



KULUMBIMBI

Mbanza Kongo – Zaire, Angola



FACULTY OF CIVIL
ENGINEERING institute
of building structures

RENOVATION OF HISTORICAL BUILDING

IN ANGOLA

NHB053 - Reconstruction and
Renovation of Historical Buildings

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Abstract. This study documentation aims to make the renovation of the **Cathedral of Mbanza Kongo** built in the **XVI century** known as **Kulumbimbi** located in the city of **Mbanza Kongo, province of Zaire, Angola**. This historical building is found in the ancient political and spiritual capital of The Kingdom of Kongo, Mbanza Kongo, added to UNESCO World Heritage in 2017. There are many controversies regarding the history behind Kulumbimbi which will be discuss in this report. On this renovation work my focus will be to add a new roof for the structure. The report will also include a summary about my country (Angola) and the province where Kulumbimbi is located ie.Zaire. Among the geographical characteristics of the location, I will stress on the relief and the weather, as it is important to have a good understand of the regional climate in order to choose the best materials for the renovation or any construction in general. Getting into the subject matter it will be covered by the history around the cathedral. Current state of the building, followed by some CAD and 3D drawings. In closing, I will propose the final roof solution for the building and a personal overview of all what has been here discussed, creating emphasis therefore in the final renovation of the roof structure.

Key words: Africa, Angola, Zaire, Mbanza Kongo, Kongo Kingdom, Climate, Kulumbimbi, Cathedral, Stone and mortar, Gable Roof, Renovation, Wood, Kambala, SUNGLAZE, Polycarbonate Panel.

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1. Introduction

The aim of this study documentation is to make the renovation of the **Cathedral of Mbanza Kongo** built in the **XVI century** known as **Kulumbimbi** located in the city of **Mbanza Kongo, province of Zaire, Angola**. This historical building is found in the ancient political and spiritual capital of The Kingdom of Kongo, Mbanza Kongo, added to UNESCO World Heritage in 2017. There are many controversies regarding the history behind Kulumbimbi, letting the builders and date of erection uncertain. The building is currently found in ruins and without a roof. On this renovation work my focus will be to add a new roof for the structure.

Before striking to the subject a summary about my country (Angola) and the province where Kulumbimbi is located ie.Zaire, will be addressed. Among the geographical characteristics of the location, I will stress on the relief and the climate, as it is important to have a good understand of the regional climate in order to choose the best materials for the renovation.

Getting into the subject matter it will be covered by the history around the cathedral. Its importance in the past and currently to the citizens. Original and current state of the building, followed by some CAD and 3D drawings. My renovation proposal of the materials, composition and implementations for the new roof.

The project will be closed with a personal overview all what has been discussed in this study documentation, creating emphasis therefore in the final renovation of the roof structure.

1.1 Angola

(1) (2)

Location: Southwest Africa

Total Area: 1.246.700 km², coast extends for 1.650 km

Population Density: ≈ 32 million inhabitants

Provinces: 18

Capital: Luanda

Major National Languages: Umbundu, Kimbundu, Kikongo, Tchokwe, Nganguela, Kwanyama, Mbunda, Ibinda.
(plus ~25 languages and ~50 dialects)

Official Language: Portuguese

Currency: Kwanza (AOA)



Figure 1 – Angola Location

NEIGHBORING COUNTRIES

North: the Republic of Congo and the Democratic Republic of Congo; East: Republic of Zambia and the Democratic Republic of Congo, South: Namibia; and West: Atlantic Ocean.

RELIEF

The country is mainly constituted by a massif of highlands, limited by a narrow strip of lowland, coastal (coastal plain), whose height varies between 0 and 200 m. Above 200 m there are elevations that can take on two different aspects: mountains or plateaus. From the coastal plains one passes, through a series of flat surfaces, staggered at different altitudes, to a vast high region of relatively flat summits, the plateau region, which varies between 1.000 m and 1.500 m and occupies most of the country (65%). Above 1.500 m and up to 2.000 m, there is a region in the center of Angola, not very extensive, which extends a little south to the southern provinces. The highest altitude is found on the Morro do Môco, in the province of Huambo and reaches approximately 2.620 m.

HYDROGRAPHY

Angola's hydrographic characteristics are closely related to the country's relief, with rivers flowing from the plateau and marginal mountain areas. There are many rivers but the largest and most navigable river in Angola is the Kwanza, with 1.000 km in length, in whose tributary, Lukala, are found the famous Kalandula Falls, of more than 100 m high. In addition to these, there are several falls and rapids on other rivers, such as the Mbridge, Kambambe, Kwanza and Ruakaná. The main hydrographic basins are the rivers Zaire, Mbridge, Kwanza (the largest), Keve or Kuvo, Cunene and Kuando.

CLIMATE

The Angolan climate has two seasons: **The Rainy Season**, hottest period that occurs between the months of October to April (The month of April is usually the wettest month), and the **Dry Season (Cacimbo)**, which corresponds to the period from May to September. In the interior of the country, we can often reach a minimum of $\sim 8^{\circ}\text{C}$ and in the hottest regions of the country to a maximum of $\sim 37^{\circ}\text{C}$.

The country has the distinct geographical position of being in the inter-tropical and sub-tropical zones of the southern hemisphere, being near the sea, and the specific features of its topography, which divide it into two distinct climatic regions:

a) The Coastal Region - with an average annual relative humidity of 30% and an average temperature above 23°C ; annual rainfall ranging between 50mm (Namibe) and 800mm (Cabinda),

b) The Interior Region - sub-divided into the **Northern Zone**, with high rainfall and high temperatures, the High Altitude Zone that encompasses the central plateau regions, which has a dry season with lower temperatures, and the **Southwest Zone**, a semi-arid region due to its proximity to the Namib Desert, an extension of the Kalahari Desert, which is subject to large tropical continental air masses.

The average temperatures in the country correspond to a high of 27°C and a low of 17°C

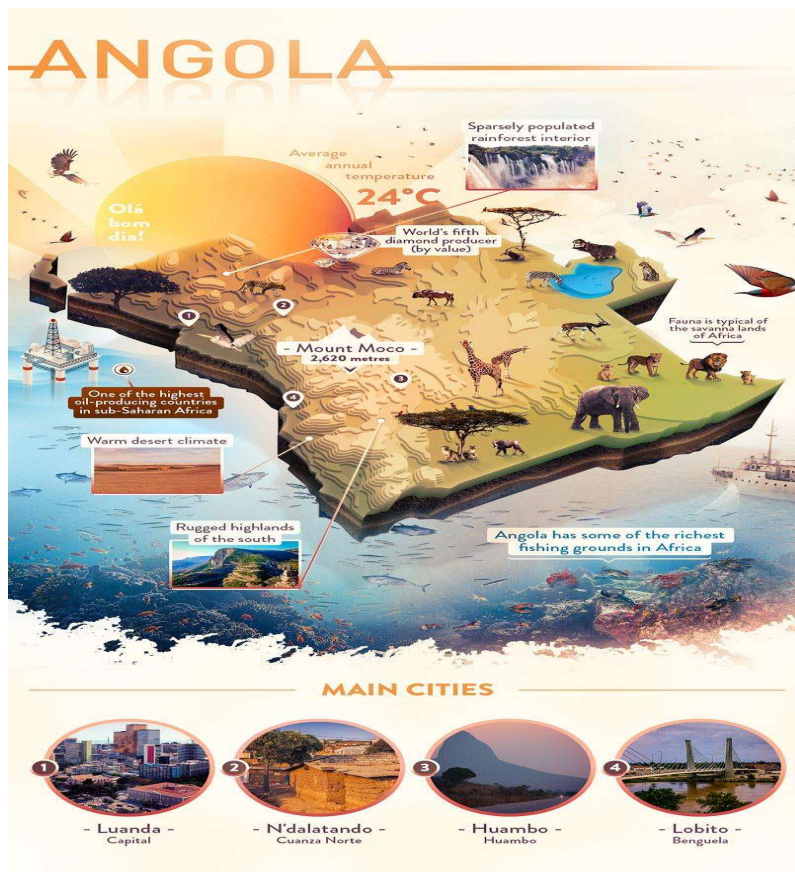


Figure 2 - Angola Animated Map (3)

