage

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reasons than for technical reasons that could affect the integrity of the rock. From an ethical point of view, the question is to know to what extent the subsoil, at depth, beyond the surfaces and parts visible and accessible to Man, is referenced as an integral part of a sanctuary area under the title of UNESCO World Heritage.

**Geological point of view:**

From a geological point of view, the probability this type of intrusive anchoring accentuates the fragility of the superimposed rock strata (flows) is very low if not negligible. These flows are of Oligocene-Miocene age (Renzulli et al., 2011), and these structures, like all geological layers or for-mations in natural outcrops - whether in an eruptive or sedimentary context - can't hardly be set in movement in their relative mass to each other, by shear or sliding, under the effect of drilling in the strict sense.

If opposite situations exist, they should be documented and brought to the attention of the scientific community. The seismic impact is a factor that could contribute to changing the state of stability. These interfaces (joints between flows) nevertheless constitute planes of permeable discon - tinuities and of greater fragility, which are preferential drainage zones and the seat of percolations and fluid circulation. It can be observed that joints in some parts of the site (Biete Abba Libanos, Bite Gabriel Raphael...) show more altered zones (dissolution). Punctual measurements of perme-ability, in the Darcy sense, carried out on very small samples (a few cubic centimeters) show values between 10-15 and 0.15 10-15 m², which is significant of moderate flows and mass transfers. These results should be buffered as they are surface measurements, obtained on altered samples, and a doubt persists as to the Representative Elemental Volume Tested (REV), including quarry samples.

Porosity and density values of scoriaceous basalts collected from church walls are also widely dispersed (1.51-1.97 g.cm-3), underlining the strong lateral variability of facies and petrophysi-cal properties at the micro and mesoscale, related to surface meteoric weathering. These values are to be compared with those of healthy scoriaceous basalt (2.04-2.16 g.cm-3) mentioned in the UNESCO report (2002).

**Technical and operational point of view:**

If a borehole were to cross a natural discontinuity (joint) and would then be partially filled with filling materials (micro-concrete type) during anchoring, the diffusion of the concrete would rather result in the re-solidification of the interfaces, by insinuating itself into the interstices. The risk of groundwater pollution seems negligible with regard to the volumes considered. The resurgence of solutions enriched by the soluble elements of the hydraulic binders, likely to generate salt crystalliza-tions must be considered, especially if the outlet points are identified and close to the facades. The envisaged method is not innovative and is similar to the techniques for stabilizing unstable natural rockfill, implemented in the field of underground structures (tunnels) but also in the field of heritage sites. The most significant example is the case of the injection and then stabilization of the soil beneath the Mont Saint Michel -already mentioned-, also classified as a UNESCO World Heritage Site in 1979.

On the other hand, it seems useful, depending on the zones where the planned anchorages are to be located, that a preliminary geophysical reconnaissance be carried out in order to reveal the possible existence, upstream, of near-surface discontinuities that could be affected by the anchorag-es. This is mainly the case for the roof of Biete Abba Libanos.»

Contribution to the analysis of the impact of anchorage Jean
Didier Mertz (LRMH/ Lalibela Rock PAthology Team)

**Göbekli Tepe**

- Neolithic site from 10th and 9th century BC – Turkey
- World Heritage Site (2018)
- Implementation 2019
- Objective: To provide long-term protection for the remains and the excavators and to facili-tate the presentation of the findings to the public.
- Specifications:
  - o Metal structure in accordance with the site topography
  - o Anchoring with micropiles

o Geological support made up of a bed of rock limestone (Germus mountain range)

Anchorages are often used in historical monuments and in particular on archaeological sites.

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Figure 183

**Saint Maurice abbey**

- Site from 4th century – Switzerland
- Swiss Heritage Site
- Implementation 2010
- Architect: Savioz Fabrizzi Architecte Design office: Alpatec SA – Martigny
- Objective: Roofing of the archaeological ruins of the Saint Maurice Abbey to protect them from falling rocks
- Specifications:
  - o Main cross-beams on three supports
  - o Three main beams supported on two points anchored in the rock wall with tie rods
  - o Suspended roof carrying 170 tons of stones for ballast

**Tombs of the Kings**

- Jerusalem
- Implementation 2017
- Architect: Michel Goutal (ICOMOS expert)
- Objective: Construction of a metal support structure for the vestibule
- Specifications:
  - o Methane semi-portal for natural rocks reinforcement with 5 anchors in the back wall of the vestibule

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o Construction of right foot with anchoring by tie rods

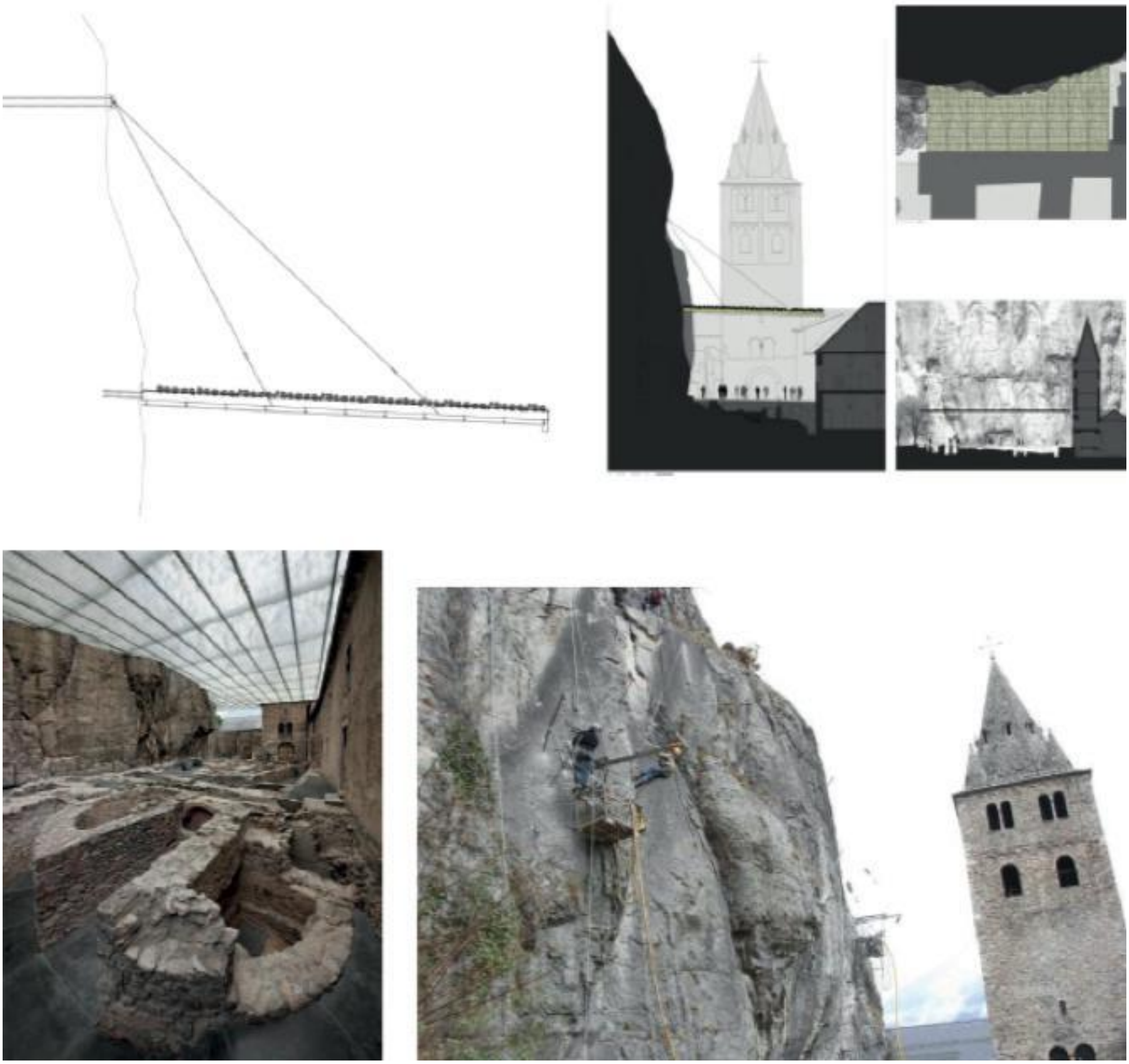

Figure 184

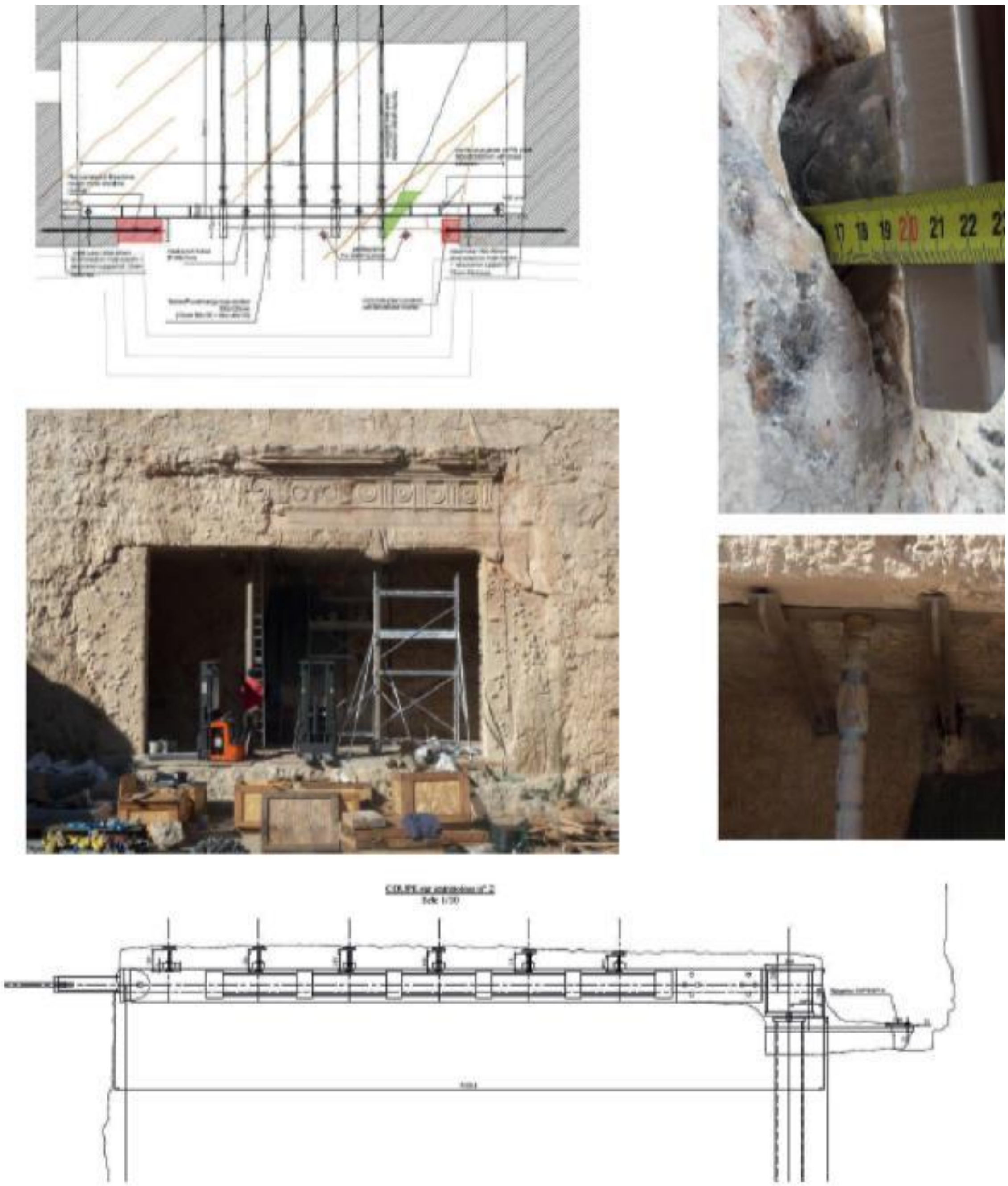

Figure 185

## 7.4. MATERIAL

The materials used must demonstrate strenght and durability. Timber, a traditional athough locally scarce material and bamboo, which is more abundant, enjoy a certain appreciation insofar as the species chosen do not conflict symbolically with the sacred character of the churches. They can be used for the support structures of the protection. Distribution plates would cushion the impact of the support points.

Bamboo, which is particularly resistant, could also be suitable if it is carefully handled. Mixed structures with partial metal reinforcement are also possible. For the stability in case of fire, the timber must be used in a relatively solid section or receive a fireproofing treatment.

## 7.5. COVERAGE

Coverage should be extended to all vulnerable parts of the site. The master plan will be driven by this objective of efficiency. It should have a flexibility of shape adapted to that of the terrain. Conti-nuity of coverage on the same group should be sought to reduce the risk of residual seepage (figures 186, 187 and 188).

A stretched or unfloded membrane covering is recommended as it combines lightness and re-versibility. Based on punctual or linear support points, a stretched textile could be deployed over the churches. The texture of the covering would be a stretched canvas of the VALMEX MEHATOP N type or similar, more or less identical to that used on existing shelters. The lifespan of the textiles is thirty to forty years depending on the climatic constraints and the quality of maintenance.

The demounting and replacement of a stretched or laid film must be possible without affecting the structure. The possibility of seasonal installation can be planed occasionally: installation for the rainy season, and removal, putting away and storage during the dry season. This option can only concern a shelter of reduced size like that of Biete Ghiorgis. The other sites are too large to allow any mobility whatsoever.

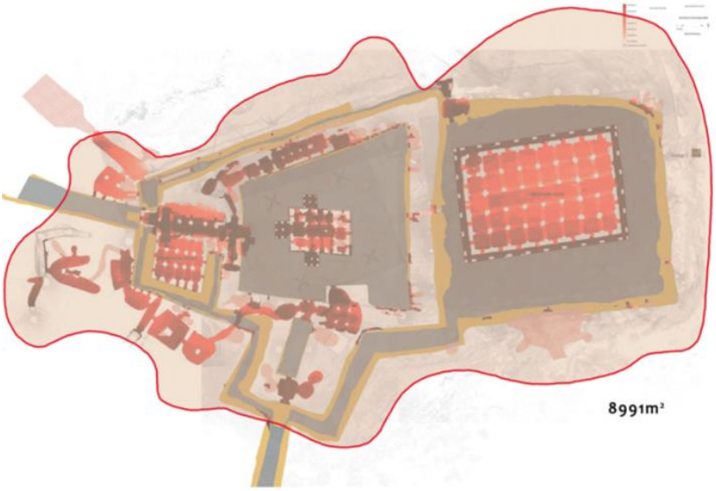



Figure 186: Group 1 Figure 187: Group 2

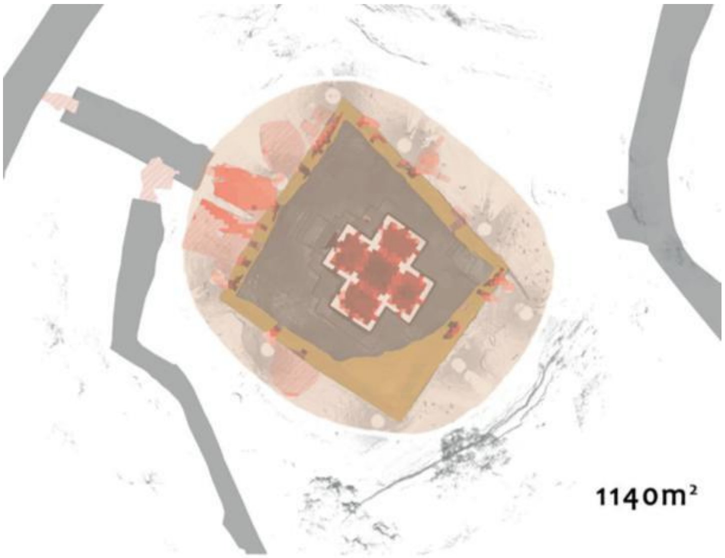


Figure 188: Group 3

# 7.6. SLOPES

The slope lines of the umbrellas will define points of convergence of the flows where the concen-tration of water must be controlled. The approach adopted in the case of the existing shelters was to follow the steepest slope of the natural terrain. This technique was determined by the planimetry of the roofs. It had the disadvantage of accumulating the entire surface of the slope and requiring gutters at the downstream edge (figure 189). The slopes must allow resonable accessibility for main-tenance and possible removal of waterproofing coatings. All precautions must be taken to prevent the public from accessing to the roof slopes from the ground.

One particular low point poses a problem. It is located in the northern outer trench of Group 1. An obstacle formed by a transverse facility at the bottom of the trench obstructs the flow to a point where the level of the Biete Golgotha Mikael church is located below. It is therefore preferable to limit as much as possible the water, which will flow to this place (figure 190). This constraint means that the general slope of the shelters in Group 1 will be directed towards the South in order to divert the flows towards the lower part of the Biete Denagel entrance.

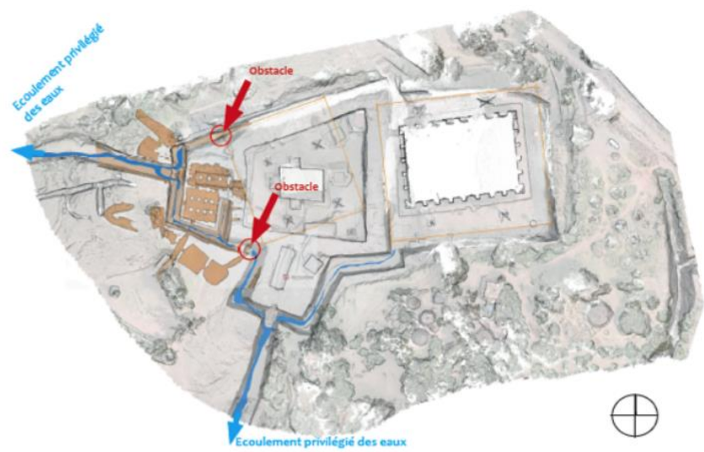


Figure 189: Biete Amanuel – Rainwater drainage pipes in the eastern trench

Figure 190: Group 1 relief

# 7.7. RAIN

The priority is to divert the flow of collected water, beyond the inner courtyards, into the trenches intended for this purpose, and where the profiles have been studied for rapid evacuation towards the low points of the site.

The collection of roof sewers can be done either through outlets or on a free linear fashion. One of the weak points of the existing shelters was the aesthetic interference of the rainwater outlets (figure 191). Indeed, the rainwater downpipes altered their general silhouette. The principle of dispersing water freely in the trenches in the immediate vicinity appears to be the simplest and maintenance-free. However, it does require an increase in the footprint of the umbrellas to reach trenches vertically.

