TRADITIONAL HAUSA MUD ROOFED ARCHITECTURE:
A PROVISIONAL CLASSIFICATION OF HAUSA STRUCTURAL SYSTEMS
AND
THEIR RESULTANT CEILING PATTERNS
VOLUME I

by

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THESIS APPROVAL

This thesis by Susan B. Aradeon meets the regulations governing the degree of Doctor of Philosophy of Ahmadu Bello University and is approved for its contributions to scientific knowledge and its literary presentation.

Internal Examiners

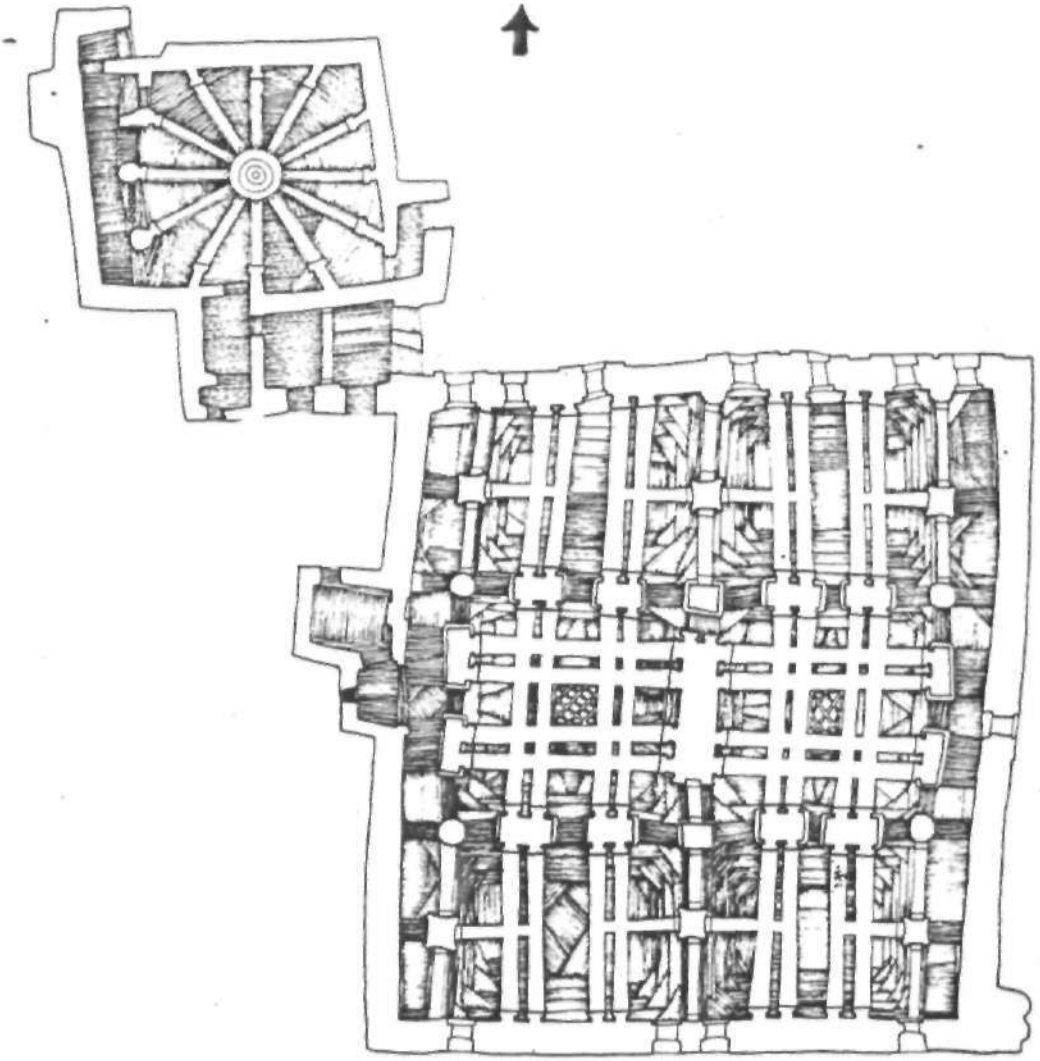
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The Zaria Mosque Complex
Ceiling Plan

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ABSTRACT

As a basis for a fuller appreciation of the qualities of Hausa architecture, this study establishes a provisional classification of the traditional Hausa structural systems for supporting mud roofs and their resultant ceiling patterns. The limitations of an architectural technology based on the use of mud and azara (planks of split palm trunk) have significantly influenced the nature of Hausa architecture. The linear azara serve as a permanent form-work, both for the beams and arches and for the ceiling/roofs. Hausa master masons consider 1.80m (6^1) the safe span for the azara. In domes, the azara must be even shorter to ensure a uniformly curved dome. These limitations on the dimensions of the azara force master masons to subdivide their soffits. The structural systems supporting these subdivisions and the ceiling patterns they generate constitute the basis for this classification.

Flat ceiling/roofs and domes have been treated separately in order to account for the more complex problems encountered in designing and erecting domes. In response to problems ensuring a smooth transition from square walls to the domical form and maintaining a uniform curvature for each dome, the master masons have designed a great variety of aesthetically pleasing structural solutions, greater than for slab roofs.

Hausa master masons have created larger clear spans than is common in mud-roofed architecture. Their

reinforced-mud arch based on cantilever action is the distinguishing feature of Hausa architecture. It has made possible the design of spans as large as 8.00m (26'3") square and the design of lofty domes despite the limitations of the available materials. The master masons have perfected three basic types of arch configurations: arches meeting at the crown, arches forming central coffers and arches abutted by half arches.

Hausa master masons have also fully exploited the aesthetic potential inherent in their structural systems. The articulation and embellishment of the soffit permanent formwork and the beam or arch configuration in ceiling/roof structures demonstrate that Hausa architectural designs are based on a conceptual integration of structural and aesthetic considerations.

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** DA refers to David Aradeon.
JCM refers to JC Moughtin.
NCMM refers to National Commission for Museums and and Monuments.

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GLOSSARY OF FOREIGN TERMS

A. HAUSA TERMS*

Alkali	alkali m. (pl. alkalai) judge
Alhaji m.	(f. alhajiya) pl. alhajai = alahazi Ar.) one who has gone on the pilgrimage to Mecca; used as a form of address.
Amini	the shigifa of Gidan Sarkin Kebbin Yabo named after the builder who built the room
azara f.	(pl. azaru = azarori) section of a split palm tree trunk used for roofing (usually giginya is employed).
Babban Gwani	literally: big expert (1) epithet for the early nineteenth century chief builder of Zaria who designed and built the Zaira Mosque (2) the reception hall at Gidan Madaki in Kafin Madaki falsely reputed to have been built by Babban Gwani
Bawan Dodo	the entrance tower to the emir's palace in Daura
birni m.	(pl. birane) a walled town
burji m.	(buraza) clayey earth with gravel content.
daki m.	(pl. dakuna) (1) a house (usually refers to a round, thatched house) (2) a room in a house
dakin	possessive of daki, Dakin X = the house of X
daurin guga m.	(1) calabash for drawing water having several sticks (kafa) attached to it to form the umbrella-like ribs which serve as the handle (2) vaulting of a ceiling.
dungu	equivalent to tuni (See Saad 1981:209).
gida m.	(pl. gidafe = gidaduwa = gidadajo) (1) compound (2) house consisting of several rooms.

*The following definitions have been paraphrased from Dictionary of the Hausa Language by R.C. Abraham The spellings have been copied from Abraham.

gidan (possessive of gida, gidan X = the house of X.

giginya f. (pl. giginyoyi = giginyu) deleb palm (Borassus flabellifer).

ginshiki m. (pl. ginshikai) (1) (a) pillar supporting roof (b) basis (2) double thickness reinforcing gown (3) Katsina Hausa: load bearing partition wall.

goruba f. (pl. gorubai = gorubobi) dum-palm (Hyphoene Thebaica).

gwani the epithet of veneration bestowed upon "a craftsman of exceptional skill, inventiveness or imagination" (Saad, 1981).

gwanita the state of being gwani; the attributes of gwani; or an instant of display of the powers of gwani (Saad, 1981).

kafa f. (pl. kafafu = kafafuwa = kafofi) (1) foot, leg. (2) each half-arch in any of the arch configurations supporting a dome.

kafar kaza (lit. chicken's foot) the arch configuration for a vault where a full transverse arch is abutted at the crown by a half-arch to create a third point support.

kafi m. (1) hut of cornstalks. (2) (a) stockade (b) town surrounded by stockade fence. (3) equivalent to zuri (See Saad, 1981: 208-210).

Kafin Madaki name of a the town north of Bauchi which was traditionally part of the fiefdom of the Madaki

kasa A. (kasa) f. (1) earth, soil (2) country, district.

katsi m. ashes from dyepit residue spread over roofs and in dyepits as an indigenous cement.

kofa f. (pl. kofofi) doorway.

kubara Birnin Kebbi Hausa: lightweight azara from the top of the deleb palm tree; used for the infilling material in reinforced mud arches (Sarkin Gini Birnin Kebbi, personal communication, September 1982).

kulli — Birnin Kebbi Hausa: the set of azara which rest on the permanent formwork azara of both legs of a reinforced-mud arch, completing the permanent formwork of the arch (Sarkin Gini Birnin Kebbi, personal communication, September, 1982).

kyaure m. — (pl. kyamare = kyaware) door made of palm timber, planks, beaten iron, etc.

laka f. — mud.

laso A. — (laso) m impervious cement for sealing roofs and dye-pits combining katsi and other vegetable materials (indigo liquid, treated animal hairs, strawless horse manure, and a fusion from the roots of a wild vine).

limam = limami = liman m. (pl. limamai) Arabic officiating Muslim priest.

Madaki m. — an important title and official position, appointed by the ruler.

Madakawaki — Katsina Hausa: equivalent to Madaki.

Magajin Gari m. — an important title and official position, appointed by the ruler in Kano and Katsina.

magini m or f. — (pl. magina) (1) builder (2) potter.

mashifidi — equivalent to kulli (See Saad, 1982:210).

rijiya f. — (pl. rijiyoyi = rigoji = rigozai = Kt. riyoji) (1) well (2) ceiling coffer.

Nufawa — Nupe people.

Sarki m. — (pl. Sarakuna = Sarakai) (1) Emir (2) Chief.

Sarkin Gini — head of the official builders, a heredidary title appointable by the emir

shigifa f. — (pl. shigifu = shigifofi = shigifai) Katsina and Sokoto Hausa: a rectangular mud room with a mud roof.

Shigifar Nufawa — the large room in the emir's palace in Birnin Kebbi where the Emir of Bida is received on his regular visits representing his people.

Shigifar Tambura	the room in the Kanta Museum in Argungun (formerly the emir's palace) where the drums are displayed.
soro m.	(pl. soraye) Kano: (1) rectangular flat-roofed house (or round house with cupola-top) where walls and roof are mud (2) lower storey of such a rectangular building.
Soron Inglia	reception room in the Kano palace built in 1934 while the emir was visiting Inglia, England.
Soron Guga	reception room in the Kano palace named after its domed ceiling.
tabo m.	swamp silt.
tambari m.	(pl. tambura) hemispherical drum.
tauyi	joists laid across the corners of a room, bay or dome compartment forming a panel which lessens the span for the remaining joists.
tubali m.	(pl. tubala = tubula) sun-dried mud brick.
tuni	Birnin Kebbi Hausa: in reinforced-mud arch construction, the bed of reinforcing azara laid parallel to the wall to redistribute the thrust of the arch over wider area of the wall; equivalent to tuni (Sarkin Gini Birnin Kebbi, personal communication, September, 1982).
turaka f.	(1) (a) that part of a rich man's compound reserved for himself when he has several wives. (b) his personal room.
Ubandoma	a very important title and official position in the emirate of Gwando, appointed by the ruler.
zaure m	(pl. zauruka) entry room for a compound which traditionally functions as a living room, workshop and place for business transactions.

zuri — Birnin Kebbi Hausa: the cantilevered azaras constituting the permanent formwork members which create the basic form of a reinforced mud arch.

B. ARAB TERMS

imam — the officiating priest of a mosque.

maqsura — the bay immediately preceeding the mihrab reserved for the temporal ruler and the imam, often surrounded by a decorative enclosure and vaulted with a dome.

mihrab — niche in the wall of a mosque indicating the direction of Mecca and hence the direction one faces during prayer.

C. FRENCH TERMS

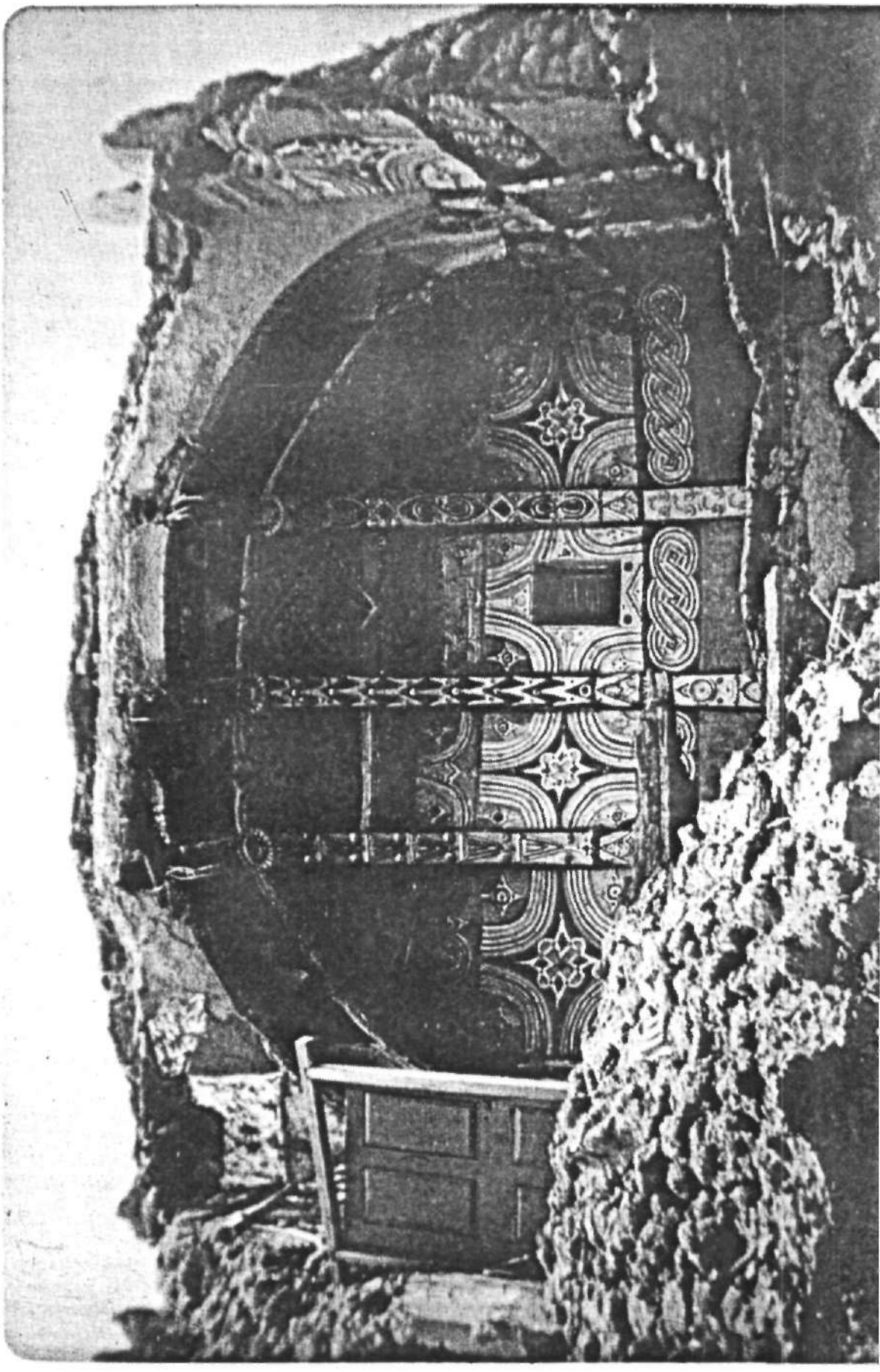
chef de canton — principal administrative representative of the government drawn from the traditional community and responsible for a district but subordinate to the national administrators posted to the district.

chef de canton des peul — the same as above but responsible only for the Fulani in the district.

pisé — walls constructed by ramming mud with a mixture of straw, dung or pebbles into a large moveable shuttering.

PART I

INTRODUCTION



CHAPTER 1

RESEARCH METHODOLOGY

1.00 Introduction

Definition of the Subject

The traditional Hausa master masons have developed a wide range of solutions to the problem of spanning space with mud roofs. These solutions, in the hands of best master masons, are especially admirable for their sensitive integration of structure and decoration. This typology classifies the structural systems and resultant ceiling patterns designed and built by Hausa master masons between 1800 and 1960, the year Nigeria became an independent nation.

The Hausa mud roof and ceiling are one monolithic whole. Similarily the floor of an upper storey forms a monolithic whole with the ceiling of its lower storey. Hausa master masons have spanned square, rectilinear and round rooms with flat and domed mud ceiling/roofs. The master masons have perfected a variety of trabeated and arcuated systems for supporting flat roofs. Their arcuated systems are capable of supporting very large spaces. They have been known to attain free spans with dimensions as large as 8.20m x 8.65m x 6.75m (26'11"x28'4"x22'3") for the flat-roofed reception hall named Babban Gwani (6.34) which was built near Bauchi in Kafin Madaki in the mid-nineteenth century

[1] Each reference to a space documented in the typology will be accompanied by a bracketed indication of the chapter and section where it is fully discussed or by an illustration whose label includes the bracketed cross-reference. The measurements for the Babban Gwani are taken from the scaled drawings in the Jos Museum collection.

and reputed to have been built by Babban Gwani.

Arcuated systems also support lofty domes. The largest domed spaces have dimensions comparable to those of the Babban Gwani. In domed rooms, the backs of the arches form the general contour of the dome. The domed form is the preferred form for the most prestigious palace rooms. Nonetheless, a dome as small as 3.00m x 3.40m x 2.75m (9'11"x11'2"x9') was measured by the author in a private home in Katsina and presumably smaller ones exist.

The Hausa master masons have also combined these systems to create large mosque sanctuaries. The Zaria Mosque, built around 1836 is the finest example. It measures approximately 18.60m x 21.70m x 5.50m (61'x 70'x18')[2] and is supported on many arches as well as piers and beams.

Both the trabeated and the arcuated space spanning solutions rely on the same principle. Lashed-azara beams and reinforced-mud arches supported by walls and/or columns or other vertical supports divide the space to be spanned into bays or vault webs. Within these subdivisions, lateral joists and tauyi (sets of contiguous timber forming ceiling panels) incrementally reduce the space to be spanned to the point at which closely spaced timber can safely support the roof.

1.10 Methodology and Practical Limitations

The methods used by master masons to reduce the

[2]These measurements were taken from the large scale architectural drawings prepared by Professor J.C. Moughtin and sent to Professor David Aradeon for the FESTAC exhibition. See the frontispiece.

space to be spanned result in ceiling patterns which contribute significantly to the aesthetics of Hausa architecture. This study is devoted to establishing a provisional classification of the traditional Hausa structural systems for supporting mud roofs and their resultant ceiling patterns. These ceiling patterns and their structural support systems are identified and analysed using examples of rooms for which measured drawings are available. In so far as possible, the most artistic and/or structurally daring versions of each ceiling pattern have been selected for study. In addition, an attempt has been made to include as many examples as possible of the oldest extant Hausa buildings in order to provide the beginnings of the basis for a study of the history of Hausa mud-roofed architecture. Unfortunately, sufficient data are not yet available for the establishment of hypotheses concerning the history of the spatial distribution of the ceiling patterns that will be described.

The analysis of Hausa structural systems used in this thesis makes no pretense of relying on the recently developed limit state theory which Professor S. Cleszkiewicz has applied to the Zaria Mosque.[3] Hausa master masons evolved an empirical understanding of their structural systems without the benefit of the limit state theory. The description of Hausa structural systems presented in this thesis is based

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[3]See below Section 3.10

on interviews with the builders, site observations (including the observation of ruins) and analysis of the measured drawings used as a basis for this typology.

With few exceptions, the spaces used as examples in this typology are discussed on the basis of scaled architectural drawings. In most, but not all cases, the drawings themselves are based on fully triangulated surveys. Unfortunately, it was seldom feasible to obtain accurate measurements for roof lines. Therefore, the roof lines have been drawn up from our general knowledge of Hausa roof structure. Financial considerations have limited the number of buildings I could personally survey. Few measurements were taken during the preliminary field work and it has not yet been possible to return to some sites; therefore, a few very interesting examples have been discussed on the basis of photographs. Several examples had to be discussed without the benefit of revealed ceiling plans and sections. In these cases, information was extrapolated from published plans indicating arch and beam configurations. In addition, some important buildings and spaces were omitted from the scope of the study because a full survey had already been prepared by the National Commission for Museums and Monuments but was not yet published.[4] Other spaces were omitted because of the difficulty of obtaining authorization to enter the building, as in the case of the summer palace at Wudil, or to enter the private spaces of the building, as in the case of the palaces of the emirs.

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[4]See Appendix IV: Inaccessible Spaces of Architectural Significance, pp. 328-29.

1.20 Sources of Documented Buildings

The most ambitious collection of architectural drawings of Hausa architecture is still awaiting publication. Under the direction of the late Professor Z. R. Dmochowski, the Federal Department of Antiquities[5](1978) recorded more than five hundred examples of traditional Nigerian structures. Many examples of Hausa architecture are among these documented buildings. This collection includes some of the finest buildings such as the Zaria Mosque complex, the former Argungun Mosque and the old section of the Emir of Katsina's Palace. Although the measurements for these buildings have not been published, a portion of the emir's palace in Katsina and the Zaria Mosque complex have been reconstructed at MOTNA, the Museum of Traditional Nigerian Architecture, on the Jos Museum site. The measurements were made by Dmochowski's Nigerian staff and by architectural students at Ahmadu Bello University with the cooperation of the Faculty of Environmental Design between 1958 and 1965. They were then drawn to scale at the Research Centre for Tropical Architecture which Professor Dmochowski established at Gdanski University in Poland. Before his death Professor Dmochowski allowed the author to trace plans and sections of the following buildings: the Babban Gwani in Kafin Madaki and both the Trophy Room and the Anteroom to the Circular Throne Room in the palace

[5]Now the National Commission for Museums and Monuments.

of the Emir of Katsina. The National Commission for Museums and Monuments has since approved authorization to reproduce these drawings from the Jos collection.

Because of the paucity of documented buildings, the majority of the rooms discussed were measured and drawn up by myself. To my knowledge only twelve sources of measured Hausa drawings are available to the public.[6] Four of these sources are theses. Two of the sources include drawings lacking any scale even though the drawings were evidently drawn to scale. A. H. Leary's (1966) plan of the Maska Mosque in his master's thesis and Geoffrey J. Williams' article (1972) which included some of Moughtin's drawings for the Zaria mosque complex both have no scale. Moreover, these twelve articles, books and theses repeat the drawings for parts of the Zaria Mosque complex and for the merchant's house on Kofar Mata Street three times each.

Scaled architectural ceiling plans and sections based on careful measurements have only been published for two architectural complexes, the Zaria Mosque with its Sharia Court and the public rooms of the emir's palace in Kano. The Zaria Mosque complex drawings have been published by Moughtin (1972) in "The Friday Mosque, Zaria City" which appeared in Savanna and by Moughtin and Leary (1965) in "Hausa Mud Mosques" in

[6]See Appendix III: Sources of Measured Ceiling Plans Available in Libraries, pp.326-27.

Architectural Review. In addition, the issue of Savanna, with "Notes and Comments: The Juma'a (Friday) Mosque, Zaria City" by Geoffrey Williams (1972) calling for the preservation of the Zaria Mosque featured Moughtin's ceiling plan of the Sharia Court on the cover and his ceiling plan of the entire complex within the context of the article. An article by Alan Leary (1977), "A Decorated Palace in Kano" published in Art and Archeology Research Papers includes plans and sections of the public rooms in the emir's palace along with a perceptive discussion of the architecture and its history. In the same article, Leary published a reconstructed version of the audience chambre which had been photographed by Lugard's expedition in 1903.

An earthen model of the Zaria Mosque complex as well as scaled drawings of the plan and section rendered in ink on plexiglass, all based on Moughtin's drawing, are on exhibit at the temporary Museum of African Culture based in the National Theatre in Lagos. They were prepared under the direction of Professor David Aradeon for the FESTAC Exhibition of African Architectural Technology held in Lagos in 1977. Another model of the Zaria Mosque, also prepared by students under Aradeon's direction, is on view at the Main Library of the University of Lagos.

The article by Moughtin (1972) on the Zaria Mosque in Savanna also illustrates the revealed ceiling plan

of the Kazaure Mosque drawn to scale and diagrams of the constructional process. A short article by A. M. Foyle (1951) in Nigeria Magazine, "The House of a Merchant on Kofar Mata-Street, Kano", includes a scaled plan which shows the positions of the supports, beams or arches as the case may be. The very brief description is supplemented by an artist's sketches of some interior views and elevations.

Only three books have included scaled drawings of Hausa architecture. In two cases the drawings serve as illustrations for chapters devoted to special aspects of Hausa architecture within the context of a book on a wider subject. Gabus (1958) published some scaled architectural drawings and sketches of facade decoration in the second volume of Arts et Symboles: Au Sahara. He published the plan, section and elevation for the entrance hall/workshop of a Hausa blacksmith, Mr. Captini, in Tahoua, Niger. The ground plan of the entire compound was also included in the publication but the ceiling plan, which is so germane to our study, was omitted. It has, however, been possible to reconstruct the ceiling plan on the basis of the information provided in the other drawings. Schwerdtfeger's (1971) chapter in Shelter in Africa, "Housing in Zaria", includes six scaled plans of entire household compounds as well as a few photographs of interiors. Schwerdtfeger's House Plan No. 78, includes demarcations for the beam

and arch supports which have proved valuable in discussion of two ceiling patterns, (6.41 and 12.41). These plans are also reproduced, but without the demarcations for beam and supports, in his recently published book, Traditional Housing in African Cities. This book is based on his studies of housing in Zaria, Ibadan, and Rabat. One third of this substantial volume is devoted to a study of the relations between family systems and the form of traditional housing in Zaria. This study also includes an analysis of the economics of the development of traditional housing stock in Zaria.

A third book, Africa Traditional Architecture by Susan Denyer (1978), includes two valuable scaled plans and some diagrams of typical ceiling plans. Foyle's ground floor plan of the merchant's compound on Kofar Mata Street in Kano is reproduced in Denyer's book for the benefit of a wider audience. The other drawings are for an Abuja dwelling, actually a room in the palace of the emir. These are more complete. They include the plan, the revealed ceiling plan, and a section. This room demonstrates the use of Hausa arches and mud ceilings in conjunction with the thatch necessary to protect the roof from the higher incidence of rainfall in Abuja.

Four theses are available, complete of with scaled architectural drawings of some examples of Hausa architecture. Two are directly concerned with Hausa

architecture and planning. Of these, one focusses on the aesthetics of traditional Hausa architecture and the other focusses on traditional urban dwellings and spaces in Zaria. The other two theses have a much broader focus. One deals with the architecture of various Nigerian peoples while the other is devoted to traditional West African mosques.

Hamman Tukur Saad's (1981) doctoral dissertation, Between Myth and Reality: The Aesthetics of Traditional Architecture in Hausaland (Volumes I and II) has some unscaled sketch plans of twentieth century compounds and spaces showing revealed ceilings. The impressive compounds built for wealthy merchants are represented by Soron Alin Iliya in Jos and Gidan Alim Mazawaje and Soron Sanda Maiganari, both in Kano. Sketch plans of dwellings owned by the head master mason in Birnin Konni and by three merchants in Maradi (Niger) represent less sophisticated Hausa architecture. Saad has also reproduced drawings of many of the other spaces available to researchers but they are so small in the University Microfilms edition that they are only useful as a source of types of arch configuration and the relative proportions of the spaces. The reproduced spaces with revealed ceiling plans include the following: plans of the eighteenth century Bawan Dodo and public spaces at the southern entry to the emir's palace in Daura, the plans of Kano architecture from Foyle's dissertation (the residence of Hamidu Bayero, the residence of Hasan

Jamil, Gidan Mofi at Kofar Ma'isa, Gidan Dan Hausa and Gidan Resident), and the Zaria Mosque complex.

Saad's long and comprehensive dissertation, which unfortunately was not available until after most of my research and writing had been completed, confirms many of my own findings. It covers a wide range of topics relevant to the background of this typology including the nature of Hausa society, the roles of the master mason and the patron, the materials and methods of construction, and the dynamics of Hausa aesthetics. For all these topics Saad provides the relevant Hausa terms. Saad also reviews some of the literature on Hausa architecture.

Professor Barbara A. Urbanowicz (1979) has written a superbly illustrated Ph.D dissertation entitled, "Selected Aspects of House Form in Zaria Urban Area". It is concerned with the grouping patterns of spaces within a neighbourhood and within a residential unit as well as residential structures and their details of construction. In addition to measured drawings of dwellings, she has presented plans of the neighbourhood near the dwelling of the imam. The plans are rendered more meaningful by the inclusion of elevations emanating from the contours of the public space. These plans combined with elevations permit us to visualize this distinctive, traditional urban space. We have used her plans and sections for two dwelling spaces (19.33 and 11.15).

Authur M. Foyle's (1959) very informative Ph.D dissertation, "The Development of Architecture in West Africa", draws on examples from Nigeria. Foyle has made floor plans for six Hausa dwellings including the one mentioned above which was published in Nigeria Magazine. The positioning of the ceiling beams and arches is indicated in these plans. They are supplemented with photographs of interiors and elevations. Three of these plans are for compounds built after World War II in Kano and Niamey. Three more are for houses built by the colonial Public Works Department in the traditional manner but planned to suit British colonial lifestyles. The P.W.D. buildings include Gidan Dan Hausa which is actually a renovation of the Kano residence of a traditional District Head. Although the two large rooms and an upper storey were added, the large lounge with its own lobby defined by the two piers was the audience chamber and waiting room in the original structure. It must have been built as far back as the 1890's. Foyle has prepared several elevations and taken a section through this part of the building.

A. H. Leary's (1966) master's thesis, "The Development of Islamic Architecture in the Western Sudan", illustrates a plan and section of the Maska Mosque based on his own measured survey. Even though the scale was omitted, it was possible to establish that the plan was drawn up at 1/16 scale

while the section was drawn up at 1/8 scale by checking and cross checking dimensions on the site.

1.30 Architectural Terminology

Hausa master masons employ a large range of words to describe features of their architecture. Often the words are drawn by analogy from the wider Hausa vocabulary. In most, but not all cases, a suitable English translation can be found. Where possible, English terms have been used throughout this thesis in the belief that the reader should be able to pick up the text at any point without constantly referring to a glossary of terms. In addition, to facilitate discussion of the distinctive of features of Hausa architecture, it has been necessary where no Hausa term exists to adapt some of the terminology in use for medieval architecture and to create some new terms.