1.2 Zaire, Mbanza Kongo (Kingdom of Kongo brief introduction)

Kulumbimbi is in an altitude of 365 m above sea level, built as a cathedral in the XVI century. Located in the province of Zaire, capital of Mbanza Kongo and also the latest ancient political and spiritual capital of the Kingdom of Kongo.

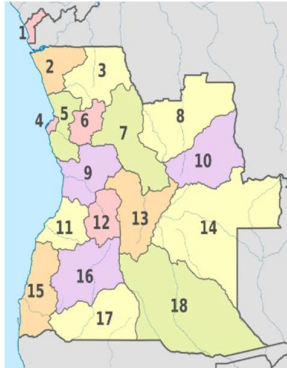


Figure 4 - Provinces of Angola (4)



Figure 5 - Province of Zaire (4)

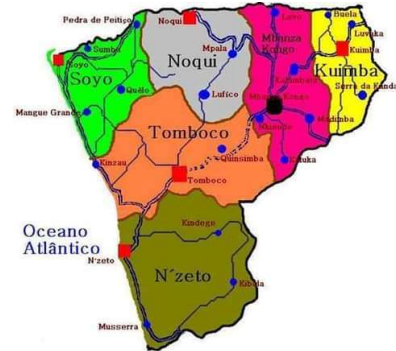


Figure 3 - 6 Municipalities of Zaire (Mbanza Kongo on pink) [Google]

This kingdom is one of the oldest and one of the most well-documented African kingdoms. Historians explain that at its height, the kingdom covered parts of present-day Angola, the Democratic Republic of Congo, and the Republic of Congo. Yet, history told by locals also includes parts of present-day Gabon, Namibia, and even Zambia. Cultural similarities tend to support this argument. (5)

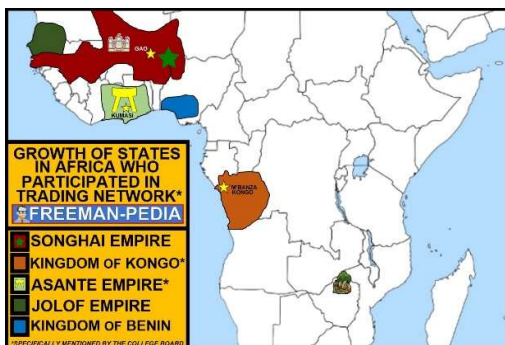


Figure 6 - Kingdom of Kongo ~1480-1500 [Google]

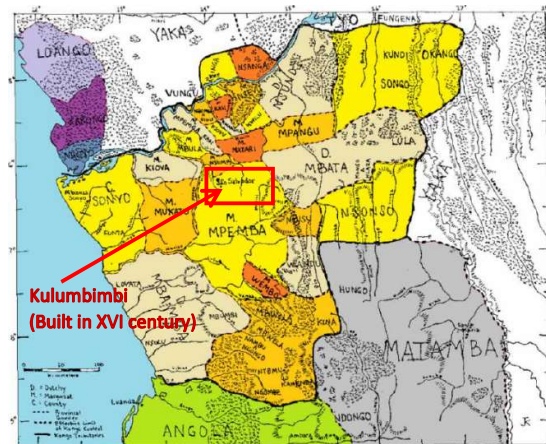


Figure 7 - Kingdom of Kongo in 1648 (28)

Capital of Zaire and former capital of Kingdom of Kongo, **Mbanza Kongo** was added to UNESCO's World Heritage in 2017. It is also found there the royal residence, the customary court, the holy tree, as well the royal funeral place which is besides **Kulumbimbi**.



Figure 8 - Kulumbimbi historical and cultural heritage (6)

The style of the building could be classed as a blend of Romanesque and Gothic and the surviving windows are typical of Medieval churches (7). Ancient Cathedral of Mbanza Kongo, the oldest in south of the Equator. Its ruins have aroused the interest of domestic and foreign experts, due to the rarity of its architectural features.



Figure 9 - Ruins of the Cathedral of Mbanza Kongo (6)

1.2.1 Climate

In Mbanza Kongo, the wet season is oppressive and overcast, the dry season is partly cloudy, and it is hot year-round. Over the course of the year, the temperature typically varies from 17°C to 33°C and is rarely below 15°C or above 35°C. (8) The chart bellow has data of 6 years back from now (2021), tracks an Average Monthly Temperature and Precipitation (days). **The maximum temperature is on March 32°C, minimum on July 16°C , wettest month is April with 20 rainy days, driest July with non rainy days.**

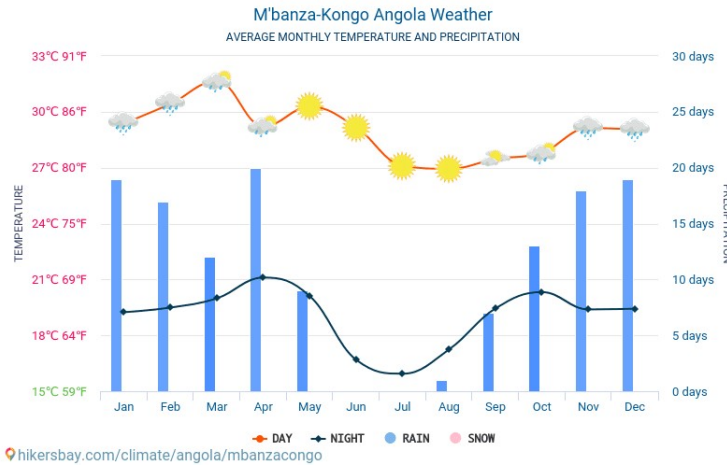


Figure 10 - Mbanza Kongo Average Monthly Temperature and Precipitation (2015-2021) (9)

Monthly precipitations above 150 mm are mostly wet, below 30 mm mostly dry. Note: Simulated precipitation amounts in tropical regions and complex terrain tend to be lower than local measurements. (10) The following chart has gathered data from 1985 onwards, it shows Average Monthly Precipitation (amount) and Wind Speed. **The highest precipitation is 133mm in April and the highest wind speed is 4,4 m/s occurring in August**