If the slopes overlap, even partially, it will be possible to transfer the water from the covering slope onto the covered slope. The architectural design will establish one or more low points for rainwater runoff with, depending on the case, adjoining or opposite slopes. In any case, the water will be sent away from the courtyards via the velum, directly into the peripheral drainage trenches.

The flow counteracts the topography when it is located upstream of the churches. This is the case for Biete Medhani Alem, Biete Amanuel and Biete Abba Libanos. In these configurations, an upstream drainage is necessary to block natural runoff from the slope. Such gutters have been created by means of a low embankment. They are satisfactory. The extension of the upstream cover will make such precaution unnecessary on Biete Abba Libanos.

Figure 191: Impact of the downspouts on the architectural perception of the shelters

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## 7.8. COLOUR

The impact of colour in the landscape is one of the best factors for integration (figure 192). The environment of the churches varies between the seasons, but it is dominated by the natural hue of the rock. If the colour of the protection were close to it, a substantial aesthetic gain would be attained. For the visible surfaces, it is suggested that the colors Camel or Hemp from the Serge Ferrari Precontraint 502 satin canvas colour chart be used.

Figure 192

## 7.9. PROTECTION FROM BIRDS

The configuration of the supporting structures must take into account the nesting phenomenon of birds that occurs on all sub-horizontal structures. Churches must be protected from droppings as well as bad weather. The project will eventually allow the deployment of nets stretched over the underside, intended to prevent this risk. The shape of this netting must be in keeping with the archi-tectural concept and its geometry should contribute to the final aesthetic.

A plenum is formed, between the underside and the stretched canvas, as in the current case. This "suspended ceiling" must remain accessible through one or more access openings. In any case, the

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absence of a nesting point would be preferable.

## 7.10. ACOUSTICS

Experience has shown that large structures deployed over the site can cause resonance with the wind and create noise disturbance. This constraint must be considered in the design of the structures with the help of an acoustician. The period of strong winds in the May should serve as a reference for measurements and modelling of possible noise pollution. Observations showed that the use of metal in the design of structures was an acoustic disadvantage due to the low vibration reduction.

## 7.11. HIGH AND LOW VOLTAGE

The sites must be artificially lit via the shelters by means of underside lighting, for the nighttime display of the monuments, as is already the case for the lighting of religious celebrations on the churches of Group 1 (figure 193) and on Biete Ammanuel (figure 194). Electrical networks and lighting must be integrated into the construction of shelters. A sound system must be distributed throughout the shelter structures.

Figure 193: Group 1

Figure 194: Biete Amanuel

# 7.12. NATURAL LIGHTING AND VISUAL CLEARANCE

The shape of the shelters should allow side views to offer visual gaps. Above all, it should allow the faithful to see the celebrations from the edges. Roof drains should be high enough to enable the clergy to stand on the counterscarps edges in the courtyards (figure 195).

The memberane material must provide a sufficient level of transparency to allow natural light without creating a greenhouse effect or unwanted reflection. Glass products should be excluded. If the coverage is not translucent enough, openings must be created in the slopes to avoid dark areas.

Figure 195

# References and Proposals

Among the constructive principles which appear to be the most suitable, three general principles are possible: 1 the plateau, 2 the stretched velum, 3 the canopy.

## 8.1. STRETCHED VELUM

The stretched canvas that evokes the tent of the nomad, may meet the expectations of local authorities. The main advantage of this architectural principle is its lightness and the reference to well-identified cultural heritage. It avoids the heavy appearance of weight-structures, and the con-frontation of an industrial vocabulary with a vernacular site. Moreover, it offers great geometric flexibility. It does not oppose the regularity of a rigid grid with the irregular shapes of the churches and the accidents of the site morphology.

The disadvantage of this process is the almost mandatory use of a metal frame to absorb the high forces required for the peripheral tension of the membrane (figure 196). There are mobile velums.
But they require masts almost as high as the wingspan spread by the canvas, and cables anchored in the ground (figure 197).

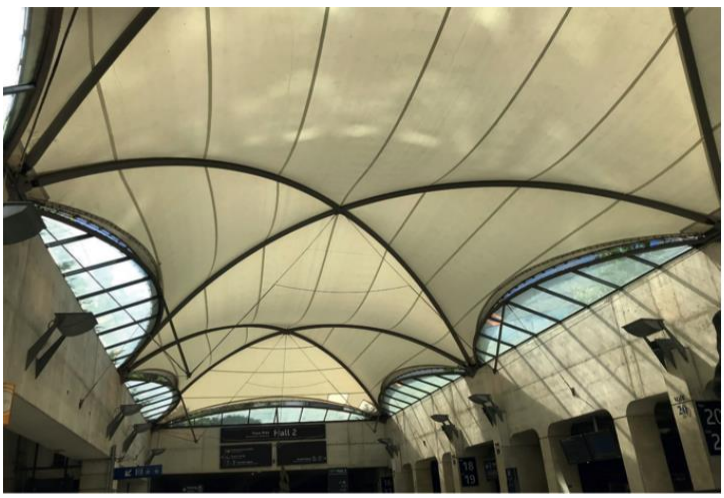


Figure 196: Strectched velum on metal structure

Figure 197: Velum supported by cables and central mast

The eventual impossibility of anchorage of this option would make the equilibrium of such structures conditional on the installation of very present counterweights (figure 198).

A velum type of protection was the subject of a prefiguration on the Biete Abba Libanos site, as it remained of small proportions and made it possible to experiment with the creation of a set placed on posts (figures 199, 200 and 201). See Appendix

Figure 198: Stretched velum on an archeological site with ballast (without anchorage) – BIBRACTE (France)

Figure 199: Prefiguration with anchorage seen from the parvis

Figure 200: Biete Abba Libanos – Prefiguration seen from the rocky plateau

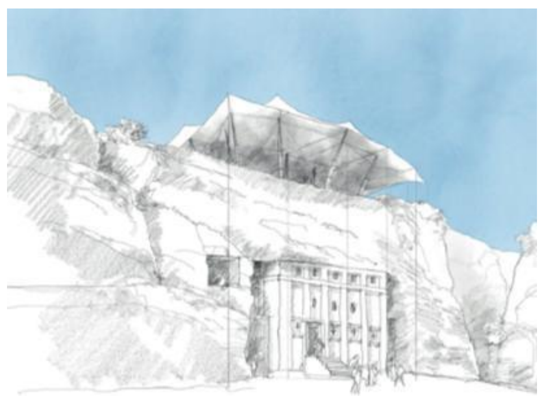


Figure 201: Biete Abba Libanos – Prefiguration project stretched canvas

## 8.2. PLATFORM

The plateaus can be arranged by articulation or juxtaposition (figure 202), building a composition that combines repetition, changes in scale and different inclinations. The plateaus are rigid but take a simple geometric shape (figure 203). The existing shelters are of the plateau family.

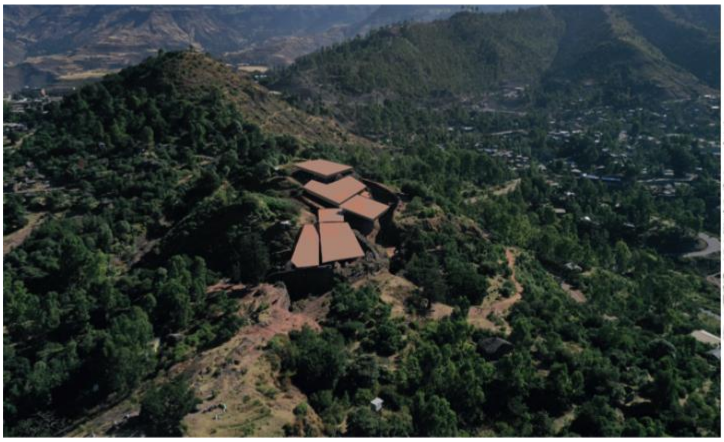


Figure 202: Extension of plateforms on Group 2

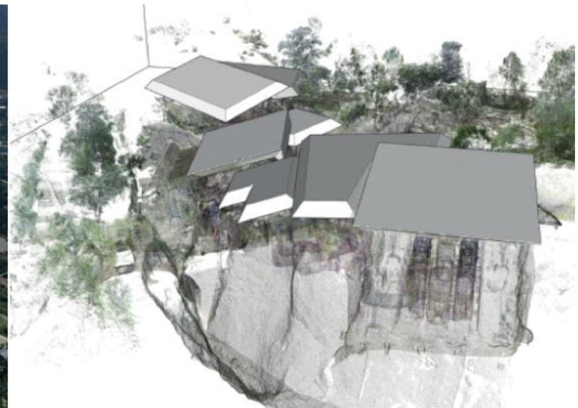


Figure 203: Sketch of the architectural composition on Group 2

The continuation of this principle and its extension to other sites has the advantage of pursuing an idea already validated with experience and easy to verify by calculation. Psychologically, the per-ception of this option could on the contrary be a disadvantage compared to the perception of the local communities.

The existing platforms have a great design quality because they are perfectly adjustable. They can be extended or reduced in both plan dimensions. They offer a variety of support points through the multiple connection nodes.

For the supports, a model of twin bars is proposed, which refines the outline while maintaining a resistance equal to or greater than that, which existed (figure 204). The layout will be complete-ly renewed because the idea of supports in the courtyards has been ruled out (figure 205). All the support points will be found on the counterscarps.

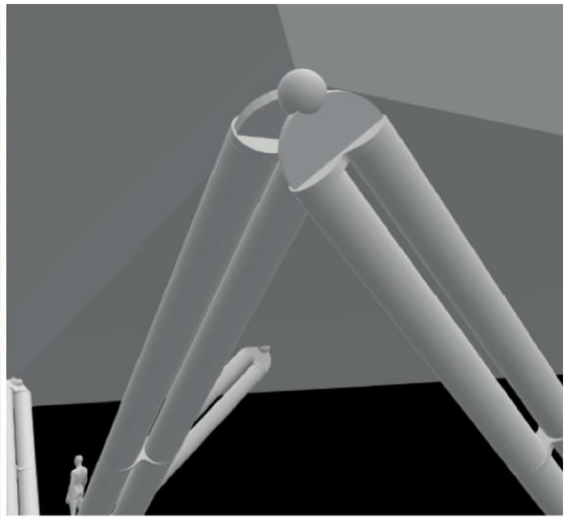


Figure 204: Support of panels for plateau shelters

*Beta Libanos - project with anchorage*

Figure 205: Biete Abba Libanos – current shelter/project with anchorage

# 8.3. CANOPY

## 8.3.1. PRINCIPLE

The canopy structures draw inspiration from nature through bio-mimicry. The forms are rather organic (figure 206) or crystallographic. The principle is that of a continuous veil with a flexible but fixed allure, which can extend over the entire group, adapting to the slope of the terrain with nerve lines.

It has many advantages, and it meets most of the requirements of the technical specifications:

- The integration into the landscape is made easy by the smoothness of the shapes and the adherence to contour lines. The architecture is similar to vernacular constructions of natural habitat.
- The continuity of coverage is ensured between different churches.
- It is possible to have the structure placed directly on the rock by lowering the structure profile at set points that define the shape.
- The large distribution surface reduces the effects of punching.
- Due to the gentle slopes, it is possible to climb onto the structure to install the waterproof membrane and to remove it occasionally.
- The maintenance is made easier. To ensure curve stops, wind stability, minimize attachment points; low areas may accomodate permanent ballast.
- The system can be bulky without resorting to heavy elements. The shape of the mat is compatible with ballasting or anchoring.
- The construction can be comprised of small, light, repetitive elements, with simple assembly, which avoids mechanical handling and its difficulties in accessing the site.
- The solidity of the structure is obtained by a combination of weaknesses rather than concentrated points of resistance and is inherently earthquake resistant.
- Cantilevers are possible. The structure is light.
- The structural principle is compatible with all natural, fibrous, metallic or organic materials, especially timber.
- The structure can be adapted on a small scale to the particular case of Biete Ghiorgis in a mobile way due to its lightness. After uncovering, the lightened dome could be moved to the side of the monument.

Figure 206: ICD ITKE Stuttgart

## 8.3.2. REFERENCES AND MATERIALS

Many canopy-type structures exist around the world today. We can cite that of the British Museum (QE II great court) by Norman Foster (figure 207), that of the Visconti courtyard at the Louvre by Rudy Riccotti which are made of glass and metal (figure 208).
In a context closer to sustainable development, there are canopies made in timber and stretched canvas such as the Pompidou Centre in Metz (Shigeru Ban) (figure 209)
These contemporary architectures are an industrial-scale version of a concept that exists in tra-ditional constructions based on small modules and plant fiber. Using small diameter stems (between 3 and 15cm), the plaiting of mats allows for spans of up to 50 metres. This common practice in Oceania and Asia is not foreign to Ethiopia. There, on a smaller scale but extremely popular, is ver-nacular practice of plaited plant material. Timber and bamboo can be used in a mixed constructive manner here.

Figure 207: British Museum - London

Figure 208: Louvre Museum – Paris

Figure 209: Centre Pompidou - Metz

## 8.3.3. PREFIGURATION ON GROUP 2

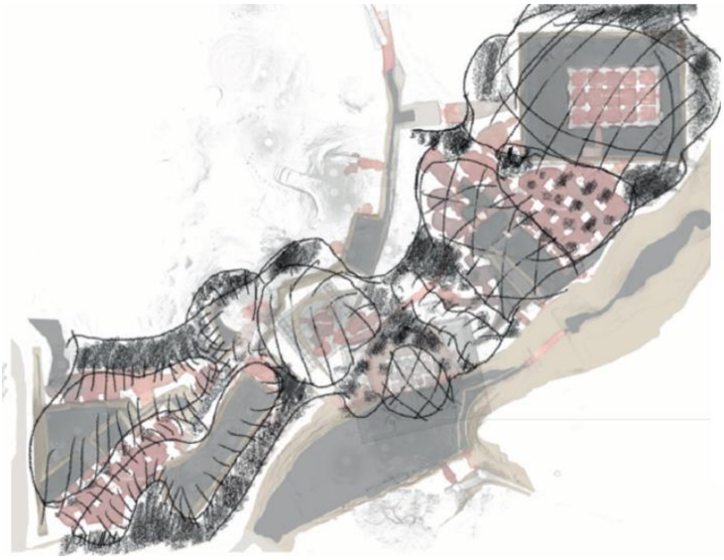
Based on the mapping of rock thicknesses and the fragility of surface horizons, a total of 24 support points distributed around the periphery of the site is proposed (figure 210). The fragile zones are cleared by means of mat folding, which is either dome-shaped or an undulating (figures 211 and 212).

To provide views or preserve an acceptable level of natural light, openings are made in the curved slopes of the canopy (figure 213).

The design will conform to a layout logic, which will be defined by the forces to be supported on the one hand, and the area to be covered on the other. Three levels of structure are considered. A first layer of thick veins of heavy section will be placed on the underside. A second layer of medium caning is placed on top. A third thin, light plaited layer will close the holes of the polygon. The stretched tarpaulin will be laid as the final waterproof layer.

The alternating convex and concave curves create natural receptacles for rainwater, which can be used to hold ballast or to connect to the lower level. Some surfaces such as the upper plateaus of Biete Qeddus Mercoreus and Biete Abba Libanos, which are devoid of traffic will be covered by the canopy directly placed on the natural ground. This covering, and the overall sloping appearance of the architecture will reduce the general wind resistance.

The structure will have an optimal reaction to seismic events.



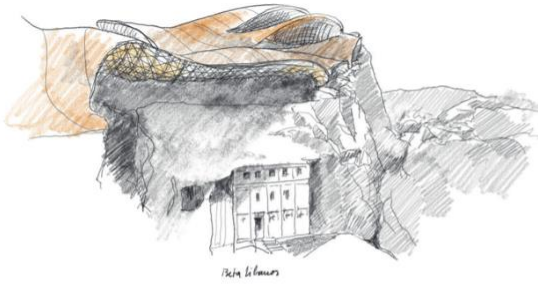
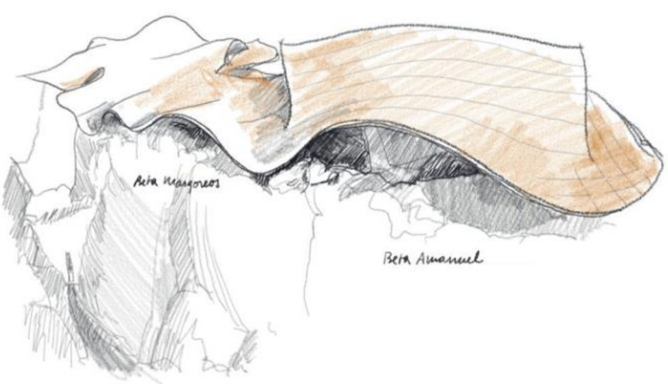


Figure 210: Layout sketch on Group 2   Figure 211: Biete Abba Libanos



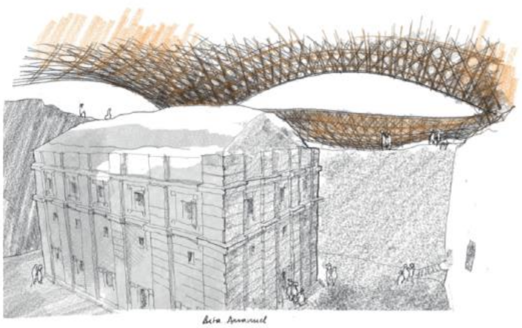


Figure 212: Biete Qeddus Mercoreus and Biete Abba Libanos

Figure 213: Biete Amanuel

Figure 214

## 8.3.4. IMPLEMENTATION

The implementation will be carried out by means of a general scaffolding, which covers the entire site and whose peaks will be set in accordance with the project by a surveyor who will set spatial po-sitional markers. The guiding lines of the primary layer will be laid out on this grid. The other two layers will then be installed from bottom to the top up to the ridge. The steems will be tied using a process that will not change over time. The supply of the stems will be done as the project progress-es, with quality control, sorting of sections and sizing on site. Workers who will climb directly onto the canopy will roll out the canvas layer from the top onto the sides.

The waterproofing and drains will be installed in the lower basins of the structure.

The design, execution and maintenance of the structure will depend on local resources, dedicated human resources, with little technological transfer. The training of teams can be implemented quickly. The execution is not subject to any import, manufacturing or industrial process hazards, except for the bamboo conservation process. The techniques as well as the materials are durable and guarantee longevity. The added value is the human factor: the geometry will be innovative because its design will be computer-assisted, but its basic technology remains ancient.