Despite this emphasis on English terminology, several Hausa terms which are used repeatedly throughout the text have been retained because they have no convenient English substitute.[7] These Hausa words have been coopted to serve as English terms; however, to avoid the confusion that might arise from the complexity of Hausa plurals, they will not be pluralized. Included in this category are several words referring to the buildings discussed: *zaure*, *gidan*, and *soron*. A *zaure* is an entry room which often incorporates the functions of a living-

[7] Foreign words adopted for repeated use in the text will no longer be underlined.

room and an office or workshop. The n in gidan and and soron is the possessive. Gidan means the house of as in Gidan Alhaji Abashi. Sometimes the term soron is used to refer to a zaure. Strictly speaking, a soro is a rectilinear space with a mud roof and mud walls. Several crucial construction terms are retained: tubali, azara, tauyi, kafa, and kafar kaza.

Hausa master masons build with tubali, hand-moulded sun-dried bricks. The tubali used by Hausa master masons are hand-moulded into a rounded, conical shape about 12cm (5") high and tapering from a base with a diameter roughly 10cm (4") wide to a diameter 4cm (1¾") wide.

Azara, the Hausa word for the fibrous plank of wood cut lengthwise from the outer trunk of the male deleb palm (Borassus flabelliber; giginya in Hausa), is also used throughout the text. Azara are now sold in 3.35m (11') lengths. These slightly wedge-shaped lengths measure approximately 5cm x 7cm (2"x 3"). Sometimes azara with a greater girth, 5cm x 15cm (2"x6"), are used as a beam to support joists and infilling members. In some areas, the trunk of the dum palm (Hyphaene Thebaica; goruba in Hausa) is used instead of the trunk of the deleb palm.

Tauyi also lacks an adequate English equivalent. In Kano, tauyi is the Hausa word for a set of azara

placed diagonally across the corners in the soffit of a room to constitute a panel which reduces the span in the soffit. In Birnin Kebbi, tauyi has another meaning. It refers to similar panels of azara laid parallel to the wall. We have retained the Kano meaning and coined the expression wall-tauyi to refer to sets of azara laid parallel to the wall.[8] We have also followed Foyle's (1959) expression, crown-tauyi, to refer to sets of azara near the apex of a dome which span the triangular space between adjacent arches intersecting at the apex. Although the master masons have no special word for these panels of azara, crown-tauyi are a standard feature of domes used for reducing the span of the infilling members.

Hausa master masons refer to the number of kafa half-arches, which support their domes and the large spans of flat roofing. Hausa reinforced-mud arches are constructed by cantilevering two opposing kafa, literally legs, out from the walls until they are close enough to be joined. Although the term kafa accurately reflects the Hausa construction process, we shall use the term arch wherever two kafa have been joined to create an arch. The kafa can be joined together in a variety of configurations. These configurations will form a central part of our study.

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[8] See below Section 4.20. Also see Appendix V: Diagrams Illustrating Architectural Technology(p.330) for diagrams illustrating the terms introduced on pages 15 and 16.

Hausa master masons named one of their distinctive arch configurations kafar kaza, chicken's foot, because it relies on three toes like a chicken. A kafar kaza is a single transverse arch abutted at its centre by a half-arch.

In order to further characterize arches by indicating their location within the dome, various terms have been adopted. Specifically, a transverse arch refers to an arch which spans the space between two walls and is perpendicular to those walls. A diagonal arch refers to an arch which spans from one corner of the room to the opposite corner. An intermediate arch refers to an arch that springs from opposite sections of opposing walls at points midway between their centres and their corners.

To underscore the structural role of the first transverse arch(or pair of transverse arches)to be joined and upon which the joints of the other arches must rest, it is referred to as the primary transverse arch. To indicate the other transverse arch which rests immediately upon and perpendicular to the primary transverse arch, the term secondary transverse arch is used. Frequently two parallel arches are placed close enough to each other to appear obviously related. Such arches are referred to as a pair of arches as in the zaure of Gidan Madawaki, Katsina (11.51). Where they are separated by less than 30cm (1'), they are referred to as twin arches as in the Zaria Mosque (11.21).

The basic construction material in Hausa architecture is specially selected mud. Hausa master masons select special types of earth for their mud construction materials, each type being particularly suited to its architectural role. In Kano burgi, clay with a gravel content, is used for the tubali and the roofing. Tabo, swamp mud with its concomittant vegetable matter, is plastered all around the cantilevered azara which form the arches and onto the underside of the azara which form the soffits. Specially selected kasa, earth with a high clay content, is used for mortar and plaster as well as for tubali in areas lacking burgi. Moreover, the earth selected for the mortar and plaster is specially prepared with an admixture of manure and, if the manure is insufficient, with 7cm (3") long cuttings of grass. The earth used for the final coat of interior plaster is usually red with a high sand content. The top layer of the roof is not earth at all but laso, ashes from indigo dyepit residue, or katsi, an indigenous cement made with laso and other locally available materials (Daldy, 1945).

1.40 Limitations of the Scope of the Typology

The time span of this typology has been restricted to one hundred and sixty years, from 1800 to 1960. This period encompasses almost all the available documented spaces which have been designed and constructed by Hausa master masons. The pre-jihad[9] inner zaure of Gidan Makama (10.31) has been retained as an excellent example of Hausa architecture. Similarily, the Bawan

[9] In Nigerian history, the jihad refers to the successful war launched in 1804 by the Fulani to reform Islam in Hausaland.

Dodo at the emir's palace in Daura, has been included in the typology even though it was probably constructed in the late eighteenth century since it was commissioned by Emir Gwari Abdu who was driven from Daura by the Fulani in 1805. Omitted from the typology are the other documented pre-jihad spaces at the southern entry to the Daura palace as well as undocumented pre-jihad spaces in the Daura palace and in the pre-jihad sections of the palaces of other Hausa emirs. These include the late fifteenth century gates to the Kano palace, Kofar Fatalwa and Kofar Kwara, which can be visited by the public. Reference has been made to Kofar Kwaru (3.52) in the discussion of Hausa structure even though it is not included in the typology. 1960 has been taken as the last construction date for the examples of traditional Hausa architecture classified in this typology in order to focus on traditional spaces rather than on modernized spaces.

By limiting the province of the typology to examples of mud-roofed architecture, a large portion of Hausa architecture has been excluded. Moughtin (1964) has described various structures roofed with thatch. Some rooms are cheaply and quickly constructed entirely of vegetable materials. A type of skeletal construction with a curtain wall of mats is common. Forked posts are sunk into the ground 60cm (2') deep at regular intervals approximately one metre on centres. Poles and withies are laid on the posts and tied together to form a circular frame upon which the roof

is raised. Then horizontal rings are tied to the verticals at regular intervals. The grass matting, which forms the skin of the wall, is tied to this framework. A central forked post receives the rafters upon which the conical thatched roof is laid.

Thatched roofing is also used for circular rooms constructed with mud. A tsangaya is a room built with cornstalks using the wattle and daub technique. Vertical cornstalks are dug into the ground to form a continuous ring with about 10cm (2") of mud internally and externally. Circular rooms constructed with tubali are usually thatched. However, Schwertdfeger (1971) reports that in Zaria during the last thirty years (now forty years), these round spaces have been supplanted by rectilinear rooms with mud roofs. This appears to have been the case in the other cities although some round spaces with flat mud roofs remain in Kano. Round, thatched structures are becoming rare in cities and less common in rural areas. In a small area north of Sokoto, the Gobirawa use mud to build hemispherical rooms and spherical granaries on the principle of enormous coiled pots. During rainy season a prefabricated thatch roof is superimposed on the mud spheres.

Even though Hausa architecture is an architecture of interior space, the typology is further restricted by its focus on structure and ceiling patterns. The external forms which fall outside the scope of this typology are the result of the structure and the

desired form of the interior space. The master mason approaches his design from the interior to the exterior. The elevation is meant to confer the prestige accorded particular interior spaces. A domed zaure is more prestigous than a flat-roofed zaure. The Hausa greatly appreciate a well-formed dome. Similarly, the greater the number and the larger the other rooms, the more prestigious the elevation becomes.

The exterior finish which also falls outside the scope of this survey contributes to the aesthetics of the elevation. From the late thirties through the sixties, exterior finish became popular and developed into elaborate embossed patterns covering the entire facade. These patterns often contain images of objects from daily life (Kirk-Greene, 1963). The patterns, however, are often conceived and rendered by magini-maizane, specialist wall decorators, after completion of the building. This exterior finish may even be rendered without reference to the original master mason.

The typology excludes the modified traditional structures that have replaced traditional dwellings for many of the wealthy and also for the traditional nobility. Such modernized structures are built with rectilinear sun-dried bricks which have been formed in a mould. A two storey elevation with walls rendered in coloured, spray cement and capped by a pitched, zinc roof has become fashionable at the expense of the traditional dome. The lofty domed zaure has been

transformed into a series of rooms while the household head has transferred his social and business activities to his upper floor livingroom which is complete with a stereo or television set. All these forms of traditional and modified traditional Hausa architecture are beyond the scope of the present typology.

1.50 The Classification

This provisional classification of Hausa ceiling patterns and their structural support systems analyses the exciting patterns which Hausa master masons have been able to create within the framework defined by the structural limitations of their construction materials. Although this typology covers the major types of Hausa ceiling patterns and their structural support systems, it must be considered provisional. Many spaces were demolished before this study was undertaken; many spaces are still not accessible to scholars; and, it was impossible to investigate every single Hausa structure. The number and extent of the variations documented in the typology suggests that the master masons probably created other variations that have not yet been documented.

This typology is divided into two parts based on differences in roof form rather than on differences in basic structural systems. A typology based on the differences between flat slabs and domes reveals the basic qualities of the most sophisticated Hausa

structural systems and their resultant ceiling patterns; the complexity of these architectural solutions would be obscured by a typology based on the difference between trabeated and arcuated structural systems. Lashed-azara beams are much less structurally sophisticated than reinforced-mud arches. Spans of 3.00m (10') have not been documented for lashed-azara beams whereas spans of 8.00m (26') have been documented for reinforced-mud arches. Theoretically lashed-azara beams could be made to span greater distances but azara cut longer and wider than the standard size would be required. It appears that both patrons and master masons prefer to build arcuated spaces with the extra funds required to purchase such special order azara. Almost all the highly developed architectural designs rely on arcuated systems even though some of these systems support flat roofs while others support domical roofs.

Part I of the typology examines the structural systems and their resultant ceiling patterns as they have been designed and built for flat slab roofs. Then, Part II examines them as they have been designed and built for domes. In the first half of the typology devoted to the flat slab roof, the special nature of the permanent formwork of the soffits, the types of vertical supports, and most of the arch configurations are introduced. In the second half, the special features of Hausa domes are introduced. Then a detailed analysis of the special features of the

permanent formwork in domical soffits treats both the upper domical portion and the lower transitional portion of the dome form. The role of vertical supports in providing peripheral spaces for domes is also explored. This is followed by a detailed investigation of the variations in structural systems and ceiling patterns which Hausa master masons have designed for the three basic types of arch configuration appropriate to domes: arches meeting at the crown, arches forming central coffers, and arches abutted by half-arches.

CHAPTER 2

HAUSA ARCHITECTURE AND ITS ENVIRONMENT

2.00 Introduction

Traditionally, the urban architectural style in Hausaland responded to the socio-ecological setting. Political and economic power was concentrated in an hereditary aristocracy which controlled the guild of master masons. Within Hausa society, the architecture of ones residence became a status symbol and therefore attracted considerable resources, both economic and human.

The societal changes brought about by political changes in the present century have altered the environment in which the traditional Hausa architecture described in this typology flourished. First in 1903, colonialism undermined the traditional emirate structure; next in 1956, limited internal self-government began the process of ending the system of indirect rule as practiced by the colonial government; a few years later in 1960, total self-government completed the process. This environment was further altered by the influx of huge sums of oil money in the late seventies. Although the physical climate has not changed, the available materials and the builder's capacity to control the climate have changed radically. A truly prestigious building is now a high rise apartment or office building. The governor's residence and the state secretariat have supplanted the emir's palace. Fortunately the emirs continue to

maintain their finest traditional public spaces, although they have also been gradually yielding to modern versions of the traditional architecture.

2.10 The African Architectural Context

The indigenous architectural styles in many West African cities differ from the styles created by rural populations in the surrounding areas even where both populations are of the same ethnic group. Where an isolated urban architectural form is found in rural areas, it has been commissioned by a local chief or wealthy trader. Many village mosques are also built in a style imported from another West African urban centre. The architecture of many West African cities is the province of specialist master masons, whereas most rural architecture is owner-built with the assistance of neighbours.

2.11 Indigenous Rural Architecture

Rural vernacular styles vary considerably, but most rural dwellings are separate units of single storey, round or square structures placed within a walled enclosure to form a compound--a dwelling for a single family centred around an outdoor space where many of the daily activities take place. The family may be nuclear but is often extended; in either case, each adult has one or two rooms of his own and may also have one or two personal granaries. The diametre of each circular room ranges from 3.00m (9'10") to more than 10.00m (32'10") for the chief's house and mosques in the Futa Jalon (Denyer, 1978). The

span of the joists for rectilinear mud roofed rooms seldom surpasses 1.80m (6').

Construction materials for the walls and roof also vary considerably. Nomadic peoples in the desert, sahel, and dry savanna construct the walls and roof as a single framed structure using bent saplings covered with grasses or woven mats. They also construct tents of homespun cloth or leather.

Shell structures made of specially prepared mud without formwork or reinforcement are rare, but known. They are more common for small granaries than for living quarters. Formerly the Mousgoum of northern Cameroons built rounded conical rooms rising 7.50m (24'8") high above 6.00m (19'9") diametre bases (Beguin, 1952). The Gobirawa, a Hausaphone group located in northwestern Nigeria, continue to construct enormous hemispherical shell dwellings and granaries, using the potter's techniques.

Further south, some peoples rely on linear wood to construct both the skeletal framework and the outer skin. The Bamileke of southern Cameroons use hollow bamboo, while the Toufon, who live in houses built on stilts in the coastal lagoon of the Republic of Benin, use the smooth ribs of the raphia palm (Raphia vinifera).

Some hill peoples construct dry stone walls which need a protective covering. The Dogon in Mali plaster the stones of their rectilinear walls with mud and

the Moufou in northern Cameroons surround the stones of their round walls with millet-stalk panelling (Aradeon, 1980a). Wattle and daub structures are more common, as are structures built in the wet-mud technique. This technique involves building with freshly formed balls, 10cm (4") in diametre, with a mud mixture including dried grasses. They must be sufficiently cohesive to be thrown to the householder, who packs them onto the wall with force. These mud balls are packed into a course which is left to dry for a day or two before work proceeds. Depending on the architectural style, the height of each course may be as low as 20cm (8") or as high as 50cm (18"). The horizontal lines of the courses are usually visible, permitting quick indentification of this technique.

Specialist masons among the Berbers in North Africa construct fortress dwellings using an entirely different rammed earth technique, the pisé technique. The master masons make a shuttering and fill it with well-prepared mud including gravel, straw or dung. This mud mixture is then rammed into place. When it is partially dried, the masons remove the shuttering and repeat the process. The shuttering is usually about a metre high. The width varies according to need ranging from as wide as two metres at the base to only 50cm (1'8") at the top (Curtis, 1983). This system also leaves distinct horizontal lines between the courses, but they are more widely spaced. The only

documented sun-dried bricks in West Africa originating outside the cities are the sausage-shaped bricks used by the Senufo in Northern Ivory Coast.

Vegetable matter and mud are the principal roofing materials. Palm fronds are often used as shingles in the rain forest region. The use of grasses for thatched roofs is widespread in both the wet and dry savanna. In the dry savanna, flat mud roofs supported on beams and forked posts are also common for mud-walled structures. In the rural areas, flat mud roofs which rest directly on mud walls only span small spaces or long narrow spaces.

2.12 Indigenous Urban Architecture

The architecture of the cities in the dry savanna and the sahel to the west of Hausaland is distinguished by the use of cylindrical, hand-moulded sun-dried bricks and flat mud roofs. Dubois' late nineteenth century description of the ruins of the Djenne Mosque is testimony to the achievements of the Djenne master masons. According to Dubois (1897), the Djenne mosque rose to the height of 11.00m (39') on a rectilinear plan which measured 26.00m x 46.00m (85'3"x183'9") for the sanctuary and an additional 20.00m x 46.00m (65'6"x183'9") for the courtyard. It is possible to gain an impression of its original grandeur. In 1909 a reconstructed version was built by Djenne master masons working under a French engineer (Mauny, 1961). The walls unlike

those in Hausa structures, were buttressed and articulated at regular intervals with towering engaged columns.

Outside of Hausaland, indigenuous mud arches and domes are found only in North Africa. Two special cases exist in West Africa: the French designed reinforced-mud pointed arches which span 1.80m (6') between the adjacent piers supporting the reconstructed Djenne mosque (Mauny, 1961; Prussin, 1974) and the single voussoir arch constructed with sun-dried bricks which occurs in the heavy post and beam structure supporting the Djingerey Ber Mosque in Timbuctoo. Otherwise, no brick or reinforced-mud arches or domes have been documented except among the Hausa and the Nupe who learned their technique from the Hausa (Perani, 1983). In the Algerian Mzab (which had strong religious and trading links with the early medieval kingdom of Ghana (southern Mauritania), with the eleventh century kingdom of Gao (Niger) (Levtzion, 1973), and probably also with fourteenth and fifteenth century Dia and Djenne (Mali) (Stevens, 1968)) mud arches are reinforced with bent palm frond ribs. Such arches rarely span more than two metres (Mercier, 1922; Etherton, 1971; Didillion, 1977).

In the Sousse, also in the Algerian desert, shallow domes are constructed with flat rectilinear, sun-dried bricks. However, the diametres of the largest of these domes only attain two metre spans (Echallier, 1966). It is against this background that we can fully appreciate the technological and aesthetic contribution

of Hausa master masons.

2.20 The Geographic Environment

Kasar Hausa, Hausaland, refers to the territory where Hausa culture and language predominate. Although the exact boundaries are imprecise, Mahdi Adamu (1978) and Saad (1981) have provided approximate boundaries. During this millennium, Hausaland has moved southwards expanding in all directions as a result of Hausa political and economic pressure as well as the assimilationist tendencies of Hausa culture. At present the northern limit is Adar where Hausaland borders with Air between Agadez and Zinder in Niger. The western limit is the land of the Djerma and Songhay where Dosso is an important centre. The eastern and southern limits are less clearly defined because they abut many smaller ethnic groups; however, Hausa culture is beginning to predominate in all the territory stretching towards Kanuriland. To the south peoples are becoming Hausanized below the line stretching from Yelwa to Birnin Gwari and Bauchi. Throughout West Africa far beyond these boundaries small communities of Hausa immigrants have been formed in many other small and large urban centres.

Important examples of Hausa architecture can be found beyond the boundaries of Hausaland. They are still standing as far east as Dosso in Niger ($3^{\circ}E$, $13^{\circ}N$) and as far west as Gombe in Nigeria ($11^{\circ}E$, $10^{\circ}N$); as

far north as Agadez in Niger (8°F, 17°N) and as far south as Abuja in Nigeria (7°F, 9°N). Although the chef de canton in Dosso is Djerma, he has an historical relationship of alliances with the Emir of Gwando in Birnin Kebbi. Thus, both the Friday Mosque (now demolished) and the palace in Dosso were built by Birnin Kebbi master masons. The Gombe Mosque was commissioned by the Fulani flag bearer who founded Gombe during the jihad. Many Hausa have settled in Agadez which has become a multi-ethnic city including Tuareg, Songhay and Hausa. The Emir of Abuja is a descendant of the pre-jihad Emir of Zaria, Emir Mahamman Makau, who fled from the Fulani in the early nineteenth century with many followers (Hogben, 1967).

2.21 The Climate

The rainy and dry seasons result in extremes of humidity and dryness and extremes of heat and relative cold. Central Hausaland is in the dry savanna while the northern reaches of Hausa architecture are sited in the sahel and the southern reaches are sited in a wet savannah area. North of Sokoto the rainy season only lasts three months during which most of the annual 508mm (20") of rain falls but in the more southernly sections of central Hausaland, rainy season lasts five and six months during which most of the annual 1,270mm (50") of rain falls (Moughtin, 1965). Because of the relatively short rainy season, and the

limited annual rainfall, at most from mid-May through September, mud roofs are practicable except in the Abuja area which lies in the wet savanna area and therefore requires a thatch superstructure. Mud roofs are less viable in Zaria which falls in the southernmost portion of central Hausaland and receives more rain over a longer period. The mud rooflines of the towns and in villages along the roads approaching from Kano and Sokoto change from flat slabs to small domes constructed with an armature of tree branches. Apparently their domical form is determined by the need to shed rain water off the roofs quickly with as little damage as possible.

The early dry season months of December and January bring severe diurnal temperature changes and dust laden wind from the Sahara. At night the temperature can fall as low as 12°C (53°F) and then rise to 33°C (91°F) by mid-afternoon (Saad, 1981). During this season, the thermal capacity of the thick mud walls and roofs significantly improves the comfort level in Hausa dwellings because the heat absorbed in the afternoon is given off at night when it is needed. The blank walls enhance this thermal capacity and keep out the heavy dust.

Periodic line squalls at the beginning and end of the rainy season occur about fifty-five times per year. Since they sometimes attain speeds of 150 kilometres

(90 miles) per hour the roofing materials and walls must be sturdy and stable (Moughtin, 1965).

2.22 The Raw Materials for Construction

In terms of natural construction materials the area is virtually denuded of non-productive trees; however, the palm trees required by the master masons are permitted to grow naturally. The trunk of the deleb palm (Borassus flabelliber; Hausa: giginya) is split into timbers to form the reinforcement for arches and pillars as well as the permanent formwork for flat slabs and domes constructed with mud. The trunk of the dum plam (Hyphaene Thebaica; Hausa: goruba) performs the same structural functions, even though its trunk often separates into several small trunks resulting in shorter lengths of straight timber. Palm timbers can be split with relative ease along the longitudinal lines of the fibres. Moreover, because of their fibrous surfaces, palm timbers bond well with mud mortar. The strength and weight of the palm timber varies depending upon whether it is cut from the lower or upper portion of the trunk. The fibres in the lower portion are dense resulting in greater structural strength and weight. According to Sarkin Gini Ibrahim Dan Karima of Birnin Kebbi, the lower portion is preferred for the permanent formwork in beams and arches and for the crucial reinforcing members. The fibres in the upper portion are less compact resulting in a lighter

and weaker structural member. Therefore the upper portion is used to help fill in the spandrels of arches and the permanent formwork of flat slabs and dome webs.

Palm timber represents a significant factor in the cost of a traditional Hausa building partly because the structural systems for roofs require a large amount of azara. The construction of a small approximately 3.00m (9'11") square roof supported on intersecting arches require 110 azara cut in 2.30m (7'6") lengths (Schwerdtfeger, 1982). Moreover, although azara grows naturally in the core areas of Hausaland, it is often transported considerable distances resulting in higher prices. Both the deleb and dum palm timbers are resistant to attack by the termites and white ants which destroy other timber. Often they outlive a building and are recycled.

The principal construction material, mud, is available in many forms and exploited selectively by the master masons. Laterite, clay, sand and pebbles as well as natural and man-made swamp soil from borrow pits are carried to the urban site by donkey load if they cannot be made available by recycling a collapsed room. Natural earth and vegetable colouring materials are also known and exploited.[1] Formerly the existence of great numbers of active, dye vats sunk into the

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[1] See Saad, 1981: 248-251 for details.

ground produced very large quantities of the indigo dye vat residue essential for indigenous cement (Shea, 1975).

2.30 The Political and Social Environment

Hausaland has long been organized into city-states, centred around cities protected by huge mud walls. The first massive Kano walls were built in the twelfth century (Moody, 1967b). By the late fifteenth century the major rulers had become Islamized. Evidence dating the Islamization of the populace is not available but it was probably more gradual. Emirs ruled their city-states or more precisely, their emirates, and taxed their citizens through a complex organization of hereditary titled offices, although according to M.G. Smith (1959), H.F.C. Smith (1971) and Lovejoy (1979) sometimes these positions were assigned to slaves rather than to members of the aristocracy.

2.31 Hausa Social Classes

Hausa society can be divided into distinct classes: the royalty, the commoners, and prior to European rule, the slaves. Some of the more important aristocratic titles include Magajin Gari, Madawaki, Waziri, Ciroma, Turaki, Galadima, and Ubandoma. Even in the past, both the titles and responsibilities varied from emirate to emirate, but in all cases the most important officials were directly reasonable to the emir. During the twentieth century many of these titled members of the aristocracy have been assigned positions in the contemporary governmental structure, but their effective

power has been considerably reduced. Trade guilds also have hereditary titled officials patterned after the aristocracy.

Commoners could and did become extremely wealthy. Some wealthy merchants in nineteenth century Kano owned hundreds of agricultural slaves (Lovejoy, 1979). Many wealthy traders controlled trading networks with counterparts or subordinates permanently stationed in communities of Hausa immigrants (zango) located in commercial centres and along trade routes throughout West Africa (Adamu, 1978).

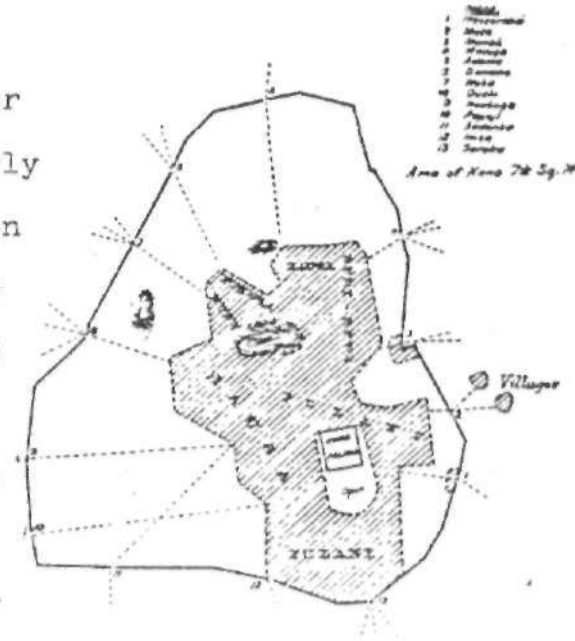
Slavery must have had a significant, if varied, role in the history of Hausa architecture. Probably more than half the population in Zaria and Sokoto emirates were servile (Smith, 1959; Lovejoy, 1979); however, given their important offices and the tendancy to intermarriage, some slaves were "freer than the free" (Smith, 1959). Some slaves must have been engaged in the prestigious building activities of their owners. All the officials of the Kano guild of master masons proudly affirm their nineteenth century slave origins; however, those in Daura claim descent from the pre-jihad emirs (Saad, 1981). Slave labour was the source of much of the surplus wealth (Adeleye, 1971; Lovejoy, 1979) which was essential for the most ambitious architectural projects. It is even conceiveable that some of the captured slaves introduced innovations into the architecture they helped to construct. Further research may clarify the historical role of slavery in the development of Hausa architecture.

2.40 Hausa Urban Form



Fig. 2.40a

Each traditional Hausa city (birni) is surrounded by massive walls made of sun-dried bricks. According to H. Moody's (1967) citation of Staudinger's late nineteenth century account, the city walls of Kano were approximately 30.00m (100') high. The walls of each Hausa city enclose an area much larger than the city proper in order to ensure agricultural land and water during an extended siege. Formerly the open space must also have been an integral part of the defensive strategy protecting the dwellings from direct contact with the flaming arrows of the enemy. The city walls are pierced by high gates approximately one kilometre apart to provide convenient access.



PLAN OF
KANO CITY (1903.

Fig. 2.40b

Traditional Hausa cities are bifocal with major roads leading to the central market and to the large open space which links the congregational mosque and the emir's palace.

In densely settled areas, paths only wide enough for donkeys and pedestrians serve as circulation arteries. These pathways are flanked by high blank walls occasionally punctuated by a bench built into the wall adjacent to a doorway. The doorway may be set back or set at an angle to the pathway creating a spatial node in front of the house.



Fig. 2.40c

2.41 Residential Clusters

Spatially distinct clusters form compact residential complexes around a focal point such as a local mosque, a Koranic school, or a small square. The boundaries of these clusters are usually determined by the circulation network, the topography, and the accessibility of common facilities (Urbanowicz, 1979). In densely settled areas these distinct clusters have disappeared. Such is the case for all of Kano City except for the fringes of the built-up area. In contrast,



Fig. 2.41a

after Nigerian independence in 1960, Zaria still had open farmland between many of the residential clusters (Urquhart, 1977). Even within fairly well built up residential clusters, the exact size and form of the public space is continually modified as rooms are added on to compounds or demolished, changing the contours of the compound (Moughtin, 1964).

2.50 The Hausa Urban Dwelling

In Hausa culture the quality of a man's dwelling contributes considerably to his status in the community. In general, the master mason traces out the plan of the compound, gida, on the ground, arranging the rooms and courtyard spaces according to his professonal judgement. As related by Alhaji Muazu who designed and built many buildings in Katsina from the 1940s through the 1960s, the patron pays according to the size and type of roof structure (whether domed with two, three, or more arches or flat with one



Fig, 2.50a

or more beams) as well as the type of finishing (whether the walls and ceiling have been plastered or decorated). Thus, the patron's desires and the constraints imposed by his financial situation determine many of the architectural features of the building. Although he may request that the master mason build a room or a whole building similar or superior to one he has already seen, the patron leaves the actual design and construction to the master mason.

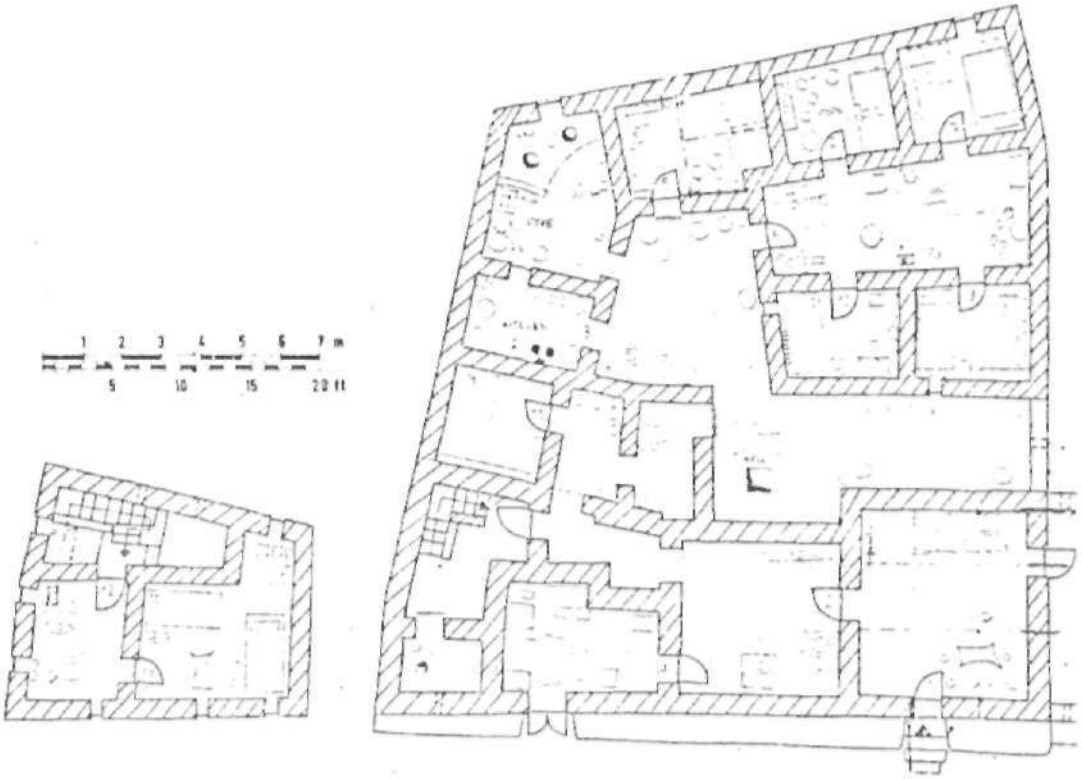


Fig. 2.506

2.51 The Zaure

The form and size of zaure have always played a central role in Hausa architecture. All Hausa dwellings, whether in the country or the city, are entered through the zaure. Each zaure has a doorway opening into the street and a door opening to another zaure or to the compound courtyard. Men never pass into the private area where the women live in seclusion. The zaure serves as a place for the craftsman's work, for business transactions, for the reading and the study of the Koran as well as for the reception of male visitors. Traditionally the nobility and wealthly men also had at least one substantial inner zaure where important guests, close friends, and relatives were received. The zaure, being public spaces, were until recently the focal point of Hausa architectural design. Consequently, most ofthe spaces discussed in this typology are zaure.