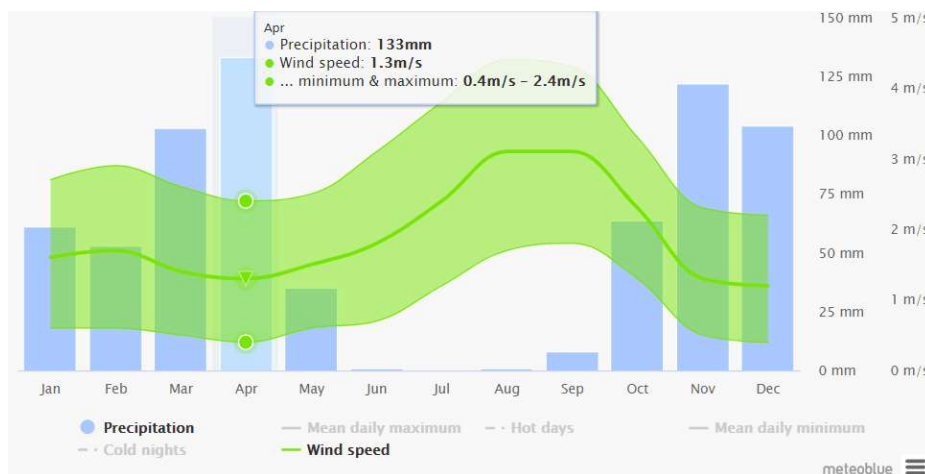


Figure 11 - Average Monthly Precipitation (amount) and Wind Speed. (since 1985) (10)

In the chart bellow humidity comfort level was based on the dew point, as it determines whether perspiration will evaporate from the skin, thereby cooling the body. Lower dew points feel drier and higher dew points feel more humid. Unlike temperature, which typically varies significantly between night and day, dew point tends to change more slowly, so while the temperature may drop at night, a muggy day is typically followed by a muggy night.

Mbanza Kongo experiences *extreme* seasonal variation in the perceived humidity.

The *muggier period* of the year lasts for 9.3 months, from *September 12* to *June 21*, during which time the *comfort level is muggy, oppressive, or miserable at least 34% of the time*. The month with the *muggiest days* in Mbanza Kongo is *March*, with *30.5 days* that are *muggy or worse*. The month with the *fewest muggy days* in Mbanza Kongo is *July*, with *4.7 days* that are *muggy or worse*.

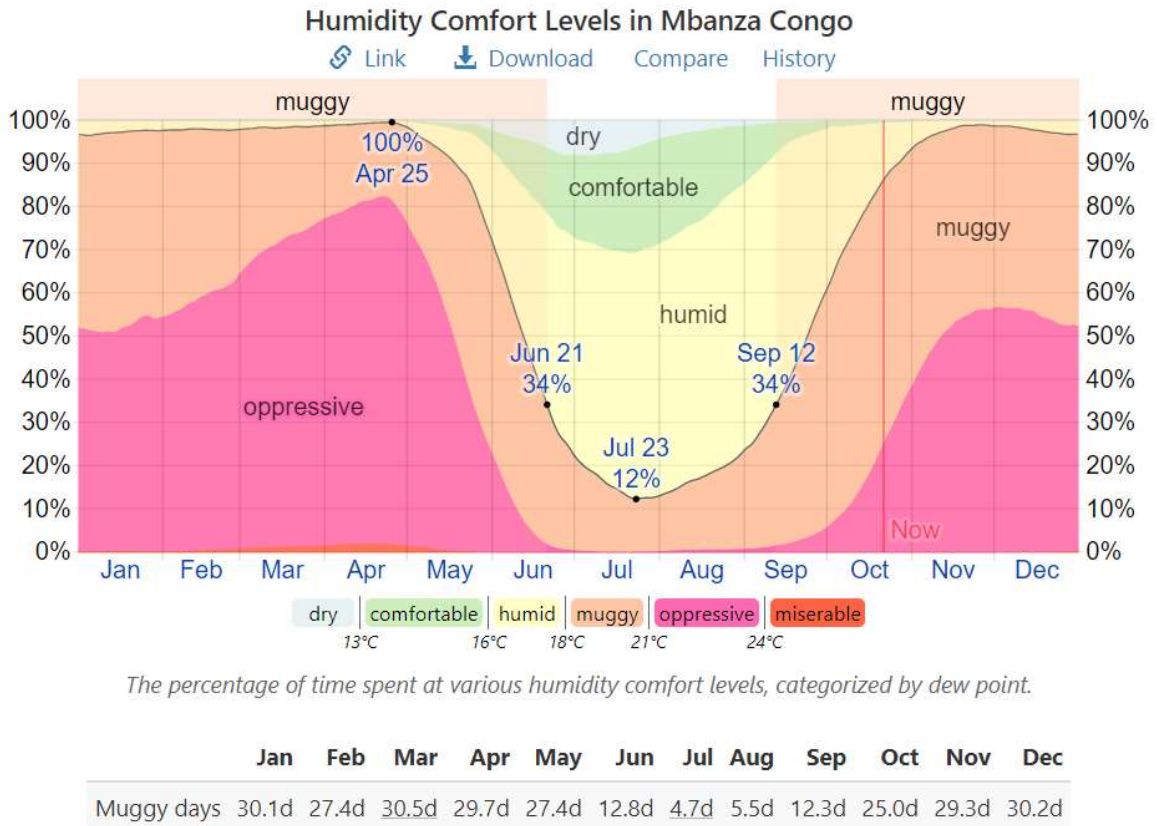


Figure 12 - Humidity Comfort Levels in Mbanza Kongo (8)

2. History

Kulumbimbi means in Kikongo (language) “what has left from the ancestors”. The history behind Kulumbimbi is very complex and has many different versions about how/ when and why it was built. Kongo Kingdom was developed with a large commercial network, being a superpower and center of trade routes for ivory, copper, raffia cloth, and pottery. Yet, 1483 marked the beginning of the kingdom's decline with the arrival of Diogo Cão who sailed the coast of Africa (5) for Portugal's interests. One of the hypotheses and accepted by many schoolers is that the cathedral was built above a previous traditional cult place in 1549 on the request of Kongo's King at the time to Portuguese missionaries and later elevated to the Cathedral of Kongo in 1596.. Reminding that in 1491 King Nzinga a Nkuwu would ask, for unknown reasons, to be baptised and most of the proceeding kings were spreading Christianity throughout the Kingdom of Kongo and were keen to have direct contact with the Vatican. (11) After King Nzinga a Nkuwu died (1506) a new ruler out of the candidates of each province should be elected by the 12 wise counsellors and the 12 governors of the 12 provinces. (5) Among the two last candidates was Mvemba a Nzinga a firm Christian later consider by the Portugueses as Apostle of Kongo and Mpanzu a Kitima a more traditionalist, in the famous Battle of Mbanza Kongo which Mvemba was victorious with the supposed support of Portugueses as some claim. By then relationship between Kongo and Portugal became stronger and through the years many trades occurred, including the construction of other structure on the request of the King or mutual agreement between both kingdoms. Those facts support the above-mentioned hypothesis and despise any other claims around the construction of Kulumbimbi.

There is also a very pertinent claim to be the first church in Sub-Saharan Africa but Ethiopian churches in Lalibela clearly preceded it. (around 1200) Instead, Kulumbimbi could take the place of the **first Catholic Church** in Sub-Saharan Africa.