## 8.3.5. RESOURCE

Ethiopia has a bamboo reserve estimated at 1 million hectares, or 67% of Africa's bamboo resources and 7% of world's reserves. The bamboo reserves are of a major environmental impor-tance in the country, which has a large forest coverage.

Bamboo species mainly present:

1. **Oldeania alpina** (English: Yushania alpine), a species endemic to the African mountains, it is frequently used in the construction of huts, fences as well as for furniture and piping. The stems can reach 20m high and 12.5cm in diameter.
2. **Oxytenantheria abyssinica**, a species endemic to the African tropics, it is frequently used in construction (huts, fencing) and for scaffolding. The stems can reach 10m high and 10cm in diameter.

**Advantages:**
- Lightness
- Good mechanical resistance
- Local production and positive ecological impact

**Disadvantages:**
- Vulnerable to biological attacks
- Dimensional variations

**Programmes and institutional organisations in Ethiopia**
**Ethiopia is a member of INBAR** (the International Bamboo and Rattan Organisation, affili-ated to the UN) and as such participates to GABAR (Global Assessment of Bamboo and Rattan)

**Participates in the Sustainable Land Management Program (SLMP)** founded by the World Bank. This sustainable land management programme, managed at the national level by the Ministry of Agriculture, includes an assessement of the bamboo's potential for land regeneration and the launch of a national programme for bamboo exploitation. Since 2013, the government has planned to increase its bamboo cover to two million hectares in five years.

## Technical specifications of bamboo:

| Characteristics | Bamboo | Oak | Pine | Concrete | Comments |
|---|---|---|---|---|---|
| Density (kg/m3) Information on the amount of material in the sample | 580-700 | 700 | 530 | 2400 | The higher the density, the stronger the material |
| Ultimate stress in axial tension [MPa] | 240 | 90 | 100 | 2 | Bamboo is almost three times more resistant to elongation than oak |
| Ultimate Stress in Axial Compression [MPa] | 80 | 58 | 50 | 25 | Used to predict the behaviour of the compressed areas that will have to bear loads |
| Young's modulus in bending [MPa] The deformation of the material subjected to a load is a function of the Young's modulus | 14000 | 13000 | 12000 | 24000 | The measurement provides information on the stiffness or flexibility of the material (performed on 1 m of bamboo) |
| Production energy (MJ/m3) Energy spent to produce the material | 30 | 80 | 80 | 240 | Production and processing of the material |
| Fail Safe Coefficient Expresses the ability to withstand very high external accidental stresses | 50 | 20 | 20 | 10 | This is for example in the case of earthquakes |

**Eastern Africa Bamboo Project (EABP):** an Addis Ababa based association for the promotion and development of a sustainable production and use of bamboo by-products in East Africa. The specific objectives are: 1 To improve the technology and know-how in bamboo processing, 2 To develop production 3 To improve the tectonics, functionality and quality of products to diversify market opportunities.

The site of Lalibela must be considered as a vast archaeological area, with all its known living and sacred components. There is a major archaeological potential under the rubble accumulated near the churches during the excavations from the 13th century. This is often ignored since these are not, a priori, new sanctuaries. The oldest settlement dates back to at least the 11th century.

Churches should be understood not as architecture, but as sculpture. The rock that makes up these sculptures is unstable to water. There is only water for four months of the year, but that is enough to put them at risk.

The restorations of the 20th century had left lasting and often regrettable traces on the epidermis. The general conservation of the monuments is today contrasted. It varies according to the age, the geology, and the topographical configuration of each sanctuary. Three churches have interior wall paintings. This decoration is not out of water in two of the churches.

The condition of the monuments is generally poor. However, it is stable when they receive protec-tion. On the other hand, it is very variable when they are not protected. The courtyards that make up their immediate surroundings are sensitive to bad weather, in the same way as the churches. They are directly involved in their preservation and must be covered. The church of Biete Golgotha Mikael and its Selassie chapel, which constitute the Holy of Holies of the monastic complex, are not watertight, and present a risk of partial collapse. This sanctuary is also the most culturally sensitive.

Shelters protect five churches and part of their courtyard. They are visually intrusive and rejected by the local communities. Their dismantling is a strong and long-standing demand, relayed by the Ethiopian authorities. It is also desired by UNESCO, which had noted their temporary nature for ten years.

No apparent disorder has been observed on the steel structures. No physical impact on the monuments was found. Only the Biete Abba Libanos shelter shows fragility on its supports.

The vulnerability of the shelters to wind was confirmed. The additional ballast needed at the foot of the structures is considered incompatible with the development of the site. The shelters provided a general response to specific situations. Their removal cannot be envisaged without the prior devel-opment of a new physical protection. The perimeter of these shelters will be redefined and adapted in a light approach to suit each situation.

The technical responses developed during the latest restorations of Biete Gabriel Raphael (2016) and Biete Debre Sina (2018) are not applicable to other cases. They do not apply to courtyards.

The definitive restoration of churches in conservation uses proven and efficient techniques that can continue to be used. Their durability is directly conditioned by the permanent maintenance of the site above water. Structural reinforcement by means of tie rods is proposed on Biete Medhani Alem and Biete Amanuel.

Three alternatives to shelters have been proposed: the stretched velum, the platform and the canopy. In all three options, a rock anchor would lighten the architecture and create a seasonal structure on Biete Ghiorgis. UNESCO has been informed of this possibility. The canopy can use Bamboo and thus promote a local and sustainable resource. This solution should allow the use of local know-how and their involvement in the construction and maintenance.

At the 4th steering committee meeting on 12th March 2021, the following decisions were taken:

1. Agreement on the need to cover the whole site: churches and courtyards
2. Agreement on the use of anchors outside the churches and courtyards
3. Discontinuation of studies on options requiring ballast or counterweights
4. Discontinuation of studies on platform protection options
5. Agreement to further study the Canopy (APS/detailed design)
6. Clergy and local communities confirm that the canopy option is respectful of integrity of the site, its sacredness and the ceremonies that take place there

At each operational stage, Ethiopian and French specialists will continue to collaborate in the project process.

Régis MARTIN
Chief Architect of Historic Monuments

Melaku Tadesse, 2006. Bamboo the millennium grass of Ethiopia: insuring in a new prosperity through a million bamboo homesteads: Eastern Africa Bamboo Project.

FAO, 2005. World Bamboo Resources: a thematic study prepared in the framework of the Global Forest Resources Assessment

Heinz L. and Patrick G., 2013. Greening value chains for sustainable handicrafts production in Viet Nam

INBAR, 2006. Database on bamboo and rattan trade: Accessed December 2006, available at http://www.inbar.int/trade/main.asp. Beijing, China, INBAR.

INBAR, 2010. Annual Report: Available at http://www.inbar.int/Board.

Kassahun E., 2003. Ecological aspects and resource management of bamboo forest in Ethiopia: Ph.D. Thesis, Swedish University of Agricultural Sciences, Uppsala, Sweden.

KEFRI, 2007. Study on bamboo and rattan research and development in Kenya Forestry Research Institute (KEFRl), INBAR.

Kibwage K., Misreave E., 2011. The value chain development and sustainability of bamboo housing in Ethiopia: International network for bamboo and rattan (INBAR).

Kigomo, B.N., 2007. Guidelines for growing bamboo: Nairobi. KEFRI

Quintans, K.N. 1998. Ancient Grass, Future natural resource: The national bamboo project of Costa Rica: A case study of the role bamboo in international development. INBAR Working paper No.16.58PP.

Xuhe, C., 2003. Journal of bamboo and rattan, vol.2, Promotion of bamboo for poverty allevia-tion and economic development: No. 4.pp.345-350.

Zhu Z., 2006 "Impact Assessment of Bamboo Shoot on Poverty Reduction in Linan China." Unpublished INBAR case study: 46-47.

Smith, N., and Marsh, J., 2005. Pro-Poor, Bamboo Opportunities in the Mekong, A joint initia-tive of Oxfam Hong Kong (OHK) and International Finance Corporation (IFC) Mekong Private

Sector Development Facility
(MPDF), Viet Nam.

Liese, W., 1985. Bamboos biology, Silvics, Properties and Utilization: GTZ, Eschborn, Germany

Tabarelli, M. and Mantovani, W., 2000. Gap phase regeneration in tropical mountain forest: the effects of gap structure and bamboo species. Plant Ecology, 148(2):149-155.

Cracking measurements of churches (1nstrumesure) 12 October 2020

Cracking measurements of churches (1strumesure) February 2021 (15 March 2021)

Monitoring measurements of shelters (1strumesure) February 2021 (22 March 2021)

Shelter's monitoring installation report (Instrumesure) October 2020

Acoustic measurements on shelters (Fédérico CRUZ BARNEY)

Initial stability study of shelters 19-147 (BMI) 12 Dec 2019

Structural study of shelters (BMI) 3 January 2020

Additional stability study of the 20-154 A shelters (BMI) 9 December 2020

Structural study of the upper parts (BMI and Instrumesure) December 2020

Prefiguration of tensioned textiles on LIBANOS (BMI)

MINERALOGICAL PROPERTIES OF THE SCORIACEOUS BASALT AND RELATION-SHIP WITH LOCAL MICROCLIMAT December 2020 (J-D. Mertz & D. Giovannacci)

Surveillance of cracks of the rock-hewn churches in Lalibela withtwelve electronics fissurometers, autonomous and temperature recorder (Instrumesure) 15 March 2021

Shelter Plenum Inspection

Dismantling of shelters – Cost Estimate

# PART II

## CANOPY PRELIMINARY DESIGN

## GROUP 2

The churches of Lalibela have always been covered in one way or another.

Based on the principle of the exhaustive coverage of the site, the canopy option was developed following the rejection of several alternative shelter designs such as mast tents and platforms on pillars. This option has the advantage of continuity of protection of the different groups of churches and is very light. The original and supple forms it generates are inspired by nature. And the supple-ness of its undulating movements contributes to good landscape integration in the uneven relief of Lalibela.

Figure 215

But these elongated forms contribute also and above all to a design that relies on the mutualisa-tion of efforts in a network of lines by adhering to a single grid. The continuity of the load descents allows the distribution of forces without any accident. The curves of the roofing allow for spaces of up to 30m to be covered without the need for an intermediate support, thus allowing a church and its courtyard to be sheltered in a single step.

The choice of bamboo as a construction technique contributes to a strong identity foundation and allows mobilizing both local resources and renewable materials.

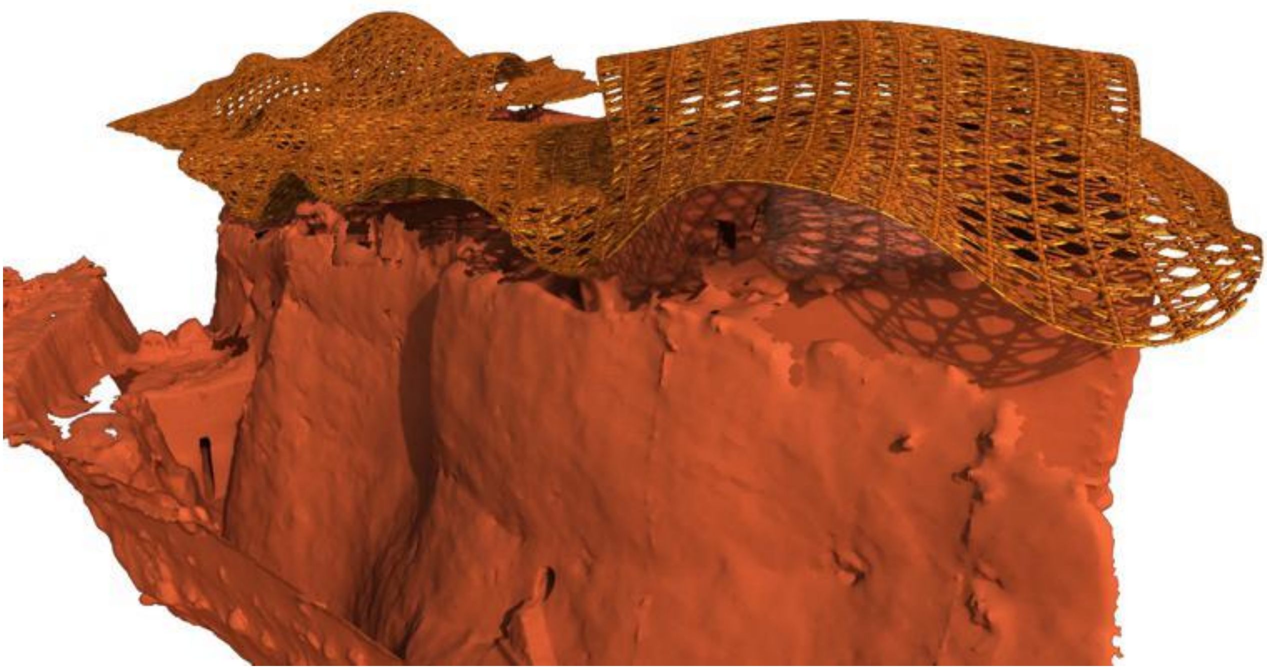


Figure 216

There are two possible uses of bamboo on site: natural bamboo or laminated bamboo (similar to glued laminated wood). Laminated bamboo could be used for the manufacture of poles. Given the topographical context and the fragility of the monuments, bamboo avoids the introduction and handling of heavy parts. In the case of natural bamboo, the extraction module will have a length of 6m for 4 to 7 cm of diameter. It can also constitute standard units of three meters in length for a diameter of 7cm. The multiplication of the ribs under the cover will favour the acoustic qualities of the protection.

Figure 217

The capacities offered by the combination of the assembled strands is infinite but limited by the complexity of the assemblies. To avoid the risk of bird nesting, it is necessary to keep rib profiles that have a downward taper and a free interval between the strands, at most equal to the thickness of a bamboo. The design modelled leads to an optimization of the amount of bamboo.


Figure 218: Canopy Structural Density

We estimate the consumption at 60dm3 of bamboo, for a total weight of about 55Kg per m2; a volume which will be less than 1200m3 of plant material to cover all three groups of churches. The linear of strands will be of the order of 190 000m. which represents approximately 54 000 bars and 27 000 nodes.

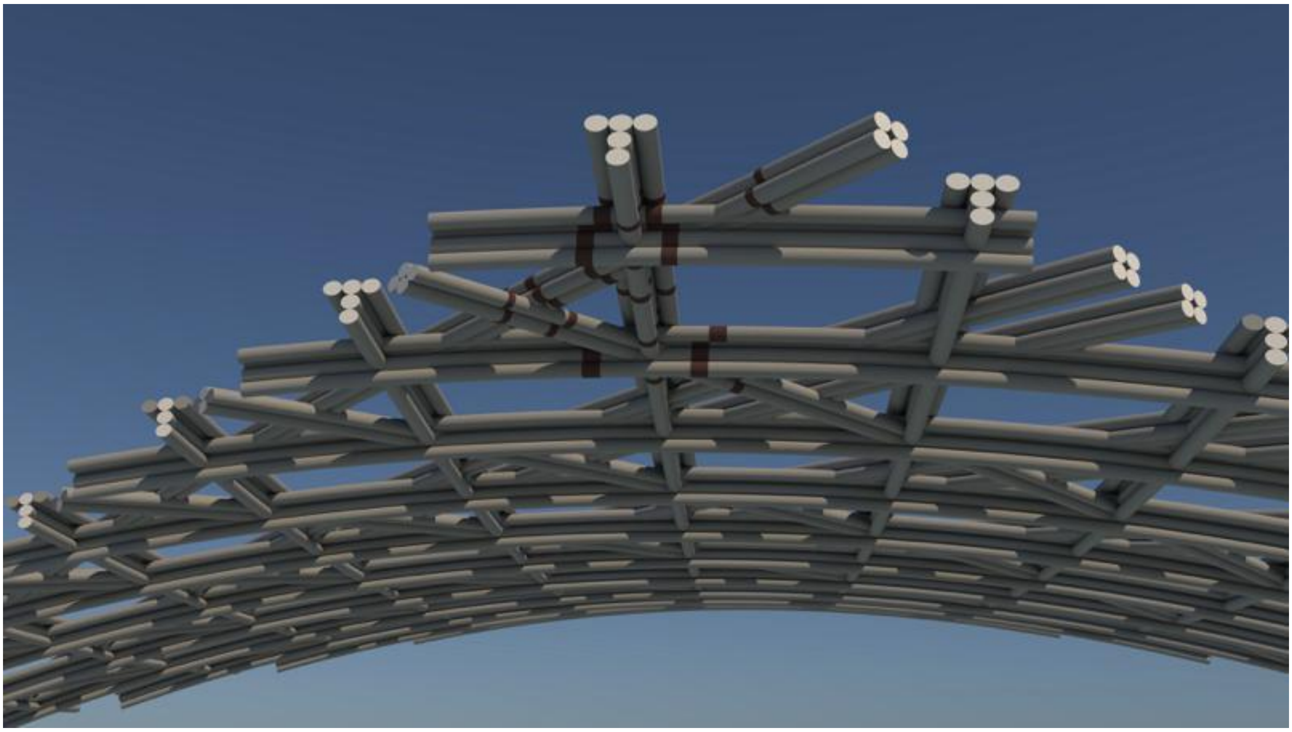


Figure 219: Canopy Structural Density

The overall weight of the Group 2 canopy will not exceed 530 tons, or an average of 18 tons per support. It is not the weight that constitutes the major constraint, but the wind. The implementation of a light canopy is subject to uplift forces that must be countered by effective fixing of the supports.

A network of 24 rock anchors has been proposed for group 2. It is located according to the 3D site map which shows the available rock thicknesses. The selected points remain away from the cavities. A complementary study of the natural physical capacities of the bedrock will make it possible to define the diameters and depths of these anchor points. This study will include drilling, grouting and pull-out tests to confirm the tensile and compressive properties of the scoria rock.