2.52 The Hierarchy of Privacy

Hausa compounds are arranged to ensure a strict hierarchy of privacy partly on account of purdah, the practice of keeping the women in seclusion. The exact form and size of a Hausa dwelling varies considerably according to the size and composition of the family as well as their financial resources and the availability of land. Ideally the patriarch of a Hausa extended family possesses a compound designed around two courtyards. The zaure open onto the semi-public court-

yard where the patriarch has his rooms and where adolescent and unmarried young men have their quarters. A room may also be reserved for guests. In Katsina male guests often sleep in the zaure. The householder's private room is called the turaka and is now usually fitted with modern chairs, a stereo, and a television. The turaka is often given the same architectural attention as the zaure. The architectural design of the shigifa, the room separating the inner and outer compounds, is also given special care.

The innermost courtyard is reserved for the female residents and young children of the compound, and it is here that each wife has her personal rooms and shares the communal kitchen, a latrine, and possibly a storeroom. Usually, each wife's rooms open onto a covered veranda. A small livingroom precedes the bedroom with its fourposter bed. Presumably because of the seclusion of purdah, the only architecturally significant spaces designed for a Hausa woman that have been documented to date are the Princess's Apartments in the Waziri's residence also known as the old Kano Treasury.

2.53 Official Residences

The official residence constituted one of the most visible traditional emblems of office. Official residences were attached to all the most important titles. The emir's residence was much more than a private dwelling; it was the seat of government. The personal quarters of the emir and his family are preceded by several

zaure where official guests are received. The emir holds court in a large, lofty space variously called the throne room or the council chambre. Sometimes he receives his courtiers in the courtyard. The compound of the Emir of Kano which was built in the late fifteenth century covers about one square kilometre (Saad, 1981) and provides housing for a large population.

2.60 Patronage and the Guild System

Hausa mud-roofed architecture must initially have been an aristocratic architectural form. Each mud-roofed building is designed and built by a magini, a specialist master mason. The commoners built their own dwellings with wattle and daub walls supporting thatched roofs as some still do today. Even for commoners, many urban dwellings have long been mud-roofed partly as a means of fire prevention; however, traditionally, the construction of lofty, domed spaces was a royal prerogative.[2]

Patronage for prestigious Hausa architecture rested initially in the hands of the Hausa royalty and, after the early nineteenth century jihad, in the hands of the Fulani rulers. These Fulani have become fully assimilated adopting Hausa language and culture, including Hausa architecture although in the mid-nineteenth century Barth (1965) could still distinguish their southern and relatively newer section of Kano where thatched dwellings still prevailed. The intersecting sets of

[2] See below Section 2.62.

arches which spring from partition walls in the eighteenth century Bawan Dodo, a multi-storeyed tower at the entry to the palace of the Emir of Daura (5.13), demonstrate that Hausa architectural technology was highly developed prior to Fulani rule. Religious leaders were also patrons of master masons (Saad, 1981). Between the 1920s, with the erosion of the emirs' powers, and Nigerian independence in 1960, many wealthy Hausa traders commissioned extensive traditional and modified traditional dwellings which combine lofty, domed spaces with storeyed houses having modern zinc roofs (Aradeon, 1980b).

2.61 The Guild and Royal Patrons

Hausa master masons are organized in an official guild system under the direction of the Sarkin Gini, literally the Head of the Master Masons, who himself is responsible to the emir. The Sarkin Gini is a lifetime, hereditary position. In Katsina the Sarkin Gini attends court daily. However, in Birnin Kebbi the Sarkin Gini is responsible to a senior traditional official, the Magijin Gari, whose duties formerly included overseeing the maintenance of the city walls and continue to include overseeing official housing for the traditional title holders.

With varying degrees of interference from the modern Public Works Department, these master masons build and repair the congregational Friday mosques and official residences of the many titled members of the

aristocracy as well as the country palaces where the emirs can retire for some relief from their official duties. These prestigious official residences constructed with traditional materials and techniques constitute significant visual symbols of their vested authority. Members of the guild also constructed the official residences for the provincial chiefs, such as the Sarkin Kurfi and the Sarkin Yabo.

Traditionally and to some extent today, the Sarkin Gini works through a hierarchy of titled master masons, distributing architectural work on behalf of the emir. If a provincial chief wishes to rebuild his residence, he makes his request to the emir, who instructs the Sarkin Gini to arrange for a master mason of the appropriate standing. The provincial ruler will be responsible for daily food payments and a gift of clothing and possible farm produce upon completion of the work. Usually the emir also provides substantial gifts upon completion. These payments are understood without negotiation. Thus, Umaru, a Birnin Kebbi master mason, was sent in 1903 by the emir to construct the official residence of the Chef de Canton of Dogondoutchi (5.25; 10.81). Umaru returned yearly for a gift, usually a large traditional gown, from his new patron even though the journey must have taken several days. In 1981 at the request of the newly installed Chef de Canton of Dogondoutchi, the emir in Birnin Kebbi sent another master mason to completely rebuild the official residence.

In accordance with traditional arrangements, the emir paid the monetary fees that master masons now expect.

The guild system continues to operate, but it has lost most of its cohesiveness and power, precisely because its technological and creative human resources are no longer in demand. Lofty domed spaces lavishly decorated with embossed patterns no longer confer the prestige now associated with one storey, zinc-roofed buildings (Aradeon, 1980b).

2.62 Wealthy Merchants as Patrons

The role of wealthy merchants as patrons of highly respected master masons prior to colonial rule has not yet been fully explored. Clearly the gradual changes in traditions since colonial administration commenced eighty years ago, emboldened many wealthy traders to build lofty, prestigious dwellings. Available evidence suggests that even during the colonial period, the approval of the emir (and perhaps also gifts of homage) was necessary in order to obtain the services of the very finest master masons and to avoid jeopardizing ones' social position. The Zaria Sarkin Gini related how one wealthy merchant was obliged to offer gifts to the emir because he had presumed to begin work on an ostentatious dwelling without obtaining the emir's consent (Saad, 1981). One of the most prestigious dwellings in Katsina (11.61) was built in stages between 1930 and 1940 by a wealthy trader, Alhaji Barmo Makudawa.

Alhaji is the title accorded each Muslim who has made the pilgrimage to Mecca. Significantly, Alhaji Barmo who was close friend of the reigning emir and financed their joint pilgrimage which in those days was an expensive, time-consuming overland journey.

2.63 The Apprenticeship System

The craft of a master mason is an hereditary craft, although it is possible for an outsider to become apprenticed. Only after five years of working first as an odd labourer and then as wall builder, are the young men ready to learn how to construct arches and domes, the marks of a full-fledged builder. This latter period lasts from three to five years for those who are successful (Saad, 1981). In addition to technical skills and empirical structural knowledge, each apprentice must acquire knowledge of the Koran and other Islamic books as well as supernatural knowledge to protect himself from rivals who might otherwise invoke evil powers to destroy the structural stability of his arches and roofs, causing them to collapse. For self protection, each master mason must possess offensive powers as well as defensive powers in order to intimidate other master masons and ensure that they will attempt neither to usurp his architectural projects nor use supernatural powers to harm him physically.

Occult powers are used to ensure adequate payment for services rendered or retribution for insufficient payment. One highly skilled Katsina master mason,

Alhaji Muazu, reports that he made the roof collapse on the zaure of a provincial chief, Sarkin Zurmi, who had not paid the agreed sum. No Katsina mason would undertake to repair the zaure, and those masons who attempted to construct arches never succeeded because of Muazu's powers. Finally Muazu allowed a roof to be completed, but only a flat roof. This account underscores the primacy of the occult in Hausa structural theory and suggests an area which merits further research.[3]

2.64 The Gwani

Some of the most respected master masons have risen above the guild system and attained gwanita status, i.e. the widespread recognition for skill and creativity expressed by the epithet gwani. The wider ramifications of gwanita have been explored by Saad (1981) in his perceptive thesis. Mukhaila Dugura, an early nineteenth century master mason who designed and built the Zaria Mosque is still known as Babban Gwani, literally the big expert. Two twentieth century master masons based in Kano have also been accorded similar acclaim, Bala Gwani and Hassan Mai Bayani. Ultimately both worked for the emir and other royal patrons, but initially Hassan Mai Bayani gained renown while constructing residences for prosperous merchants. Bala Gwani also built imposing dwellings for non-aristocratic wealthy men.

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[3] See Saad (1981) for confirmation and elaboration of this account.

2.70 Towards a History of Hausa Architecture

The present state of our knowledge of Hausa architectural history is insufficient to provide the basis for an acceptable account of the development of the distinctive features of Hausa architecture.

2.71 The Paucity of Dated Structures

Several centuries lapse between the two fifteenth century gates of the Kano palace, Kofar Kwaru (3.32) and Kofar Fatalwa, and the next dated buildings. The older reception halls of the emir's palace in Katsina (5.23, 6.14) were built prior to the nineteenth century jihad. Gidan Makama (10.31), the residence of a Kano official, and the Bawan Dodo at the emir's palace in Daura (5.13) were both built in the eighteenth century. The dated early nineteenth century rooms and buildings remain few and far between. Only three standing structures have been dated to the first half of the nineteenth century. The Bauchi Mosque was built in 1807 when the new city was founded as a provincial outpost by one of the jihad flag bearers. This large flat roofed mosque is supported on huge overstructured columns. It's simplicity and austerity is in keeping with the reforming ideals of the jihad. In contrast, the Zaria Mosque complex (9.20, 9.60, 10.61, 11.21, 12.21) built a little less than thirty years after the Bauchi Mosque is much more sophisticated. The Zaria Mosque and Sharia Court were commissioned by Emir Abdulkarim c.1836. This mosque complex was designed and built by Babban Gwani Mukhaila Dugura whose approximate life span is 1784-1852 (Saad, 1981). Prior to his death Babban Gwani also built the entry spaces to the head

builder's dwelling in Zaria. One other structure could conceiveably date back to this period; however, available evidence only warrants dating it to the first three-quarters of the nineteenth century. The Amini (9.11), a lovely shigifa with an ambulatory was commissioned by the Sarkin Kebbin Yabo Mahman Yelli. No information is available concerning whether the space was commissioned early or late in Yelli's reign. Unfortunately, according to the Sokoto History Bureau's "Notes on Yabo History", Yelli had one of the longest reigns possible, from 1818 to 1878 except for a short hiatus. Although many more structures can be dated to the second half of the nineteenth century, they are located in many areas of Hausaland and will not suffice to present a coherent picture of the architectural developments in any one emirate.

The necessity for constant maintenance of mud structures coupled with the continual military conflicts throughout the history of Hausa emirates has prevented a full account of Hausa architectural history. Mud structures can last for centuries but only with regular maintenance. Such maintenance was probably neglected after a severe military defeat and/or the death of the responsible officials or patrons. The official residences of the emir and his court must have been particularly susceptible to the vagaries of political power. Moreover this regular maintenance must often have involved renovations which significantly altered the architectural designs. In addition, it is standard

the architectural designs. In addition, it is standard practice to recycle the materials from unused building (Schwerdtfeger, 1971).

2.72 Hausa Architectural History as Based on Available Evidence

Despite these constraints, extensive research into the history of Hausa architecture should prove rewarding. To date only A.H. Leary (1966) in his thesis has attempted a history of Hausa architecture. Leary refers to African written accounts such as the anonymous Kano Chronicle and the seventeenth century Tarikh es-Sudan as well as the early sixteenth century account by Leo Africanus. Leary (1966, 1977) also sites descriptions of Hausa architecture provided by nineteenth century European explorers. H.L.B., Moody (1967a; 1967b) has provided the same type of historical resources for the mud walls of Kano.

While not embarking on a history of Hausa architecture, Saad (1981) provides much relevant historical information in addition to discussing some of the written sources. He identifies existing pre-jihad structures and refers to the arch construction still visible in the pre-jihad ruins at Kirfi. Saad further suggests that the "Hausa vault" is a long standing development in the history of Hausa architecture" because its invention is attributed to Gizo, the spider of folklore who also created the rainbow.

Relying on oral research, Saad also provides information on the relationship between builders and their patrons.

Several stages in the history of Hausa architecture emerge from the available evidence; however these developments are yet to be precisely dated and defined. Although the origins of Hausa mud-roofed architecture remain obscure, it appears to have been partly an outgrowth of a defensive strategy. By the twelfth century, massive earthern walls had been built around Kano encompassing a much larger area than the buildings themselves in order to provide sufficient agricultural land and water to withstand a long siege (Moody, 1967b). Mud roofs protect a settlement from the conflagrations caused by flaming arrows and other projectiles during a slave raid or war. These protective measures had become standard by the early sixteenth century when Leo Africanus visited Kano (and reported that "the walls and houses whereof are built for the most part of a kind of chalk (mud)" (Leo, 1966).

Hausa culture is assimilationist (Adamu, 1978); hence, the question of the nature of external influences, if any, also needs clarification. Islam was probably introduced by the Wangarawa, Malian traders. Some aspects of political rule and Islam were also fostered by contacts with Bornu. North African traders and clerics have been in Hausaland since the late middle ages. Slaves were captured in the areas south of Hausaland. If the Hausa absorbed architectural influences from any of these sources, they transformed those influences into a

new architectural style exhibiting distinctive features, the arch and dome.

By the late eighteenth century, the distinctive features of Hausa architecture were well developed. Arches intersecting at the crown span more than five metres square to support a lofty dome in Gidan Makama in Kano (10.31). In conjuction with engaged partition walls, the arches of the Bawan Dodo in Daura (5.13) intersect to form a central coffer over an approximately nine metre square flat-roofed space. These arches supported a 21.34m (70') high tower. In the second quarter of the nineteenth century, the Zaria Mosque complex (9.20, 9.60, 10.61, 11.21, 12.21) was designed with accomplished versions of all the distinctive Hausa structural systems. Embossed designs embellish partitions of the interiors of both the Bawan Dodo and the Zaria Mosque but they do not exhibit the colourful horror vacui patterns of the twentieth century. The Kano Audience Chambre photographed by Lugard's contingent (10.82) seems to represent an intermediate stage in the evolution of this style of decoration. The azara of the soffit permanent formwork are still revealed and the embossed work has distinct designs. In contrast, the existing twentieth century reception halls of the Kano palace possess horror vacui designs which blend into each other as they cover the entire walls, arches and soffit permanent formwork. Since the thirties,

this embossed work has been coloured with oil-based enamel paints rather than with the traditional paints.

2.73 Sources of Hausa Architectural History

A history of Hausa architecture must be based on a combination of sources. Historians are continually augmenting and revising their history of the Hausa which has already become extremely detailed. Mahdi Adamu (1978) has supplemented this political history with work on the commercial and cultural history of Hausa migrants. Other scholars have worked on aspects of economic and social history. All these scholars draw on the small body of available written literature but their greatest contributions lie in their field research.

A history of Hausa architecture must also rely extensively on oral history supplemented by current scholarship on Hausa history and society. A systematic reexamination of the written sources from the viewpoint of the architectural historian is essential as is a reexamination of the available hard data, the existing structures and ruins. The present typology is partly designed to provide a background to such a reexamination of Hausa architecture.

2.80 The Urgency

Changes in the life-styles of the patrons and the availability of materials requiring a minimum of maintenance in conjunction with increasing labour costs

has brought about considerable modification in traditional Hausa architecture. Wealthy men and officials no longer receive guests within the zaure. Instead they entertain in upper storey livingrooms equipped with stereos and television sets. Zinc roofs and sprayed cement walls simplify matters for the patron while simultaneously conferring prestige. Since master masons seldom receive commissions to construct lofty Hausa arches and domes, very few of the younger master masons are competent in these traditional techniques. Each year during the rainy season, more roofs collapse causing more house owners to decide to substitute zinc if their buildings can be salvaged at all. Moreover, when the elderly men who commissioned their traditional dwellings die, some children prefer to construct more modern buildings on the site. Thus, it is essential that traditional Hausa architecture be thoroughly documented before becoming so greatly transformed that it is no longer possible to preserve a worthy record of this distinctive aspect of Hausa culture.



Fig. 2.80a

CHAPTER 3

HAUSA STRUCTURE

3.00 Introduction

The discussion of Hausa structure which follows is descriptive and, at best, can merely serve as a preface to a scientific analysis of Hausa structure. After brief descriptions of tubali walls and lashed-azara beams and brackets, this chapter highlights variations of the basic technique for constructing arches and several techniques for effecting their intersection. Since arches are normally plastered, it is possible that further fieldwork focussing on structure per se will bring to light additional techniques. The basic procedure for erecting a roof slab or dome skin above walls on an armature of beams or arches is also described.

3.10 Towards a Scientific Structural Analysis

Despite the crucial role reinforced-mud arches play in Hausa architecture, arch structure alone is incapable of supporting the Zaria Mosque according to Professor S. Cleszkiewicz (1977) who has undertaken a structural analysis of the mosque. He determined that

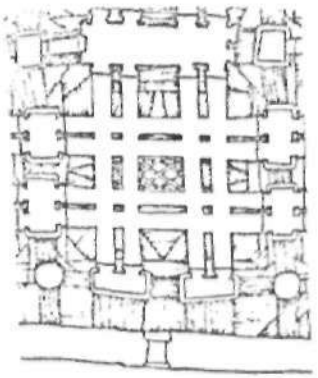


Fig. 11.21c

the heavy self-weight of the arches and the dome skin was too great for the arches because of their comparatively narrow cross-sections. Cleszkiewicz ultimately explained the 140 year existence of the mosque on the "basis of the recently developed limit state theory." Accordingly, the arches carry the actual load in the first stage of construction only, then the dome skin takes over. "Due to creep phenomenon, a redistribution of internal forces takes place until an equilibrium is achieved." From then on, the dome skin operates as a dome structure in combination with the arches. "The horizontal forces and local tensile stresses are taken up by the azara rods." Presumably the arches and domes in all Hausa structures

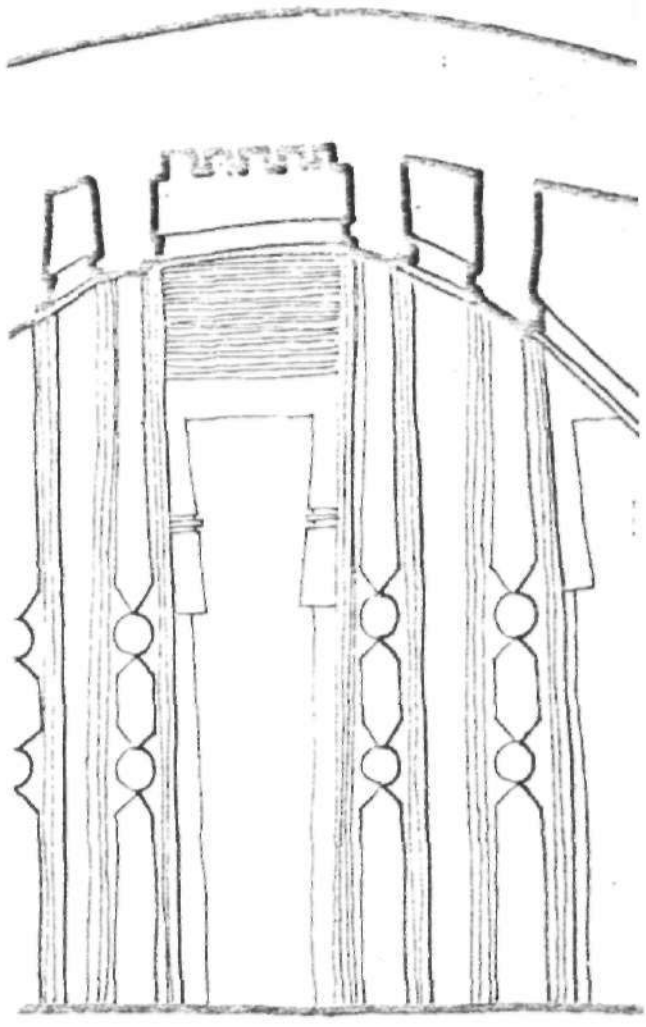


Fig. 11.21

operate as a monolithic whole but this must be tested more fully in the field and the structures laboratory.

3.20 Walls

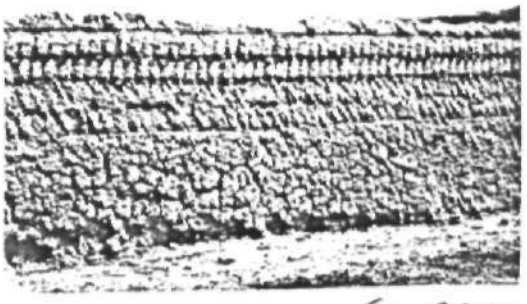


Fig. 3.20a

Hausa walls are load bearing. The average room has battered walls three tubali wide at the base and one tubali wide at the shallow parapet. Rooms supporting an upper storey and those supporting large spaces have walls four or five tubali thick at the base. All tubali-work involves a thick, mud mortar. The walls of substantial buildings have foundations several tubali deep.

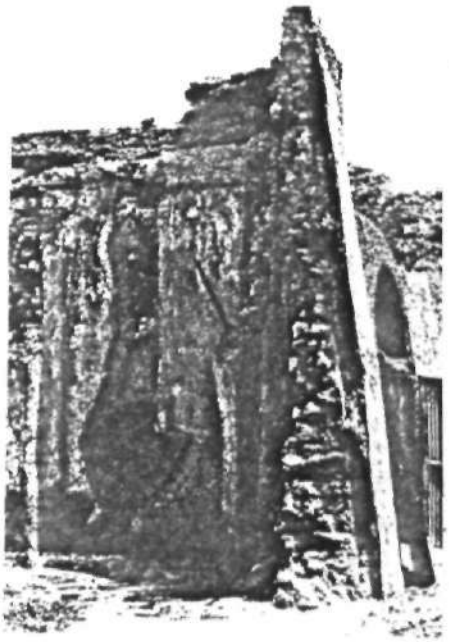


Fig. 3.20b

3.30 Azara Brackets

Azara brackets project from walls, partition walls, columns, piers, and pilastres. In size, they range from 15cm to 45cm

(6"-18") deep and from 30cm to 45cm (12"-18") wide. To make an azara bracket, two layers of azara are superimposed and cantilevered from the wall or other vertical support. Then mud is packed onto the azara. In Hausa architectural designs, brackets are used for two specific structural functions as well as for aesthetic effect.



Fig. 3.30a

3.31 Brackets Functioning to Support Wall-Tauyi Bay 2, Outer Zaure, Gidan Yarima (Katsina)

In some cases, the brackets perform a function that appears, on the basis of our present knowledge, to be distinctively Hausa. They help support a cantilevered wall-tauyi panel which in turn reduces the space to be spanned to the opposite wall. Occasionally two brackets project from a wall to support the wall-

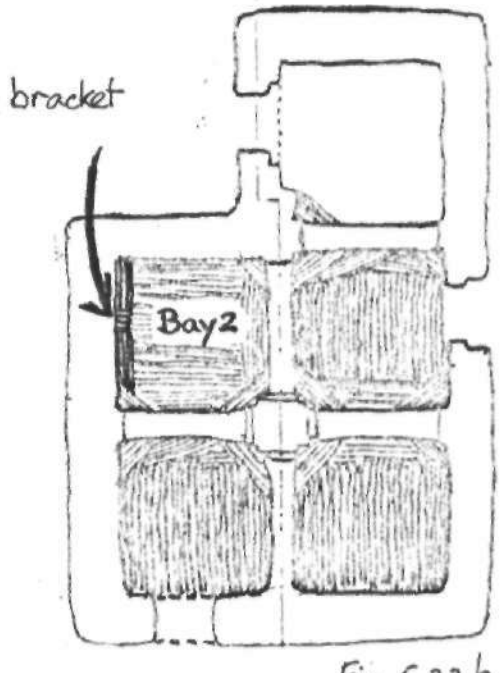


Fig. 5.22b

tauyi. One of the bays in the outer zaure of Gidan Yarima, labelled Bay 2 in the ceiling plan, offers an example of the former procedure. Like all wall-tauyi, these cantilevered wall-tauyi are only capable of supporting another level of azara joists.

3.32 Brackets Functioning to Reduce the Distance to be Spanned by a Beam

Kofar Kwaru, Emir's Palace (Kano)

Usually brackets are placed opposite each other in order to reduce the span for a superimposed beam or arch by providing the bearing which is cantilevered into space. Such is the case for the brackets that support the beams in the soffit of the Kofar Kwaru, one of the gate houses for the Kano Palace, said to date back to the fifteenth century. It is also the case for all

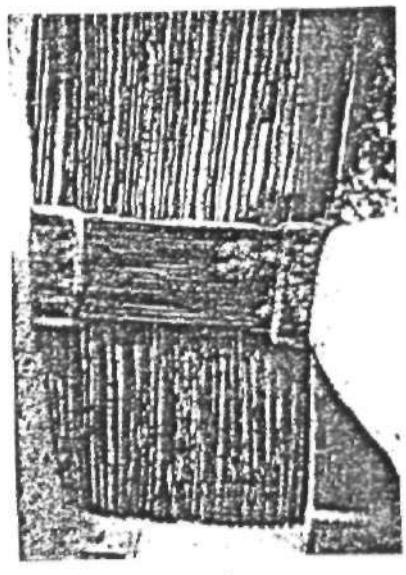


Fig. 3,32a

the cruciform brackets above the columns in the Kazaure Friday Mosque (5.27) and above the piers in Gidan Chef des Peuls in Zinder (5.26). In all these cases, the brackets perform structural and aesthetic roles simultaneously. They provide the required bearing while they articulate the transition from vertical to horizontal structural members.



Fig. 5.27c

3.33 Brackets Functioning Principally as Embellishment
Shigifar Tambura, Kanta Museum (Argungun)

Sometimes the aesthetic function of brackets becomes their raison d'etre. In the Shigifar Tambura (the room where drums, tambura, are displayed) of Kanta Museum in Argungun, the cruciform brackets are designed principally for their aesthetic effect. These cruciform brackets form the immediate

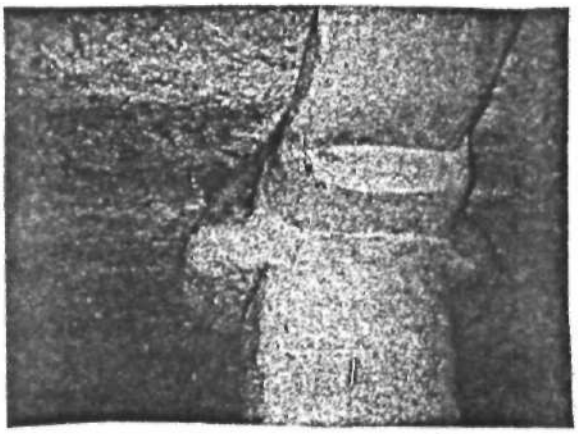


Fig. 3.33a

support for beams which span from one wall to the next, parallel to the entry wall. They are built in layers. The first layer is perpendicular to the beams while the second layer directly supports the beams. The projection of the first layer, it will be noted, supports nothing. Instead its upper surface is smoothly moulded and curved back towards the beam in order to create the impression of fully symmetrical cruciform brackets.



Fig. 5.27d

3.40 Lashed-Azara Beams

Lashed-azara beams are very common in Hausa architecture and reveal their own structure unless their sides and soffits are smoothly plastered as is frequently the case. Since the azara form the structural component of the beams regardless of plastering, we

shall refer to them as lashed-azara beams. These beams consist of one or usually two layers of azara spanning between opposing walls or brackets and tied tightly together with local fibre cord. Sometimes tree trunks are substituted for the azara. Then, mud is forced down into the interstices. Such a beam can be used alone or in combination with piers as is the case with the lashed-azara beams in the Shigifar Tambura at the Argungun Museum.[1]



Fig. 3.40a

3.41 Anteroom, Sharia Court (Zaria; Jos Museum)

Prior to the 1960s, the azara in the beams in the Zaria Mosque complex were exposed and they have been handled in this manner in the copy at the Museum of Traditional Nigerian Architecture in Jos. A lashed-azara beam combines with the

[1]See above Section 3.33.

walls to support the anteroom of the Sharia Court. The anteroom measures only 4.28m x 2.65m x 3.00m (14'x8'8"x9'10"). A lashed-azara beam 37cm (1'3") wide rests on brackets which cantilever 17cm (7") into the narrower span. Thus the beam itself spans 2.31m (7'6"). The length of the room is spanned by two sets of contiguous joists 1.98m (6'6") and 1.90m (6'3") long respectively. They rest on the walls and the lashed-azara beam.