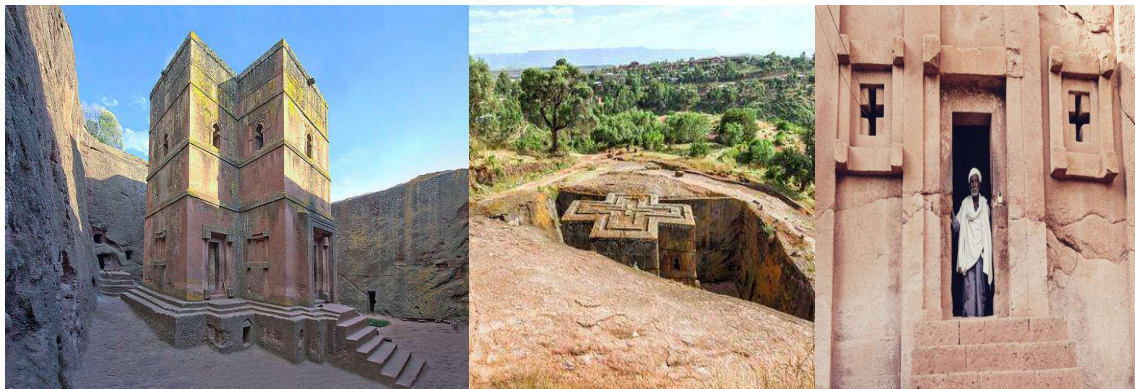


Figure 13 - Rock-Hewn Churches, Lalibela (XIII Century) (27)

Other people claim that it was built by the local people but different from another Kingdom in the region from XI century The Great Zimbabwe (12), in Kongo Kingdom were no documented stone constructions prior to the first contact with the Portuguese, 1483.



Figure 14 - The Great Zimbabwe [Google]

The local construction in the Kingdom of Kongo were made of wattle and daub which is a composite building method used for making walls and buildings, in which a woven lattice of wooden strips called wattle is daubed with a sticky material usually made of some combination of wet soil, clay, sand and straw. The building was usually covered with a thatched roof.



Figure 16 - Wattle and daub Houses (29)



Figure 15 - Local architecture of the region [Google]



Figure 17 - Local architecture of the region 2 [Google]

Eyewitness accounts from travellers and missionaries provide detailed descriptions of the architecture and construction techniques of the Kongo (Figure below matches some features with the following statement). The fences and house walls deservedly receive particular notice. They consisted of artfully woven vegetal material that created double-sided designs. Kongo architecture, basketry, and textiles were intimately related expressive genres. Similar creation techniques for all three produced common motifs that graced the built environment, the movable furniture that outfitted it, and the bodies of its dwellers. Rui de Pina reported the impressions of the first visitors to the Kongo in 1491 who saw the large structures of the king's palace. These houses were "beautiful and all decorated and woven of diverse loops (*laços*) made of palms of many colors." (13)



Figure 18 - House of Teke people



Figure 19 - Elite Couple and Compound from the Kongo (1692) (13)

With that being said it is hard to take all other hypothesis as the cathedral of Mbanza Kongo clearly shows an unusual architecture found in the region. It is rather closer to medieval period churches.



Figure 20 - Cathedral of Mbanza Kongo (Kulumbimbi)



Figure 21 - Oldest church in Porto, Portugal built in VI century (Renovated) (14)

2.1 Original state of the building

The XVI century cathedral consists of stone-and-mortar and the structure was once covered with a simple gable roof. A smaller doorway on the far wall opened to the bishop compound. Eustachio da Ravenna's 1711 drawing of the bishopric of the Kongo, now missing from the Propaganda Fide archives in Rome but published by Louis Jadin in 1964 (Figure below). The drawing was part of a project for reorganizing the cathedral and its surroundings that would elaborate upon existing structures. The cathedral appears in the drawing as a rectangular church with a single nave, a gable roof, and a large arched entrance that stood in the axis of the other archway linking the nave to the choir. (15)

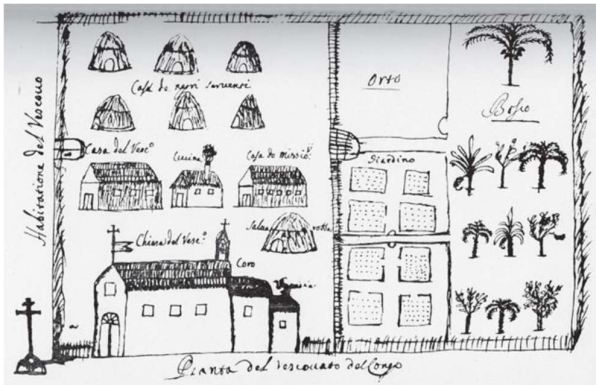


Figure 22 - Eustachio da Ravenna, Plan of the Bishopric of Congo. 1711 (15)

Windows on the front and the side walls bring light to the interior. A choir and sacristy of diminishing height complete the building, which is topped by two crosses, a flag, and a small bell tower. The simple facade articulates a square window in the upper tier and a large arched doorway composed of a fanlight opening at the top and a two-door gate at the bottom. **The cathedral measured about 31 by 15 meters, with the choir about 7 by 6 meters. In Friar Eustachio's drawing, the cathedral stands directly on the public square, next to a monumental cross.** (15)

2.2 Destruction and Preservation

The history of the cathedral's partial destruction and conservation can be traced from the beginning of the seventeenth century. The cathedral was around 1645 one of three stone-and-mortar churches in the capital. In 1694, it was one of the few surviving churches in the ruined capital at the height of the era of civil wars. It still stood whole, although damaged by the roots of overgrown trees. Renovations might have taken place during the eighteenth century, since in 1781 the once more abandoned cathedral stood with some of its side chapels intact. In 1845, the principal chapel and its altar was found on a stepped platform, the chapel of the Sacrament and the sacristy standing. A decade later, in 1858 Portuguese lieutenant reported that the church was in a similar state, as did Bentley in 1879. (15) There is no exact date for renovation stated by the Angolan government.

3. Current state of the building

The sixteenth-century rectangular shaped parish church later elevated to the Cathedral of Kongo in 1596 suffered greatly through the centuries, yet it still partially stands today. The choir, where the altar remains, has about 7 x 6 m and two small windows on the wall. It opens on the opposite wall through the door to a possible private enclosure of the bishop's residence which is now in complete ruins. (15)



Figure 24 - Kulumbimbi Altar/Choir [Google]



Figure 23 - Kulumbimbi Interior Look From Bishop's Residential Door [Google]



Figure 25 - Kulumbimbi Exterior (Choir/Altar Zone) [Google]

Despite the fact of non available dimensions for the structure in the following picture is possible to compare the height of the structure with the people around which may have an average of 1.75m.



Figure 26 - Kulumbimbi Frontal View [Google]

3.1 Technical Surveys

The measurements are not precise. Floorplan's dimensions were acquired using Google Earth and Sections by checking 3D models available since 2014 on *sketchfab* website which unfortunately the user did not make available its dimensions or model to download.

3.1.1 3D Models

3D surveys in the historical center of Mbanza Kongo (Zaire, Angola), carried out under the project “Mbanza Kongo, cidade a desenterrar para preservar (city to dig up to preserve)”, whose main purpose was the registration of this former capital of the Kingdom of Kongo, founded in the XIV century, in the UNESCO World Heritage List. (16)



Figure 27 - Kulumbimbi 3D Model Upper Diagonal View (17)

Other angles from the same model.