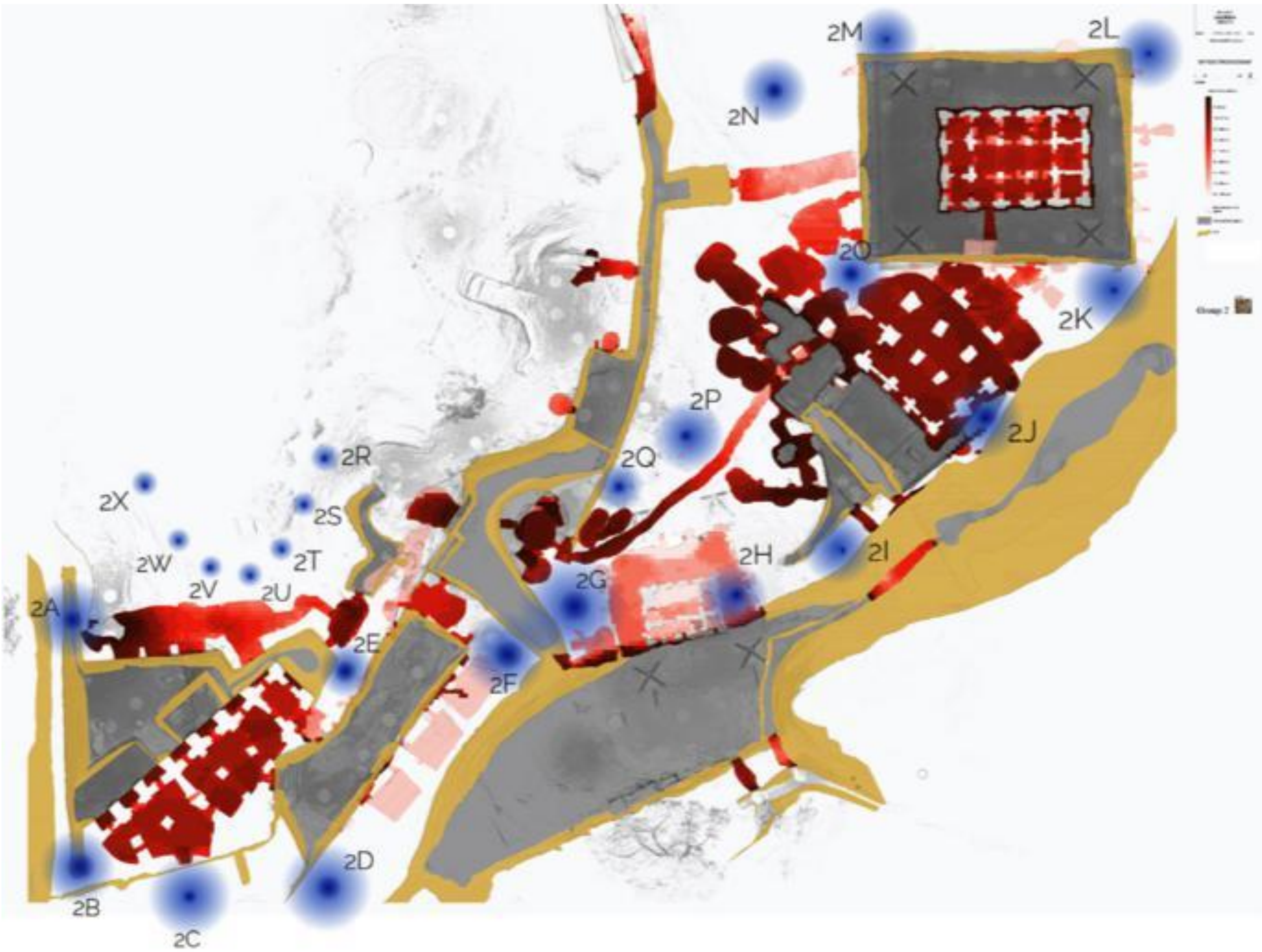



Figure 220

In order not to present an obstacle to worship activities, the locations of the canopy bases will be distributed in areas devoid of visitation and out of the worshippers' walking routes. No support will be placed in the courtyards, according to the specifications of the feasibility study.

Figure 221

The flexibility of the canopy comes from the bamboo itself, but also from the composite nature of the strands and the multiplicity of assembly nodes. The elasticity of the structure makes it a natural and permanent anti-seismic object.

The constructive principle allows an assembly of the structure by small light elements which do not put in danger the fragility of the monuments which remain by necessity vulnerable in the heart of the building site. Lifting equipment is unnecessary or reduced to simple winches. The connection device can also be traditional and made of local material. The assembly technique does not require highly specialized skills but only rigorous supervision. Training in assembly techniques is quick. The assembly time of the whole group 2 can be estimated at 200 working days for 20 workers and three specialized team managers.

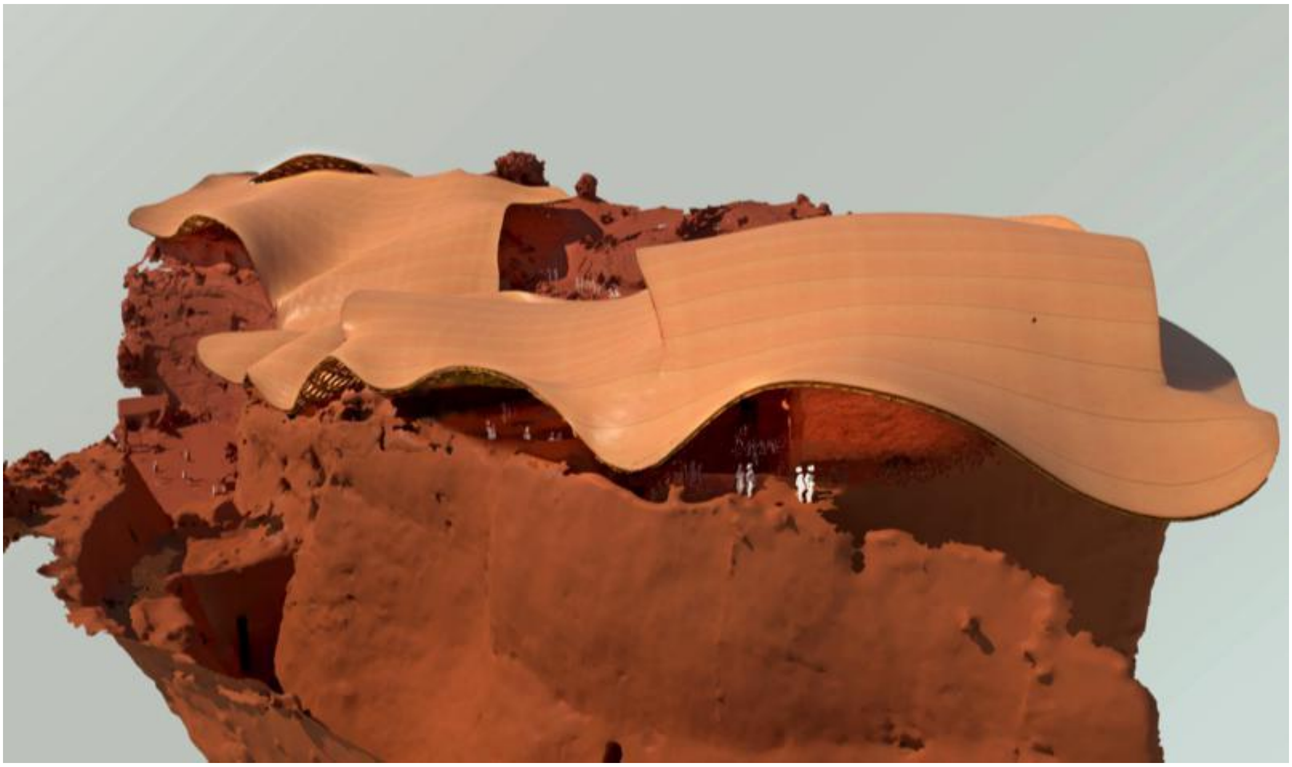


Figure 222

The lifespan of a bamboo structure when left under cover is around 50 years provided that a borax pest control treatment is carefully applied prior to implementation. The coverage would be achieved by rolling out a waterproof, traction and UV resistant tarpaulin, stretched in assembled layers. It can be installed by climbing directly onto the top of the structure. It is non-transparent, and of a colour close to the natural ground, but it can be slightly translucent to improve the level of light let inside.

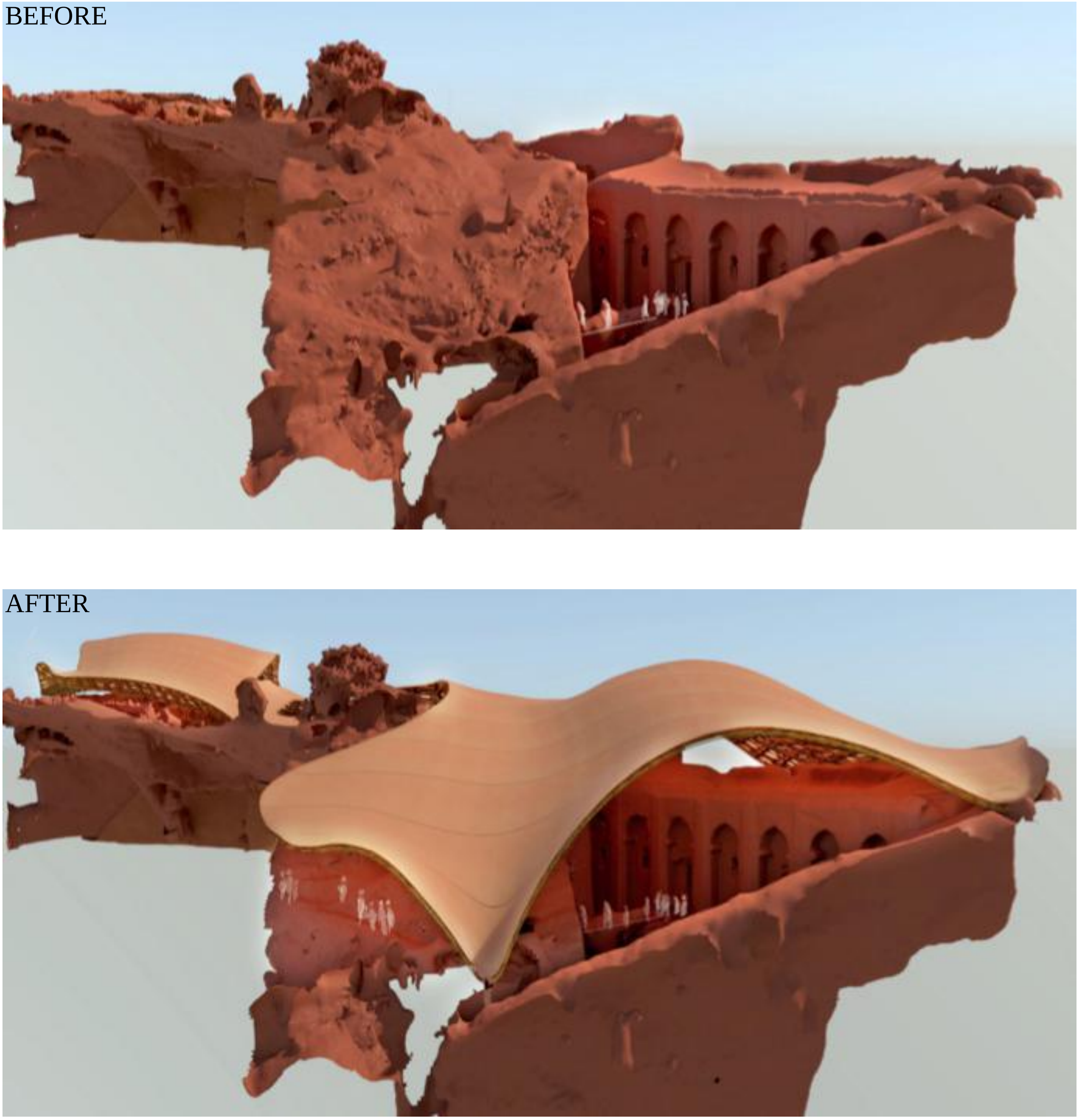



Figure 223

## GROUP 3

The site of the isolated church of Beta Gyorgis differs from the other two groups because it is dug into the hillside, in a more open and less bumpy area. The rock is also of better quality, and the planimetry of the surroundings is less threatened by a return to the natural state.

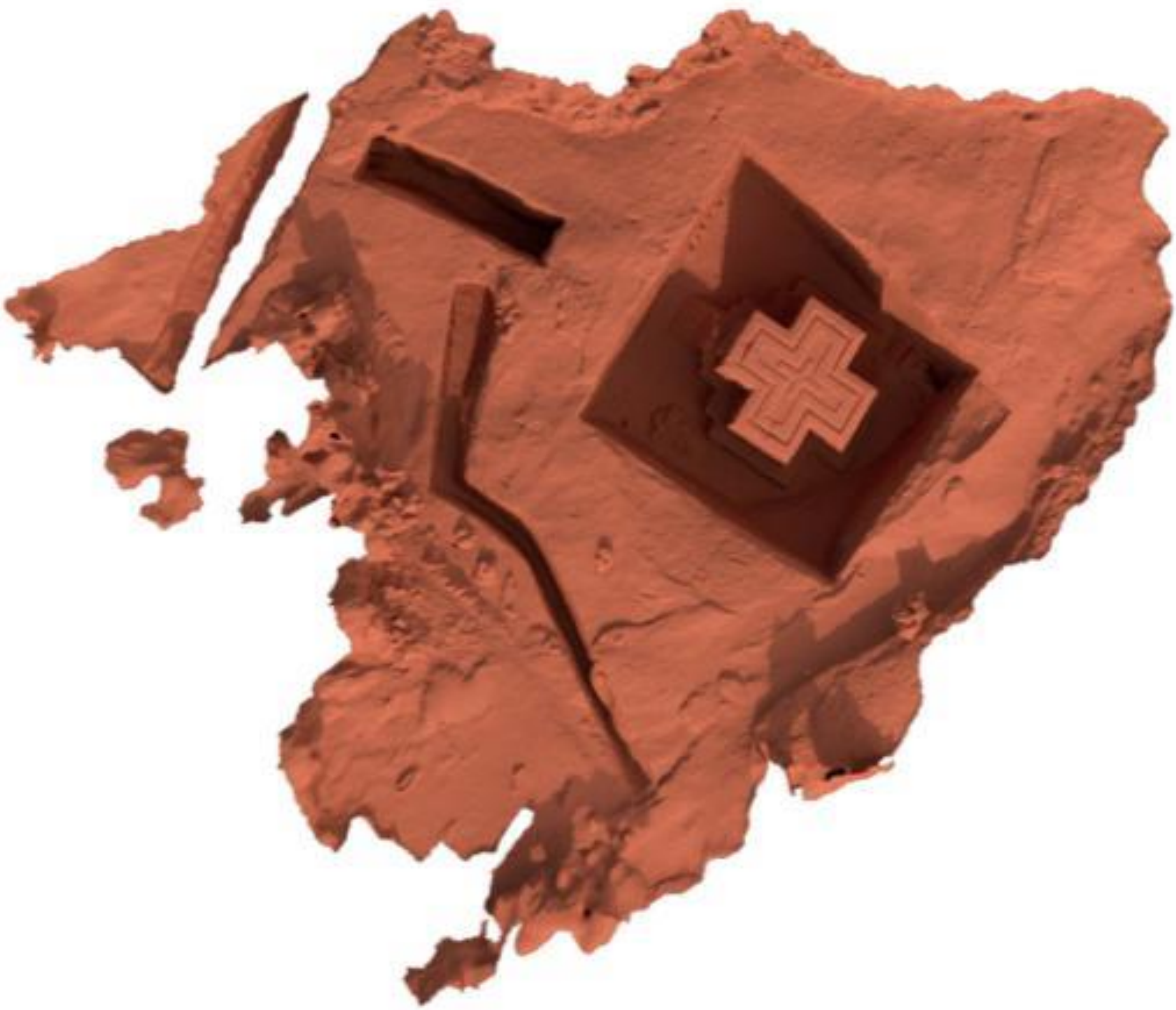


Figure 224

The main constraint results from the need, for symbolic and representation reasons, to preserve the birds eye view of the monument during the dry season, and consequently to make its protection mobile. For that, a relative lightness and a good handiness/maneuverability of the canopy object must be privileged. The creation of a fan-shaped structure deployed above the church from a single point of support located in the mild slope of the south of the courtyard is thus proposed.

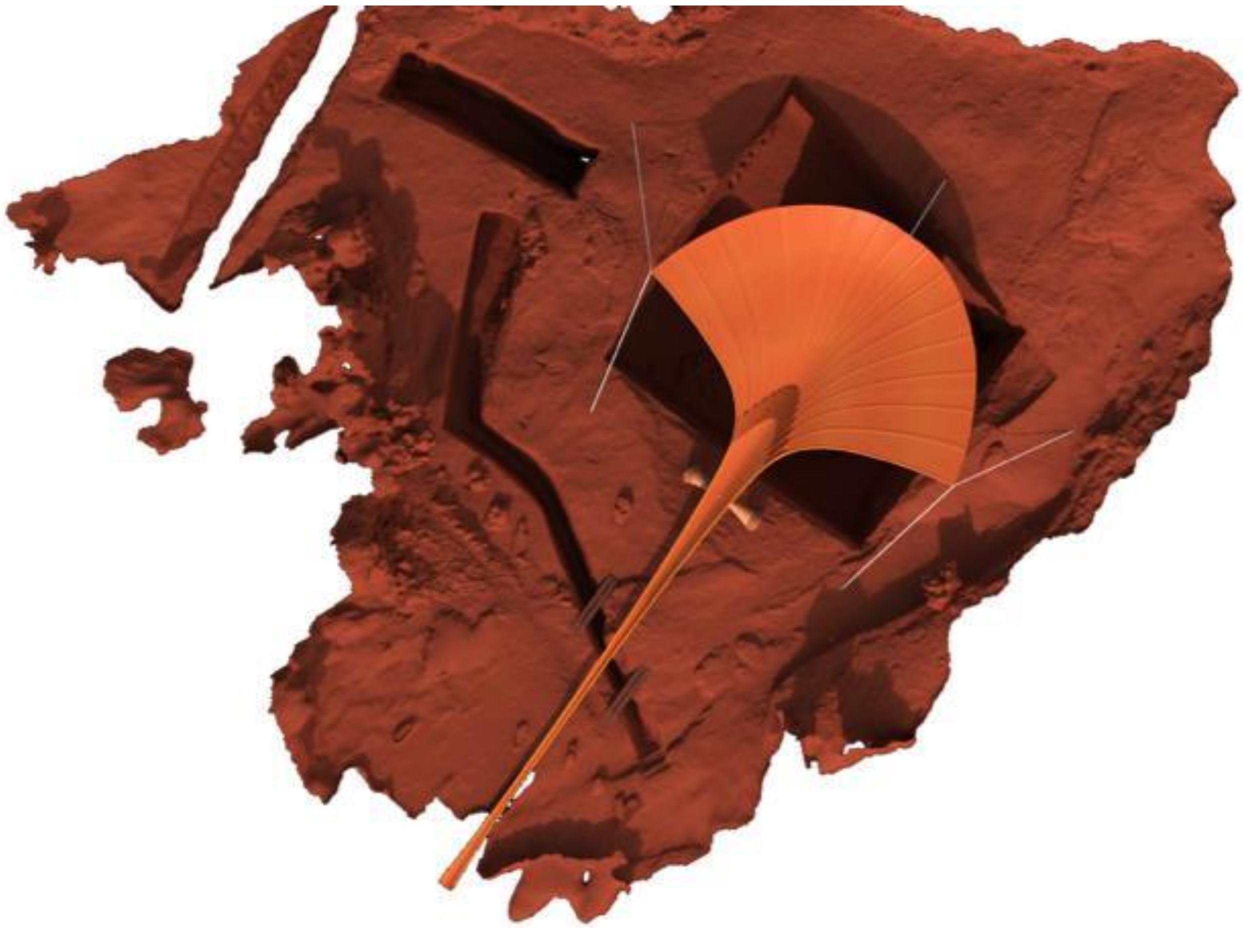


Figure 225

The reference is the liturgical fan from the Church of Abuna Abraham of Debra Tsion Kidane Mehret.