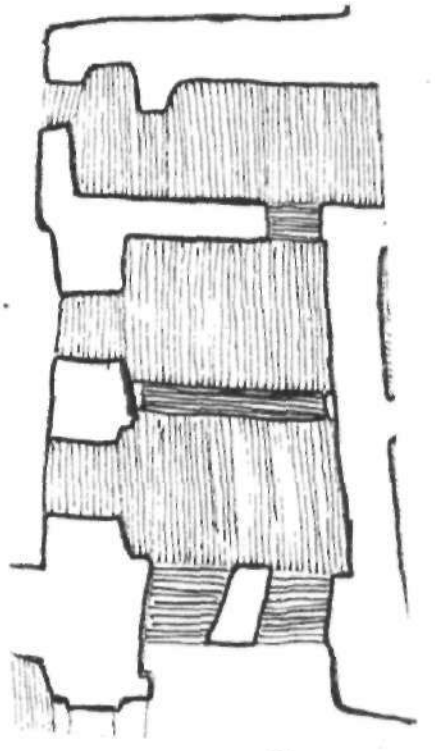


Fig. 10.61d

3.50 Reinforced-Mud Arches

The structure of the Hausa arch is based on the cantilever principle. The key to the construction of this reinforced-mud arch is the rigid azara which functions simultaneously as the permanent formwork and the



Fig. 3.52 b

tensile reinforcement for the arch. Successive cantilevered sets of azara rest on the wall near the arch. In the upper portions of the arch, these sets rest on the backs of the previous sets as well as on the bulk of the spandrel. The rigidity of this permanent formwork is maintained by binding the successive sets to each other with fibre cord and by wedging in the spandrel material. Mortar also binds the permanent formwork azara to the bulk of each spandrel and binds the materials within each spandrel. The spandrel is constructed with additional reinforcing azara which slope up from the wall and with tubali, both whole and split into pieces, that can be wedged into place between azara. Extra azara cut from

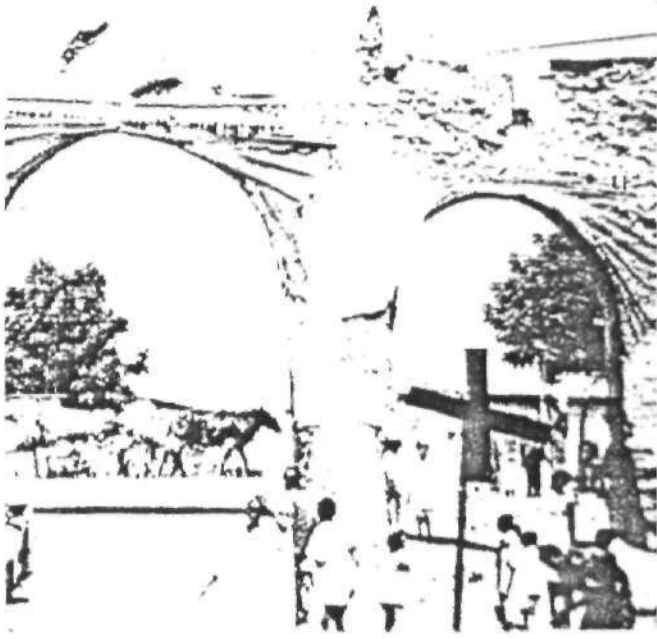


Fig. 350a

the top of the palm are also used as infilling material. Unlike the lashed-azara beam where the mortar is not integral to the structural action of the beam, the reinforced-mud arch acts as a monolithic whole. It would not be structurally stable if any portion were removed.

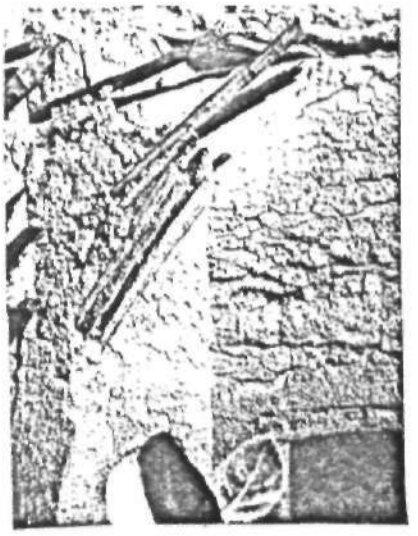


Fig. 3.51d

Several versions of the reinforced-mud arch can still be seen today. All rely on the cantilever principal. The version commonly referred to as the Hausa arch is the most sophisticated and the most widespread version. The other versions which are here designated the Doraye arch and the Bauchi arch differ in their handling of the permanent formwork. The Doraye arch is a generally recognized version of the Hausa arch but the distinctive features of the

Bauchi arch have not received the attention they warrant. Very few proven versions of these arch variations have been established because to do so requires seeing the permanent formwork which is normally plastered-over. However, the form of the arches and the roofs of several of the nineteenth century rooms in Bauchi area including the Babban Gwani at Kafin Madaki (6.24), the outer zaure of the Emir of Bauchi, and the outer zaure of Gidan Kassim (originally built for the Alkali) suggest that these spaces are supported on sets of intersecting Bauchi arches.

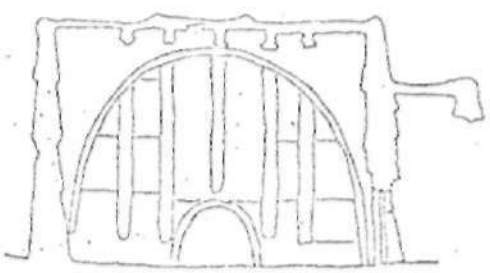


Fig. 6.24c

3.51 The Hausa Arch

The construction of even the smallest, reinforced-mud arch requires much more knowledge, skill and time than the construction of a lashed-azara beam. According to Sarkin Gini

Ibrahim Dan Karima of Birnin Kebbi and published sources (Daldy, 1945; Moughtin, 1972; Saad, 1981), the master mason begins constructing an arch simultaneously from both spring points. To form one kafa, literally leg, of the arch, he imbeds a set of three or more azara tied together (BK: zuri; K: kafi)[2] well into the wall and slightly cantilevered at a steep incline. The first zuri is imbedded vertically in the wall. Each successive zuri is laid at a progressively diminishing slopes to create the permanent formwork for the basic curve of the final arch form. Three or four sets of cantilevered zuri suffice for each leg of an arch. Both legs are cantilevered into the space simultaneously from opposing walls and joined by laying a set of long, horizontal azara (BK: kulli; K: mashifidi) atop their extremities. Thus in an arch

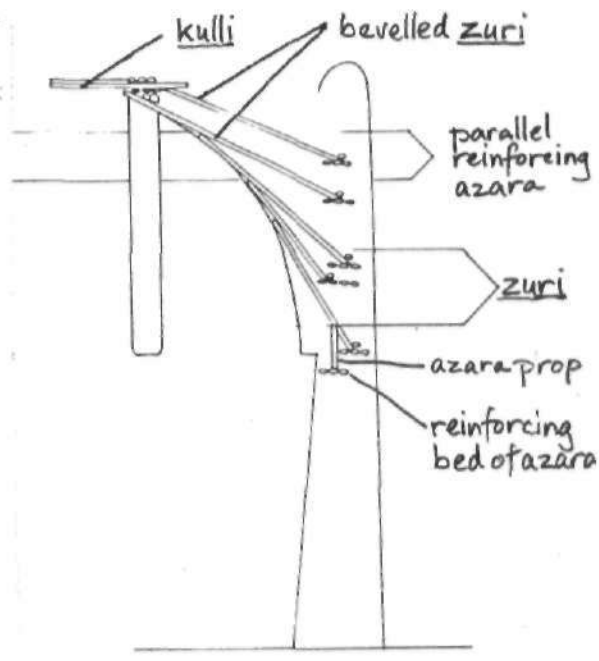


Fig. 3.51a

[2] BK indicates a Birnin Kebbi term and K indicates a Kano term.

with a large span, the kulli is long, thereby creating a flat, baskethandle arch. The ultimate form of the arch can be considerably modified during the plastering of the soffit at which time the final shape is created.

The description of arch construction technology given by Saad (1981) is the most detailed. Saad provides Hausa names for the different structural elements and the approximate dimensions of the sloping zuri as follows: the first zuri is .50m (18"), the second .75m (2'6"), the third 1.00m (3'4"), and the fourth 1.50m (4'11").

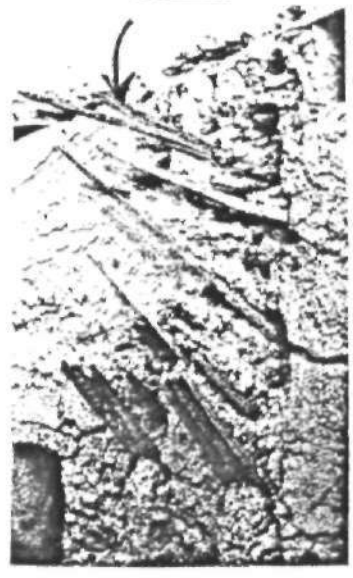


Fig. 3.51b

Several factors ensure that the permanent formwork is structurally sound. At least one quarter, and often more, of each cantilevered zuri is imbedded in the masonry of the wall. Each zuri as well as the vertical azara serving as a prop, rests on a bed of reinforcing azara (BK: tuni) that has been

laid in the wall extending on both sides of the arch to redistribute the thrust of the arch over a wider area of the wall. Another parallel, reinforcing azara is laid directly on the back of each zuri. Then the back of each zuri is tightly with packed with broken tubali and with sloping kubara (BK), very lightweight azara cut from the top of the deleb palm tree. The zuri are bound together at every joint and also at secondary points after the infilling matter has been wedged between two successive zuri.



Fig. 3.51c

The kulli which completes the permanent formwork of the arch is supported in two places. The uppermost ends of sloping zuri which have been bevelled to minimize the risk of slippage and to reduce the bulk of the formwork support the soffit of the kulli. The bevelled ends of another sloping zuri are tied to the bevelled ends of the kulli. A



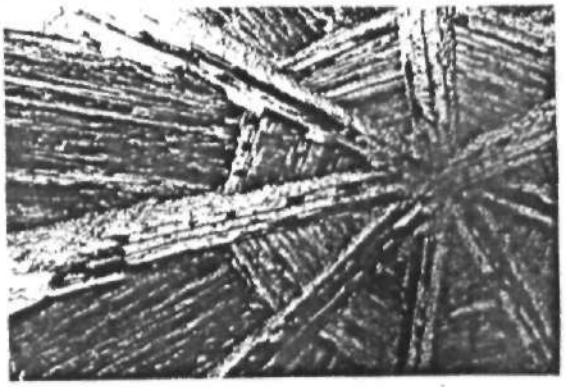
Fig. 3.50b

second kulli is superimposed on the first to increase the structural depth of this joining member. The formwork is then plastered with tabo, swamp silt, to fill out its form.

3.52 The Doraye Arch

Reception Room for District Heads, Doraye Palace (via Kano)

In some cases the zuri abut each other rather than being linked with a kulli. This can occur with arch configurations meeting at the crown.[3] The ends of the abutting zuri are bevelled and the zuri themselves are steeply inclined so that the result is a pointed arch. For a space spanned by two transverse and two diagonal arches, this system reduces the load and the bulk at the apex which would otherwise be a minimum of eight azara thick.





Figs. 3.52a
3.52b

[3] See below Section 3.61.

3.53 The Bauchi Arch

Shigifa, Gidan Alkali Kassim (Bauchi)

The nineteenth century master masons in Bauchi area evolved an arch technology that differs from the one documented elsewhere and commonly referred to as the Hausa arch. The spandrel of this Bauchi arch consists of horizontally cantilevered azara laid on top of each other with thin layers of mortar whereas the spandrel of the Hausa arch[4] consists of inclined, cantilevered azara and tubali. As in the Hausa arch, the permanent formwork azara, the zuri, of the lower third of a Bauchi arch cantilever into the space at an incline which approximates the curve of the arch. However, the curving shape of the upper portion of the arch is effected with perfectly



Fig. 3.53a

[4] See above Section 3.51.

horizontal, cantilevered azara. Each azara is slightly longer than the preceeding azara, so that their ends approximate the required curve. In the Shigifa of Gidan Alkali Kassim a series of cornices on the wall cantilever into the space to reduce the distance to be spanned by the horizontally cantilevered azara.

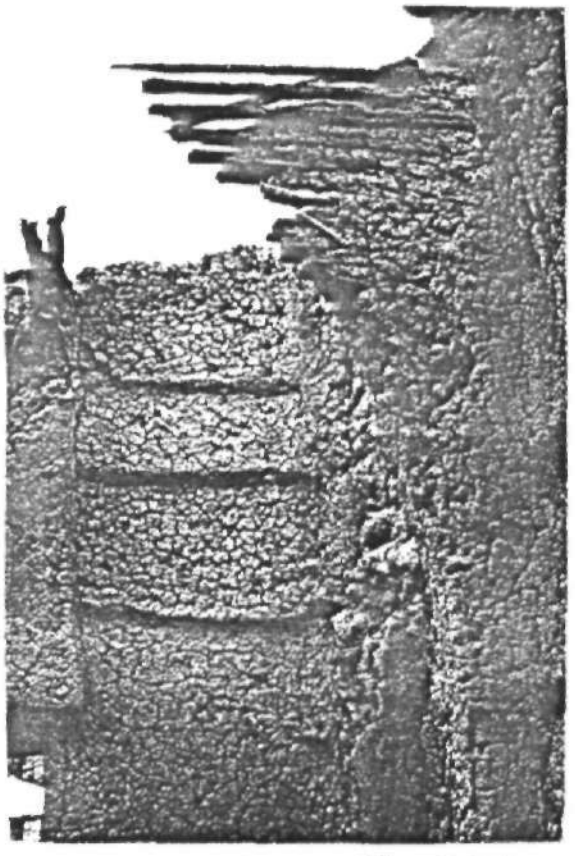


Fig. 3.53b

The technology of the Bauchi arch explains why the largest documented space spanned by Hausa master masons, the Babban Gwani in Kafin Madaki via Bauchi (6.24), has a flat rather than a domical roof even though a domical roof is more efficient. The spandrel of the arches supporting a domed space curve to follow the lines of the dome skin whereas the spandrel of arches supporting a flat roof must rise up to the junction between the

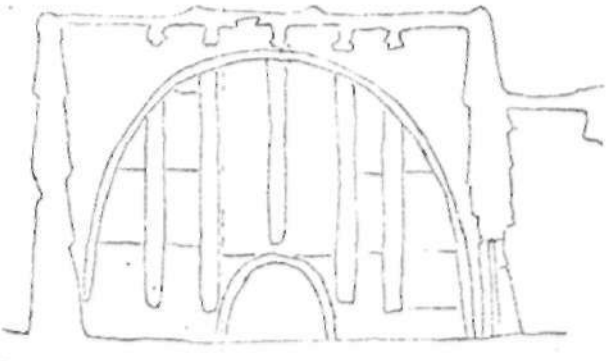


Fig. 6.24c

roof and the wall. Thus, very large, flat-roofed rooms have very large spandrels to support. Despite the advantages of a domed structure, the Bauchi arch technology necessarily results in a flat roof which follows the contours of the horizontally cantilevered azara.

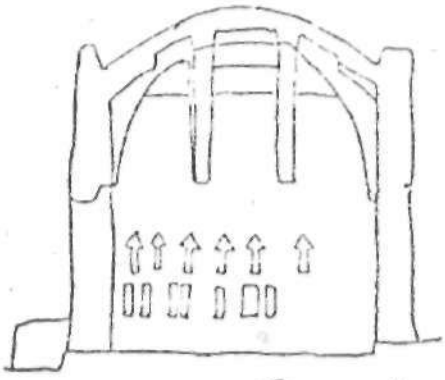


Fig. 11.15b

3.60 Armature for Intersecting Arches

All domes and many slab roofs rest on an armature of intersecting arches which involves great precision on the part of the master mason. The structural system for average domes supported by arches intersecting at the crown differs significantly from the system developed for domes supported by sets intersecting arches forming coffers. However, the structural system for large domes with arches meeting at the crown ressembles the structural system for coffer-forming arch

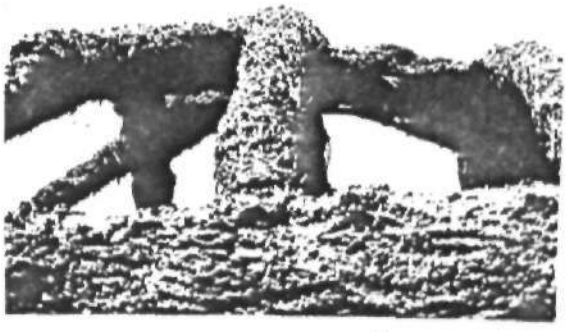


Fig. 3.60a

configurations. In all cases, the azara forming the permanent formwork are the central elements in the structural system. These permanent formwork azara rise from the walls forming the legs of the arches. The first azara to be joined, which by definition form the primary transverse arch or arches, always span the shorter dimension of the space.

3.61 Armature for Arches Meeting at a Single Point at the Crown

For domes supported by arches intersecting at the crown, the permanent formwork azara of the kafa abut rather than rest on each other. The azara of the primary transverse arches abut each other while the azara of the secondary transverse arches abut their joints. The ends of these azara are bevelled to

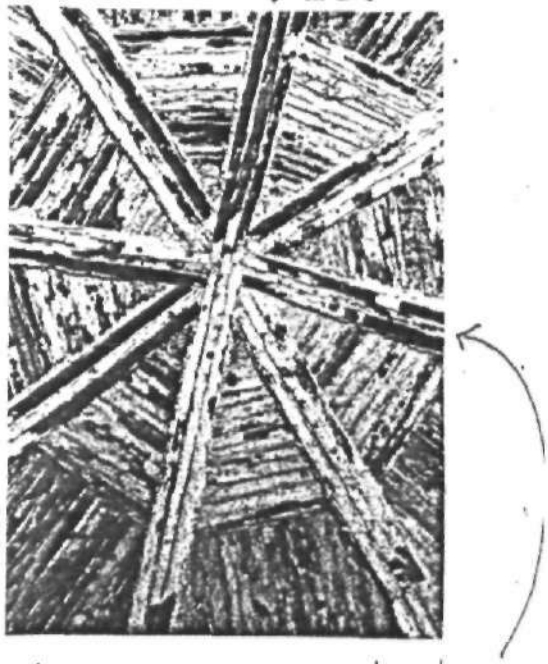


Fig. 3.52C

abut each other firmly and they are held in place by the pressure they exert against each other. The azara members in the permanent formwork of the diagonal arches are bevelled laterally so that they can be wedged into place, thereby reinforcing the rigidity of the structure. This type of framework is visible in the Reception Room for the District Heads at Doraye Palace where the permanent formwork of the arches remains unplastered.

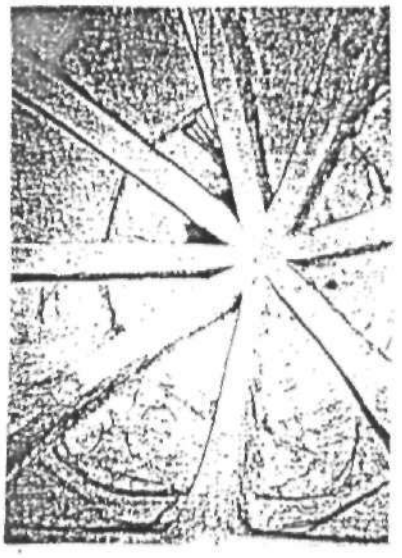


Fig. 9.71a

3.62 Armature for Arches Meeting at a Ring Beam at the Crown

Although, most domes with arches meeting at the crown rest on eight kafa, very large domes have been known to rest on twenty-four kafa (twelve arches). The intersection of twenty-four kafa to complete the large

arch configurations would be unwieldy. Instead the master masons create a ring beam by joining each kafa to the adjacent kafa with lateral beams. Hausa nomenclature acknowledges that this ring beam is comparable to coffer-forming arches. Rigiya (well) is the word for coffer in Hausa. According to Saad (1981) the hollow created within the circumference of a ring beam is also called a rigiya.

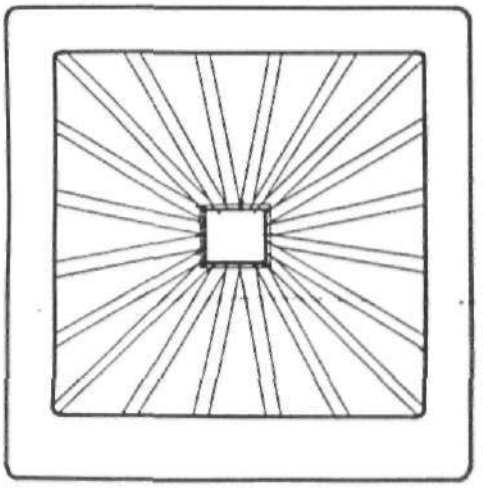


Fig. 10.82a

3.63 Armature for the Intersection of Two Arches

Two perpendicular transverse arches which intersect suffice to support very small domes. According to Sarkin Gini Sahabi of Argungun, this arch configuration is treated as a single transverse arch and two kafa rising from opposing walls to abut the transverse arch at its apex. Presumably this solution is

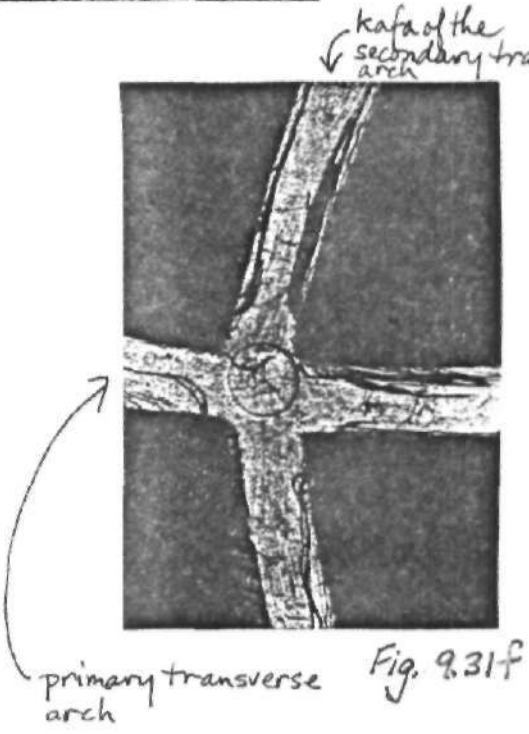


Fig. 9.31f

viable because it is restri-
ted to relatively short spans.

3.64 Armature for Arches Forming Central Coffers

In domes supported by arches which intersect to form central coffers, all the kafa rise simultaneously. The kafa rising from adjacent corners overlap and are tied together first so that they brace each other (3.64-1). Then long lateral azara which can attain 4.90m (16') in large domes, are tied to join the junctures of these corner azara (3.64a-2) As Sarkin Gini Ibrahim explained in his lucid description of the construction procedure, these azara are laid "from the kafa rising from the north to the kafa rising from the south", thereby completing the permanent formwork of these north-south arches. Then a similar set of azara is laid across them to join the kafa rising from the east and west (3.64a-3). An

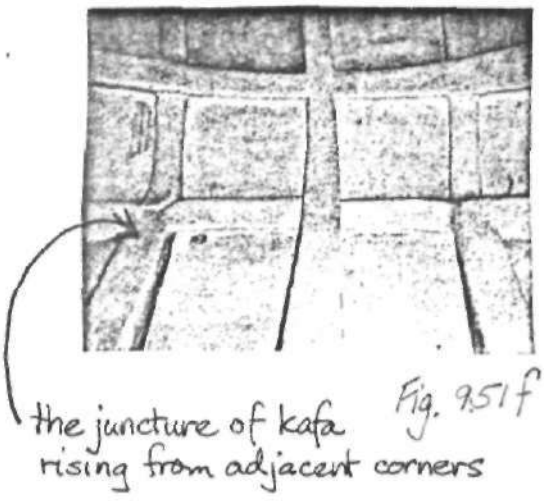


Fig. 9.51f



Fig. 9.51g

additional set is laid on the north-south axis and this grid is tied at all intersecting points (3.64a-4). Finally the upper portion of the grid is filled out with azara which have been cut short enough so that they can be placed in the east-west direction and wedged in between the north-south azara (3.64a-5). After they are tied into place, the entire grid is covered with infilling members and plastered with a mixture of swamp silt and grass to give the intersecting arches their ultimate form.

Sometimes the soffits are only minimally plastered and therefore reveal which sets of permanent formwork azara, those forming the north-south or those forming the east-west arches, are laid in place first. In such cases, the soffit of one arch abuts the other arch allowing the knowledgeable viewer to realize that the permanent formwork of the abutting arch rests on the permanent formwork

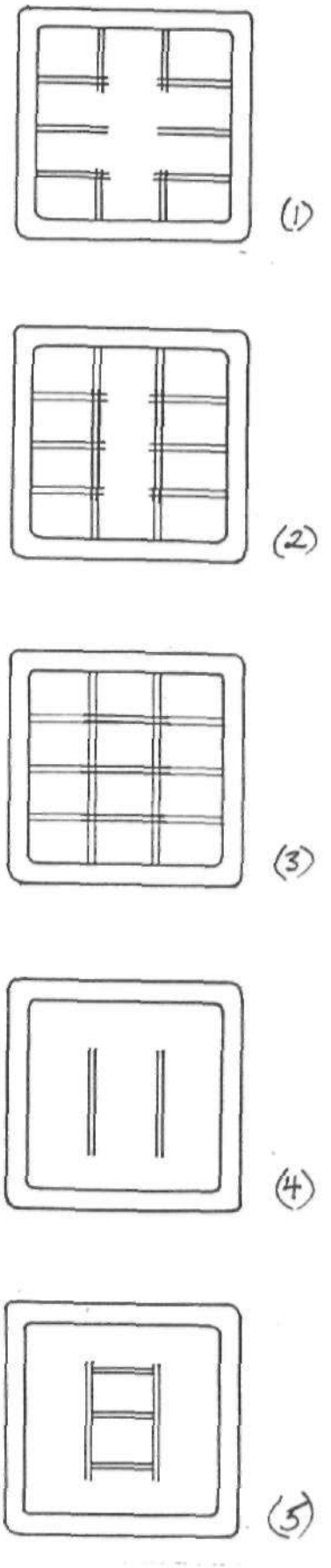


Fig. 3.64a

of the abutted arch. In large domes, where the back of the apex of the arches is flat, the external domical from is achieved by packing the dome skin with additional mud.

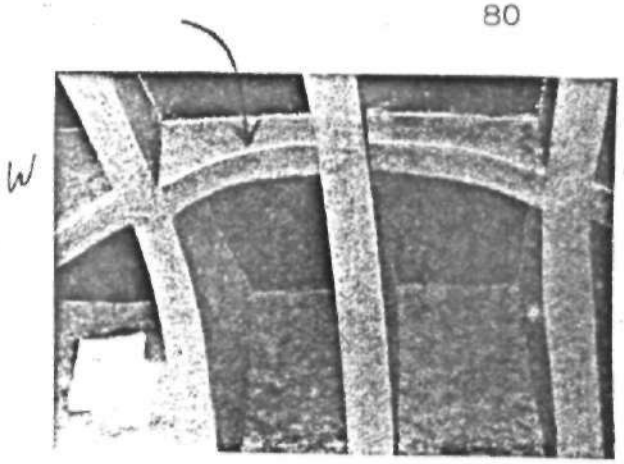


Fig. 3.64b

3.65 Armature for an Arch Abutted by a Kafar Kaza (Half-arch)

Because the transverse arch is the structural arch which provides the basic support for the roof slab or dome, the permanent formwork for the transverse arch in a kafar kaza arch configuration is always tied together first. Then the permanent formwork azara for the additional perpendicular kafa are laid on the transverse arch and tied to it.

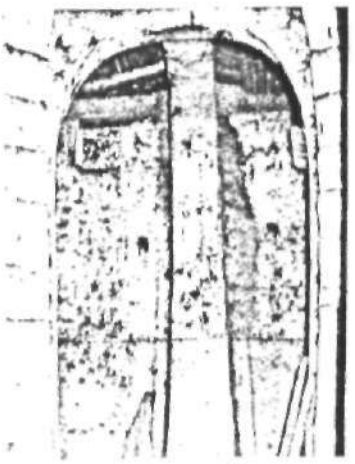


Fig. 3.65a

3.70 The Slab Roof and the Dome Skin

3.71 Similar Materials and Construction Techniques

The materials and methods for construction of flat and

domed ceiling/roofs are basically the same. The ceiling/roofs actually consist of at least four different materials in layers but working together to form an organic whole.

Daldy (1945) has described in detail the standard materials and construction techniques for Hausa ceiling/roofs. On the inner layer, closely spaced azara joists, approximately 5cm x 7cm (2"x3"), create a permanent formwork which covers the entire soffit of the ceiling/roof. Sometimes these azara joists are more widely spaced and infilling members made of smaller girths of azara, reeds, or sticks are laid over them to fill in the interstices. In the best examples, these infilling members are arranged to create overall patterns in the ceiling. Mats are laid over the



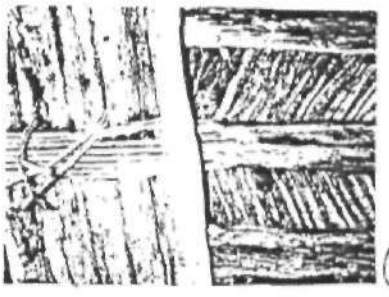
(1)

(2)

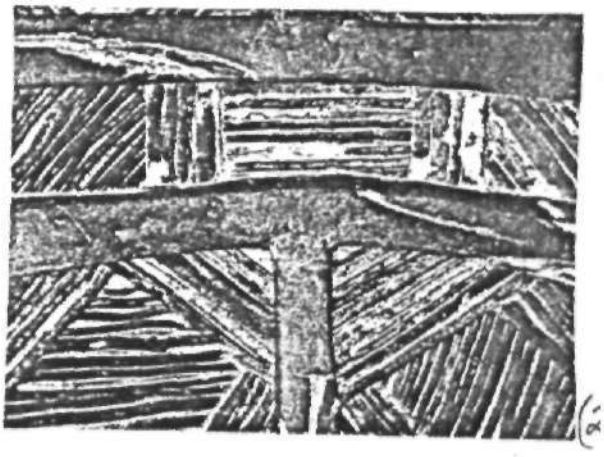
(3)

Fig. 3.71a

initial layer to prevent the 10cm (4") of wet-mud mortar (K: burgi) which constitutes the third layer from falling through interstices between infilling members. In Zaria the mud mortar is only about 5cm (2") thick but it is covered by a layer of earth 10-15cm (4"-6") deep (Schwerdtfeger, 1982). Finally the entire slab or dome is covered with katsi, ashes from dyepit residue, in order to make it impervious to the rain. The katsi layer is 10cm (4") thick for domes but it has to be thicker, 15cm (6"), for flat roofs because rain water will drain off a flat roof more slowly. A fifth layer, a layer of well-prepared mud, forms the interior plastering. Laso, an indigenous cement, is used for the roofing in high quality construction. Laso is a more impervious compound including katsi, indigo liquid, treated animal hairs (gashinjima), and strawless



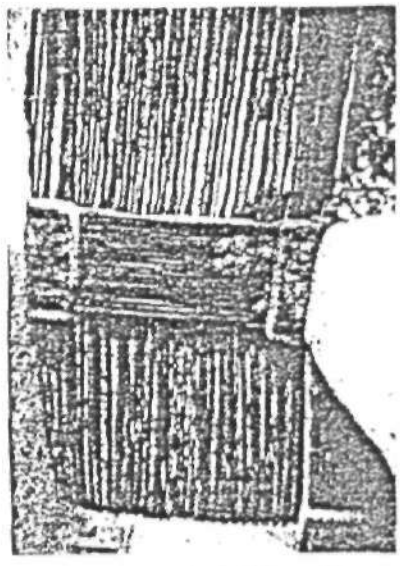
(1)



(2

Fig. 3.71b

horse manure. A fusion from the roots of a wild vine (loda or dafara) is mixed into this mixture twice a day for ten days. Laso should remain impervious for about four or five years. Other compounds are also used depending upon the availability of materials and funds.