Figure 28 - Kulumbimbi 3D Model Front View (17)



Figure 30 - Kulumbimbi 3D Model Top View (17)

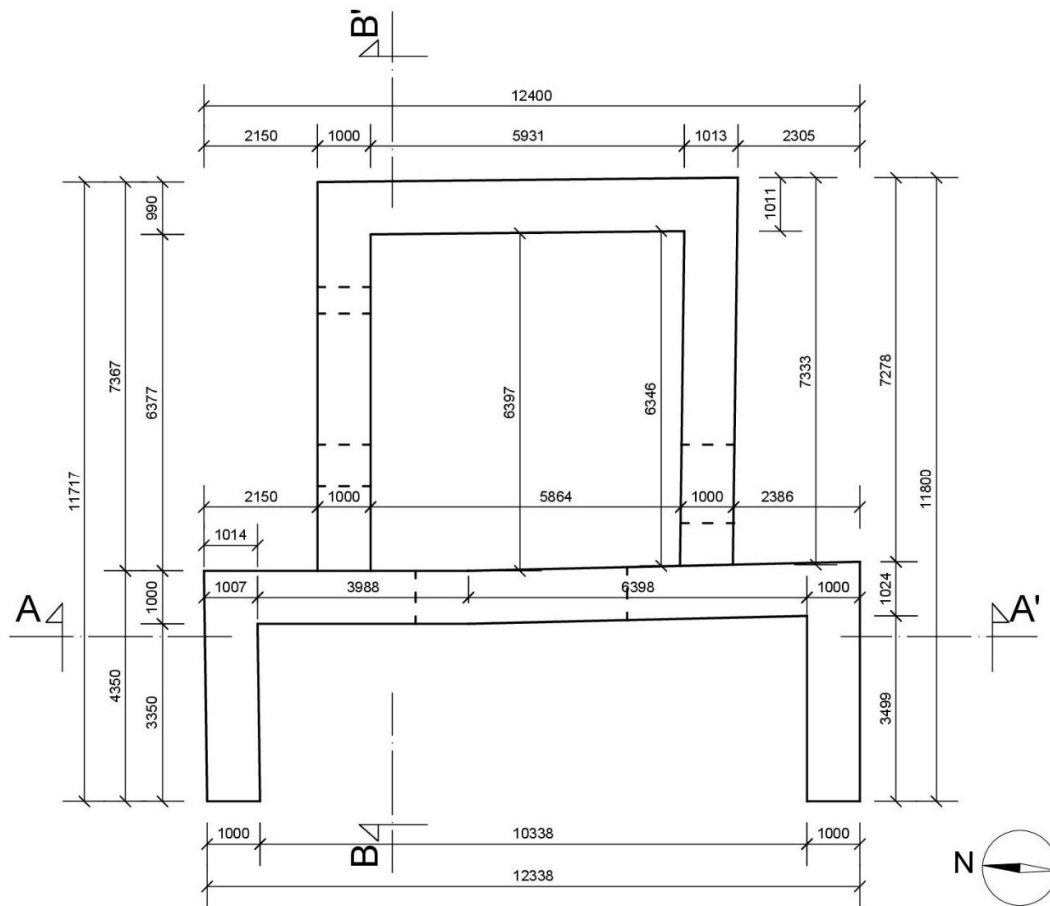


Figure 29 - Kulumbimbi 3D Model Side View (17)

3.1.2 CAD Drawings

Drawings of existing state of the building were made with the Software AutoCAD.

FLOOR PLAN



SECTION A - A'

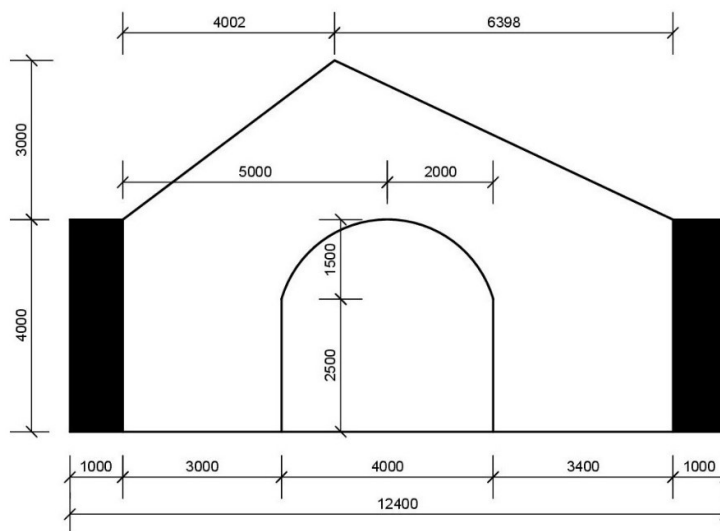
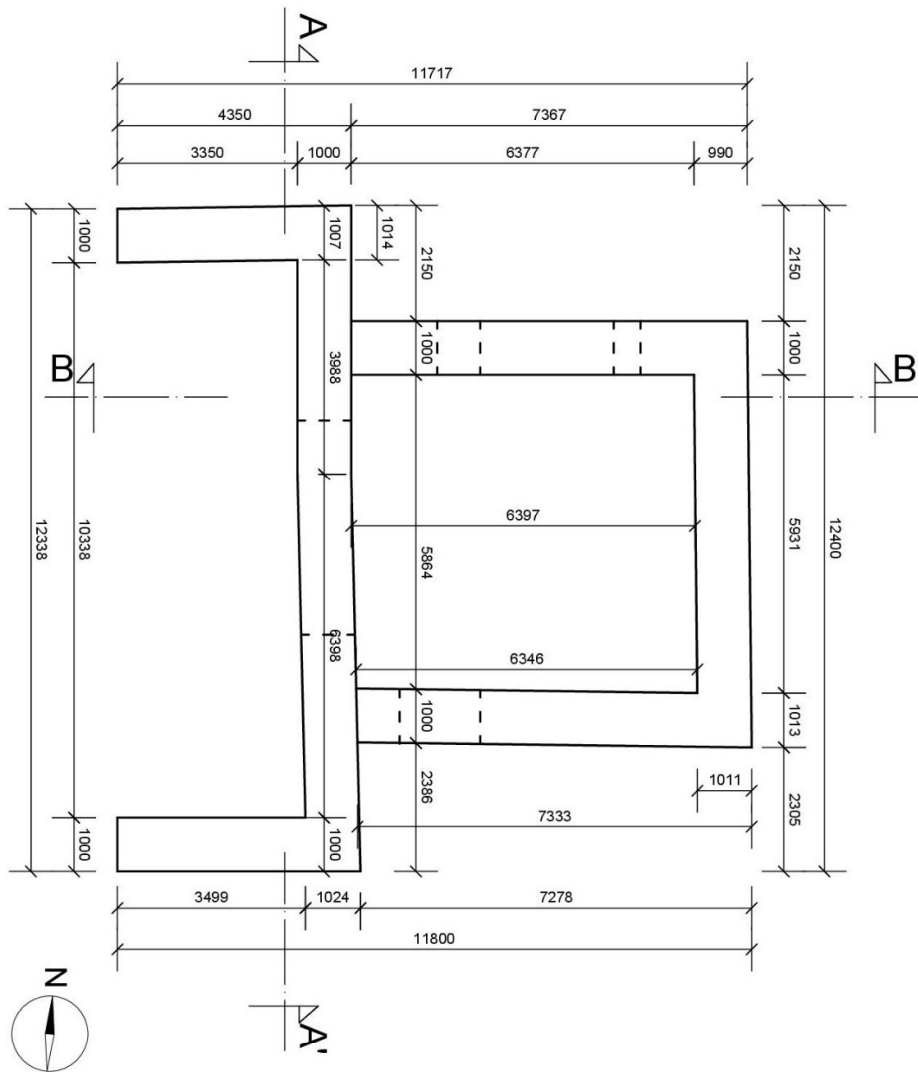