Figure 226

The comprehensive coverage of the surroundings is not as compelling as on the rest of the site. Indeed, the counterscarps of the courtyard do not have any ornamental sculpture or other sanctuary entrances. And it is impossible to block the runoff from the rocky plateau. The goal will be to limit the amount of water introduced into the cavity as much as possible, and to completely preserve the church itself, as well as its steps.

A counterweight is necessary to balance the cantilever of the structure. It will consist of a thir-ty-meter flail launched into the slope from the crest of the counterscarp. This lever arm will also

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serve as a steering wheel for mobility, and as an outlet for the return of the collected rainfall. The rigidity of the arm will be obtained by an internal helicoidal structure with double revolution of bamboo whose core will be formed by a perforated aluminum mast.

To facilitate the mobility of the whole, the membrane and its bamboo ribs will be folded in a central position. The deployment will be obtained by the traction of the ends maintained attached to the ground, while the shaft continues its forward march. It is the force of the motorization of the wheels and the movement of inertia of the unit which causes the deployment of the fabric and maintains it tended. The resting place will be constituted by a two-wheel axle whose casing will contain batteries and a remote controlled electric motor. The flail and the fan can be dissociated when the object is stored. The rolling device can be attached to the two twin elements, or alterna-tively attached to one or the other when they are separated. In the deployed position, the canopy will be secured to the ground by cables at the axle, span ends, and shaft. A fixed safety stop will be positioned in front of the wheels to prevent wrong move.

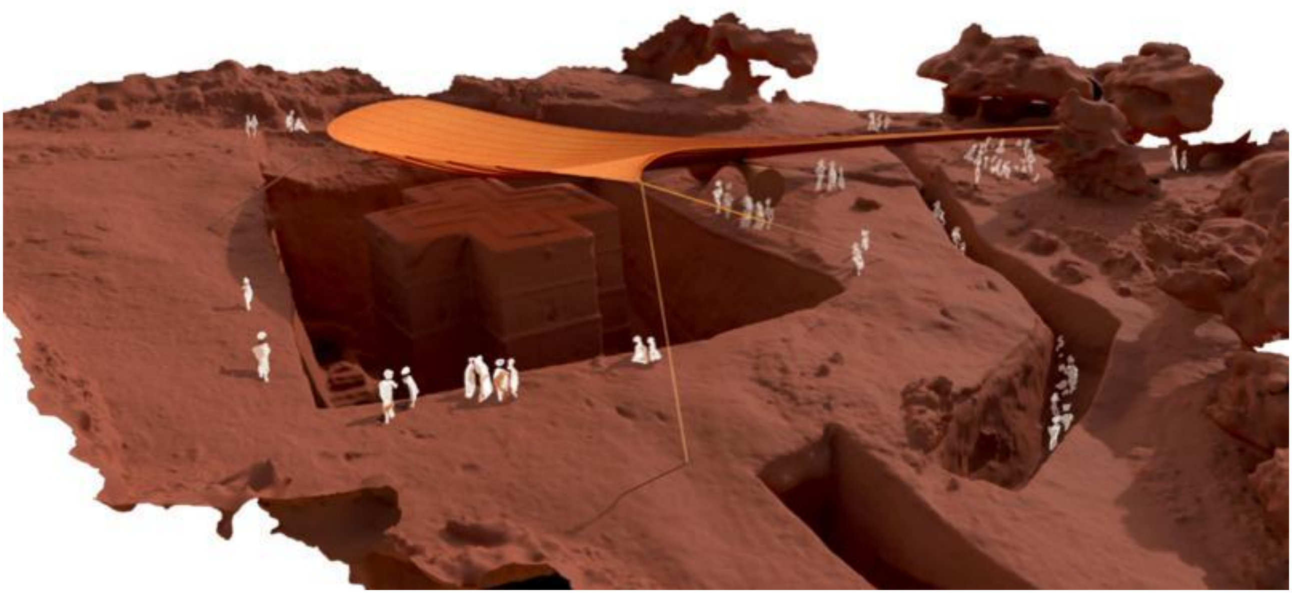

Figure 227

Two movable steel walkways will be placed on the access trench to the church to allow the wheels to cross this obstacle. They will be stored in the body of the lever arm.
The deployed canopy can be positioned either on the church (wet season) or set back near it (dry

season) to provide shade for pilgrims in the immediate vicinity of the trench entrance.

Given the perfect balance of the masses, and the electric assistance, two people alone will be able to carry out the maneuvers and the security, in less than one hour.

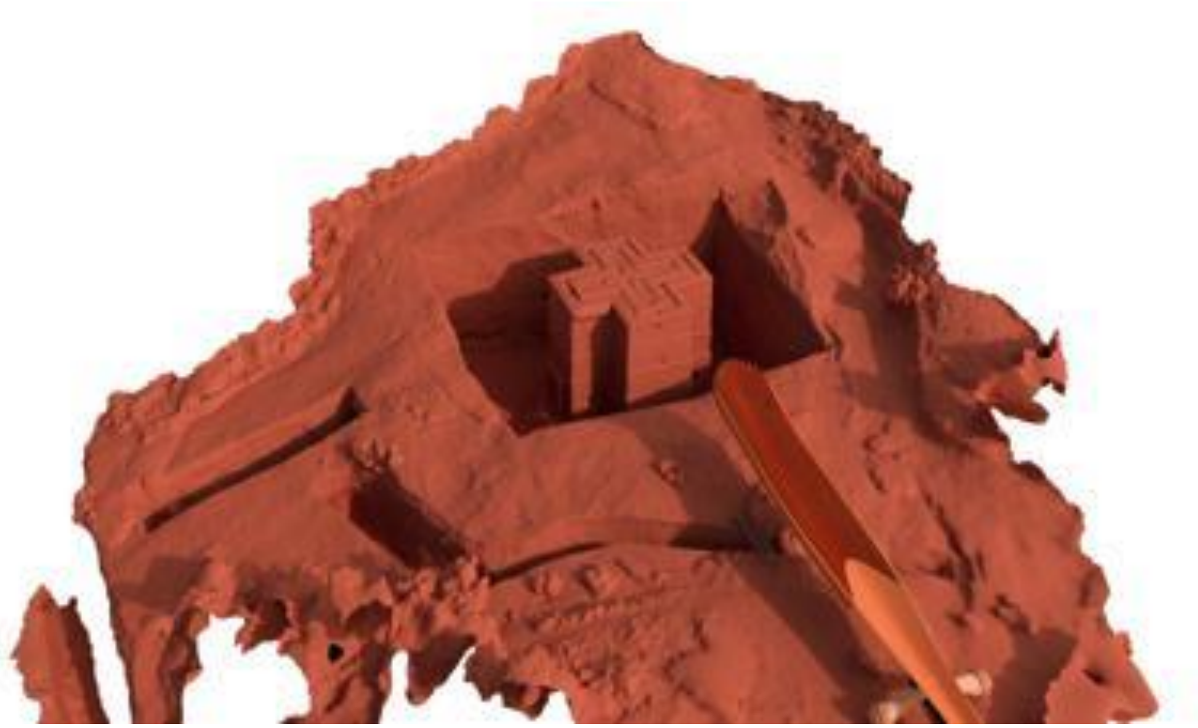

Figure 228: Folded state of the canopy, under movement

Régis MARTIN
Chief Architect of Historic Monuments

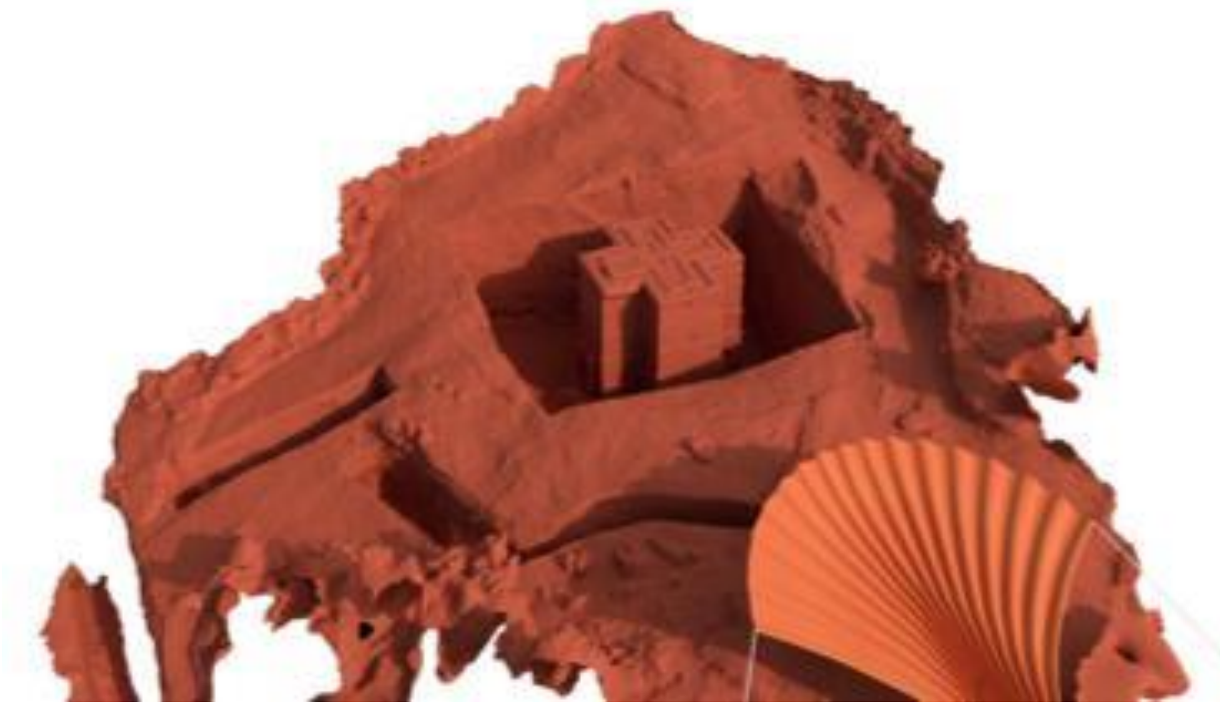

Figure 229: Backward position of the canopy providing shade for pilgrims

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ROCK-HEWN CHURCHES,
LALIBELA
Africa
Ethiopia
Rock-Hewn Churches,
Lalibela
Biete Michael
(Biete
Golegotha)
Biete Meskel
Biete Mariam
Biete Debresina
Biete
Medhane
Alem
Biete Denagel
Biete Giorgis
Biete Amanuel
Biete
Aba Libanose
Biete
Merkerios
Biete
Gebrael-Rufael
39°2'E
39°2'15"E
39°2'30"E
39°2'45"E
39°3'E
12°2'15"N
12°2'N
12°1'45"N
12°1'30"N
Heritage
Index Contour
Intermediate Contour
Core
Tukul
Road
Buffer
Building
Canopy
Churches
Open Area
Power Sub Station
1:3,000
Coordinate System: Adindan UTM Zone 37N
Projection: Transverse Mercator
Datum: Adindan
Units: Meter
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# ፌደራል ነጋሪት ጋዜጣ

# FEDERAL NEGARIT GAZETTE

OF THE FEDERAL DEMOCRATIC REPUBLIC OF ETHIOPIA

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21st Year No.69
ADDIS ABABA 28th August. 2015

ማውጫ



CONTENTS



## የሚኒስትሮች ምክር ቤት ደንብ ቁጥር ፫፻፵፬/፪ሺ፯

## የላሊበላ ውቅር አብያተ ክርስቲያናት ዓለም አቀፍ ቅርሶች የተከለሉ ሥፍራዎችን ለመሰየም የወጣ የሚኒስትሮች ምክር ቤት ደንብ

የሚኒስትሮች ምክር ቤት የኢትዮጵያ ፌደራላዊ ዲሞክራሲያዊ ሪፐብሊክ አስፈፃሚ አካላትን ሥልጣንና ተግባር ለመወሰን በወጣው አዋጅ ቁጥር ፮፻፺፩/፪ሺ፫ አንቀጽ ፭ እና ስለቅርስ ጥናትና አጠባበቅ በወጣው አዋጅ ቁጥር ፪፻፱/፲፱፻፺፪ አንቀጽ ፵፪ (፩) መሠረት ይህን ደንብ አውጥቷል፡፡

### ክፍል አንድ

### ጠቅላላ

፩. **አጭር ርዕስ**

ይህ ደንብ "የላሊበላ ውቅር አብያተ ክርስቲያናት ዓለም አቀፍ ቅርሶች የተከለሉ ሥፍራዎችን መሰየሚያ የሚኒስትሮች ምክር ቤት ደንብ ቁጥር ፫፻፵፬/፪ሺ፯" ተብሎ ሊጠቀስ ይችላል፡፡

## COUNCIL OF MINISTERS REGULATION No. 344/2015

## COUNCIL OF MINISTERS REGULATION TO PROVIDE FOR THE DESIGNATION OF THE MONOLITHIC CHURCHES OF LALIBELA HERITAGE RESERVED AREA

This Regulation is issued by the Council of Ministers pursuant to Article 5 of the Definition of Powers and Duties of the Executive Organs of the Federal Democratic Republic of Ethiopia Proclamation No.691/2010 and Article 42(1) of the Research and Conservation of Cultural Heritage Proclamation No 209/2000.

### PART ONE

### GENERAL

1. **Short Title**

This Regulation may be cited as the "Monolithic Churches of Lalibela World Heritage Reserved Area Designation Council of Ministers Regulation No. 344/2015".

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ነጋሪት ጋዜጣ ፖ.ሣ.ቁ. ፹ሺ፩
Negarit G. P.O.BOX 80001

**፪. ትርጓሜ**

የቃሉ አገባብ ሌላ ትርጉም የሚያሰጠው ካልሆነ በስተቀር በዚህ ደንብ ውስጥ፦

፩/ "አዋጅ" ማለት ስለቅርስ ጥናትና አጠባበቅ የወጣው አዋጅ ቁጥር ፪፻፱/፲፱፻፺፪፤

፪/ በአዋጁ አንቀጽ ፫ የተሰጡ ትርጓሜዎች ለዚህ ደንብም ተፈጻሚ ይሆናሉ፤

፫/ "ባለሥልጣን" ማለት በአዋጅ ቁጥር ፪፻፱/፲፱፻፺፪ የተቋቋመው የቅርስ ጥናትና ጥበቃ ባለሥልጣን ነው፤

፬/ "እምብርት ዞን" ማለት መካነ-ቅርሱ በዓለም-አቀፍ ቅርስነት የተመዘገበበትን የላቀ ሁለንተናዊ እሴት የያዘው የቅርሱ ይዞታ የሚገኝበት ስፍራ ሆኖ፣ የቅርሱን ጥንታዊ ይዘት እና ሙሉዕነት የሚያሳየው እና መካነ-ቅርሱን ለመጠበቅና ለማስተዳደር የሚረዱ ሥራዎች ብቻ የሚከናወኑበት የቅርሱ ክልል ነው፤

፭/ "ደጀን ዞን" ማለት ለተመዘገበው መካነ-ቅርስ ተጨማሪ ጥበቃ ለማድረግ እንዲቻል በእምብርት ዞኑ ዙሪያ የሚከለል አዋሳኝ ስፍራ ሲሆን፣ በዚህ ስፍራ የሚኖረውን የመሬት አጠቃቀም እና የልማት ሥራዎች ለመወሰን የሚያስችል ድንጋጌ የወጣለት እና ቅርሱ ከአካባቢው ጋር የሚኖረውን የእይታና መልክዓ-ምድራዊ ትስስር ለመጠበቅ ታስቦ የሚከለል ስፍራ ነው፤

፮/ "ሰው" ማለት የተፈጥሮ ሰው ወይም በሕግ የሰውነት መብት የተሰጠው አካል ነው፤

፯/ ማንኛውም በወንድ ፆታ የተገለፀ አነጋገር ሴትንም ይጨምራል፡፡

**2. Definitions**

In This Regulation unless the context requires otherwise:

1/ "Proclamation" means the Research and Conservation of Cultural Heritage Proclamation No. 209/2000;

2/ definitions provided for under Article 3 of the Proclamation shall be applicable to this Regulation;

3/ "Authority" means the Authority for Research and Conservation of Cultural Heritage Established under Proclamation No. 209/2000;

4/ "Core Zone" means an area that demonstrates the Outstanding Universal Value of the site, for which the heritage is included in the World Heritage List, and other important features that illustrate the integrity and authenticity that contribute for the protection and management of the heritage;

5/ "Buffer Zone" means an area surrounding the heritage which was complementary legal and customay restrictions placed on its use and development to give an added layer of protection to the heritage and, includes the immediate setting of the nominated heritage, important views and other attributes that are functionally important as a support to the heritage and its protection;

6/ "person" means any natural or juridical person;

7 any expression in the masculine gender includes the feminine.