(1)



(2)

Fig. 3.72a

3.72 The Limitations of Mud and Azara

The limitations of an architectural technology based on the use of mud and azara have greatly influenced the nature of Hausa architecture. Azara perform a vital structural role. They act as a permanent formwork, both for the beams and arches and for their ceiling/roofs. Azara form the soffit and the immediate support for the mud slab or dome during construction. This permanent formwork ensures that the ceiling/roof takes on the

domical form when so desired. It also constitutes an integral part of the monolothic ceiling/ roof providing the necessary tensile reinforcement. In slab roofs, the positioning of these azara depends on their capacity to support the dead load of the roofing above them. Hausa master masons operate on the principle that closely spaced or contiguous 5cm x 7cm (2"x3") azara joists can safely support this dead load if they do not surpass 1.80m (6') (Daldy, 1945). In domes, the lengths of the azara must be even shorter to prevent the creation of a pitched roof and ensure a uniformly curved dome.

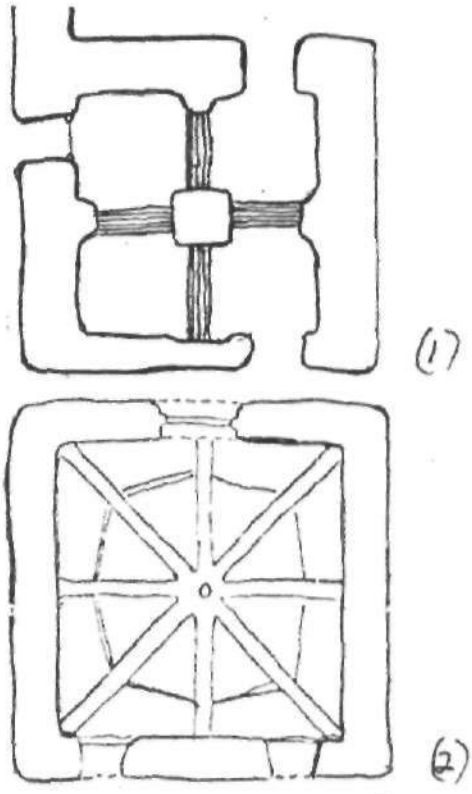


Fig. 3.72b

The limitations on the dimensions of the infilling members of the permanent formwork in slab roofs and domes considerably influences their design by forcing the master masons to subdivide their

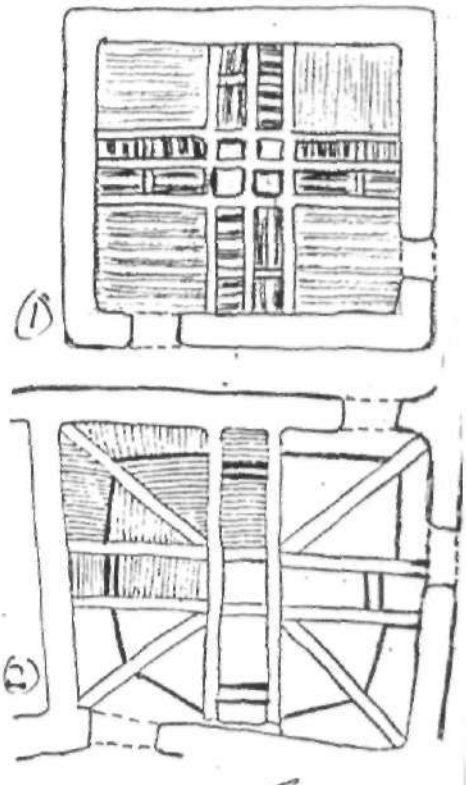
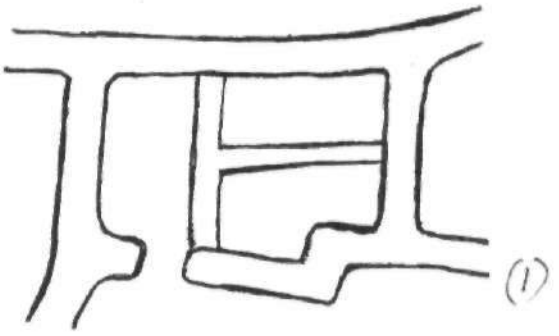


Fig. 3.72c

soffits. These subdivisions constitute the basic distinctions in the typology of Hausa ceiling/roof structures and ceiling patterns which follows in Parts II and III of this thesis.



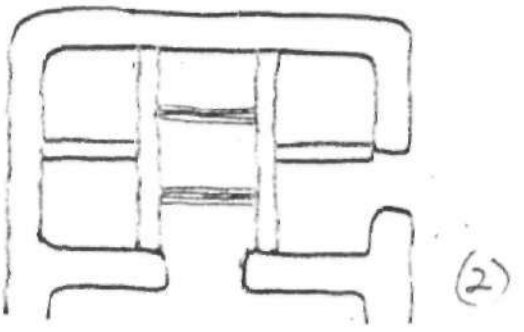


Fig. 3.72d

3.80 Structure and Aesthetics

Because the typology which follows in Parts II and III classifies such a great range and variety of structural solutions to spanning spaces with mud roofs, this typology is testimony to the artistic creativity of Hausa master masons. Moreover, the finest of the ceiling patterns created by these structural systems attain high aesthetic standards. The ceiling patterns also demonstrate that Hausa architectural designs are based on a conceptual integration of structural and aesthetic considerations.



Fig. 11.14d

PART II

FLAT CEILING/ROOFS
THEIR STRUCTURE AND RESULTANT CEILING PATTERNS

CHAPTER 4

THE PERMANENT FORMWORK OF THE SOFFIT

4.00 Introduction

Hausa master masons have designed a variety of configurations for the elements in the permanent formwork of their mud slab roofs. Working within the confines of the 1.80m (6') span which they have taken as a safe maximum span for an azara joist, they create patterns by changing the arrangement of joists, tauyi, infilling members, and mats.

The introduction of tauyi and infilling members is sometimes a response to economic restraints; the shorter, narrower azara lengths which otherwise are remainders or wastes are cheaper than the longer lengths. Similarily the use of mats with widely spaced joists represents an economy since mats are cheaper than azara. The best master masons transform this economy into an aesthetic pattern.

Many of the basic types of permanent formwork arrangements are discussed here on the basis of examples in a single building, the Friday Mosque at Kazaure (5.27). Lashed-azara beams resting on columns have been used to reduce the large span of the Kazaure Mosque, which measures roughly 11.00m (36') square, into bays



Fig. 5.23b

small enough to be spanned by the same structural solutions used for small, insignificant rooms. Although each bay is approximately 1.80m (6') square, the master mason has varied the patterning of the members of the permanent formwork. It is therefore evident that this patterning was determined by aesthetic as well as structural and financial considerations.

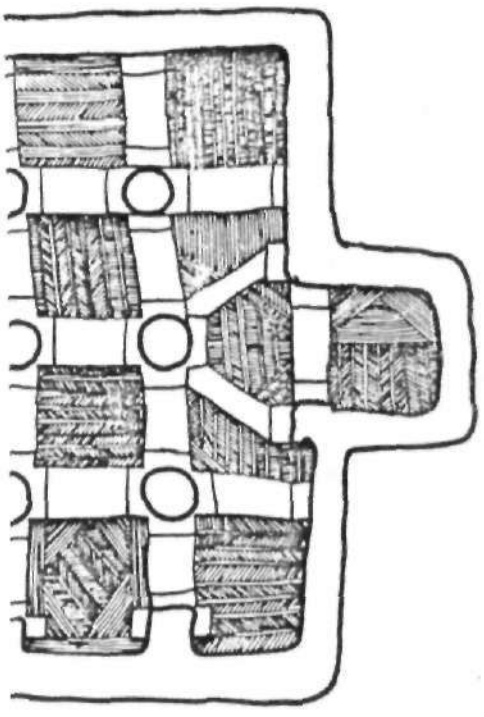


Fig. 5.28c

4.10 Joists

4.11 Contiguous Joists

Bay 15b, Friday Mosque (Kazaure)

The most basic spanning system used by the Hausa master masons is represented by Bay 15b of the Kazaure Mosque. Here the azara are placed parallel to one another and contiguous so that no infilling is needed. The underside of these azara look like flooring planks; however, they function as joists which are closely spaced to prevent the mud roofing, or flooring in the case of an upper

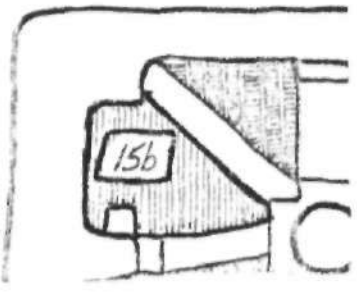


Fig. 5.28d

level, from falling through the interstices.

4.12 Joists with Mats

Anteroom in the Old Kano Treasury*

One azara beam supports paired azara joists in this unimposing room. This framework is covered with woven mats, before being covered with mud. Although the space spanning solution is simple, the pairing of the azara joists coupled with the contrasting colours and textures creates a lovely ceiling pattern.



Fig. 4.12a

4.13 Joists with Infilling Members

Bay 2, Friday Mosque (Kazaure)*

Bay 2 represents a simultaneously more complex and yet cheaper system. The parallel azara are more widely spaced, 18cm (7") on centres, and the interstices between them filled with short azara laid over and perpendicular to the principal azara. In this case the principal azara are performing the supportive function of joists while the perpendicular

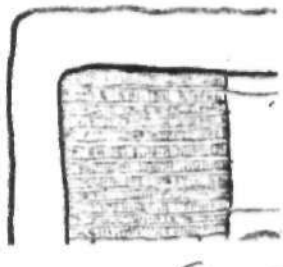


Fig. 5.28e

infilling members prevent the mud roofing from falling through the spaces between the joists. This type of ceiling configuration is appreciated for its aesthetic as well as its economic values. When handled with care, it introduces a pleasing pattern into the ceiling.

4.14 Joists with Infilling Members in Herringbone Pattern Bay 6, Friday Mosque (Kazaure)*

Bay 6 represents the same type of solution with the difference lying only in the pattern created by the infilling members. Here they are placed at forty-five degree angles to the azara joists with the direction of the inclination alternating to create a herringbone pattern. In this case the pattern is clearly determined by aesthetic rather than structural or economic considerations.

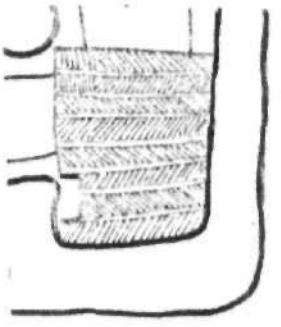


Fig. 5.28f

4.15 Contiguous Joists and Infilling Members Bay 12 and Bay 7, Friday Mosque (Kazaure)*

Bay 12 is another version of Bay 2 created by grouping several

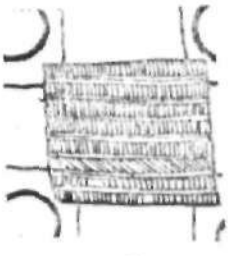


Fig. 5.28g

azara joists together in place of the single azara. In this version the interstices are wider than in the single azara version. Similarily the contiguous joists in Bay 7 support the same type of herringbone pattern as the single azara joists in Bay 6.

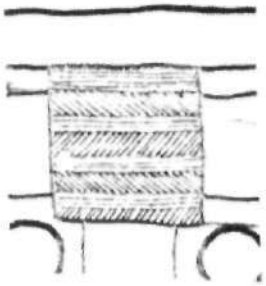


Fig. 5.28h

4.16 Composite Azara Joists and Infilling Members

Gallery, Gidan Sarkin Kebbin Yabo (Yabo)

Two azara are tied together to create a longer joist. These composite azara joists are then handled like regular azara joists supporting infilling members.



Fig. 9.11g

4.20 Tauyi

Slightly more complex solutions capable of spanning slightly larger spaces can be achieved by using tauyi. A tauyi is a triangular panel constructed by spanning the space between the walls at the corner of a room with contiguous azara. It becomes a cohesive unit when the mud roofing material is packed onto it. It functions simultaneously to reduce the ceiling span and to support one

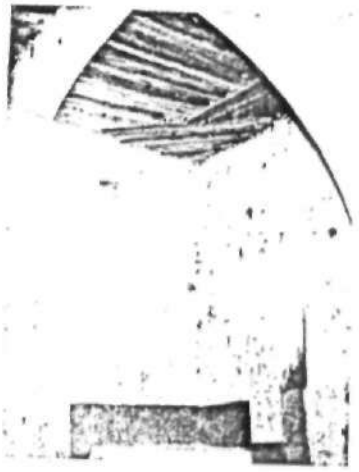


Fig. 4.20a

side of a superimposed azara platform which in turn further reduces the ceiling span. Some Hausa master masons limit the concept of tauyi to a set of azara in the corner of a room. The broader concept of tauyi used here refers to any similar set of azara spanning the space between any of the following supports: walls, arches, beams, brackets or other tauyi, provided these azara are placed on the diagonal to span the corner of a room, a bay or a dome compartment.

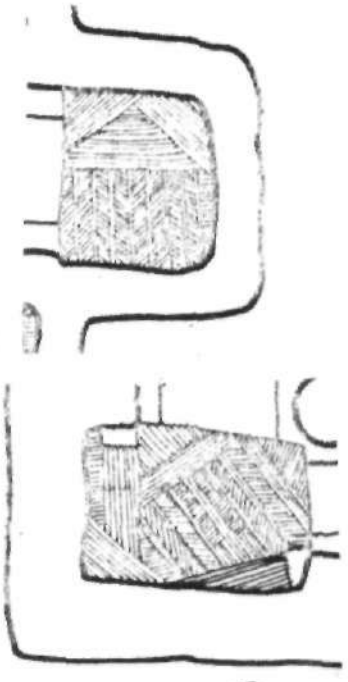


Fig. 5.22a

4.21 Tauyi

Bay 1 and the South-East Corner of Bay 18, Friday Mosque (Kazaure)*

The angle of inclination of a set of tauyi azara to the adjacent walls varies from forty-five degrees each, as in Bay 1 of the Kazaure Mosque, to a combination of sixty and thirty degrees as in Bay 18, or even to combination as oblong as eighty and ten degrees.



Figs. 5.22i
5.22j

4.22 Wall-tauyi

Bay 10, Friday Mosque (Kazaure)*

The same dual functions of

reducing the ceiling span and supporting a superimposed azara panel are sometimes performed by contiguous azara laid parallel to the wall. Because both Hausa and English lack a precise term for such a set of contiguous azara, the term wall-tauyi has been adopted. The azara panels along the southern, eastern and western sides of Bay 10 are all wall-tauyi by this definition.

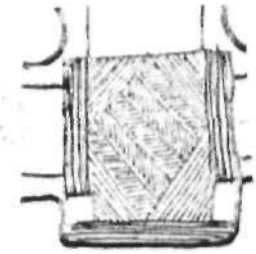


Fig. 5.28k

Outer Zaure, Gidan Yarima (5.22)

The concept of wall-tauyi is extended to include not only a set of contiguous azara laid parallel to the wall but also any similar set of azara parallel to the sides of an arch or a beam. In the bays of the outer zaure of Gidan Yarima, wall-tauyi flank the arches to reduce the span required of the joists.

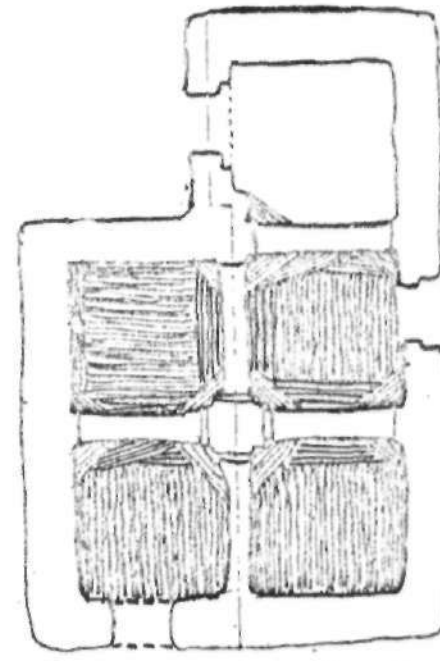


Fig. 5.22b

4.23 Superimposed Tauyi Panels

Kofar Duka Wuya (Kano; Jos Museum)

A wall-tauyi may also be contiguous to a another wall-tauyi rather

than to the wall itself. Such is the case for the wall-tauyi in the ceiling of Kofar Duka Wuya, a gate in the Kano walls reconstructed at the Jos Museum of NigerianTraditional Architecture. Here the tauyi and wall-tauyi are repeatedly superimposed raising the soffit like a pyramid until only 30cm (1') remain for spanning by contiguous joists. This technique provides a slight incline for the roofing to allow for efficient drainage.

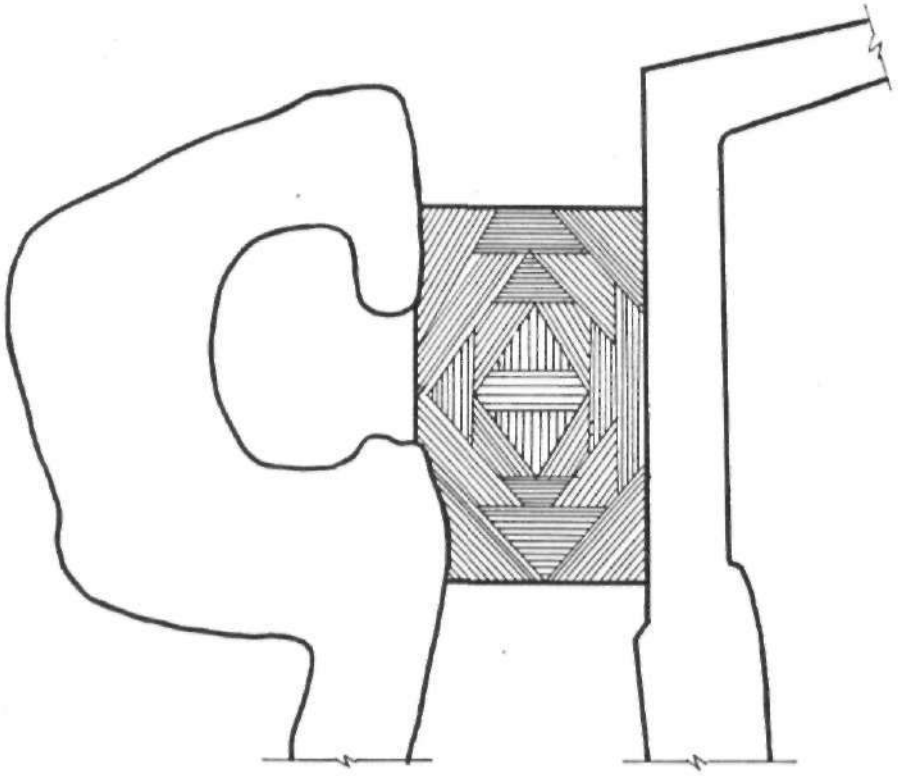


Fig. 4.23a

CHAPTER 5

THE VERTICAL SUPPORTS

5.00 Introduction

In addition to walls,[1] four types of vertical support are frequently employed by Hausa master masons: (1) columns and piers, (2) pilastres, (3) engaged load bearing partition walls which abut the exterior wall at right angles and extend partially into the space, and (4) freestanding load-bearing partition walls. Given the structural limitations of azara, vertical supports are often placed in a space to significantly increase its dimensions by making possible the subdivision of the ceiling into bays which can be safely spanned with joists, infilling members, tauyi and wall-tauyi.

Hausa master masons articulate their supports, thereby reinforcing their structural capacity and visually reflecting their structural function. To increase the structural stability of a pier or a column it is designed with a larger girth at the base than at the crown. In some cases, the structural member tapers gradually towards its core as in Danbaladi's zaure in Kantchi (5.21). In other cases, a larger approximately one metre high protruding base supports a pier of reduced girth as in the outer zaure of Gidan Yarima (5.22). This structural feature simultaneously enhances the form of the pier by reducing its girth and encouraging the viewer's eye to follow the rise of its form.

1. See above Section 3.20.

Where a pier supports lashed-azara beams, it is standard practice to visually define the junction between the vertical and horizontal members. Lashed-azara brackets surmount the pier and are cantilevered in the directions of the spans of the beams resting on the pier. Thus the brackets reestablish the original girth of the pier and in some cases further cantilever the bearing of the beam, reducing its required span.

Where the vertical member supports reinforced-mud arches, the directions of the arch spans are often articulated by pilastres as in the throne room at Kantche (5.15). The pilastres also increase the girth of the support in the directions of the spans while confining the cross section of the increased girth to the portion of the vertical member which directly receives the thrusts of the arches. As with brackets, pilastres visually express the structural function of the vertical support. Usually each pilastre and its arch form a continuous surface. The pilastre and arch follow the lines of the permanent formwork-azara which rise from the pier passing through the additional support provided by the pilastre.

Hausa master masons handle partition walls in basically the same manner as piers and columns. Although partition walls are seldom tapered, they support brackets and beams as well as pilastres and arches. This similarity in their architectural treatment is reflected in the Hausa language: all the vertical supports, regardless of

their precise form, are referred to as ginshiki.

Hausa roofs are structured in such a way that it is possible to increase the span by creating bays which rest solely on vertical supports as is the case for all the central bays in Kazaure Mosque (5.27). The load of the roof slab rests on beams or arches which transfer the load to the vertical supports. In one type of spatial configuration, a central bay is surrounded by an ambulatory which increases the effective space. In one of the oldest examples, the late eighteenth century Bawan Bodo (5.13), the vertical supports are partition walls abutting the enclosing walls. Since the pairs of partition walls are fairly widely spaced and each partition is pierced by a doorway, the central space effectively flows to the peripheral areas. Rows of piers are also used to effectively create many adjacent bays for large mosque spaces.

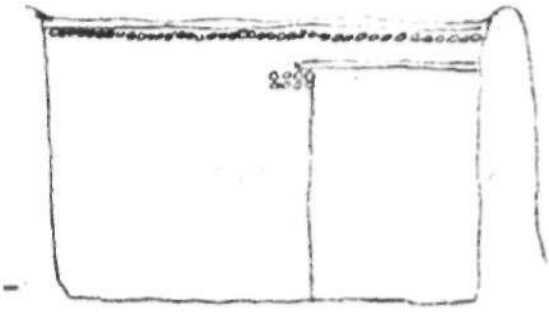
This chapter considers the manner in which the arches and beams interact with the vertical supports to subdivide the soffits and create a variety of ceiling patterns. Since Hausa master masons have developed a great many arch configurations for arches used alone with only the walls as vertical supports, Chapter 6 is devoted to such arch configurations.

5.10 Load Bearing Partition Walls

5.11 Engaged Partition Abutting a Wall and Supporting a Beam

Outer Zaure, Gidan Jimini (Katsina)

Room dividers, which begin in the centre of one wall and extend halfway into the room, are frequently used in zaure where a moderately large space is desired without the expense of a dome. These partitions have the added advantage of providing a measure of privacy for those sitting within the zaure because the entry door is generally placed opposite the partition thus offering the passerby a view to only a portion of the zaure at most.



5.11a

Structurally the partition serves as a support for azara joists spanning from the partition straight across to the walls parallel to it on either side. A large lashed-azara beam extends from the end of the partition to the opposite wall. This beam supports the remaining azara joists so that the entire ceiling is covered.

A partition is the principle support for the slab roof of the zaure of Gidan Jimini. This zaure was built in Katsina between 1870 and 1882 according to Ahmadu a son of the former owner, Baraya Mohammadu. The partition measures 55cm x 2.40 (1'10"x7'10") while the zaure itself measures 4.20m x 4.55m x 2.65m (13'11"x14'11"x8'8"). A lashed-azara beam extends from the partition to span the remaining 1.80m (6'). In the case of Gidan Jimini, the width of the end of the partition is expanded by the addition of brackets which take the form of a squared-off capital projecting from both sides of the end of the partition. This bracket/capital widens the immediate support for the lashed-azara beam. By widening the width of the beam itself, the master mason has diminished the length required for the azara joists which rest on the beam.

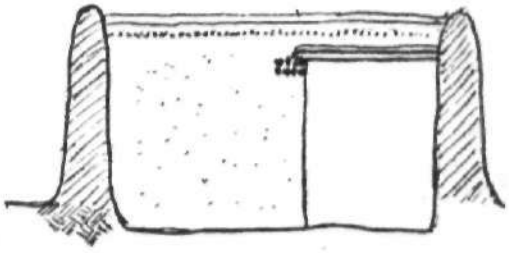


Fig. 5.11a



Fig. 5.11b

Because the partition in Gidan Jimini extends more than

halfway into the room and virtually divides the space in half, the viewer experiencing the space never registers its full size. Any possible sense of spaciousness is further reduced by the relatively low height of the zaure, 2.65m (8'8"), when compared to most zaure. In addition, the floor of the zaure is 30cm (1') below the threshold level so that the zaure, upon entering, appears lower than it actually is. Sarkin Gini Mallam Sani explained that formerly, a great many, if not most rooms, were dug below ground level. This procedure is economical in terms of both materials and labour. The dug out earth can be used for the walls without the necessity of being dug elsewhere and transported to the building site. In addition, the lower 30cm (1') of wall and partition is ready-made requiring no effort whatsoever.

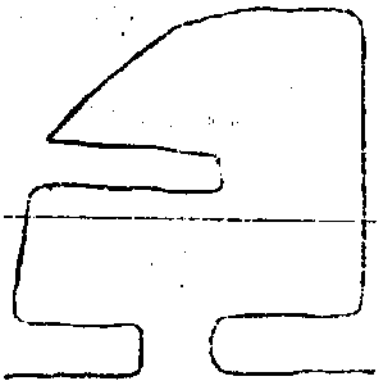


Fig. 5.11c

5.12 Engaged Partition Abutting a Wall and Supporting Twin Arches

Zaure, Gidan Alhaji Dalhatu (Batagarawa via Katsina)*

The length of the partition can also be extended by springing an arch from its edge to the opposite wall. In the zaure Gidan Alhaji Dalhatu, the master mason has used twin arches to span 2.50m (8'3") between a partition and the opposite wall. The partition itself is 80cm (2'8") wide but only protrudes 1.45m (4'9") into a zaure which measures 4.00m x 4.75m x 3.95m (13'2"x15'7"x13'0"). Here the partition barely impinges upon the space which the viewer experiences. Hence, this zaure seems much larger than the Gidan Jimini zaure. The higher ceiling, 3.95m (13'2") versus only 2.16m (7'1") in Gidan Jimini, and the use of the lighter, twin arches also contribute significantly to the impression of spaciousness.

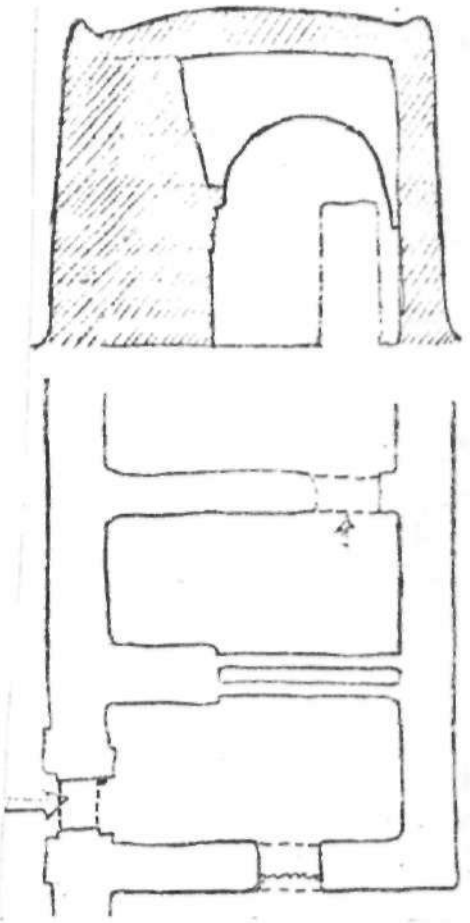


Fig. 5.12a
Fig. 5.12b

5.13 Paired, Engaged Partitions Supporting Intersecting Transverse Arches with an Ambulatory Passing under Openings Pierced in the Partitions

Bawan Dodo, Emir's Palace (Daura)

The eighteenth century Bawan Dodo, the entry to the palace of the Emir of Daura, is one of the oldest documented Hausa buildings.

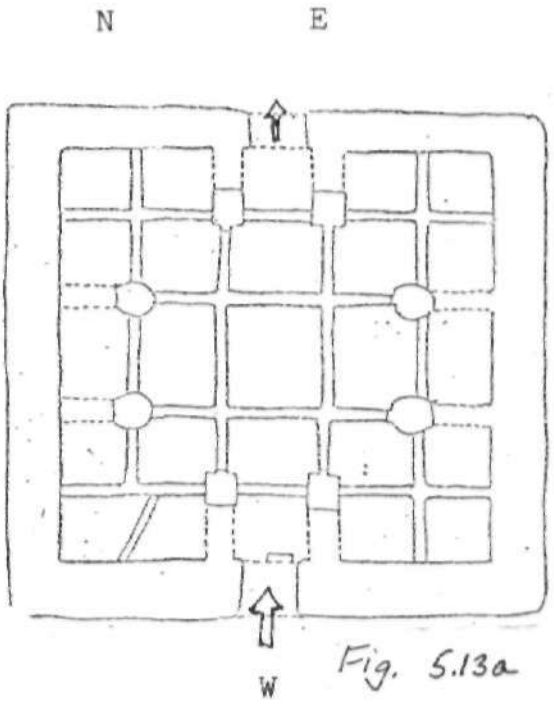


Fig. 5.13a

The reflected ceiling plan shows two sets of intersecting arches springing from partition walls which themselves abut the walls. All the kafa for these arches were begun simultaneously and the intersections of the rising adjacent kafa were probably also tied simultaneously. The form of the completed arches spanning the north-south span suggests that they are the primary transverse arches. The soffits of the completed east-west arches are uneven and clearly higher than the soffits of the north-south arches which have a more naturally curving form. These differences in level suggest that the north-south arches are the primary



Fig. 5.13b
looking N at E-W arches

transverse arches while the east-west arches are the secondary transverse arches. Moreover, the span between the north-south arches is the shortest span 5.15m (16'11") as against 5.40m (17'8") for the east-west arches. The master mason's choice of the north-south arches as his primary transverse arches ensures that upon entering the hall from either doorway, the emir and his guests will have full view of these more aesthetically pleasing arches. The master mason has also differentiated these primary transverse arches from the secondary arches by having them spring from round columnar forms at the ends of the partition walls whereas the secondary arches spring from pier-like forms.