Figure 31 - Kulumbimbi CAD Drawing Floorplan and Section A-A'

FLOOR PLAN



SECTION B - B'

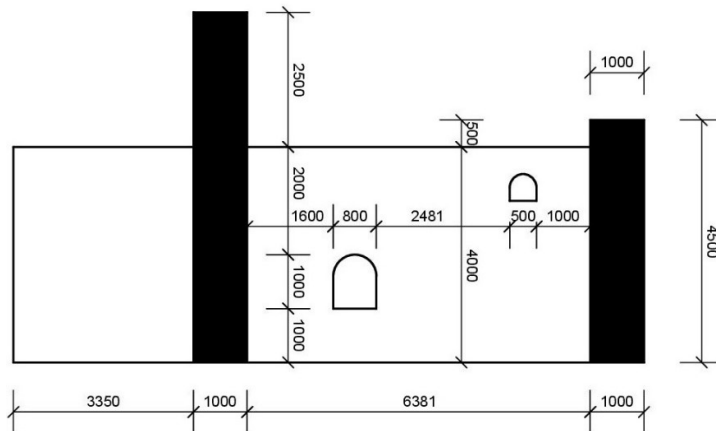


Figure 32 - Kulumbimbi CAD Drawing Floorplan and Section B-B'

4. Renovation

This study will not make the renovation of the whole building, which in fact is very in need of. Instead, for the purpose of this study documentation the previous gabled roof will be reconstructed now with new materials and finishes.

4.1 Solutions (Gabled Roof)

Three possible solutions are considered which mainly differ on the used materials. Some features of the fictitious artistic drawing below gave me inspiration for the final roof solution.



Figure 33 - Artistic drawing (Discussion Forum of Computer's Game Age of Empires) (18)

1st SOLUTION

Metals will be used rather than wood due to the muggy climate of the city because of the wood's ability to absorb moisture following with the growth of bacteria/ insects and finally its decay, a special care on the insulation would be crucial. The roof would be a common pitched cold roof with steel truss, ceramic tiles covering and hidden ceiling in the interior.

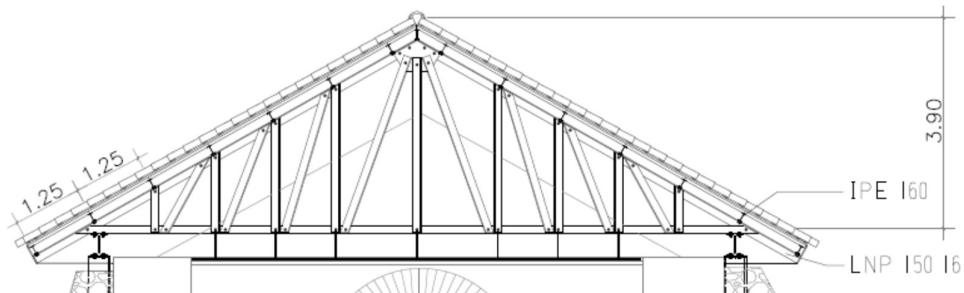


Figure 34 - 1st Roof Solution Frontal view (19)

Eave's and dropped ceiling details.

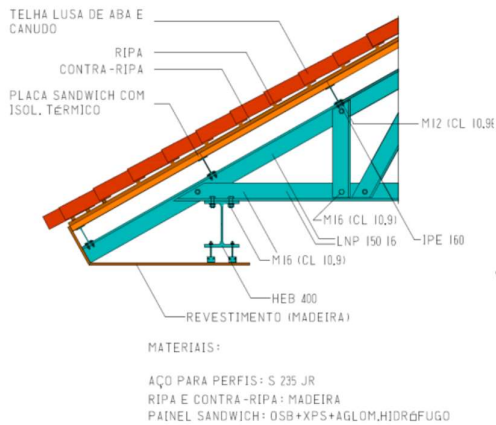


Figure 35 - 1st Roof Solution Eave's Detail (19)

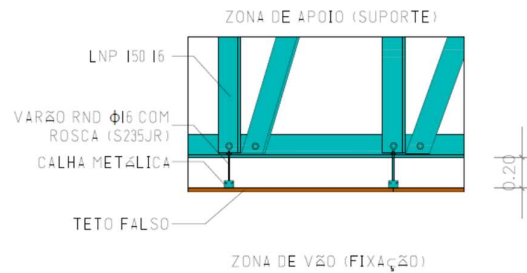


Figure 36 - 1st Roof Solution Dropped Ceiling Detail (19)

2nd SOLUTION

In order to be closer to the original structure a pitched warm thatched roof would be placed.

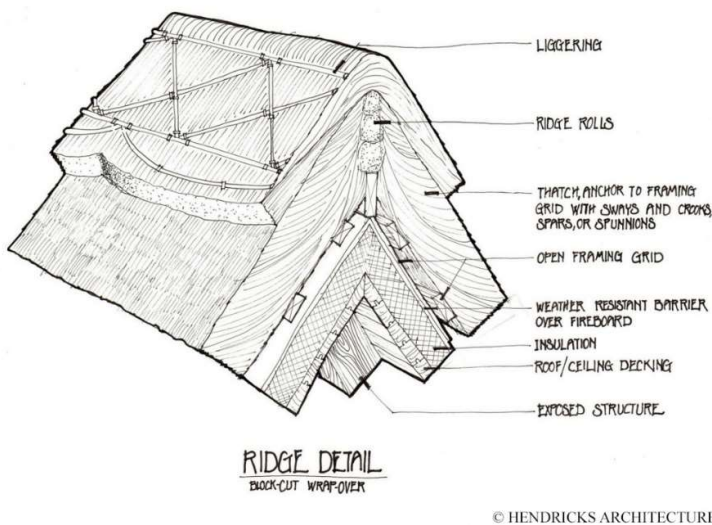


Figure 37 - 2nd Roof Solution Ridge Detail (20)

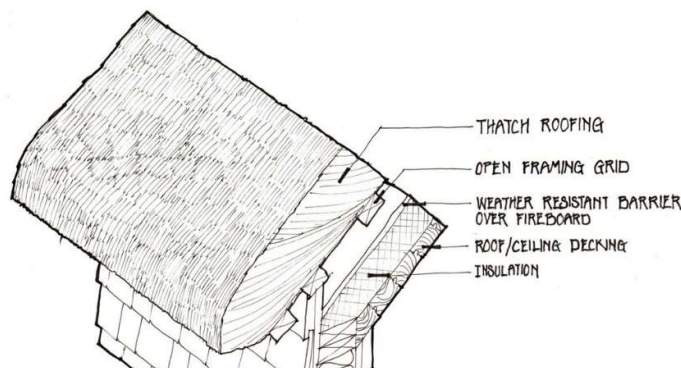


Figure 38 - 2nd Roof Solution Eaves Detail (20)

3rd SOLUTION

To increase the safety of the roof truss (insects, fungus, etc) a pitched cold roof would be placed.