## ክፍል ሁለት

## ስለላሊበላ ውቅር አብያተ ክርስቲያናት የዓለም አቀፍ ቅርሶች ክልል ስፍራ አስተዳደር

**፫. የተከለሉ ሥፍራዎችን ስለመሰየም**

የሚከተሉት የላሊበላ ውቅር አብያተ ክርስቲያናት ዓለም አቀፍ ቅርሶች እምብርትና ደጀን ዞኖች በዚህ ደንብ ተሰይመዋል፡-

፩/ ቤተ መድኃኒዓለም፤

፪/ ቤተ ማርያም፤

፫/ ቤተ መስቀል፤

፬/ ቤተ ደናግል፤

፭/ ቤተ ደብረሲና፤

፮/ ቤተ ሚካኤል (ቤተ ጎልጎታ)፤

፯/ ቤተ አማኑኤል፤

፰/ ቤተ መርቆርዮስ፤

፱/ ቤተ አባሊባኖስ፤

፲/ ቤተ ገብርኤል-ሩፋኤል፤

፲፩/ ቤተ ጊዮርጊስ፡፡

**፬. የቅርስ ቦታዎች እምብርት ዞኖች**

የላሊበላ ውቅር አብያተ ክርስቲያናት ዓለም አቀፍ ቅርስ ቦታዎች እምብርት ዞን ስፋቱ 41.74 ሄክታር ሆኖ፡-

፩/ በ$12^0$ 2' 7.8" ሰሜን ላቲትዩድ እና $39^0$ 2' 50.57" ምሥራቅ ሎንግትዩድ፤

፪/ በ$12^0$ 2' 6.29" ሰሜን ላቲትዩድ እና $39^0$ 2' 51.29" ምሥራቅ ሎንግትዩድ፤

፫/ በ$12^0$ 2' 4.6" ሰሜን ላቲትዩድ እና $39^0$ 2' 52.3" ምሥራቅ ሎንግትዩድ፤

፬/ በ $12^0$ 2' 2.51" ሰሜን ላቲትዩድ እና $39^0$ 2' 53.23" ምሥራቅ ሎንግትዩድ፤

## PART TWO

## RESERVED AREAS OF THE MONOLITHIC CHURCHES OF LALIBELA WORLD HERITAGE SITE

**3. Designation of Reserved Areas**

The following Core and Buffer Zones of the Monolithic Churches of Lalibela World Heritage Sites are hereby designated:

1/ Biete Medhane Alem;

2/ Biete Mariam;

3/ Biete Meskel;

4/ Biete Denagel;

5/ Biete Debresina;

6/ Biete Michael (Biete Golegotha);

7 Biete Amanuel;

8/ Biete Merkerios;

9/ Biete Aba Libanose;

10 Biete Gebrael-Rufael;

11/ Biete Giorgis.

**4. Core Zones of the Reserved Area**

The Core Zone of the Monolithic Churches of Lalibela World Heritage Sites Covers 41.74 hectare and includes the area between:

1/ $12^0$ 2' 7.8'' Latitude North and $39^0$ 2' 50.57' Longitude East;

2/ $12^0$ 2' 6.29'' Latitude North and $39^0$ 2' 51.29'' Longitude East;

3/ $12^0$ 2' 4.6'' Latitude North and $39^0$ 2' 52.3'' Longitude East;

4/ $12^0$ 2' 2.51'' Latitude North and $39^0$ 2' 53.23'' Longitude East;

፭/ በ12$^0$ 2' 0.17" ሰሜን ላቲትዩድ እና 39$^0$ 2' 53.23" ምሥራቅ ሎንግትዩድ፤

፮/ በ12$^0$ 1' 52.36" ሰሜን ላቲትዩድ እና 39$^0$ 2' 52.33" ምሥራቅ ሎንግትዩድ፤

፯/ በ12$^0$ 1' 52.32" ሰሜን ላቲትዩድ እና 39$^0$ 2' 50.86" ምሥራቅ ሎንግትዩድ፤

፰/ በ12$^0$ 1' 53.22" ሰሜን ላቲትዩድ እና 39$^0$ 2' 48.08" ምሥራቅ ሎንግትዩድ፤

፱/ በ12$^0$ 1' 51.78" ሰሜን ላቲትዩድ እና 39$^0$ 2' 45.96" ምሥራቅ ሎንግትዩድ፤

፲/ በ12$^0$ 1' 50.16" ሰሜን ላቲትዩድ እና 39$^0$ 2' 44.38" ምሥራቅ ሎንግትዩድ፤

፲፩/ በ12$^0$ 1' 48.47" ሰሜን ላቲትዩድ እና 39$^0$ 2' 42.58" ምሥራቅ ሎንግትዩድ፤

፲፪/ በ12$^0$ 1' 46.45" ሰሜን ላቲትዩድ እና 39$^0$ 2' 40.74" ምሥራቅ ሎንግትዩድ፤

፲፫/ በ12$^0$ 1' 45.88" ሰሜን ላቲትዩድ እና 39$^0$ 2' 39.98" ምሥራቅ ሎንግትዩድ፤

፲፬/ በ12$^0$ 1' 44.58" ሰሜን ላቲትዩድ እና 39$^0$ 2' 37.86" ምሥራቅ ሎንግትዩድ፤

፲፭/ በ12$^0$ 1' 44.83" ሰሜን ላቲትዩድ እና 39$^0$ 2' 36.02" ምሥራቅ ሎንግትዩድ፤

፲፮/ በ12$^0$ 1' 45.48" ሰሜን ላቲትዩድ እና 39$^0$ 2' 35.02" ምሥራቅ ሎንግትዩድ፤

፲፯/ በ12$^0$ 1' 46.56" ሰሜን ላቲትዩድ እና 39$^0$ 2' 35.05" ምሥራቅ ሎንግትዩድ፤

፲፰/ በ12$^0$ 1' 48.14" ሰሜን ላቲትዩድ እና 39$^0$ 2' 36.46" ምሥራቅ ሎንግትዩድ፤

፲፱/ በ12$^0$ 1' 47.31" ሰሜን ላቲትዩድ እና 39$^0$ 2' 31.34" ምሥራቅ ሎንግትዩድ፤

5/ 12$^0$ 2' 0.17'' Latitude North and 39$^0$ 2' 53.23'' Longitude East;

6/ 12$^0$ 1' 52.36'' Latitude North and 39$^0$ 2' 52.33'' Longitude East;

7/ 12$^0$ 1' 52.32'' Latitude North and 39$^0$ 2' 50.86'' Longitude East;

8/ 12$^0$ 1' 53.22'' Latitude North and 39$^0$ 2' 48.06'' Longitude East;

9/ 12$^0$ 1' 51.78'' Latitude North and 39$^0$ 2' 45.96'' Longitude East;

10/ 12$^0$ 1' 50.16'' Latitude North and 39$^0$ 2' 44.38'' Longitude East;

11/ 12$^0$ 1' 48.47''Latitude North and 39$^0$ 2' 42.58'' Longitude East;

12/ 12$^0$ 1' 46.45'' Latitude North and 39$^0$ 2' 40.74'' Longitude East;

13/ 12$^0$ 1' 45.88'' Latitude North and 39$^0$ 2' 39.98'' Longitude East;

14/ 12$^0$ 1' 44.58'' Latitude North and 39$^0$ 2' 37.86'' Longitude East;

15/ 12$^0$ 1' 44.83'' Latitude North and 39$^0$ 2' 36.02'' Longitude East;

16/ 12$^0$ 1' 45.48'' Latitude North and 39$^0$ 2' 35.02'' Longitude East;

17/ 12$^0$ 1' 46.56'' Latitude North and 39$^0$ 2' 35.05'' Longitude East;

18/ 12$^0$ 1' 48.14'' Latitude North and 39$^0$ 2' 36.46'' Longitude East;

19/ 12$^0$ 1' 47.31'' Latitude North and 39$^0$ 2' 31.34'' Longitude East;

፳/ በ$12^0$ 1' 48.07" ሰሜን ላቲትዩድ እና $39^0$ 2' 27.1" ምሥራቅ ሎንግትዩድ፤

፳፩/ በ$12^0$ 1' 56.71" ሰሜን ላቲትዩድ እና $39^0$ 2' 19.86" ምሥራቅ ሎንግትዩድ፤

፳፪/ በ$12^0$ 1' 59.16" ሰሜን ላቲትዩድ እና $39^0$ 2' 22.81" ምሥራቅ ሎንግትዩድ፤

፳፫/ በ$12^0$ 1' 59.2" ሰሜን ላቲትዩድ እና $39^0$ 2' 22.85" ምሥራቅ ሎንግትዩድ፤

፳፬/ በ$12^0$ 1' 59.88" ሰሜን ላቲትዩድ እና $39^0$ 2' 24.9" ምሥራቅ ሎንግትዩድ፤

፳፭/ በ$12^0$ 2' 0.67" ሰሜን ላቲትዩድ እና $39^0$ 2' 26.74" ምሥራቅ ሎንግትዩድ፤

፳፮/ በ$12^0$ 2' 0.92" ሰሜን ላቲትዩድ እና $39^0$ 2' 28.21" ምሥራቅ ሎንግትዩድ፤

፳፯/ በ$12^0$ 2' 2.47" ሰሜን ላቲትዩድ እና $39^0$ 2' 30.26" ምሥራቅ ሎንግትዩድ፤

፳፰/ በ$12^0$ 2' 2.87" ሰሜን ላቲትዩድ እና $39^0$ 2' 30.95" ምሥራቅ ሎንግትዩድ፤

፳፱/ በ$12^0$ 2' 3.73" ሰሜን ላቲትዩድ እና $39^0$ 2' 33.18" ምሥራቅ ሎንግትዩድ፤

፴/ በ$12^0$ 2' 4.16" ሰሜን ላቲትዩድ እና $39^0$ 2' 34.84" ምሥራቅ ሎንግትዩድ፤

፴፩/ በ$12^0$ 2' 3.73" ሰሜን ላቲትዩድ እና $39^0$ 2' 36.78" ምሥራቅ ሎንግትዩድ፤

፴፪/ በ$12^0$ 2' 4.02" ሰሜን ላቲትዩድ እና $39^0$ 2' 38.15" ምሥራቅ ሎንግትዩድ፤

፴፫/ በ$12^0$ 2' 4.24" ሰሜን ላቲትዩድ እና $39^0$ 2' 39.19" ምሥራቅ ሎንግትዩድ፤

፴፬/ በ$12^0$ 2' 3.7" ሰሜን ላቲትዩድ እና $39^0$ 2' 44.23" ምሥራቅ ሎንግትዩድ፤

20/ $12^0$ 1' 48.07'' Latitude North and $39^0$ 2' 27.1'' Longitude East;

21/ $12^0$ 1' 56.71'' Latitude North and $39^0$ 2' 19.86'' Longitude East;

22/ $12^0$ 1' 59.16'' Latitude North and $39^0$ 2' 22.81'' Longitude East;

23/ $12^0$ 1' 59.2'' Latitude North and $39^0$ 2' 22.85'' Longitude East;

24/$12^0$ 1' 59.88'' Latitude North and $39^0$ 2' 24.9'' Longitude East;

25/$12^0$ 2' 0.67'' Latitude North and $39^0$ 2' 26.74'' Longitude East;

26/$12^0$ 2' 0.92'' Latitude North and $39^0$ 2' 28.21'' Longitude East;

27/$12^0$ 2' 2.47'' Latitude North and $39^0$ 2' 30.26'' Longitude East;

28/$12^0$ 2' 2.87'' Latitude North and $39^0$ 2' 30.95'' Longitude East;

29/$12^0$ 2' 3.73'' latitudes north and $39^0$ 2' 33.18'' Longitude East;

30/$12^0$ 2' 4.16'' Latitude North and $39^0$ 2' 34.84'' Longitude East;

31/$12^0$ 2' 3.73'' Latitude North and $39^0$ 2' 36.78'' Longitude East;

32/$12^0$ 2' 4.02'' Latitude North and $39^0$ 2' 38.15'' Longitude East;

33/$12^0$ 2' 4.24'' Latitude North and $39^0$ 2' 39.19'' Longitude East;

34/$12^0$ 2' 3.7'' Latitude North and $39^0$ 2' 44.23'' Longitude East;

፴፭/ በ12⁰ 2' 4.92" ሰሜን ላቲትዩድ እና 39⁰ 2' 45.85" ምሥራቅ ሎንግትዩድ፣

፴፮/ በ12⁰ 2' 6.14" ሰሜን ላቲትዩድ እና 39⁰ 2' 47.72" ምሥራቅ ሎንግትዩድ፣

፴፯/ በ12⁰ 2' 7.4" ሰሜን ላቲትዩድ እና 39⁰ 2' 48.7" ምሥራቅ ሎንግትዩድ፣ እና

፴፰/ በ12⁰ 2' 7.94" ሰሜን ላቲትዩድ እና 39⁰ 2' 50.03" ምሥራቅ ሎንግትዩድ፣

መካከል ያለውን ሥፍራ ያካትታል፡፡

፭. **የቅርስ ቦታዎች የደጀን ዞኖች**

የላሊበላ ውቅር አብያተ-ክርስቲያናት ዓለም አቀፍ ቅርስ ቦታዎች ደጀን ዞን በዚህ ደንብ አንቀጽ ፬ በተመለከተው እምብርት ዞን ዙሪያ የሚያካልል ሆኖ፡-

፩/ በ12⁰ 1' 43.28" ሰሜን ላቲትዩድ እና 39⁰ 2' 43.04" ምሥራቅ ሎንግትዩድ፣

፪/ በ12⁰ 1' 44.33" ሰሜን ላቲትዩድ እና 39⁰ 2' 44.23" ምሥራቅ ሎንግትዩድ፣

፫/ በ12⁰ 1' 46.2" ሰሜን ላቲትዩድ እና 39⁰ 2' 45.6" ምሥራቅ ሎንግትዩድ፣

፬/ በ12⁰ 1' 52.61" ሰሜን ላቲትዩድ እና 39⁰ 2' 53.02" ምሥራቅ ሎንግትዩድ፣

፭/ በ12⁰ 1' 52.28" ሰሜን ላቲትዩድ እና 39⁰ 2' 53.59" ምሥራቅ ሎንግትዩድ፣

፮/ በ12⁰ 1' 50.41" ሰሜን ላቲትዩድ እና 39⁰ 2' 52.12" ምሥራቅ ሎንግትዩድ፣

፯/ በ12⁰ 1' 43.9" ሰሜን ላቲትዩድ እና 39⁰ 2' 51.29" ምሥራቅ ሎንግትዩድ፣

፰/ በ12⁰ 1' 47.35" ሰሜን ላቲትዩድ እና 39⁰ 2' 45.6" ምሥራቅ ሎንግትዩድ፣

፱/ በ12⁰ 1' 43.9" ሰሜን ላቲትዩድ እና 39⁰ 2' 51.29" ምሥራቅ ሎንግትዩድ፣

35/12⁰ 2' 4.92'' Latitude North and 39⁰ 2' 45.85''Longitude East;

36/12⁰ 2' 6.14'' Latitude North and 39⁰ 2' 47.72'' Longitude East;

37/12⁰ 2' 7.4'' Latitude North and 39⁰ 2' 48.7'' Longitude East;

38/12⁰ 2' 7.94'' Latitude North and 39⁰ 2' 50.03'' Longitude East.

5. **Buffer Zones of the Reserved Area**

The Buffer Zone of the Monolithic Churches of Lalibela World Heritage Sites encompasses the area surrounding the Core Zone referred to in Article 4 of this Regulation and stretches between:

1/ 12⁰ 1' 43.28'' Latitude North and 39⁰ 2' 43.04'' Longitude East;

2/ 12⁰ 1' 44.33'' Latitude North and 39⁰ 2' 44.23'' Longitude East;

3/ 12⁰ 1' 46.2' Latitude North and 39⁰ 2' 45.6'' Longitude East;

4/ 12⁰ 1' 52.61'' Latitude North and 39⁰ 2' 53.02'' Longitude East;

5/ 12⁰ 1' 52.28'' Latitude North and 39⁰ 2' 53.59'' Longitude East;

6/ 12⁰ 1' 50.41'' Latitude North and 39⁰ 2' 52.12'' Longitude East;

7/ 12⁰ 1' 43.9'' Latitude North and 39⁰ 2' 51.29'' Longitude East;

8/ 12⁰ 1' 47.35'' Latitude North and 39⁰ 2' 45.6'' Longitude East;

9/ 12⁰ 1' 43.9'' Latitude North and 39⁰ 2' 51.29'' Longitude East;

፲/ በ12$^0$ 1' 47.35" ሰሜን ላቲትዩድና 39$^0$ 2' 49.92" ምሥራቅ ሎንግትዩድ፤

፲፩/ በ12$^0$ 7' 31.76" ሰሜን ላቲትዩድ እና 39$^0$ 2' 48.66" ምሥራቅ ሎንግትዩድ፤

፲፪/ በ12$^0$ 1' 48.9" ሰሜን ላቲትዩድ እና 39$^0$ 2' 49.02" ምሥራቅ ሎንግትዩድ፤

፲፫/ በ12$^0$ 1' 47.35" ሰሜን ላቲትዩድ እና 39$^0$ 2' 48.98" ምሥራቅ ሎንግትዩድ፤

፲፬/ በ12$^0$ 7' 31.76" ሰሜን ላቲትዩድ እና 39$^0$ 2' 48.66" ምሥራቅ ሎንግትዩድ፤

፲፭/ በ12$^0$ 1' 31.76" ሰሜን ላቲትዩድ እና 39$^0$ 2' 48.44" ምሥራቅ ሎንግትዩድ፤

፲፮/ በ12$^0$ 1' 46.78" ሰሜን ላቲትዩድ እና 39$^0$ 2' 49.31" ምሥራቅ ሎንግትዩድ፤

፲፯/ በ12$^0$ 1' 47.03" ሰሜን ላቲትዩድ እና 39$^0$ 2' 48.66" ምሥራቅ ሎንግትዩድ፤

፲፰/ በ12$^0$ 1' 46.78" ሰሜን ላቲትዩድ እና 39$^0$ 2' 49.31" ምሥራቅ ሎንግትዩድ፤

፲፱/ በ12$^0$ 1' 46.7" ሰሜን ላቲትዩድ እና 39$^0$ 2' 46.39" ምሥራቅ ሎንግትዩድ፤

፳/ በ12$^0$ 1' 43.17" ሰሜን ላቲትዩድ እና 39$^0$ 2' 42.79" ምሥራቅ ሎንግትዩድ፤

፳፩/በ12$^0$ 1' 42.49" ሰሜን ላቲትዩድ እና 39$^0$ 2' 41.96" ምሥራቅ ሎንግትዩድ፤

፳፪/በ12$^0$ 1' 42.06" ሰሜን ላቲትዩድ እና 39$^0$ 2' 38.94" ምሥራቅ ሎንግትዩድ፤

፳፫/በ12$^0$ 1' 42.2" ሰሜን ላቲትዩድ እና 39$^0$ 2' 37.07" ምሥራቅ ሎንግትዩድ፤

፳፬/በ12$^0$ 1' 42.71" ሰሜን ላቲትዩድ እና 39$^0$ 2' 35.48" ምሥራቅ ሎንግትዩድ፤

10/ 12$^0$ 1' 47.35'' Latitude North and 39$^0$ 2' 49.92'' Longitude East;

11/ 12$^0$ 7' 31.76'' Latitude North and 39$^0$ 2' 48.66'' Longitude East;