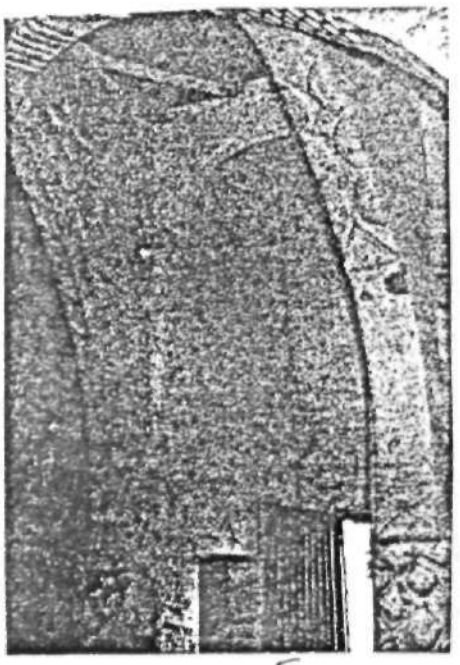


Fig. 5.13c

The span of the arches is significantly increased by the device of partition walls. Moreover, doorways are cut into these walls to create an ambulatory effect. These doorways are about

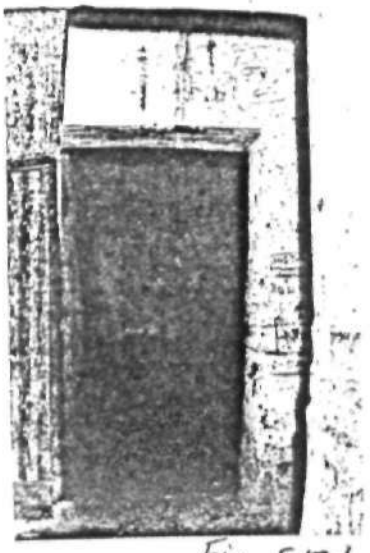


Fig. 5.13d

1.20m (4'0") wide and only 2.00m (6'7") high. The partitions themselves extend two metres (6'7") into the space. Thus, the room actually measures 8.90m x 9.30m (29'2"x30'6") or approximately nine metres square (29'7"). Thus, the space is considerably larger than the approximately five metre square (16'5") space spanned by the intersecting arches.



Fig. 5.13e

5.14 Freestanding Partition Supporting Beams

Dakin Alhaji Abashi, Gidan Yarima (Katsina)

Another form of partition, the freestanding partition, has also been used to support ceilings spanning large spaces. In the example measured in the back section of the Yarima compound (occupied by Alhaji Abashi in 1977), the partition is also intended as a room divider to ensure a measure of privacy for the sleeping area while leaving the floor space as free as possible. The room is an approximate rectangle 4.48m x 5.85m x 3.80m (14'9"x19'2"x 12'6")which is built 30cm (1') below

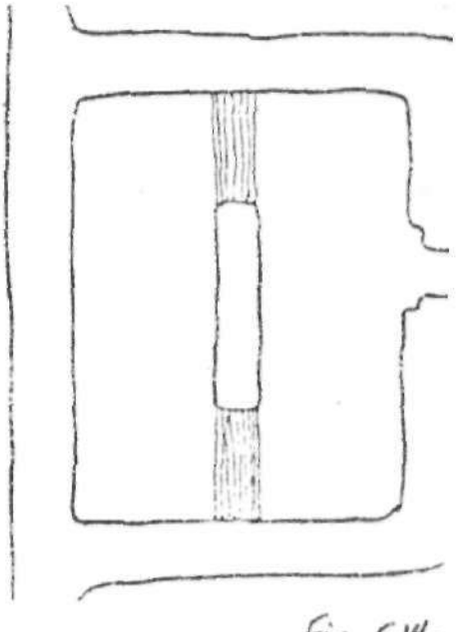


Fig. 5.14a

grade like the Gidan Jimini zaure. Thus, Abashi's room is larger than the zaure studied so far. However, it is not a zaure and therefore lacks the door leading into the inner portion of the compound which all zaure have.

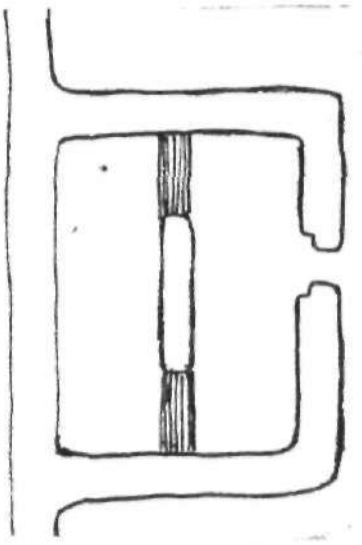


Fig. 5.14a

Despite its actual size, the viewer experiences the room as a relatively small room. The partition which measures 2.85m x .55m (9'4"x1'10"), creates this impression because it actually divides space in half lengthwise allowing approximately 1.50m (5') of circulation space on either side. Moreover, because the room is used as an all-purpose one room home, it is crowded with the family's possessions. The back, private part of this room is very dark. The only direct lighting comes from a few holes in the upper portion of the back wall. The circulation space also serves to permit a small amount of light and air to filter into the private areas.

Two piers could have effectively spanned the required space and allowed for vastly improved air and light circulation.[2] However, a double pier solution is incapable of creating a space which functions effectively as if it were two rooms, one more public like a zaure and the other private for sleeping and dressing.

5.15 Freestanding Partition Supporting Arches

Throne Room, Gidan Chef de Canton (Kantche, Niger)

Freestanding partition walls have also been used in conjuction with arches to create large, flat-roofed zaure. In 1943, Babali, a master mason trained in Kano but resident until his death in Zinder, reconstructed the throne room for the father of the chef de canton Kantche, Amadou Saka. The dimensions of the zaure are impressive 7.15m x 9.30m x 5.48m (23'6"x30'6" x18'),especially for a provincial town. The partition is small, approximately 1.00m x 2.35m (3'3"x 7'8") relative to the entire

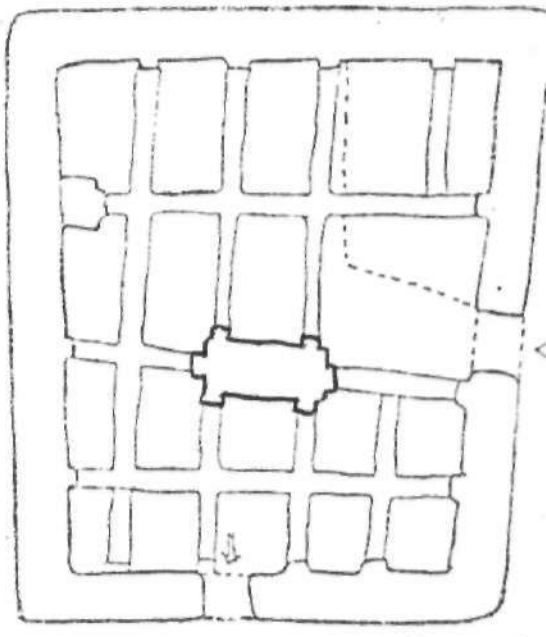


Fig. 5.15a

[2] See below Sections 5.25 and 5.26.

space and barely obstructs our sense of a huge space. The large staircase leading to the upper level also adds an aura of grandeur to this large room despite the crude workmanship.

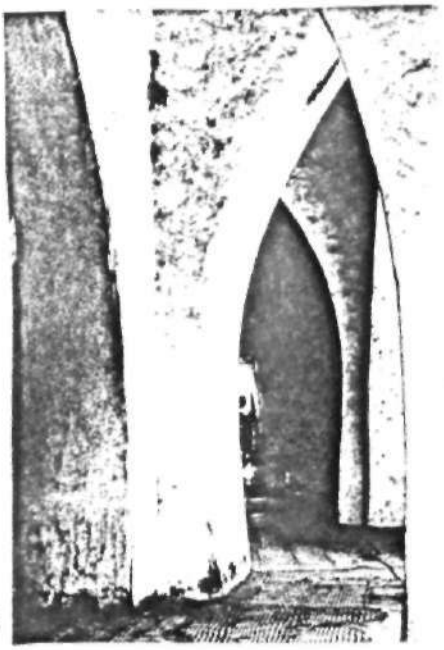


Fig. 5.15b

5.16 Freestanding Partition and Piers Supporting Interlocking Bays

Friday Mosque (Maska)

Arches spring from piers to support the Friday mosque for this small town. The freestanding partition wall is actually a huge, elongated pier capable of resisting considerable thrust from all sides. This huge pier serves as a base for arches which spring from all four sides. Each of these arches abuts a wall. They constitute transverse arches which are intersected by transverse arches springing from the four piers which surround the central pier. These latter arches rise parallel to the peripheral wall. Thus four bays, each supported on intersecting arches,





Figs. 5.16a
5.16b

surround the central pier. One edge of each of these bays is the central pier. The opposite peripheral wall itself forms another edge for each bay. The outer flanking edges are formed by beams spanning from the piers to the wall. The beams form an ambulatory type extension of the space because they are only 3.05m (10') high whereas the arches rise to 4.00m (13'1") and the ceiling itself is 4.20m (13'9"). The bays themselves have very irregular dimensions, roughly 3.05m x 4.27m (10'x14'), 4.57m x 3.66m (15'x12'), 2.60m x 3.35m (8'6'x11") and 2.74m x 4.27m (8'x14'). This irregularity reflects the unsophisticated level of the workmanship. Despite this awkwardness, the arches form sweeping curves rising smoothly up from the floor as pilastres. The half of each arch springing from the central pier plays a dual role. On the one hand, it is part of the primary



Fig. 5.16c

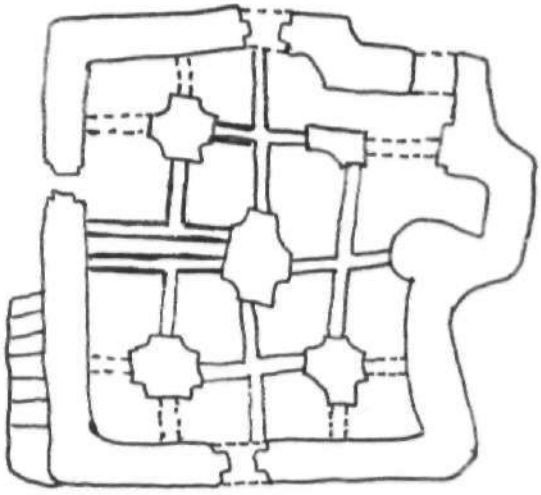


Fig. 5.16d

transverse arch for its own bay. On the other hand, it defines an edge for each of the flanking bays. Thus the master mason has created interlocking bays and vistas. This spatial design is sophisticated despite the level of the execution.

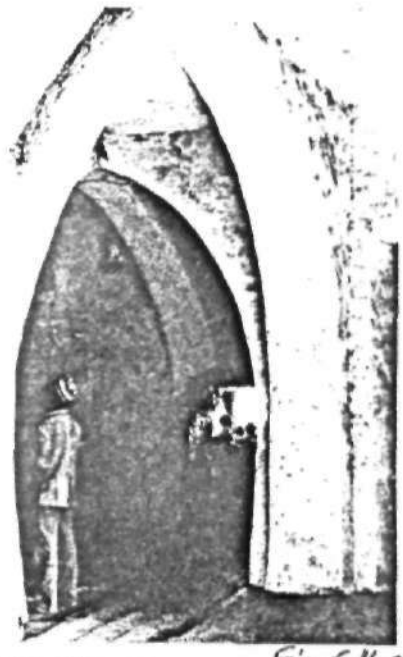


Fig. 5.16e

5.20 Columns and Piers

5.21 Central Pier and Pilastres Supporting Beams

Danbaladi's Zaure, Gidan Chef de Canton (Kantche, Niger)

The placement of a single column in the centre of a zaure permits the builder to span a fairly large space. In the late nineteenth century Danbaladi, the great-grandfather of the present cantonal chef for Kantche, commissioned the zaure now bearing his name. The master mason constructed a 2.83m (9'3") high zaure supported on a central pier. This pier in conjunction with pilastres attached to three of the walls supports the exposed lashed-azara beams upon which the ceiling joists rest. The central pier is

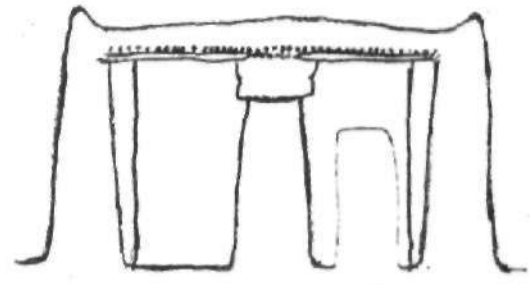


Fig. 5.21a

massive. It occupies 1.10m x 1.10m (3'7"x3'7") at the ground. As it rises, it tapers to the base of the bracket/capital which juts out again to the 1.10m (3'7") girth. The ceiling measures 4.42m x 4.50m (14'x15') but the effective space is reduced on the ground level because of the pronounced batter of the walls which project 20cm (8") into the space. The floor space measures only 4.02m x 4.10m (13'2"x13'6"). Much of that space is occupied by the central pier which takes up more than a square metre and by the pilastres which are each approximately 70cm (2'4") wide and project 35cm (1.2") out into the room. Thus, the effective floor space between the pilastres and the pier is only 1.25m (4'2") and 1.35 (4'4").

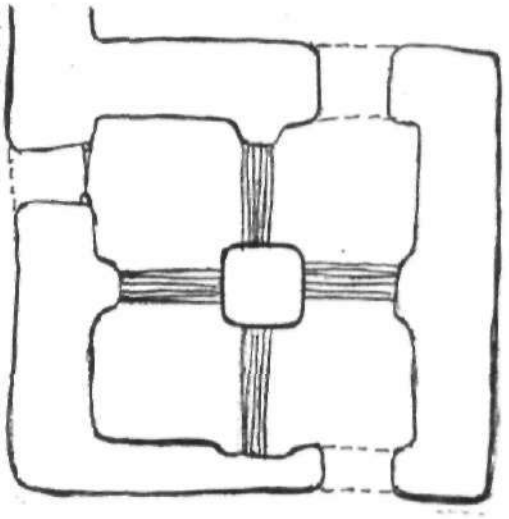


Fig. 5.21b

The viewer experiences this old zaure as a very heavy, over-structured, small room. The relatively low ceiling for a zaure, 2.83m (9'3"), and the reduced

space between the central pier and the pilastres as well as the massiveness of the walls and piers creates this impression. Furthermore, this zaure has now been relegated to the position of a passageway between the much vaster throne room and the private area of the chef's compound. The contrast in scale between this zaure and the preceding one, the throne room rebuilt by Babali, also influences our sense of cramped space in the older zaure.

5.22 Central Pier and Pilastres Supporting Arches Outer Zaure, Gidan Yarima (Katsina)

Large spaces such as the outer zaure of Gidan Yarima are also created through the use of a central pier in combination with four arches. The arches span the space from the central pier to each of the walls to form bays. Standard Hausa techniques further reduce the spans for the joists in each bay.

In 1890, Sarkin Gini Ida built the complex now called

Gidan Yarima. Originally, Gidan Yarima was the hot, dry season residence for the Emir, Sarkin K. Abubakar. According to the present Yarima's elderly uncle, Lord Lugard was lodged in Gidan Yarima when he visited Katsina in the early twentieth century. The outer zaure is supported by an articulated central pier and four arches. This system allows for a large room where many people can await a possible audience with the emir. It also serves as a formal point of separation between the emir's compound and the surrounding town. Even the emir's horses pass through this outer zaure to their pasturing courtyard. Thus, it appears that the Sarkin Gini in collaboration with the emir had decided to provide a spacious zaure with just enough embellishment in the form of the articulated pier and four arches to ensure that all those entering the zaure would realize that they are entering the outer zaure of their emir. Full embellishment was reserved



Fig. 5.22a

for the inner, domed audience chamber where the emir actually received his visitors.

The plan of the outer zaure of Gidan Yarima looks like a large square divided into four bays with an additional bay added on along the wall through which one gains entry into the rest of the compound. This bay has a door providing access to a court-yard for the royal horses. The main space is an approximate square with its largest dimensions 6.05m x 6.15m (20'x20'4"). One massive pier and four radiating arches support the ceiling which is 4.20m (13'8") high. The main entry and the entry to the inner corridor leading to the reception hall (now in ruins) are placed in opposite corners of the main space.

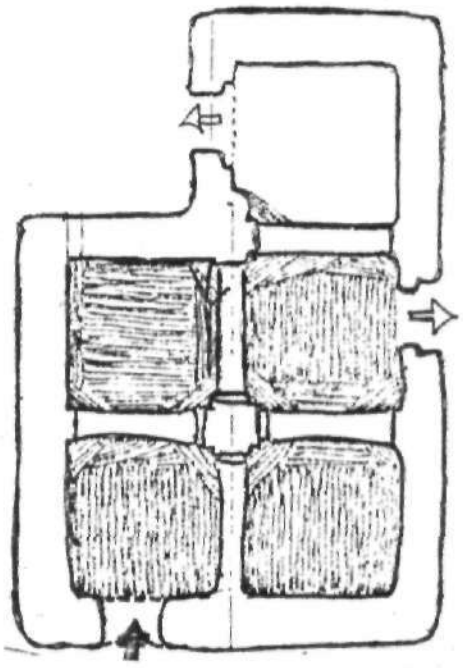


Fig. 5.22b

The pier itself is a huge square with rectilinear shafts facing the four walls. The central core measures 80m (2'8") square. The projecting shafts, which could also be considered deep pilastres,

add another 20cm (8") in each direction. These shafts articulate the directions of the spans which must be supported by the arches resting on the central pier. They also contribute to a reduction of the arch span. The span is further reduced by brackets. Four brackets project 10cm-20cm (4"-8") from the articulated pier. Corresponding brackets are cantilevered out from the opposite walls under the springing of the arches. The pier, including its projections, reduces the space to be spanned by 1.20m (4'). The brackets which create the impression of supporting both ends of each arch reduce the space by another 10cm (4') each. Thus, the actual space to the spanned from wall to wall has been reduced from 6.15m (20'2") to 4.75m (15'8"). The central pier divides this space roughly in half so that no arch is actually spanning a space wider than 2.35m (8') wide.

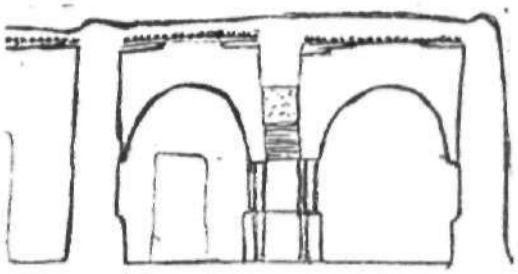


Fig. 5.22c

These arches divide the entire ceiling into four bays with the

fifth bay being bounded by an arch which separates it from the central area. Each bay is approximately 3.05m (10') square from the wall to the centres of the arches. The arches themselves vary in width from 53cm (1'9") to 57cm (1'11") and thus contribute to a significant reduction of the space to be spanned. The space between the arches and the walls is actually 2.50m (8'3"). The area surrounding the central pier is built up with tauyi resting on the arches. Tauyi are also used between the wall and the arches in conjunction with superimposed wall-tauyi.

The master mason has used several of the devices available to him to reduce the space to be spanned by the joists. In Bay 2, the bay in the corner opposite both principal doorways, he has used tauyi to support wall-tauyi to reduce the space by 36cm (1'2") on one side. On the opposite side, he has used a bracket and a single

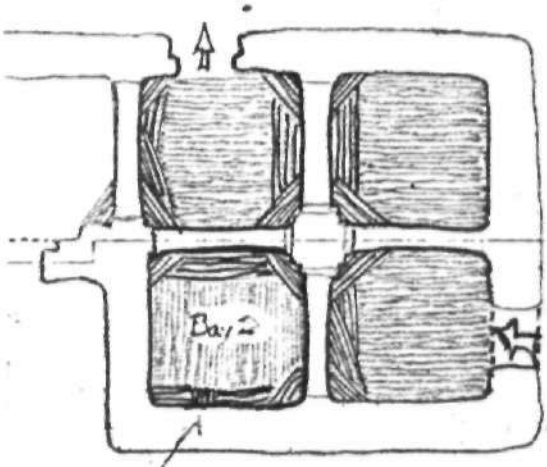


Fig. 5.22d

tauyi to support a wall-tauyi which reduces the span by 20cm (8"). Thus, a span which had been 2.70m (8'10") from wall to arch has been reduced to 2.19m (7'3").

5.23 Two Kafa Springing From Opposite Sides of The Central Pier to Abut Their Respective Transverse Arches

Anteroom to the Fulani Emir's Circular Throne Room, Emir's Palace (Katsina; Jos Museum)

The anteroom to the Fulani Emir's Circular Throne Room in the oldest part of the palace of the Emir of Katsina combines the kafar kaza arch configuration with a central column. The kafa of two kafar kaza spring from opposite sides of a central pier to abut their respective transverse arches which are parallel to each other. Kafa also spring from the other two sides of the central pier to abut the walls at their crowns.

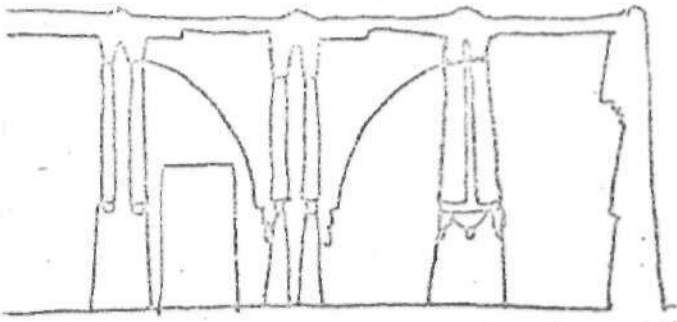
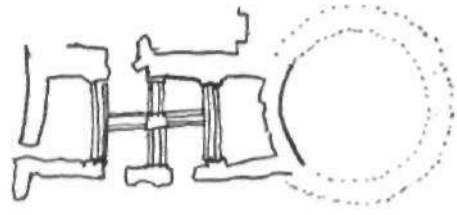


Fig. 5,23a

The room would have been structurally sound if the master mason had omitted both the central

pier and the kafa. Despite the ample dimensions of this long, rectangular room which measures 4.80m x 11.41m x 4.00m (15'9"x37'5"x13') the kafa springing from the .86cm (2'10") square central pier only span approximately 1.80m (6') each to their respective transverse arches. Thus the kafar kaza are structurally unnecessary. Parallel arches suffice to support the larger Trophy Room in the same palace. However, the architectural interest of this lobby would have been lost if the simple parallel arch solution had been adopted. As it is, the central pier with its emanating double kafar kaza arch configurations creates a pleasing anteroom rather tnan a cold, austere hall. The arches spring from 1.50m (5') and rise to 3.50m (11'5"). Below their spring lines, they are embellished with large tear drop motifs which act as a transition from the main body of the pier to the 30cm (1') projections of the brackets which constitute the



5.23b

visual spring points of the arches. The arches all have a deep recess gouged out along the centre of their soffits which creates the impression that they are thin, twin arches. Actually they are contiguous twin arches with breadths ranging from 60cm - 90cm (2'-3') wide at their spring lines. They taper where necessary to 60cm (2') at their apexes although they appear much less heavy. The master mason has handled these kafar kazar and the space they create with great sensitivity.

This long, rectangular room is convex at the southern end where it takes on the form of the circular, thatched Fulani Throne Room which it had formerly abutted. The Fulani emir adjusted to the huge, mud vaulted rooms of his conquered subjects as well as he could but apparently he refused to place his throne in one of their rectangular structures. A huge,

circular room with a diameter 8.54m (26') and walls 1.02m (3'4") thick, was built for him. It has long since been demolished although Professor Dmochowski was able to trace the outlines of the foundation.

5.24 Central Pier Supporting Tree Trunk Beams Outer Zaure, Gidan Chef de Canton, (Madaoua, Niger)

In the outer zaure of Gidan Chef de Canton at Madaoua, a single pier assisted by tauyi supports tree trunks (rather than the preferred azara) which span a space 5.15m x 6.65m x 4.40m (17'x 21'10"x15'). The pier is only 70cm (2'4") square in contrast to the 1.10m (3'7") square pier in Danbaladi's zaure. Yet it is much taller and supports a much larger space. The pier including its exposed bracket/capital rises to 4.40m (15') whereas the piers and bracket/capital in the much older zaure only rise to 2.83m (9'3"). Structurally, the longer

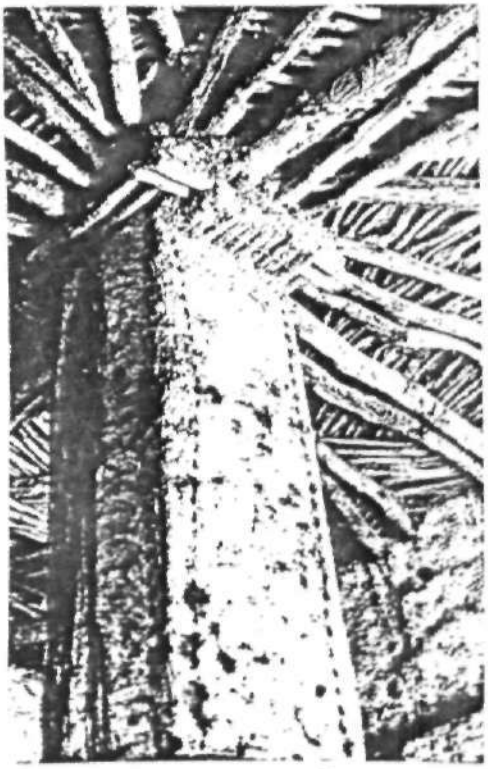


Fig. 5.24a

span, 3.15m (10'4"), is taken care of by the wider diametre, approximately 15cm (6") of some of the major tree trunk beams. These beams are laid on the wall and pier approximately in pairs but they are neither contiguous nor are they tied together.

An attempt has been made to form a pattern on the ceiling by having the beams radiate from the centre in pairs despite the unevenness of their natural form. Five or six beams emanate as a loose cluster from the pier toward each wall. A few beams are laid from the walls to these principal beams meeting them near the centre of the room. The infilling members are all branches which radiate roughly around the central pier.

5.25 High Central Pier and Beams Forming a False Dome Zaure, Gidan Captini (Tahoua, Niger)

In Tahoua, a town on the fringes of Hausaland in Niger, a master mason has raised a central

pier well above the wall height and relied on the pitch of the beams spanning from the wall to the pier in order to create a pseudo-dome form. The zaure of Gidan Captini, which measures 3.50m x 4.10m x 3.65m (11'6"x13'6"x12'), was constructed in this manner. The 50cm (1'8") square pier is 3.35m (11') high. The pier and its bracket/capital rise 60cm (2') above the wall level to provide a substantial slope for the roof. The entire ceiling rests on two exposed transverse, lashed-azara beams which emanate from the bracket/capital to span the shorter dimension. They each span approximately 1.50m (4'11") from the central pier to their respective walls. Five sets of lashed beams, consisting of three tree trunks each, rest on the primary transverse beam. The interstices between these beams are filled in with smaller branches or millet stalks and roofed over with mud to form a sloping roof that, in elevation, appears to be a fairly good approximation of the shallow Hausa dome.

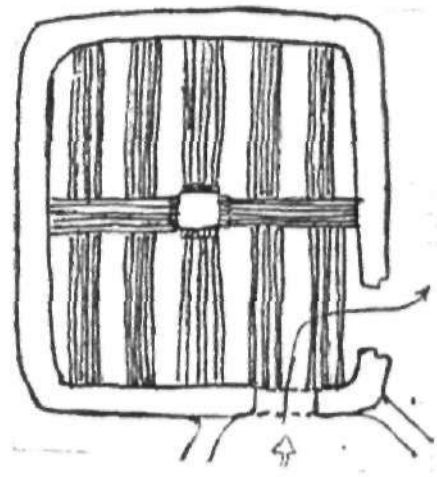


Fig. 5.25a

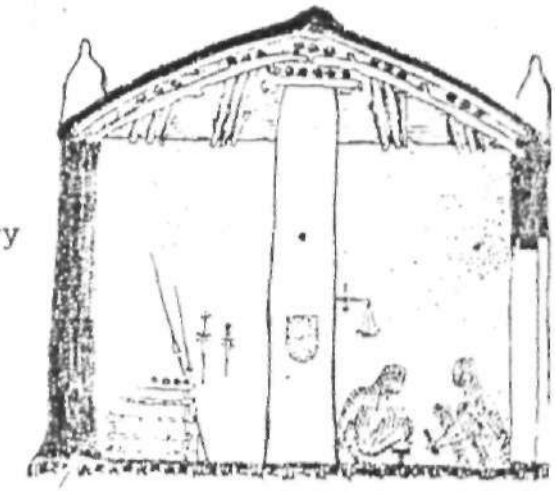


Fig. 5.25b

5.26 Twin Piers and Brackets Supporting Beams

Outer Zaure, Gidan Chef de Canton (Dogondoutchi, Niger)*

Two piers are often used to form large, flat-roofed zaure as is the case in the outer zaure of the Chef de Canton Alzika in Dogondoutchi. This zaure was built in 1912 by Umaru, the son of Sarkin Gini Birnin Kebbi and destroyed in 1981 to make room for a new palace. It measures 4.80m x 5.75m (16'9"x19') with two large rectangular piers placed in the centre 1.30m (3'11") apart. The piers measure approximately .85m x 1.05m (2'9"x3'6") with their longer dimension facing the centre. The entry and the doorway into the compound are also centrally placed generating an axial movement through the zaure. Despite the axial movement, the floor space and ceiling room is sufficiently ample to create a pleasing atmosphere for this reception room.

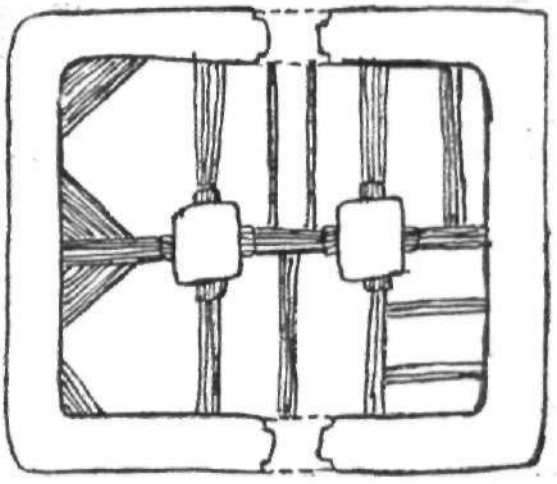


Fig. 5.26a

5.27 Twin Piers and Pilastres with Brackets Supporting Beams

Outer Zaure, Gidan Chef des Peul (Fulani)
(Zinder, Niger)

When two piers are combined with very deep pilastres, a much wider zaure space can be spanned as is the case with the outer zaure for Brah Gourgoudou, the Chef des Peuls in Zinder. This zaure measures 6.50m x 7.00m x 3.20m (21'4"x23'x1'6"). The pilastres are approximately 90cm (3') wide and protrude a minimum of 60cm (2') into the space. Thus they significantly contribute to the reduction of the span. Two huge rectangular piers are placed in the centre 1.80m (5'9") apart. Even though the opening into the compound is placed slightly off centre, the entry is centrally placed and the long dimension of the piers face the central axis so that the viewer perceives the zaure space as a passageway. The use of engaged piers flanking both doors contributes structurally

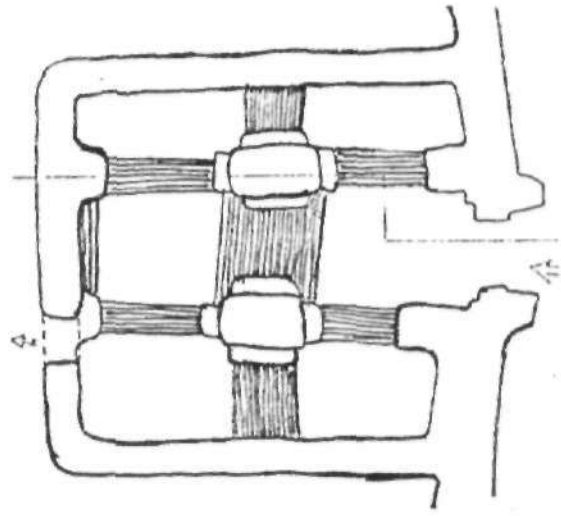


Fig. 5.27a

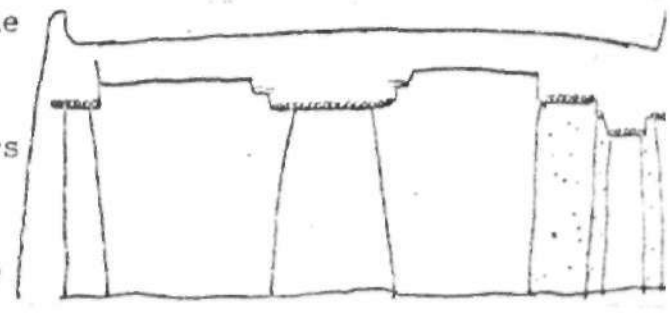


Fig. 5.27b

to the ceiling support and aesthetically to the axial flow of space.