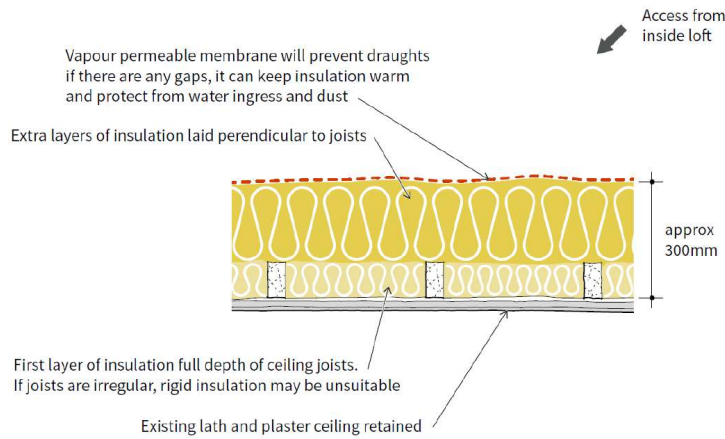


Figure 39 - 3rd Solution Horizontal Roof composition (21)

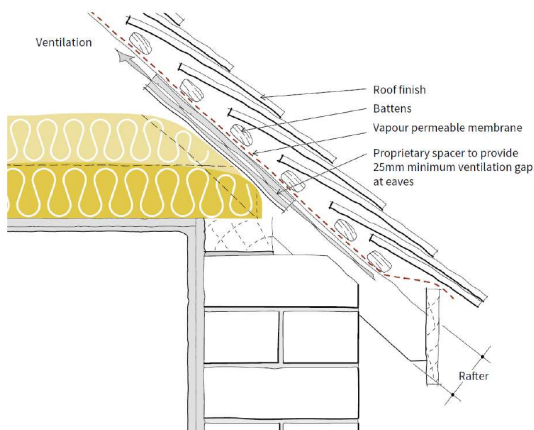


Figure 40 - 3rd Solution Eaves Detail (21)

CONCLUSION

After analyzing the mentioned solutions above with the Teacher Jan Müller (supervisor of this study work) we have considered the **2st Solution** to preserve some feature of the original roof. Pruposed alteration on this solution is the placement of **glass boards (1x1 m) instead of thatch**

4.2 Final Solution

Pitched roof with Kambala timber (22) rafter covered with polycarbonate panels using SUNGLAZE roofing system. This system consists of aluminium profile and polycarbonate sheets which is a great alternative to glass due to structural requirements, cost and impact resistance (23).

- Some other benefits of SUNGLAZE:
- Glass-like clear appearance,
 - Standing seam leak-proof performance,
 - Free thermal expansion, Caulking and silicone free,
 - Withstanding high loads,
 - Easy, fast and safe installation,
 - Minimal maintenance

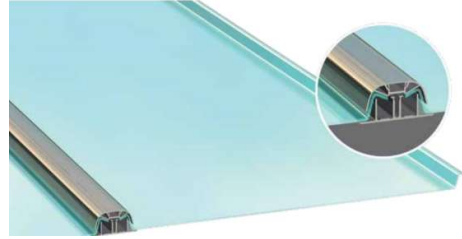


Figure 41 - SUNGLAZE panels (24)

Rafters are in an axial distance of 800mm. Panel type SUNGLAZE 6/800 (6mm thick, 800mm width). Thermal conductivity 0,21W/m2.k, U-value 5,04 W.m2.k, Acoustic insulation 26 db. (24)



Figure 42 -Illustration of wooden rafter with polycarbonate panels (different company) [Google]

Kambala (Iroko, Mvule) tree is found in most of the provinces in Angola. Can reach a height of 40-45 m and thickness about 150 cm. It has a **very durable wood, hardly impregnable**, which does not require any preservative treatment. **An ideal material for outdoor use.** Nevertheless, the sapwood is extremely fragile, hence the particularity of exporting logs without their sapwood. Tones change from golden to brown with time (25) (26) Timber rafter used has dimensions 100x150 mm.



Figure 44 - Kambala wood [Google]



Figure 43 - Kambala timber [Google]

4.2.1 Assembly

Firstly we will instal the roof above the choir (interior) .

FLOOR PLAN

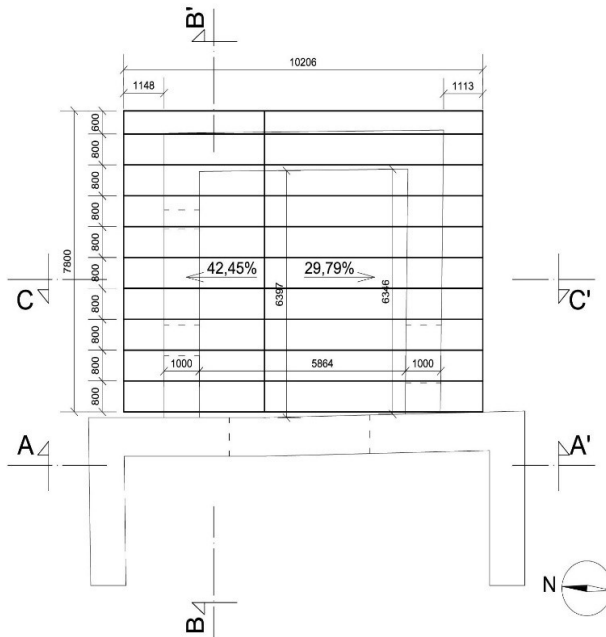


Figure 45 – Floorplan Roof above the choir (inner roof)

Concrete ring beam is cast on site to level the walls before screwing C16 timber wall plate on top for placement of the roof structure followed by the installation on SUNGLAZE panels.

SECTION C - C'

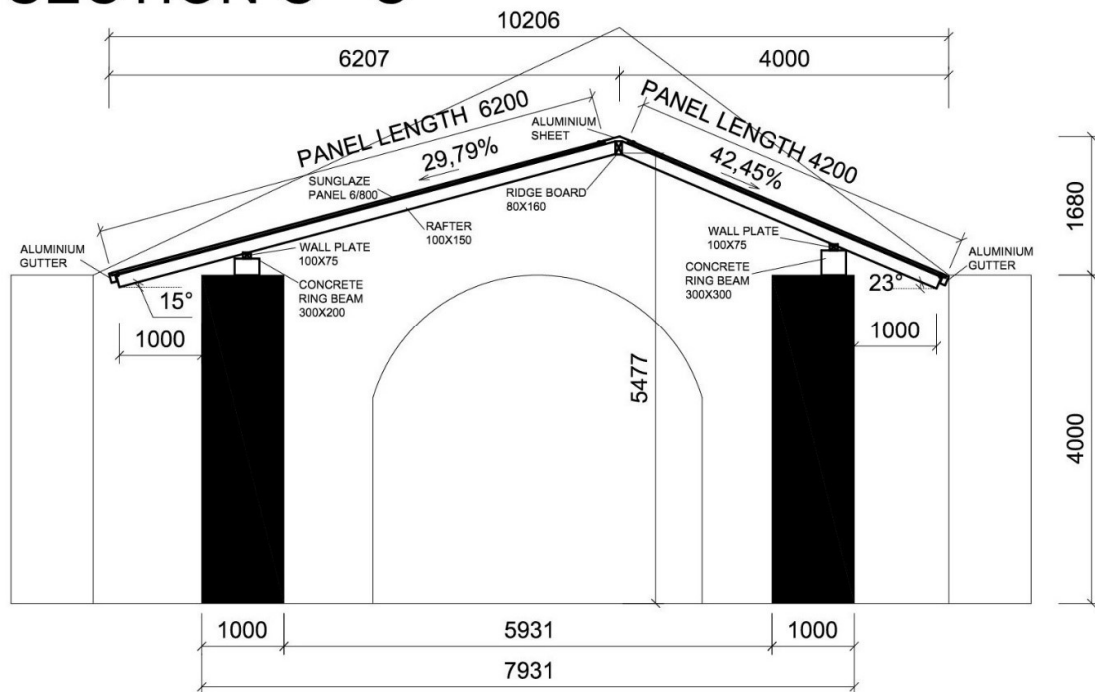


Figure 46 - Section C-C' Roof above the choir (inner roof)

To finish we install the roof above the old naive (exterior).