12/ 12$^0$ 1' 48.9'' Latitude North and 39$^0$ 2' 49.02''Longitude East;

13/ 12$^0$ 1' 47.35'' Latitude North and 39$^0$ 2' 48.98'' Longitude East;

14/ 12$^0$ 7' 31.76'' Latitude North and 39$^0$ 2' 48.66'' Longitude East;

15/ 12$^0$ 1' 31.76'' Latitude North and 39$^0$ 2' 48.44'' Longitude East;

16/ 12$^0$ 1' 46.78'' Latitude North and 39$^0$ 2' 49.31'' Longitude East;

17/ 12$^0$ 1' 47.03'' Latitude North and 39$^0$ 2' 48.66'' Longitude East;

18/ 12$^0$ 1' 46.78'' Latitude North and 39$^0$ 2' 49.31'' Longitude East;

19/ 12$^0$ 1' 46.7'' Latitude North and 39$^0$ 2' 46.39'' Longitude East;

20/ 12$^0$ 1' 43.17'' Latitude North and 39$^0$ 2' 42.79'' Longitude East;

21/ 12$^0$ 1' 42.49'' Latitude North and 39$^0$ 2' 41.96'' Longitude East;

22/ 12$^0$ 1' 42.06'' Latitude North and 39$^0$ 2' 38.94'' Longitude East;

23/ 12$^0$ 1' 42.2'' Latitude North and 39$^0$ 2' 37.07'' Longitude East;

24/ 12$^0$ 1' 42.71'' Latitude North and 39$^0$ 2' 35.48'' Longitude East;

፳፭/ በ$12^{0}$ 1' 42.24" ሰሜን ላቲትዩድ እና $39^{0}$ 2' 33.94" ምሥራቅ ሎንግትዩድ፤

፳፮/ በ$12^{0}$ 1' 41.59" ሰሜን ላቲትዩድ እና $39^{0}$ 2' 32.46" ምሥራቅ ሎንግትዩድ፤

፳፯/ በ$12^{0}$ 1' 40.84" ሰሜን ላቲትዩድ እና $39^{0}$ 2' 31.63" ምሥራቅ ሎንግትዩድ፤

፳፰/ በ$12^{0}$ 1' 40.44" ሰሜን ላቲትዩድ እና $39^{0}$ 2' 31.02" ምሥራቅ ሎንግትዩድ፤

፳፱/ በ$12^{0}$ 1' 40.22" ሰሜን ላቲትዩድ እና $39^{0}$ 2' 30.41 "ምሥራቅ ሎንግትዩድ፤

፴/ በ$12^{0}$ 1' 39.29" ሰሜን ላቲትዩድ እና $39^{0}$ 2' 27.06" ምሥራቅ ሎንግትዩድ፤

፴፩/ በ$12^{0}$ 1' 38.64" ሰሜን ላቲትዩድ እና $39^{0}$ 2' 24.61" ምሥራቅ ሎንግትዩድ፤

፴፪/ በ$12^{0}$ 1' 38.39" ሰሜን ላቲትዩድ እና $39^{0}$ 2' 23.14" ምሥራቅ ሎንግትዩድ፤

፴፫/ በ$12^{0}$ 1' 38.53" ሰሜን ላቲትዩድ እና $39^{0}$ 2' 22.02" ምሥራቅ ሎንግትዩድ፤

፴፬/ በ$12^{0}$ 1' 38.46" ሰሜን ላቲትዩድ እና $39^{0}$ 2' 19.54" ምሥራቅ ሎንግትዩድ፤

፴፭/ በ$12^{0}$ 1' 38.42" ሰሜን ላቲትዩድ እና $39^{0}$ 2' 18.38" ምሥራቅ ሎንግትዩድ፤

፴፮/ በ$12^{0}$ 1' 37.52" ሰሜን ላቲትዩድ እና $39^{0}$ 2' 15.4" ምሥራቅ ሎንግትዩድ፤

፴፯/ በ$12^{0}$ 1' 35.94" ሰሜን ላቲትዩድ እና $39^{0}$ 2' 10.52" ምሥራቅ ሎንግትዩድ፤

፴፰/ በ$12^{0}$ 1' 33.24" ሰሜን ላቲትዩድ እና $39^{0}$ 2' 8.88" ምሥራቅ ሎንግትዩድ፤

፴፱/ በ$12^{0}$ 1' 34.57" ሰሜን ላቲትዩድ እና $39^{0}$ 2' 6.61" ምሥራቅ ሎንግትዩድ፤



25/ $12^{0}$ 1' 42.24'' Latitude North and $39^{0}$ 2' 33.94'' Longitude East;

26/ $12^{0}$ 1' 41.59'' Latitude North and $39^{0}$ 2' 32.46'' Longitude East;

27/ $12^{0}$ 1' 40.84'' Latitude North and $39^{0}$ 2' 31.63'' Longitude East;

28/ $12^{0}$ 1' 40.44'' Latitude North and $39^{0}$ 2' 31.02'' Longitude East;

29/ $12^{0}$ 1' 40.22'' Latitude North and $39^{0}$ 2' 30.41 Longitude East;

30/ $12^{0}$ 1' 39.29'' Latitude North and $39^{0}$ 2' 27.06'' Longitude East;

31/ $12^{0}$ 1' 38.64'' Latitude North and $39^{0}$ 2' 24.61'' Longitude East;

32/ $12^{0}$ 1' 38.39'' Latitude North and $39^{0}$ 2' 23.14'' Longitude East;

33/ $12^{0}$ 1' 38.53'' Latitude North and $39^{0}$ 2' 22.02'' Longitude East;

34/ $12^{0}$ 1' 38.46'' Latitude North and $39^{0}$ 2' 19.54'' Longitude East;

35/ $12^{0}$ 1' 38.42'' Latitude North and $39^{0}$ 2' 18.38'' Longitude East;

36/ $12^{0}$ 1' 37.52'' Latitude North and $39^{0}$ 2' 15.4'' Longitude East;

37/ $12^{0}$ 1' 35.94'' Latitude North and $39^{0}$ 2' 10.52'' Longitude East;

38/ $12^{0}$ 1' 33.24'' Latitude North and $39^{0}$ 2' 8.88'' Longitude East;

39/ $12^{0}$ 1' 34.57'' Latitude North and $39^{0}$ 2' 6.61'' Longitude East;

፵/ በ$12^0$ 1' 57.54" ሰሜን ላቲትዩድ እና $39^0$ 2' 17.3" ምሥራቅ ሎንግትዩድ፤

፵፩/ በ$12^0$ 2' 0.2" ሰሜን ላቲትዩድ እና $39^0$ 2' 17.3"ምሥራቅ ሎንግትዩድ፤

፵፪/ በ$12^0$ 2' 1.36" ሰሜን ላቲትዩድ እና $39^0$ 2' 23.32" ምሥራቅ ሎንግትዩድ፤

፵፫/ በ$12^0$ 2' 2.26" ሰሜን ላቲትዩድ እና $39^0$ 2' 25.26" ምሥራቅ ሎንግትዩድ፤

፵፬/ በ$12^0$ 2' 5.35" ሰሜን ላቲትዩድ እና $39^0$ 2' 28.21" ምሥራቅ ሎንግትዩድ፤

፵፭/ በ$12^0$ 2' 6.22" ሰሜን ላቲትዩድ እና $39^0$ 2' 29.76" ምሥራቅ ሎንግትዩድ፤

፵፮/ በ$12^0$ 2' 7.62" ሰሜን ላቲትዩድ እና $39^0$ 2' 32.21" ምሥራቅ ሎንግትዩድ፤

፵፯/ በ$12^0$ 2' 8.88" ሰሜን ላቲትዩድ እና $39^0$ 2' 35.45" ምሥራቅ ሎንግትዩድ፤

፵፰/ በ$12^0$ 2' 8.99" ሰሜን ላቲትዩድ እና $39^0$ 2' 36.17" ምሥራቅ ሎንግትዩድ፤

፵፱/ በ$12^0$ 2' 8.63" ሰሜን ላቲትዩድ እና $39^0$ 2' 28.9" ምሥራቅ ሎንግትዩድ፤

፶/ በ$12^0$ 2' 8.92" ሰሜን ላቲትዩድ እና $39^0$ 2' 38.9" ምሥራቅ ሎንግትዩድ፤

፶፩/ በ$12^0$ 2' 9.42" ሰሜን ላቲትዩድ እና $39^0$ 2' 40.16" ምሥራቅ ሎንግትዩድ፤

፶፪/ በ$12^0$ 2' 9.49" ሰሜን ላቲትዩድና $39^0$ 2' 40.81" ምሥራቅ ሎንግትዩድ፤

፶፫/ በ$12^0$ 2' 10.36" ሰሜን ላቲትዩድና $39^0$ 2' 39.88" ምሥራቅ ሎንግትዩድ፤

፶፬/ በ$12^0$ 2' 12.37" ሰሜን ላቲትዩድ እና $39^0$ 2' 38.51" ምሥራቅ ሎንግትዩድ፤

40/ $12^0$ 1' 57.54'' Latitude North and $39^0$ 2' 17.3''Longitude East;

41/ $12^0$ 2' 0.2''Latitude North and $39^0$ 2' 17.3''Longitude East;

42/ $12^0$ 2' 1.36'' Latitude North and $39^0$ 2' 23.32'' Longitude East;

43/ $12^0$ 2' 2.26'' Latitude North and $39^0$ 2' 25.26'' Longitude East;

44/ $12^0$ 2' 5.35'' Latitude North and $39^0$ 2' 28.21'' Longitude East;

45/ $12^0$ 2' 6.22'' Latitude North and $39^0$ 2' 29.76'' Longitude East;

46/ $12^0$ 2' 7.62'' Latitude North and $39^0$ 2' 32.21'' Longitude East;

47/ $12^0$ 2' 8.88'' Latitude North and $39^0$ 2' 35.45'' Longitude East;

48/ $12^0$ 2' 8.99'' Latitude North and $39^0$ 2' 36.17'' Longitude East;

49/ $12^0$ 2' 8.63'' Latitude North and $39^0$ 2' 28.9'' Longitude East;

50/ $12^0$ 2' 8.92'' Latitude North and $39^0$ 2' 38.9'' Longitude East;

51/ $12^0$ 2' 9.42'' Latitude North and $39^0$ 2' 40.16'' Longitude East;

52/ $12^0$ 2' 9.49'' Latitude North and $39^0$ 2' 40.81'' Longitude East;

53/ $12^0$ 2' 10.36'' Latitude North and $39^0$ 2' 39.88'' Longitude East;

54/ $12^0$ 2' 12.37'' Latitude North and $39^0$ 2' 38.51'' Longitude East;

፶፭/ በ120 2’ 14.35” ሰሜን ላቲትዩድ እና 39$^{0}$ 2’ 38.11” ምሥራቅ ሎንግትዩድ፤

፶፮/ በ12$^{0}$ 2’ 15.22” ሰሜን ላቲትዩድ እና 39$^{0}$ 2’ 37.75” ምሥራቅ ሎንግትዩድ፤

፶፯/ በ12$^{0}$ 2’ 16.3” ሰሜን ላቲትዩድ እና 39$^{0}$ 2’ 36.46” ምሥራቅ ሎንግትዩድ፤

፶፰/ በ12$^{0}$ 2’ 16.94” ሰሜን ላቲትዩድ እና 39$^{0}$ 2’ 36.17” ምሥራቅ ሎንግትዩድ፤

፶፱/ በ12$^{0}$ 2’ 18.56” ሰሜን ላቲትዩድ እና 39$^{0}$ 2’ 36.53” ምሥራቅ ሎንግትዩድ፤

፷/ በ12$^{0}$ 2’ 19.61” ሰሜን ላቲትዩድ እና 39$^{0}$ 2’ 36.85” ምሥራቅ ሎንግትዩድ፤

፷፩/ በ12$^{0}$ 2’ 20.26” ሰሜን ላቲትዩድና 39$^{0}$ 2’ 36.71” ምሥራቅ ሎንግትዩድ፤

፷፪/ በ12$^{0}$ 2’ 20.94” ሰሜን ላቲትዩድ እና 39$^{0}$ 2’ 35.95” ምሥራቅ ሎንግትዩድ፤

፷፫/ በ12$^{0}$ 2’ 21.23” ሰሜን ላቲትዩድ እና 39$^{0}$ 2’ 35.74” ምሥራቅ ሎንግትዩድ፤

፷፬/ በ12$^{0}$ 2’ 21.48” ሰሜን ላቲትዩድ እና 39$^{0}$ 2’ 36.13” ምሥራቅ ሎንግትዩድ፤

፷፭/ በ12$^{0}$ 2’ 20.94” ሰሜን ላቲትዩድ እና 39$^{0}$ 2’ 37” ምሥራቅ ሎንግትዩድ፤

፷፮/ በ12$^{0}$ 2’ 19.32” ሰሜን ላቲትዩድ እና 39$^{0}$ 2’ 39.08” ምሥራቅ ሎንግትዩድ፤

፷፯/ በ12$^{0}$ 2’ 17.84” ሰሜን ላቲትዩድ እና 39$^{0}$ 2’ 40.16” ምሥራቅ ሎንግትዩድ፤

፷፰/ በ12$^{0}$ 2’ 16.87” ሰሜን ላቲትዩድ እና 39$^{0}$ 2’ 41.14” ምሥራቅ ሎንግትዩድ፤

፷፱/ በ12$^{0}$ 2’ 15.55” ሰሜንላቲትዩድ እና 39$^{0}$2’ 44.05” ምሥራቅ ሎንግትዩድ፤

55/ 12$^{0}$ 2’ 14.35’’ Latitude North and 39$^{0}$ 2’ 38.11’’ Longitude East;

56/ 12$^{0}$ 2’ 15.22’’ Latitude North and 39$^{0}$ 2’ 37.75’’Longitude East;

57/ 12$^{0}$ 2’ 16.3’’ Latitude North and 39$^{0}$ 2’ 36.46’’ Longitude East;

58/ 12$^{0}$ 2’ 16.94’’ Latitude North and 39$^{0}$ 2’ 36.17’’ Longitude East;

59/ 12$^{0}$ 2’ 18.56’’ Latitude North and 39$^{0}$ 2’ 36.53’’ Longitude East;

60/ 12$^{0}$ 2’ 19.61’’ Latitude North and 39$^{0}$ 2’ 36.85’’ Longitude East;

61/ 12$^{0}$ 2’ 20.26’’ Latitude North and 39$^{0}$ 2’ 36.71’’ Longitude East;

62/ 12$^{0}$ 2’ 20.94’’ Latitude North and 39$^{0}$ 2’ 35.95’’ Longitude East;

63/ 12$^{0}$ 2’ 21.23’’ Latitude North and 39$^{0}$ 2’ 35.74’’ Longitude East;

64/ 12$^{0}$ 2’ 21.48’’ Latitude North and 39$^{0}$ 2’ 36.13’’ Longitude East;

65/ 12$^{0}$ 2’ 20.94’’ Latitude North and 39$^{0}$ 2’ 37’’Longitude East;

66/ 12$^{0}$ 2’ 19.32’’ Latitude North and 39$^{0}$ 2’ 39.08’’Longitude East;

67/ 12$^{0}$ 2’ 17.84’’ Latitude North and 39$^{0}$ 2’ 40.16’’ Longitude East;

68/ 12$^{0}$ 2’ 16.87’’ Latitude North and 39$^{0}$ 2’ 41.14’’ Longitude East;

69/ 12$^{0}$ 2’ 15.55’’ Latitude North and 39$^{0}$ 2’ 44.05’’ Longitude East;

፸/ በ$12^0$ 2' 14.88" ሰሜን ላቲትዩድ እና $39^0$ 2' 45.56" ምሥራቅ ሎንግትዩድ፣

፸፩/ በ$12^0$ 2' 13.45" ሰሜን ላቲትዩድ እና $39^0$ 2' 46.43" ምሥራቅ ሎንግትዩድ፣

፸፪/ በ$12^0$ 2' 11.98" ሰሜን ላቲትዩድ እና $39^0$ 2' 47.18" ምሥራቅ ሎንግትዩድ፣

፸፫/ በ$12^0$ 2' 10.86" ሰሜን ላቲትዩድ እና $39^0$ 2' 47.76" ምሥራቅ ሎንግትዩድ፣ እና

፸፬/ በ$12^0$ 2' 7.44" ሰሜን ላቲትዩድ እና $39^0$ 2' 48.19" ምሥራቅ ሎንግትዩድ፣

መካከል ያለውን ሥፍራ ያካትታል፡፡

## ክፍል ሦስት

## ስለላሊበላ ውቅር አብያተ ክርስቲያናት ዓለም አቀፍ ቅርሶች አስተዳደር

### ፮.ስለክልል ሥፍራው አስተዳደር

፩/ ባለሥልጣኑ በአዋጁ አንቀጽ ፭ መሠረት በላሊበላ ከተማ ውስጥ በሚያደራጀው የመካነ ቅርስ ጽሕፈት ቤት አማካይነት ክልል ሥፍራውን ያለማል፣ ያስተዳድራል፣ ሕገ ወጥ ተግባራት እንዳይፈጸሙበት ይከላከላል፡፡

፪/ የዚህ አንቀጽ ንዑስ አንቀጽ (፩) ድንጋጌ እንደተጠበቀ ሆኖ የላሊበላ ዓለም አቀፍ ቅርሶች የክለላ ሥፍራ አማካሪ ኮሚቴ (ከዚህ በኋላ "ኮሚቴ" እየተባለ የሚጠራ) በዚህ ደንብ ተቋቁሟል፡፡

### ፯. የኮሚቴው አባላት

፩/ ኮሚቴው የሚከተሉት አባላት ይኖሩታል፡-

ሀ) የላሊበላ ከተማ ከንቲባ...............ሰብሳቢ፣

ለ) የላስታ ወረዳ አስተዳዳሪ...............አባል፣

ሐ) የላሊበላ ከተማ ባህልና ቱሪዝም ጽህፈት ቤት ኃላፊ..............................አባል፣

መ) የወልዲያ ዩኒቨርስቲ የማህበረሰብ አገልግሎት ኃላፊ............................አባል፣

ሠ) የላሊበላ ውቅር አብያተ ክርስቲያናት ደብር ጽሕፈት ቤት ተወካይ.......አባል፣

70/ $12^0$ 2' 14.88'' Latitude North and $39^0$ 2' 45.56'' Longitude East;

71/ $12^0$ 2' 13.45'' Latitude North and $39^0$ 2' 46.43'' Longitude East;

72/ $12^0$ 2' 11.98'' Latitude North and $39^0$ 2' 47.18'' Longitude East;

73/ $12^0$ 2' 10.86'' Latitude North and $39^0$ 2' 47.76'' Longitude East; and

74/ $12^0$ 2' 7.44''Latitude North and $39^0$ 2' 48.19'' Longitude East.