5.28 Columns with Brackets Supporting Beams to Form Contiguous Bays

Friday Mosque (Kazaure)*

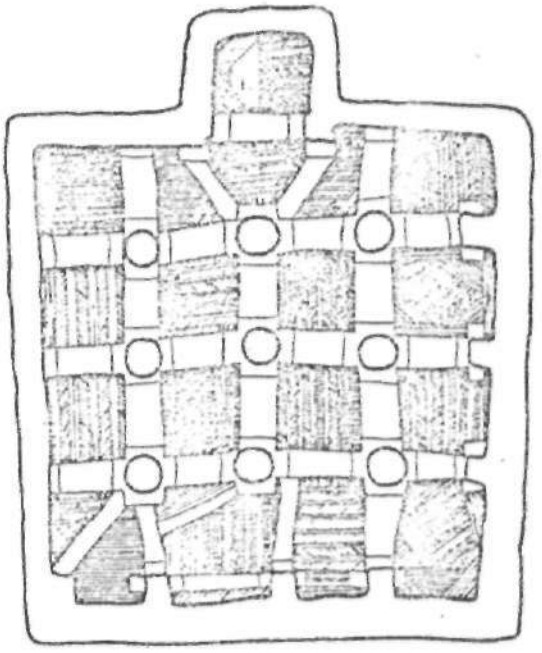


Fig. 5.28a

The interior span of this provincial mosque as shown on the documented plan is approximately 11.00m (36') square.[3] Nine heavy columns, each approximately one metre in diametre, support the lashed-azara beams which divide the space. Fourteen of the resulting bays are virtually square. The two bays immediately in front of the mihrab have been handled differently. If the plan had been completely regular, a lashed-azara beam would have had to rest on the beam which separates the mihrab from the rest of the mosque. This would have led to complications in the contours of the roof. Instead, the master mason chose to use two lashed-azara beams, one resting on each side

[3] See above 4.11, 4.13, 4.14, 4.15, 4.21, and 4.22 for details of some of the bays.

of the mihrab. Both beams span to the column which is directly in front of the mihrab. These three irregular shaped bays allow the master mason to maintain his roofline.

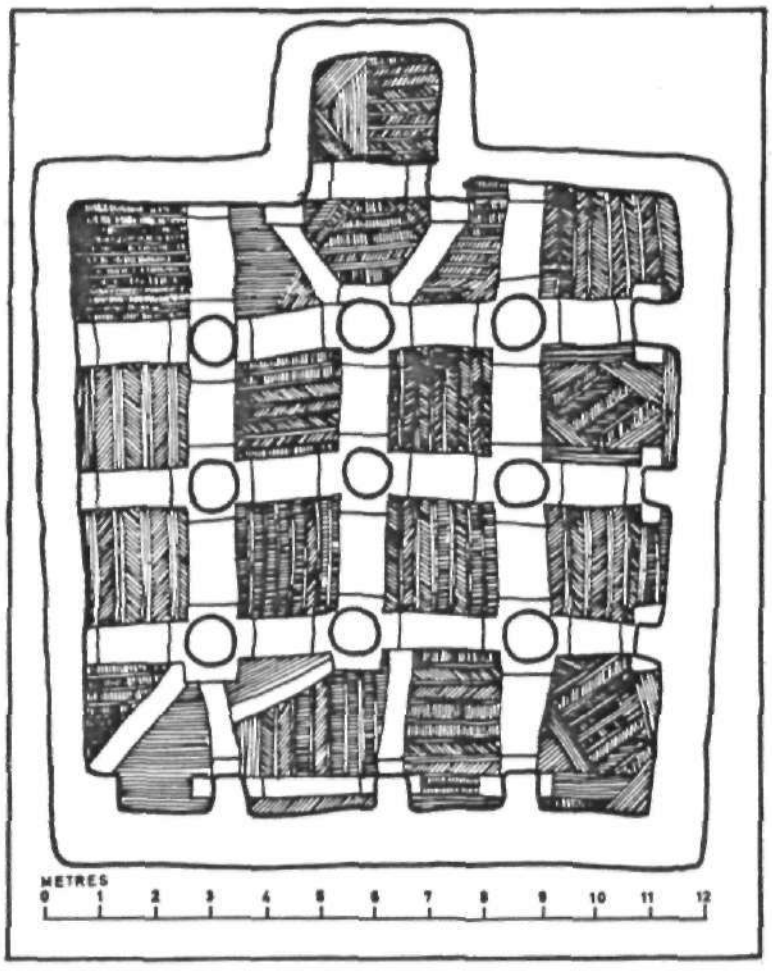


Fig. 5.28a

CHAPTER 6

ARCHES SPRINGING FROM THE WALLS

6.00 Introduction

Some of the arch configurations used in domes are also used in rooms with flat ceiling/roofs. In the latter cases, the backs of the arches are built up so that the spandrel forms a level surface which supports the flat soffit. Theoretically, these same configurations can be achieved with beams spanning from wall to wall but such solutions are restricted to very small rooms and rarely if ever receive the attention of talented master masons.

6.10 Parallel Arches

6.11 One Single Arch

Boys' Room, Gidan Hassan Jamil (Kano)

The boys' room of Gidan Hassan Jamil illustrates that a single arch can effectively and simply span a larger space than a beam, even a beam used in conjuction with pilastres and brackets. Located off the outer zaure, the boys' room is approximately 3.75m square (12'6). The shorter

dimension, 3.50m (12'), is spanned by a single, centrally placed arch which is 55cm (1'9") wide.

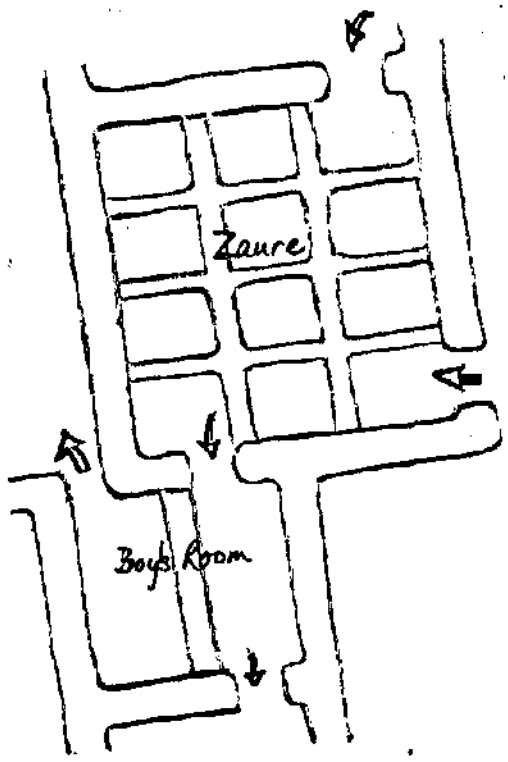


Fig. 6.22a

Gidan Hassan Jamil is a large compound built in Kano by a wealthy merchant in 1947. This simple room serves as a passageway to the private area of the dwelling the upstairs and to the women's quarters. It is also used as the access to the stable. In addition, boys about nine years old and above who no longer share their mothers' bedrooms sleep here, hence the name boys' room.

6.12 Two Parallel Arches

Inner Zaure, Gidan Madawaki (Katsina)

This simple, inner zaure serves to separate the outer zaure from the inner spaces of the compound rather than functioning as a space for receiving special guests of the compound head. The compound was designed and built in 1960 by

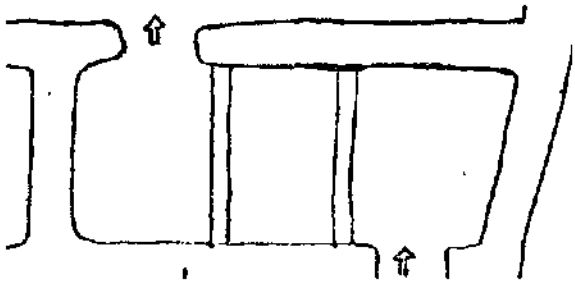


Fig. 11.51d

which time special guests would be entertained in an upper floor, modern livingroom.

Because it immediately follows the 6.00m high outer zaure, this smaller zaure is perceived as smaller than it really is. This zaure measures 2.50m x 5.90m x 3.26m (8'4"x19' 4"x10'8"). It is also slightly irregular in shape in order to adjust to the other structures in the compound. The wall separating it from the outer zaure is 50cm (8") shorter than the 590m (19'4") long wall opposite it. The viewer's eyes gloss over this difference as they look towards the door placed diagonally opposite and through which the bright light of the compound shines. The viewer's eyes then focus on the two roughly equidistant arches which span the shorter dimension to support the infilling members of the ceiling

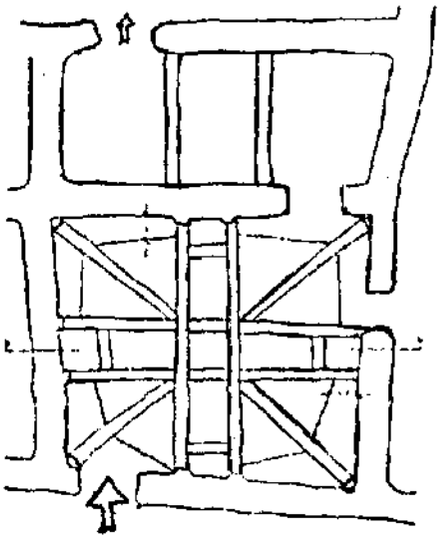


Fig. 11.51e

and enhance this passageway.

6.13 Paired, Parallel Arches

Outer Zaure, Gidan Iro (Katsina)

Builders frequently use arches simultaneously to broaden the width of a room and extend its length. When working with small dimensions, a lashed-azara beam can perform the same structural function equally well. However, the curvature of the arch contributes an aesthetic form in addition to performing the structural function.

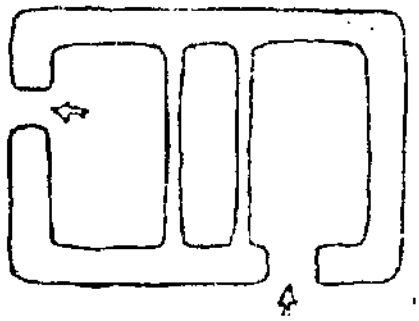


Fig. 6.13a

In the outer zaure of Gidan Iro, two parallel arches work together to create a longer space resulting in a room which measures 2.80m x 4.24m x 2.80m (9'3"x14'1"x 9'3"). The arches permit the extension of the width of the space to 2.80m (9'), substantially more than the standard 1.80m (6') for lashed-azara beams. The arches are placed in the centre of the room .91m (3') on centres so

that visually they form a pair. The room extends 1.55m (5'1") to the right and left of this pair of arches, thereby creating a room 4.24m (14'1") long. The arches themselves are narrow, only 22cm (8") wide, at the soffit and shallow, springing at 1.50m (5') and reaching their apexes at 2.60m (8'6") from the ground.

To underscore his intention that the arches be paired, the master mason built up a simple embossed decoration in mud plaster between the arches and at the base of each arch. Structurally, the two arches could have been more widely spaced to form a longer room. It would have been feasible to make the room 5.60m (18'4") long by spacing the arches 2.00m (6'7") on centres but such an increased length would have created an unpleasant corridor-like effect out of the zaure space.



sketches of embossed designs

Fig. 6.13b

6.14 Three or More Pairs of Parallel Arches

Council Chambre, Emir's Palace (Katsina)

Some of the large rooms in the old palace of the Emir of Katsina (one of which has been replicated at the Jos Museum), are supported by parallel arches grouped into pairs. One hall has three pairs and the other has four pairs. The pairing of the arches creates visual interest that would be lacking if they had been placed equidistant from each other. Perhaps the master mason's decision to forego maximizing the structural value of his arches was related to the prestigious associations generated by paired arches. Paired arches and multiple arches are essential for the creation of the large, lofty domes[1] whereas single arches are only used for small domes over very small spaces for flat-roofed rooms.

The use of these parallel arches makes possible a long and

[1] See below Chapter 11.

fairly wide hall, high enough to create a sense of grandeur in the space and thus appropriate for royal occasions.

The Emir of Katsina's Council Chambre which is supported on eight parallel arches measures approximately 5.92m x 10.44m x 3.57m (19'5"x34'3"x15). The eight parallel arches span the 5.92m (19'5") width. Four arches are spaced fairly closely while two pairs of arches are set apart from this central group. The northeastern pair spring from the floor rather than from eye level (the spring line for the other arches). This pair constituted the dividing line between the emir's area and the area for the guests. Thus the space reserved for the emir was distinguished architecturally.

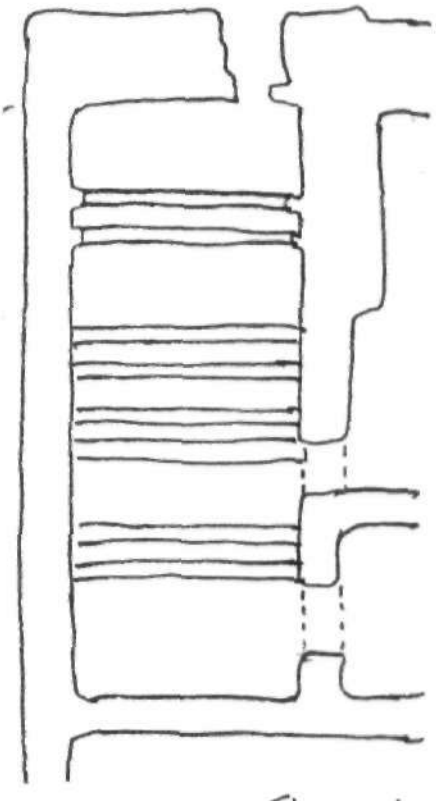


Fig. 6.14a

6.20 Intersecting Arches

Intersecting arches form an excellent framework for the soffit permanent formwork because they brace each other. Sometimes they

are used to create an aura of grandeur in a flat-roofed zaure where the additional time and expense involved to create a dome is unacceptable (6.21, 6.23). Other times they support an upper storey (6.22). Still other times they are constructed with the Bauchi arches which normally generate flat roofs (6.24).

6.21 A Single Arch Intersecting a Pair of Twin Arches Zaure, Gidan Alhaji Yusufu Danburimi (Katsina)

The zaure of Alhaji Yusufu Danburimi is a fine example of how Hausa master masons play with the structural limitations of the available technology to create aesthetically pleasing patterns in their ceilings. Alhaji Muazu, a talented master mason who is now retired, built this zaure for a relative. The zaure measures only 4.25m x 4.75m (14'x16') yet one has the impression that it is a fairly large room partly because the 3.35m (9') high ceiling is supported on arches. A pair of primary transverse arches intersect

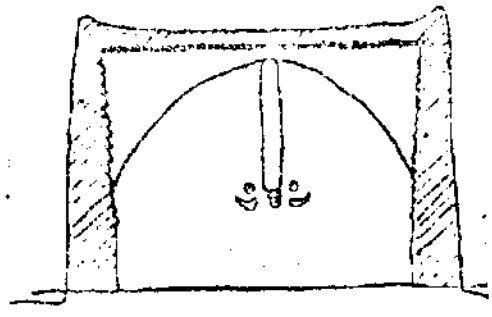


Fig. 6.21a

a secondary transverse arch to subdivide the ceiling into four msin bays. Short azara fill in the space between the paired arches thereby reducing the space to be spanned in each bay to approximately 1.80m (6').

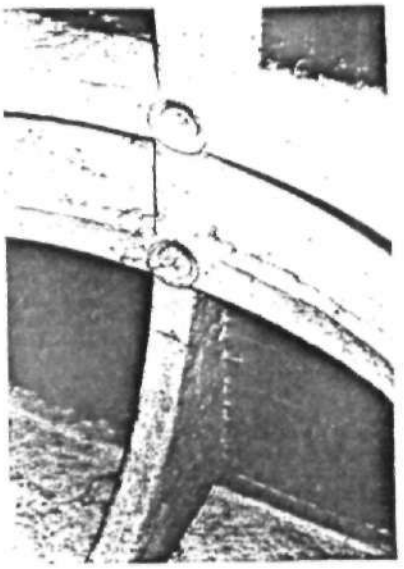
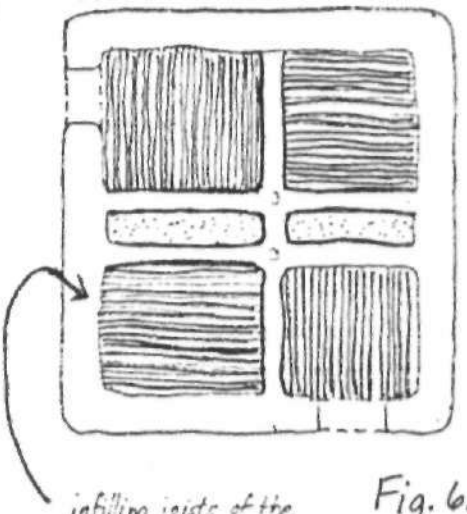


Fig. 6.21b

The secondary transverse arch is not structurally essential. Azara joists could easily span from the pair of transverse arches to the northern and southern walls which run parallel to them. The northern span measures 1.90m, which is a negiligible 10cm (4") more than the standard practice, and the southern span measures 1.75m, which is 5cm (2") less than this preferred maximum span.

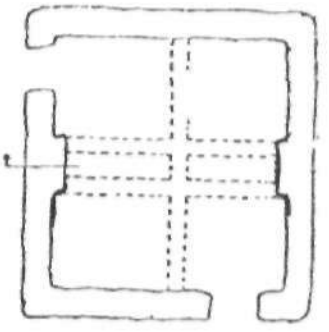


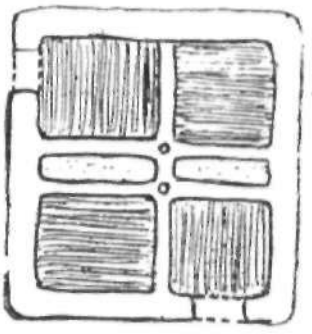
infilling joists of the south-western square supported on the secondary transverse arch and the wall; they span 2.45m [35cm (1'2") more than standard practice]

Fig. 6.21c

The secondary transverse arch plays an aesthetic rather than structural role in this modest zaure by providing the frame for the play of lines in the ceiling. The directional change in the infilling ceiling members is dependent on this secondary

arch for the support of two bays (the north-eastern and the south-western bays). Note that in the south-western bay, the master mason has successfully used azara infilling members 30cm (1') longer than the generally accepted maximum length in order to maintain his ceiling pattern. Clearly, Muazu's desire to create a pleasing pattern in the ceiling is his paramount concern.





Figs. 6.21d
6.21c

The placement of azara to create a revolving pattern is a common practice among Hausa builders. However, Muazu is especially skillful in integrating his decorative elements within the form of his main support. The embellishment of the paired arches which form this main support emphasizes his structural and decorative sensitivity. The paired arches are each .30m (1') wide and approximately .50m (1'7") apart. They have a common base which protrudes .30m (1') from the

wall. At .95m (3') from the floor, this unifying base begins to recede back into the wall in a series of stepped mouldings until it is flush with the wall at the ceiling. This stepped moulding was used on the arches themselves in the early nineteenth century in the Zaria mosque but here Muazu's moulding simultaneously unites the paired arches and emphasizes the height of the room. A simple pattern also decorates the spring points of the secondary arch which rises from the side walls.

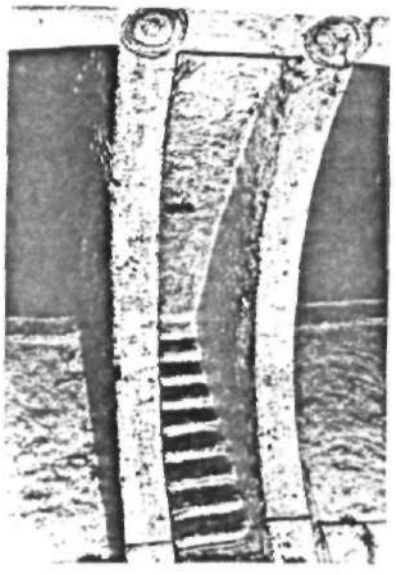


Fig 6.21e

6.22 A Pair of Arches Intersecting Three Parallel Arches

Zaure, Gidan Hassan Jamil (Kano)*

The ground floor plan of Gidan Hassan Jamil reveals an arch system for the zaure which is frequently used in large rooms supporting an upper storey. Three parallel arches span the shorter distance and a pair of arches intersects them in order to

span the longer length. Thus, the weight of the ceiling is transferred to the walls at regular intervals. The room measures approximately 5.70m x 6.25m (18'8"x20'7") according to the plan, but no height measurements are available. The arches divide the ceiling into twelve small sections, each approximately 1.25m (4'3") square, which are filled in with parallel infilling members.

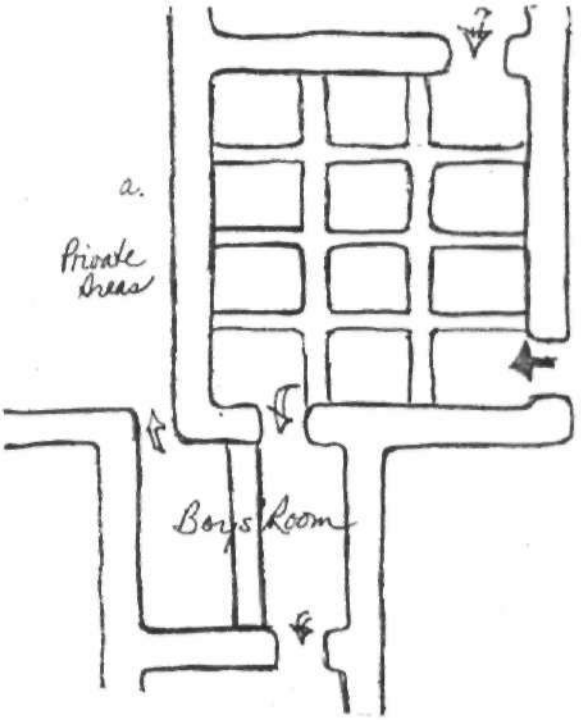


Fig. 6,22a

6.23 Intersecting Multiple Transverse Arches-Sets of Two

Gidan Dan Halima (Dutsin Ma)

A wealthy provincial merchant commissioned this moderate-sized zaure in 1951. The flat ceiling has been handled with good taste. In a space 5.25m x 5.75m (17'2"x 18'4"), sets of twin arches intersect forming four small coffers. The large, corner compartments are spanned by pairs of contiguous azara joists through which the yellow ochre matting can be seen.

The azara joists between the arches are handled in the same manner with one additional decorative touch. Between each pair of arches, one space is filled with joists placed laterally and the other space is filled with joists placed longitudinally. These contrasting patterns focus attention on the central spaces which are set off against the larger background of the ceiling joists.

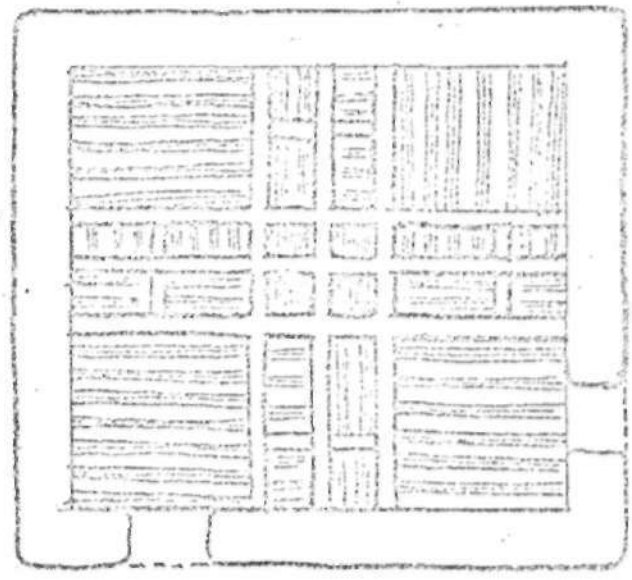


Fig. 6.23a

6.24 Intersecting Multiple Transverse Arches - Sets of Five

The Babban Gwani, (Kafin Madaki via Bauchi)

In about 1860, Madakin Bauchi Abdulkadiri, a traditional title holder, had a new dwelling built for himself in Kafin Madaki, a small village founded twenty years previously about forty-five kilometers north on the Bauchi-Ningi-Kano road as a frontier garrison. The building comprises one enormous reception

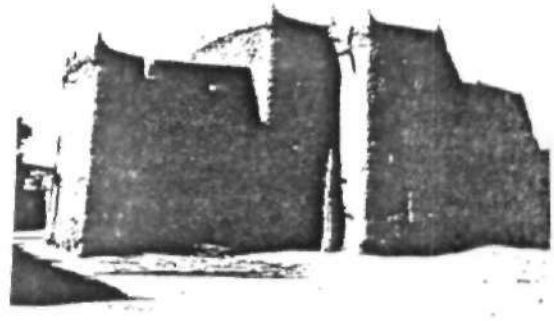


Fig. 6.24a

hall complete with a large hearth and five other rooms, one for his private use and the others for his four wives. The great hall has been named after Babban Gwani who is reputed to have built it.[2] This attribution is dubious. The workmanship is inferior to Babban Gwani's workmanship in the Zaria Mosque and the technology used for spanning large spaces differs.

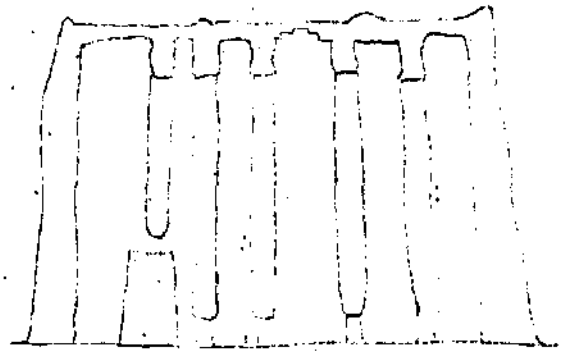


Fig. 6.24b

The dimensions of the Babban Gwani are impressive considering the materials used in construction. It measures 8.40m x 8.55m x 6.55m (27'7" x 28'0" x 21'6"). Two sets of five rather heavy arches intersect to support the flat roof. The arches spring at 55cm (1'10") above the floor from brackets projecting 25cm (18") and rise to 5.50cm (18'). Their width varies between 40-50cm (1'4"-1'8").

[2]See above Section 2.54.

A moulding runs down the centre of the arches making them appear less unwieldy. The interior of the coffers formed by the intersecting arches is recessed 50-75cm (1'8"-2'5") from the crown of the arches whose backs are built up to form a flat roof. The centre arches are placed about 1.37m (4'6") on centres while the two outer arches are placed closer, about 1.00m (3'33") on centres.

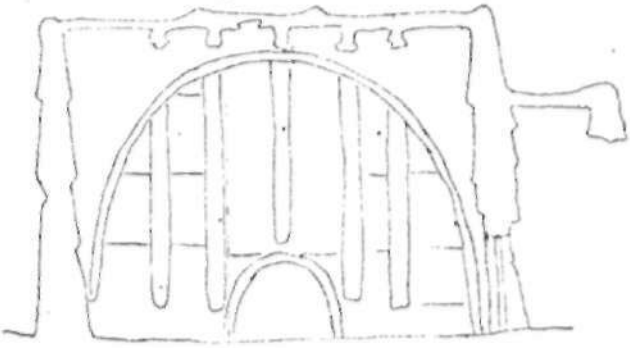


Fig. 6.24c

The walls are battered from both the interior and exterior but several projecting string course cornices are formed by adding an extra tubali to the wall thickness to prevent excessive reduction in the width. The projections occur at irregular intervals, at 87cm (2'9"), 1.95m (6'5"), 3.50m (11'6") and 4.00m (13'2") from the ground. Their horizontal divisions on the wall slightly modify the

verticality of the thrust of the arches. The walls are 1.00m (3'3") thick at the base but they are battered so that they are only .37m (1'3") at the soffit line of the ceiling. They rise much higher, at least two metres (6'7"), than they would if the roof had been domical rather than flat. Thus the hall appears massive from the exterior as well as the interior.

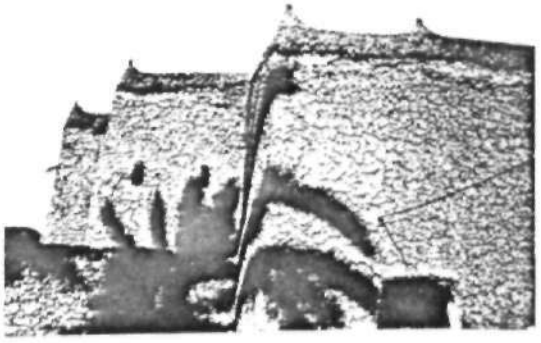


Fig. 6.24d

6.30 Arches Abutted by Kafar Kaza (Half-arches)

6.31 One Transverse Arch Abutted by a Kafar Kaza

Room 5, Schwerdtfeger's House Plan No. 78 (Zaria)

The roof of this small, oddly shaped room is supported on a single kafar kaza. The room is basically a rectangle 2.10m x 3.20m (7'x10'6") but the side facing the compound widens to 2.30m (7'6") and then turns abruptly back to the narrower width. The third kafa spans a little more than half the

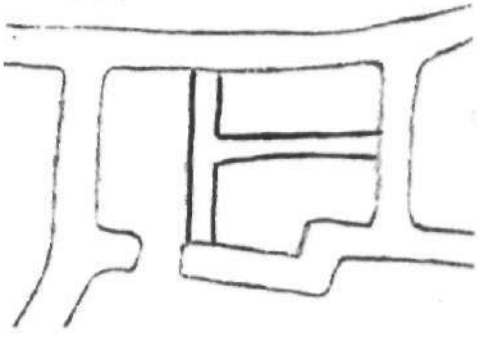


Fig. 6.31a

length of the room before it abuts the full transverse arch.

It would have been technically possible to support the room on a single more centrally placed transverse arch. However, the kafar kaza solution lends to the small room an aura of elegance that is associated with coffered solutions. Since the entry in this case is placed to the side, one of the transverse arches creating the central coffer would have been rising directly in front of the entry thereby creating a distinctly cramped space. Thus, the kafar kaza solution which frees the space opposite the entry is particularly appropriate to the master mason's purpose.