FLOOR PLAN

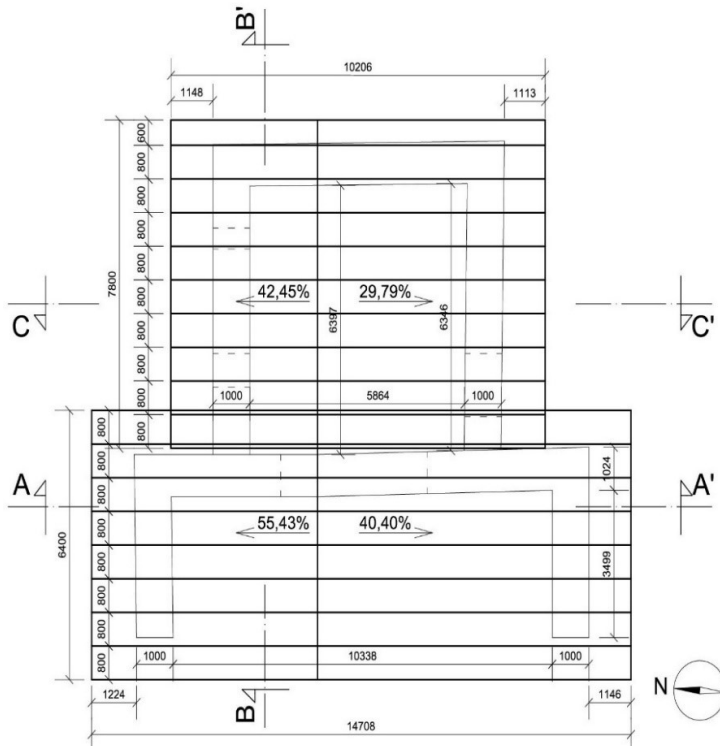


Figure 47 - Floorplan Final Roof Installation

Installation of the second roof will follow the same steps as the latter. The additional of steel rod is to support the normal forces deal to the span of the roof.

SECTION A - A'

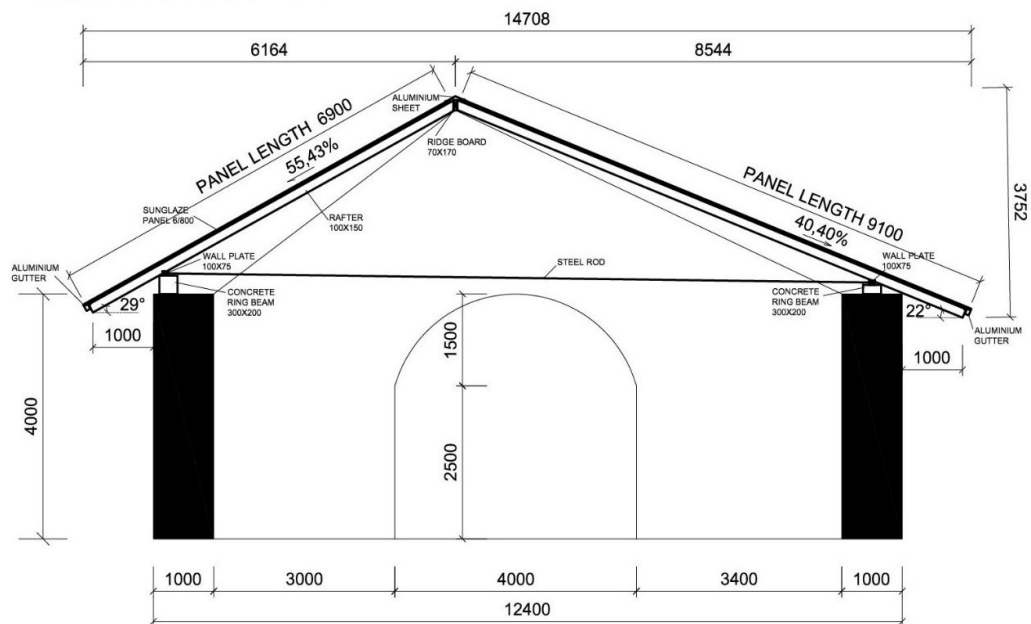


Figure 48 -Section C-C' Roof above the old naiver (exterior roof)

5. Conclusion

To conlude, we can affirm that **“Kulumbimbi the Ruins of the XVI Century Cathedral of Mbanza Kongo” has an extreme significant impact either historically and architecturally.** From the historical point of view **some citizens (minority) see it as a curse** that should be demolished stating that Christianity was used like a mask for the slow infiltration, invasion and destruction of the Kongo Kingdom. By building the Cathedral on top of an ancient traditional cult place, later the Kingdom being recognized by the Vatican as a Christian Kingdom had to follow some of their laws (as others Catholic Christian’s kingdoms/ empires in other continents at the time), made easy for the big flow of Portugueses which many times came as missionaries bringing then various internal conflicts between two sides: **traditional inclined locals citizens** that saw this suddenly big interest with covers of religion as a treat to conquer the Kingdom; and the **more religious inclined locals citizens saw it as a blessing (currently the majority, still see it as a blessing)** with a friendly, holy and not threatening relationship. The history showed that the religious side have won the battles on field with the military support of the Portugueses making Kulumbimbi one of the first of various stone and mortar structures built in the country. Therefore, the history speaks by itself and shows which side was right during that period.

Nevertheless, **the cathedral should be preserved and renovated** to act as a physical proof of this historical background so that the future generations will learn how to negotiate with other nations without losing its sovereignty to a dramatically destructive and unreversible extent, preserve a peaceful mutual benefit relationship with interchange of skills and knowledge. The cathedral is indeed an amazing architectural work built of stone and mortar, which by the renovation of the roof structure can attract more tourists (National and International). The rafter made of local and strong wood (Kambala) against fungi/ insects will diminish the need of constant maintenance. The polycarbonate panels will protect against the UV radiations and the frequent big number of rains on the region. SUNGLAZED covers will also bring a beautiful aesthetics for the structure. The government should authorize a survey and renovation which among the Angolans Engineers should be the assistance of Portugal or any other country with engineers that possess high experience on such type of structures as Kulumbimbi shows to be in a state of future collapse. **This act would be very beneficial for the implementation of the final solution proposed in this study documentation with more precise dimensions. Renovated and preserving this UNESCO World Heritage will be a win not just for the local citizens but for the World.**

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