## PART THREE

## ADMINISTRATION OF THE MONOLITHIC CHURCHES OF LALIBELA WORLD HERITAGE RESERVED AREA

### 6. Administration of the Reserved Area

1/ The Authority shall develop, administer and protect the designated heritage site from illegal acts through the site management office to be organized at Lalibela city pursuant to Article 5 of the Proclamation.

2/ Without prejudice to sub-article (1) of this Article an Advisory Committee to the designated heritage site (hereinafter the "Committee") is hereby established.

### 7. Members of the Committee

1/ The Committee shall have the following members:

a) Lalibela Town Mayor.........Chairperson;

b) head of Lasta woreda Administration ........................................member;

c) head of Lalibela town Tourism and culture Branch Office...........................member;

d) head of Woldia University Community Service.................................member;

e) representative of the Monolithic Church of Lalibela.......................................member;

ረ) የላስታ ወረዳ የሚገኙ የሃይማኖት ተቋማት ተወካዮች..................አባላት፣

ሰ) የላሊበላ አካባቢ ሀገር ሽማግሌዎችና ታዋቂ ግለሰቦች ሁለት ተወካዮች........... ........................................አባላት፣

ሸ) የላሊበላ ከተማ የሴቶችና የወጣቶች ማህበራት ሁለት ተወካዮች.................. ........................................አባላት፣

ቀ) የላሊበላ አካባቢ የቱሪስት አገልግሎት ሰጪ ተቋማት ማህበር አንድ ተወካይ..................................አባል፣

በ) የመካነ ቅርሱ ጽሕፈት ቤት ኃላፊ..........................አባልና ፀሐፊ፣

፪/ የዚህ አንቀጽ ንዑስ አንቀጽ (፩) ድንጋጌ እንደተጠበቀ ሆኖ ኮሚቴው አስፈላጊ ሆኖ ሲያገኘው ሌሎች አካላትንም በስብሰባው እንዲሳተፉ ሊፈቅድ ይችላል፡፡

፰. <u>የኮሚቴው ሥልጣንና ተግባሮች</u>

ኮሚቴው የሚከተሉት ሥልጣንና ተግባራት ይኖሩታል፦

፩/ በላሊበላ ውቅር አብያተ ክርስቲያናት ዓለም አቀፍ ቅርስ አካባቢ የሚኖሩ የኅብረተሰብ ክፍሎች ባለቤትነት ተሰምቷቸው በቅርስ አጠባበቅ ላይ የጐላ ተሳትፎ ስለሚያደርጉበትና ከአካባቢው ባለድርሻ አካላት ጋር ቅንጅትና ትስስር ስለሚፈጠርበት አግባብ ሁኔታዎችን ያመቻቻል፣

፪/ የጽሕፈት ቤቱን ዓመታዊ እቅድ የእቅድ ክንውን ይገመግማል፣ ለባለሥልጣኑ ከመቅረቡ በፊት መርምሮ የማሻሻያ አስተያየት ይሰጣል፣

፫/ ጽሕፈት ቤቱ ኃላፊነቱን ለመወጣት በሚያስችሉት ሌሎች ጉዳዮች ላይ ይመክራል፣ ሃሳብ ያቀርባል፡፡

f) a representative from each religious institution in the city of Lalibela .......................................members;

g) two representatives of Elders and Renowned people from the town of Lalibela.............. .......................................members;

h) two Representatives of Lalibela Town women and youth associations .......................................members;

i) representative of Lalibela town Tourist Service Delivery Institutions operators .........................................member;

j) site manager..........member and secretary.

2/ Without prejudice to sub-article (1) of this Article the Committee, as may be necessary, allow other bodies to attend the meetings.

8. **<u>Power and Duties of the Committee</u>**

The Committee shall have the powers and duties to:

1/ facilitate conditions to develop sense of ownership among the local population surrounding the heritage sites to play active role in the protection of the heritage and as to the creation of strong coordination and linkage between stakeholders of the surrounding area;

2/ review the annual plans and performance of the office before they are being submitted to the Authority;

3/ deliberate and forward proposals on such other issues to enable the Office to properly discharge its responsibilities.

**፱. የኮሚቴው ስብሰባ**

፩/ ኮሚቴው መደበኛ ስብሰባውን በሦስት ወር አንድ ጊዜ ያደርጋል፣ ሆኖም አስፈላጊ ሆኖ ሲገኝ በሰብሳቢው ጥሪ በማንኛውም ጊዜ አስቸኳይ ስብሰባ ሊያደርግ ይችላል፡፡

፪/ ከኮሚቴው አባላት ከግማሽ በላይ በስብሰባው ላይ ከተገኙ ምልዓተ ጉባዔ ይሆናል፡፡

፫/ የኮሚቴው ውሳኔዎች በስብሰባው በተገኙ አባላት በድምፅ ብልጫ ያልፋሉ፣ ሆኖም ድምፅ እኩል በእኩል የተከፈለ እንደሆነ ሰብሳቢው ወሳኝ ድምፅ ይኖረዋል፡፡

፬/ የዚህ አንቀጽ ድንጋጌዎች እንደተጠበቁ ሆኖ ኮሚቴው የራሱን የስብሰባ ሥነ-ሥርዓት ደንብ ሊያወጣ ይችላል፡፡

**ክፍል አራት**

**ልዩ ልዩ ድንጋጌዎች**

**፲. ክልከላ**

፩/ በአዋጁ አንቀጽ ፵፪ (፪) የተመለከቱት የተከለከሉ ተግባራት እንደተጠበቁ ሆኖ፣ በዚህ ደንብ አንቀጽ ፬ በተመለከቱት እምብርት ዞኖች ውስጥ የሚከተሉትን ተግባራት መፈፀም የተከለከለ ነው፡-

ሀ) በቅርሶቹ ላይ ጉዳት ሊያስከትሉ የሚችሉ ኬሚካሎችንና ከፍተኛ ጨረር አመንጪ መሣሪያዎችን መጠቀም፣

ለ) ጥናትና ምርምርን ጨምሮ ማንኛውንም በባለሥልጣኑ ያልተፈቀደ ሥራ ማከናወን፡፡

፪/ በአዋጁ አንቀጽ ፵፪ (፪) የተመለከቱት የተከለከሉ ተግባራት እንደተጠበቁ ሆኖ፣ በዚህ ደንብ አንቀጽ ፭ በተመለከቱት ደጀን ዞኖች ውስጥ በባለሥልጣኑ የተሰጠ ፈቃድ ሳይኖር የሚከተሉትን ተግባራት ማከናወን የተከለከለ ነው፡-

**9. Committee Meetings**

1/ The Committee shall meet once in every three months; provided, however, that an extra-ordinary meeting of the Committee may be held at any time whenever called by the Chairperson.

2/ There shall be a quorum where more than half of the members are present at any meeting of the Committee.

3/ Decisions of the Committee shall be passed by majority vote; in case of a tie, the Chairperson shall have a casting vote.

4/ Without prejudice to the provisions of this Article, the Committee may adopt its own rules of procedure.

**PART FOUR**

**MISCELLANEOUS PROVISIONS**

**10. Prohibition**

1/ In addition to the prohibited activities provided for under Article 42 (2) of the Proclamation carrying out the following activities within the Core Zone shall also be prohibited:

a) using chemicals and high radiation tools that can cause damage to the heritages;

b) carrying out any activity which is not authorized by the Authority.

2/ In addition to the prohibited activities provided for under Article 42 (2) of the Proclamation carrying out the following activities within the Buffer Zone without the authorization of the Authority shall also be prohibited:

ሀ) የቅርሱን የእይታ ትስስር እና የላቀ ሁለንተናዊ እሴት የሚጎዳ የህንፃ ግንባታ፣

ለ) ከፍተኛ ኃይል ተሸካሚና አስተላላፊ የኤሌክትሪክና የስልክ ምሰሦዎች ተከላ፣

ሐ) የውሃ ማጠራቀሚያ ጋኖች ግንባታ፣

መ) የማዕድን ማውጣትና ቁፋሮዎች፣

ሠ) በቅርሶቹ ላይ ጉዳት ሊያስከትሉ የሚችሉ ዛፎችን መትከል።

## ፲፩. የባለሥልጣኑን ፈቃድ ስለማግኘት

በደጀን ዞኖች ውስጥ የሚፈቀዱ ተግባራትን ለማከናወን የሚፈልግ ማንኛውም ሰው ባለሥልጣኑን ማማከርና ይሁንታ ማግኘት አለበት፡፡

## ፲፪. አስተዳደራዊ መቀጫ

በዚህ ደንብ አንቀጽ ፲ የተከለከሉትን ተግባራት በመተላለፍ በቅርሶችና በቅርስ ክለላ ስፍራዎች ላይ ጉዳት ያደረሰ ማንኛውም ሰው በሌሎች አግባብነት ባላቸው ሕጎች መጠየቁ እንደተጠበቀ ሆኖ በደረሰው ጉዳት ልክ አስተዳደራዊ መቀጫ እንዲከፍል ይደረጋል፡፡

## ፲፫. የመተባበር ግዴታ

ማንኛውም ሰው ይህን ደንብ በማስፈጸም ረገድ ከጽህፈት ቤቱ ጋር የመተባበር ግዴታ አለበት፡፡

## ፲፬. ደንቡ የሚፀናበት ጊዜ

ይህ ደንብ በፌደራል ነጋሪት ጋዜጣ ታትሞ ከወጣበት ቀን ጀምሮ የፀና ይሆናል፡፡

አዲስ አበባ ነሐሴ ፳፪ ቀን ፪ሺ፯ ዓ.ም

ኃይለማርያም ደሳለኝ

የኢትዮጵያ ፌደራላዊ ዲሞክራሲያዊ ሪፐብሊክ

ጠቅላይ ሚኒስቴር

a) construction of buildings affecting the visual integrity and Outstanding Universal value of the heritage site;

b) installation of high tension electric and telephone transmission towers;

c) construction of water reservoirs;

d) mining and quarrying activists;

e) planting trees that can cause damage to the Heritage.

## 11. Consulting and Getting Approval from the Authority

Any person who intends to carry out activities permitted within the Buffer Zone shall consult and get approval of the Authority.

## 12. Administrative Penalty

Whosoever causes damage to heritages or the reserved heritage area in contravention of Article 10 of this Regulation, without prejudice to the punishments provided for in the other relevant laws, shall be subject to administrative penalty equivalent to damage sustained.

## 13. Duty to Cooperate

Any person shall have duty to cooperate with the Office for the implementation of this Regulation.

## 14. Effective Date

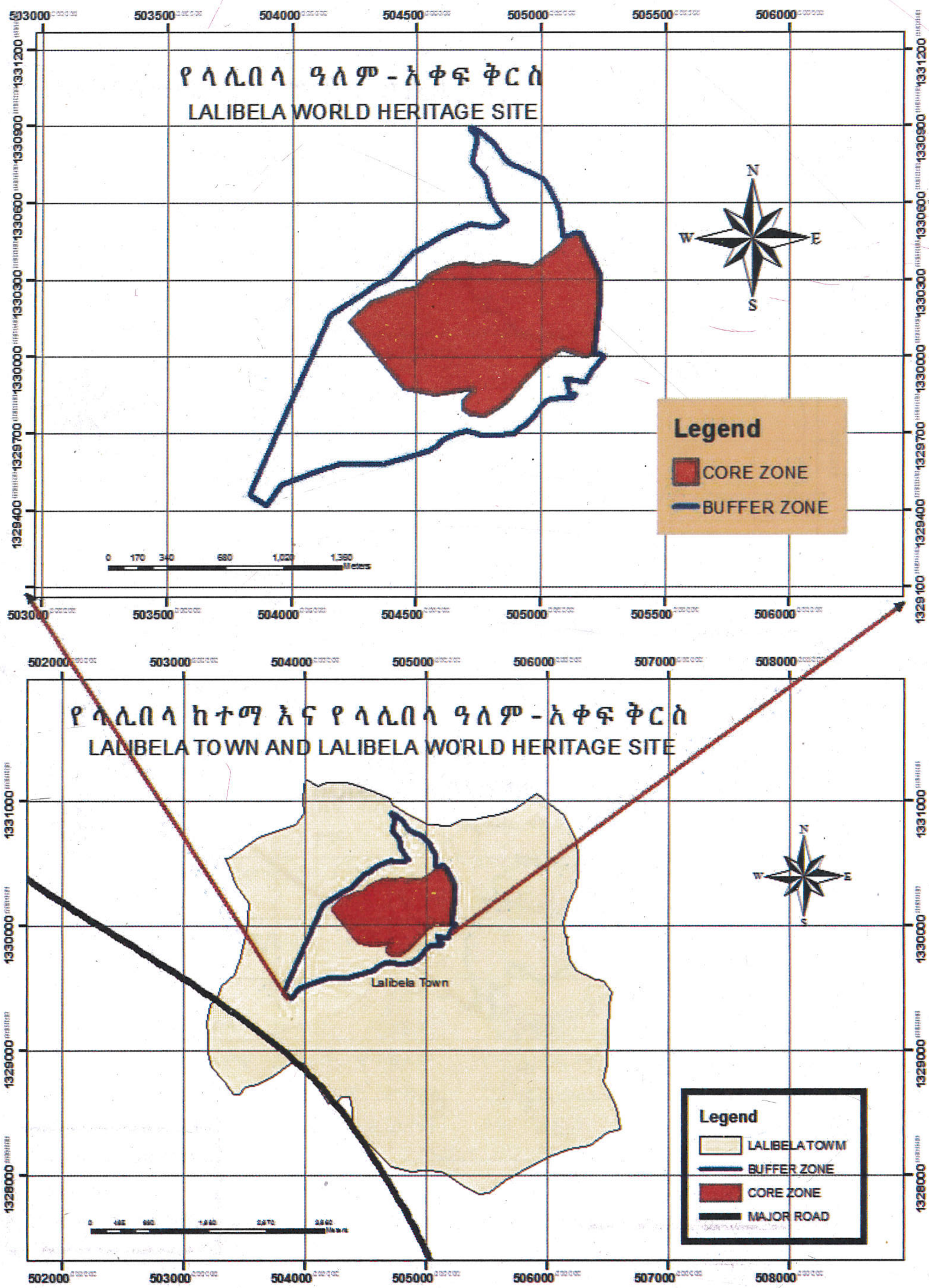
This Regulation shall enter into force on the date of publication in the Federal Negarit Gazette.

**Done at Addis Ababa, this 28th day of August, 2015.**

**HAILEMARIAM DESSALEGN**

**PRIME MINISTER OF THE FEDERAL DEMOCRATIC REPUBLIC OF ETHIOPIA**

## አባሪ ፩ Annex 1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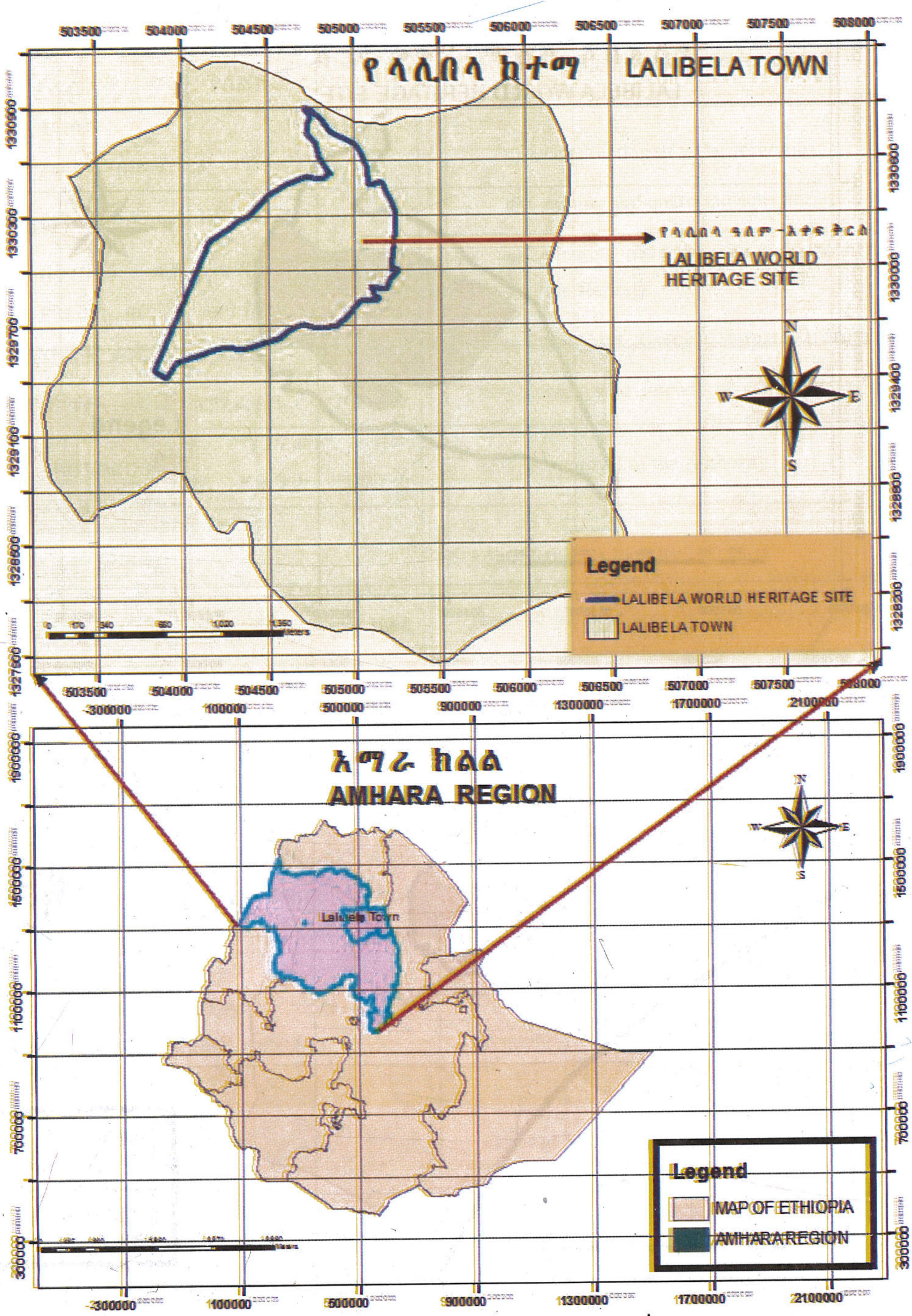
## አባሪ ፪ Annex 2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