Fig. 6.32b

PART III

DOMES
THEIR STRUCTURE AND RESULTANT CEILING PATTERNS



CHAPTER 7

SPECIAL FEATURES OF HAUSA DOMES

7.00 Introduction

This chapter defines the similarities and the crucial differences between Hausa slab roofs and domes. The quantity and quality of architectural designs in this second part of the typology devoted to domes demonstrates that master masons and their patrons have preferred to design and construct domes for their lofty, prestigious spaces. This preference derives in part from the structural efficiency of the Hausa dome. This preference was also influenced by the high quality of the complex architectural designs generated in response to the distinctive problems inherent in dome structure.

7.10 The Form of Hausa Domes

A Hausa dome is a vaulted construction spanning a square or less frequently circular space, wherein all sides curve upwards towards a single high point. Arches form the principle support for the dome skin. Consequently, the arches determine the basic form of a Hausa dome. The soffit of the dome skin commences its curve towards the apex at a lower height than the upper surface of the dome, resulting in a shallow elevation for the dome. The upper surface of the dome is necessarily raised to accommodate the reinforcing azara in the spandrels of the arches which are cantilevered at a rising slope from the walls

supporting the dome.[1] The form of the arches and their respective domes varies considerably, including arches which are: pointed at the apex—Reception Room for the District Heads, Doraye (3.52); flattened at the apex—Princess's Upper Storey Room, Old Treasury, Kano (11.31); parabolic—Senior Wife's Room Gidan Ubandoma, Birnin Kebbi (9.31); gently curving— outer zaure, Gidan Madawaki, Katsina (11.51); and steeply curving— zaure Gidan Liman, Zaria, 10.33) as well as intermediate versions of all of the above. The same variations in arch form and therefore in dome skin also occur in oblong, cloistered vaults.[2]

Although the basic curve of the dome skin is determined by the rise of thesupporting arches, the actual contours of the dome soffit vary, depending on the arrangement of the permanent formwork infilling members of the soffit. In some cases, the rise of the infilling members of the permanent formwork corresponds closely with the rise of the arches as in the Sharia Court (9.21). In other cases, a slight change in the slope of the permanent formwork members occurs at the division between the lower transitional portion and the upper domical portion of the dome as in the outer zaure of Gidan Madawaki (11.51) and the Shigifa Nufawa (10.32). In still other cases, the infilling members are arranged in tiers, as in the bays of the Zaria Mosque (11.21 and 12.21).

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[1] See above Section 3.50.

[2] See below Chapter 12.

Hausa master masons have fully exploited the potentialities inherent in their dome technology. Their dome forms, transform static spaces into dynamic spaces where the viewer's eye follows the contours of the dome and its arches. Thus spaces of moderate dimensions acquire a grand and imposing character that is more difficult to achieve with slab roofs.

7.20 The Superior Structural Efficiency of Hausa Domes Relative to Slab Roofs

The differences in the Hausa architectural designs for slab roofs and domes executed in mud derive from different structural approaches and from different structural problems deriving from these structural approaches. In rising to the challenge to roof large spaces with locally available materials of relatively low strength, the master masons designed arches. A slab is the appropriate roof form for a space spanned by Bauchi arches because their spandrels are reinforced with horizontal layers of azara,[3] whereas the structurally appropriate roof form for a standard Hausa arch is the dome. The cantilevered reinforcement azara in standard arches slope upwards towards the arch crown conforming more closely to the curve of the arch.[4] The domical form effectively conforms to the form of the backs of these structurally efficient

[3] See above Section 3.53.

[4] See above Section 3.51.

arches; it eliminates the excess load and materials which would be required to raise the spandrels of these arches to the height of the dome crown. Thus, because of the efficiency of the Hausa arch, the dome form it supports is structurally more efficient than the flat slab for spanning large spaces.

7.30 Similarities Between Slab Roofs and Domes

Despite the division of this provisional classification between slab roofs and domes, there are many similarities between the structural systems and the resulting ceiling patterns used by Hausa master masons in their designs for these two roof structures. The same supports are used for both roof structures. Piers, columns, partition walls, and pilastres used in combination with lashed-azara brackets, lashed-azara beams and reinforced-mud arches subdivide the roof into spans which can be safely roofed with the available materials and technology. However, a dome must be free of internal supports in order to fully realize the aesthetic potential of its form. Therefore all vertical supports for domed roofs are restricted to the periphery of each dome or domical bay. Similarily, the lashed-azara beams are restricted to the periphery of each dome or domical bay. The formwork of the soffits of both slab roofs and domes consists of joists and tauyi although variations in the patterning appropriate for flat and domical roofs are established in sub-

sequent sections. Two types of arch configuration are found in both roof structures: intersecting sets of coffer forming arches and kafar kaza in a duplicated configuration.

7.40 Structural Solutions Limited to Slabs Roofs

Flat roofs are essential or particularly appropriate for certain design programmes and structural solutions. Two of the arch configurations discussed in Chapter 6 fall into this category. The arch configuration consisting of parallel arches (6.12) is limited to a flat roof because the armature of this configuration is incapable of ensuring the required uniform curvature at the ends of a room. Similarily, the arch configuration consisting of a single kafar kaza (6.41) lacks sufficient armature for both ends of a room. The design programme involving a lofty space supporting an upper storey is inevitably roofed by the flat slab of the upper storey as in the zaure of Gidan Hassan Jamil (6.11). Structural solutions relying on the Bauchi arch generate flat slab roofs because the spandrel of a Bauchi arch is reinforced by azara which extend back horizontally into the wall as in the Babban Gwani at Kafin Madaki (3.53; 6.34). For structural solutions involving arches springing from a central pier as in Gidan Yarima (5.22), a flat slab is also more appropriate. Domical roofing requires a dome over each bay in order

to exhibit the lofty, rising form of the dome. If a pier were used to support the edge of several domed bays, drainage problems would occur in the centre because some drainage from each bay would converage immediately above the main structural support and at a considerable distance from the proper outlet. It must however, be acknowledged that the master mason for the Zaria Mosque (9.61) resolved this drainage problem about 150 years ago. Solutions which maximize the structural potential of azara joists by making use of large compartments which measure 1.80m (6') wide are also restricted to slab roofs because of the structural rigidity of linear azara.[5]

7.50 The Distinguishing Structural Features of Hausa Domes

Master masons have had to solve more complex structural problems in designing and building domes and, in response to this challenge, they have created a greater variety of aesthetically pleasing structural solutions. The major distinguishing structural problem is the need to ensure a transition from the walls defining square or rectilinear floor plans to the domed roofs.

The transfer of the load from the circular edge of the dome to the square or rectilinear foundation only poses problems where the walls supporting the domes are square or rectilinear. Spaces supported

[5] See below Section 7.40.

on round walls pose no special problem of load transfer. However, in large complexes including many rooms, contiguous circular rooms create awkward junctures. Architectural designs based on square or rectilinear spaces are more successful even if they pose more complex structural problems.

The need to maintain a uniform curvature in the dome skin is also an essential feature of dome technology which further distinguishes it from flat roof technology. Both Hausa technologies depend on rigid linear azara for the infilling members of the soffit formwork; however, the azara in domes must be arranged to effect a curvilinear form despite their own linear form. Given the rigidity of these azara members, many azara panels sloping at slightly differing angles are required to enable the permanent formwork to approximate a uniformly curving dome form.[6] In order to achieve an adequate number of changes in the slope of the permanent formwork in a dome, each azara panel must be smaller than the 1.80m (6'0") wide panel which has become standard for flat slabs. Thus, the permanent formwork in a dome consists of more subdivisions and smaller azara panels than is appropriate for the permanent formwork of a flat slab.

7.51 The Tauyi Solution

Hausa master masons have adopted the standard tauyi panels to create an octagonal base for the domical form. The tauyi span between adjacent walls creating an additional support for the base of the domical form and also reducing the distance to the spanned

[6] See below Section 8.20.

from the corners to the apex so that it will correspond more closely to the distance being spanned from the centres of the walls to the apex. The role of tauyi in the formation of Hausa domes is discussed more fully in the next chapter dealing with the permanent formwork patterning in the soffits of domes.[7]

7.52 The Diagonal Arch or Kafa (Half-arch) Solution

Arched diagonal supports in the form of full arches (10.30 - 10.80) and kafa (11.50, 11.60, 11.70) perform a crucial form-giving role in the design of many domes. In rare instances (10.60, 10.70) intermediate arches are substituted for the diagonals. In addition to contributing to the support of the dome skin, the backs of the diagonals determine the form of the dome in each corner. The curve of their arching-up action at their bases is designed to create a transitional area in the soffit and to assist in the formation of an imaginary circular base which can ensure a uniform curvature in the dome. The diagonals must arch up in a shallower curve than the transverse arches and they must also be longer in order to rise to the imaginary circle or octagon that the master mason achieves with the cantilevered azara of the permanent formwork before he continues to build the arches up to the crown. In some instances this level in the dome is clearly marked by lateral

[7] See below Section 8.30.

joists as in Gidan Madawaki (11.51) and Gidan Magajin Gari, Katsina (10.41) or by lateral beams as in Shigifa Nufawa (10.32). This is especially true in domes whose infilling members in the lower transitional area and in the upper domical area are arranged in differing patterns.

The structural role of diagonal arches and kafa is subordinate to the structural role of transverse arches. Their subordinate structural role has been deduced from two types of evidence. On the one hand, there is no evidence of corner stress. The corner cracks which could result if an equal share of a dome's load were forced down through the diagonal arches or kafa to the corners is non-existant. On the other hand, minimal plastering on the arch soffits of some coffered domes, such as the outer zaure of Gidan Madawaki, Katsina (11.51) and Gidan Alhaji Barmo Makudawa (11.61) reveals that their diagonals are the highest arches to intersect at the apex. The greater height of the diagonals indicates that they were resting on the permanent formwork azara of the principal supports for the dome. Sometimes in umbrella arch configurations, diagonal arches merely abut the transverse arches. The revealed formwork of the arches in the Reception Room for District Heads at Doraye (3.52) illustrates this technique of abutting the diagonal kafa, in this case psuedo-diagonal kafa since the space is circular. Both these superimposed and these abutting diagonals

are nonetheless essential to the realization of the dome.

7.53 The Internal Vertical Support Solution

Vertical supports used in conjuction with a dome function in lieu of a continuous wall. Unlike flat-ceilinged spans, normally the span of a dome is free of vertical supports. Where a column interrupts the free span, it has been designed to buttress the crown of a dome that appeared to be in danger of collapse. In Birnin Kebbi, this type of buttress-column was resorted to for the outer zaure in both the emir's palace (10.51) and the Ubandoma's residence (9.31). Unfortunately the Ubandoma's zaure collapsed despite the additional internal support. Chapter 8 is devoted to vertical supports which have been used to support domes above square spaces. In those instances where the supports approximate a circular arrangement as in the Amini at Yabo (9.11), the vertical supports solve the problem of transferring the load of a dome onto square walls. In these instances, the supports absorb the load and a roof links them to the walls thereby creating an ambulatory.

7.60 Structural Solutions Limited to Domes

The distinctive structural features of dome technology have generated some structural solutions which are restricted to dome technology. These distinctive solutions are summarized in this section

before preceeding to the more thorough analysis of their use in Hausa architectural designs which follows in subsequent chapters.

7.61 The Soffit Permanent Formwork Patterns

Hausa master masons have had to design more complex patterns for the infilling members of dome soffits than for those of flat slab soffits. The additional compartments required in a dome soffit so that the linear infilling azara will approximate the required curvature and effect the necessary transition from a square base to the domical form, provide the occasion for additional patterns in the ceiling. Some of these compartments must also be of a less regular form. They are triangular in domes with arch configurations meeting at the crown as well as with arch configurations supplemented by diagonal kafa and trapezoidal with arch configurations supplemented by lateral beams or joists. Each irregularity in the form of these compartments further challenges the creativity of the master mason.

Moreover, the tauyi in domes must necessarily create a unified pattern encircling the entire space whereas in slab roofs they are often used less regularly.[3] In domes, tauyi are handled as important structural and design elements whereas this is rarely the case in slab roofs where their role is less significant.

[3] See below Section 4.21 and above Section 8.30.

7.62 The Arch Configurations

Hausa master masons have responded to the special structural requirements of domes by developing so many different arch configurations that three categories of intersecting arches have been established for this portion of the typology which deals with domes: arches that meet at the crown, arches that form central coffers, and duplicated kafar kaza. In order to create the multiple soffit compartments required for dome technology, these arch configurations involve the use of more arches per square metre than would be appropriate in a flat roof. Moreover, many of these configurations involve diagonal and intermediate arches to assist in the transition from the square to the domical form. Both the additional arches and these two particular arch types are structurally unnecessary and, because of their own load, structurally detrimental to the design of a flat roof.

7.63 A Circular Arrangement of Vertical Supports

The arrangement of supports in a circular formation is a response to the special problems of dome construction. Such is the case with the columns in the Amini at Yabo (9.11) and with the protruding engaged columns in the Zaria Sharia Court (10.61) The vertical supports in these solutions function in lieu of a circular wall. Although round-walled spaces roofed with flat slabs are known, this circular formation for vertical supports is not used for slab roofs where it would generate many

smaller spans in the soffit formwork than would be generated by the standard grid formation.

CHAPTER 8

THE PERMANENT FORMWORK OF THE SOFFIT

8.00 Introduction

The permanent formwork of the dome skin is compartmentalized to ensure that each individual, infilling member in the soffit maintains the short span necessary for the formation of a uniformly curving dome. The arches themselves compartmentalize the soffits. Arches meeting at the crown create triangular compartments while those forming central coffers and those abutted by kafa form square and rectilinear compartments. Sometimes additional arches are incorporated into the dome armature to further ensure a well-formed dome even though the arches are structurally superfluous. In other cases, vertical and lateral joists, lateral beams, and lateral ribs further compartmentalize the span between adjacent arches. Many lateral beams are also structurally significant because they brace the rising arches.

As with most dome technologies, the soffits of the Hausa domes which rest on square and rectilinear bases can be divided into two distinct sections even where their juncture is only visible to the trained eye: the upper domical portion which is uniformly curving and the lower transitional portion which rises to form a roughly circular or octagonal base for the domical portion. In the transitional portion, infilling members rising from the corners

must span greater distances than those rising from the walls. In some cases, this difference is handled through the use of tauyi. In other cases, the infilling members rise vertically from the walls to rest on an octagonal base created by lateral joists, beams or, in small domes, crown-tauyi.

8.10 Sub-compartments of the Soffit

8.11 Vertical Joists

In small shallow domes, the compartments created by four arches intersecting at the crown are sometimes further subdivided by azara joists. In the small zaure built in Bauchi by the Sarkin Gini Alhaji Abdu, azara joists rise from the backs of the tauyi to rest on the crown of the arches. Two joists tied together rise from each corner. Their function is to reduce the span for the horizontally placed infilling reeds which revolve around the arches and joists.

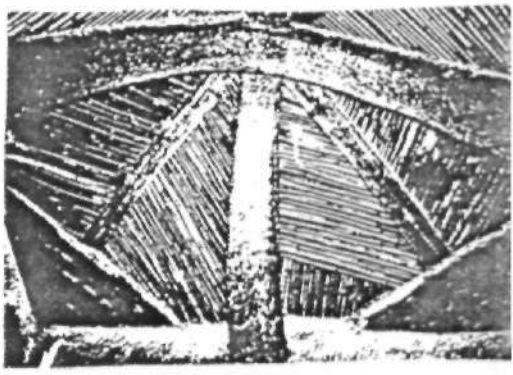


Fig. 10.13a

Similar vertical joists are used in the round thatched-roofed room in the emir's palace at Abuja. Here the coupled joists rest on the walls and create a slightly

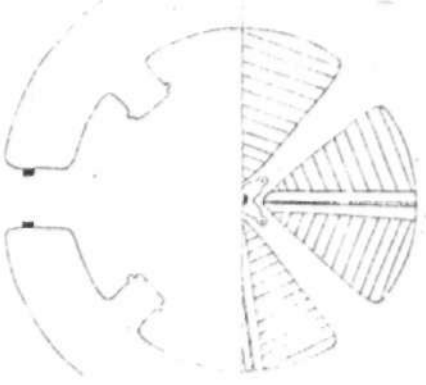


Fig. 10.14a

pitched soffit in conjunction with the four principal arches which spring from the floor. The curvilinear form of the deep arches dominates our awareness of the soffit so that it appears to be a shallow dome.

8.12 Lateral Joists

Azara members (6cm x 15cm) (2"x5") in cross section, are occasionally spanned from arch to arch to assist in creating an octagonal base for the dome. In the livingroom for the former Magajin Gari of Katsina (now the emir), the handling of the joists demonstrates this function. They are laid on the backs of the arches at varying distances from the wall. In order to reduce the differences in span from the apex to the corner and from the apex to the centres of the walls, they are laid 55cm (1') (10") further from the corners than from the centres of the walls. The joists thus create an octagonal shape within which

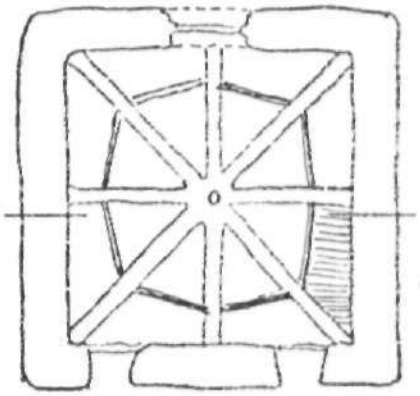


Fig. 10.41c

the distance from the octagon to the apex remains approximately the same in order to make possible an evenly rounded dome skin.

8.13 Lateral Beams

Lateral beams brace adjacent arches as they rise. Such is the case for the short lateral beams spanning between the paired arches in the outer zaure of Gidan Mada-waki. Sometimes, lateral beams perform a vital role in the dome's structure since they constitute the octagon which serves as an adequate base for the domical form. Such is the case in the Shigifa Nufawa dome which also provides an example of exposed azara beams where the cord-tying which usually unites the azara is dispensed with in order to enhance the aesthetic effect by ensuring clean lines in the soffit. In this case, the two azara members which constitute each lateral beam are wedged tightly together and imbedded in mortar on the backs of the arches.

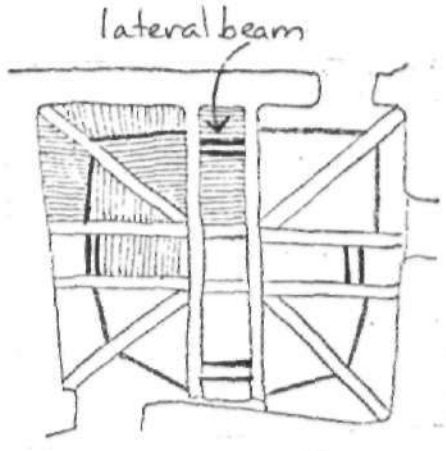


Fig. 11.51c

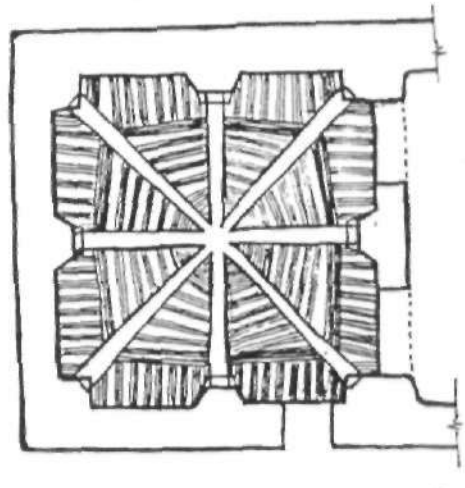


Fig. 10.32c

In some domes where the bracing function of the lateral beams is minimal, these beams appear overstructured for their minor structural function of supporting infilling members. In such cases, their form was desired for its aesthetic effect. In the Dosso Mosque, lateral beams placed at the edge of the crown-tauyi encircle the apex of the dome of the maqsura, the bay adjacent to the mihrab which is reserved for the temporal ruler and the imam. The case of the inner zaure of Gidan Makama demonstrates that the edge of the crown-tauyi is strong enough to support the vertical infilling members which rest on it. The deep, lateral beams in the Dosso maqsura were designed to create a pattern with the deep arches which support the dome. Similarily, the lateral beams on the fringes of the coffer pattern in the outer zaure of Gidan Alhaji Barmo Makudawa have been designed to

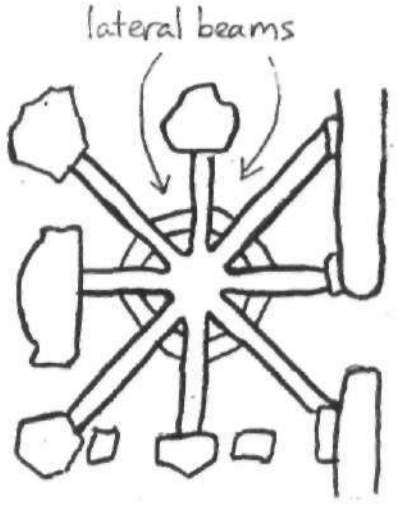


Fig. 10.42a

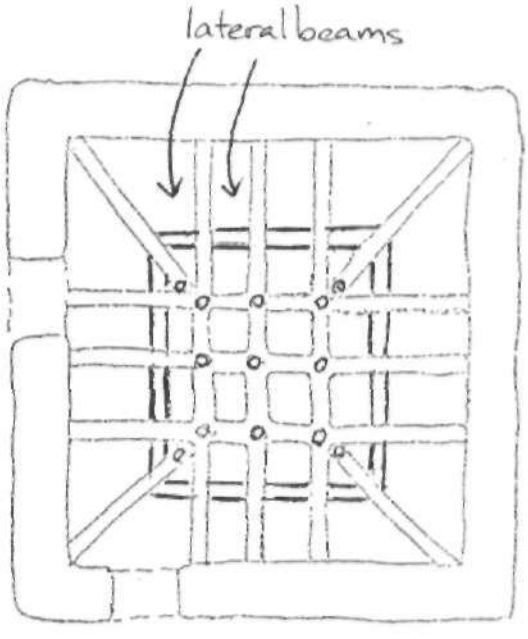


Fig. 11.61a

create a border for the pattern of arches and false ribs. These lateral beams support the ends of vertical, infilling members but this structural function could have been effectively executed by lateral joists as is the case in the corner compartments of the outer zaure of Gidan Madawaki Katsina.

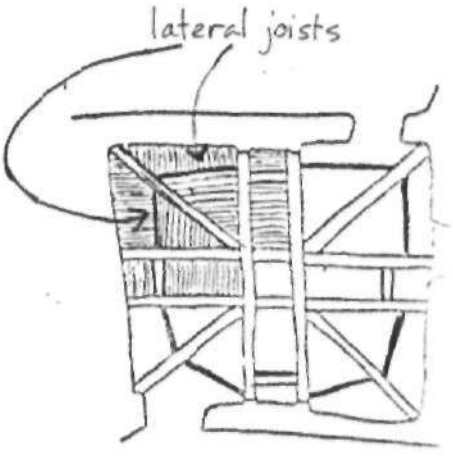


Fig. 11.51c

8.14 False Ribs

False rib (barauniyar kafa) is the term master masons use for a purely decorative rib used to bisect a coffer on the diagonal (Saad, 1981). In these cases, the span of the coffers could easily have been spanned by infilling members. The master mason who designed the outer zaure of Alhaji Barmo Makudawa effectively employed false ribs to form a decorative diamond which creates a dynamic play between the square lines of the inner coffer ribs and the square lines of the outer lateral beams.

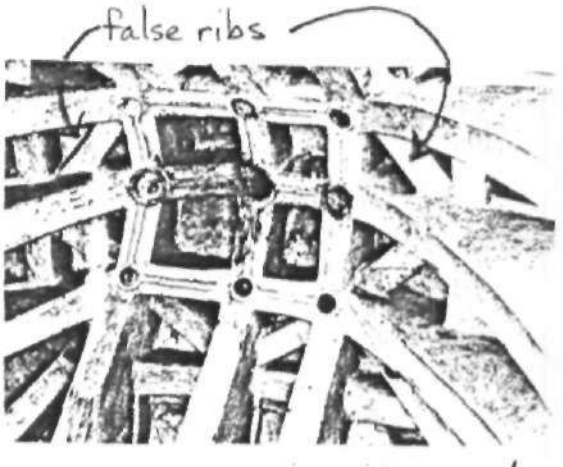


Fig. 11.61b

8.20 Infilling Members in the Domical Portion of the Soffit

8.21 Crown-tauyi



Fig. 9.31e

Virtually all domes have crown-tauyi which contribute to the rounded form of the skin of a dome. These tauyi span from arch to arch near the apex of a dome or near the central coffer at the apex. They form a panel upon which vertical azara infilling members are laid. Without the crown-tauyi, these vertical infilling members would have to be laid in such long units that the rising curve of the dome skin would be compromised and transformed into a pitched roof. Since adjacent arches support the azara members which constitute a crown-tauyi, the number of crown-tauyi in a dome is determined by the number of rising arches meeting at the crown. Thus, four crown-tauyi panels are clearly visible revolving around the apex of the Senior Wife's Room in Gidan Ubandoma at Birnin Kebbi and eight

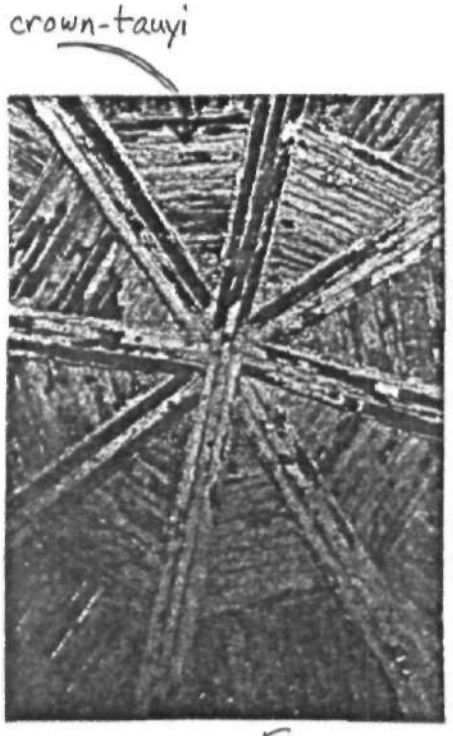


Fig. 3.52c

crown-tauyi revolve at the apex of the District Head's Reception Hall at the Doraye Palace. Crown-tauyi also revolve around the coffers in the Mallam's Room at the Panisau Palace where they serve to reduce the span for the infilling members. By extension, we can refer to the azara panels flanking the long, transverse arch in the Guest's Room at the Panisau Palace as crown-tauyi.



Fig. 13.20b

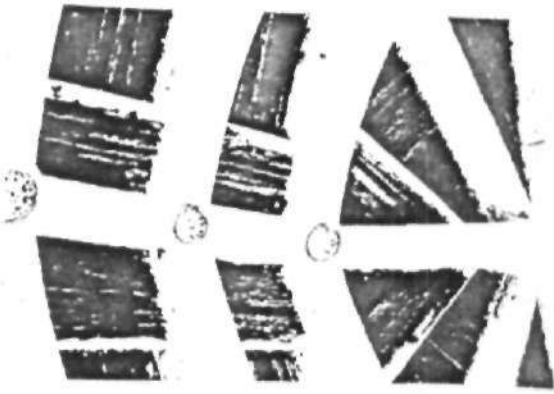


Fig. 11.41d

8.22 Infilling Patterns Below the Crown

For arches intersecting at the crown, the simplest pattern for the infilling members in the domical portion of the soffit below the crown-tauyi is to continue the lateral placement of the crown-tauyi members. Where the arches are closely spaced as in the Sharia Court and the Dosso inner zaure, the simplicity and clarity of this approach is successful. This same lateral placement can also be used in coffered domes as in

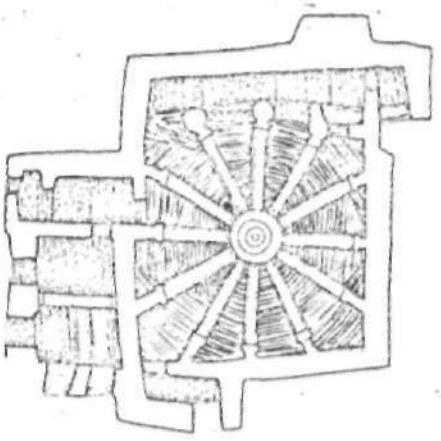


Fig. 10.61b

Gidan Madawaki Katsina. It is handled as a decorative pattern in the Shigifa Nufawa of the Emir's Palace in Birnin Kebbi where the infilling members are set in pairs and the matting is revealed.

Vertical placement of the azara is also common. Vertical azara rise to the backs of the crown-tauyi and the diagonals as in Gidan Makama. The beautiful sunburst pattern in each of the central domes of the Yangoro Mosque relies on vertical azara rising directly to the crown without any transitional area.[1]

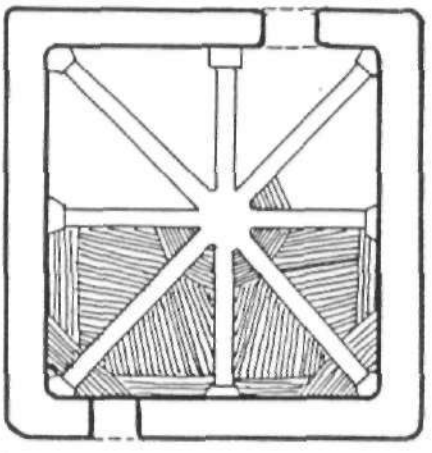


Fig. 10.31a

8.30 Infilling Members in the Transitional Portion of the Dome

8.31 Tauyi

In small, shallow domes, a single tauyi spanning each corner suffices to create a roughly octagonal base. Such is the case in the dome of the outer zaure for the Magagin Gari of Maska.

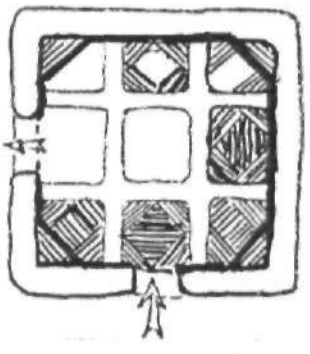


Fig. 11.11e

[1] See below Section 10.11.

Here the distance between the corners and the circular form is approximately 45cm (1'6") which can be easily spanned by a single tauyi.

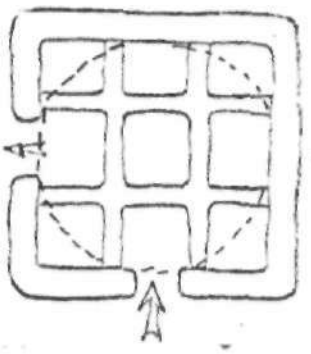


Fig. 11.11f

The same method can be adapted for vaults in rectilinear spaces. Each of the four corner compartments of the inner zaure of the Magajin Gari of Maska measures approximately 1.20m x 1.30m (almost 4'x4'3"). Their soffits are filled in with tauyi. These tauyi serve as a squinch transforming the rectangle into an oblong hexagon. The first azara of one of the tauyi are laid into the wall 10cm (4") lower than the 2.75m (9') average height of the wall. The successive azara in this tauyi are placed slightly higher so that the tauyi panel slopes up 23cm (8') from the corner to the uppermost azara. This slope of the tauyi also contributes to the form of the shallow dome. Once this tauyi has been constructed,

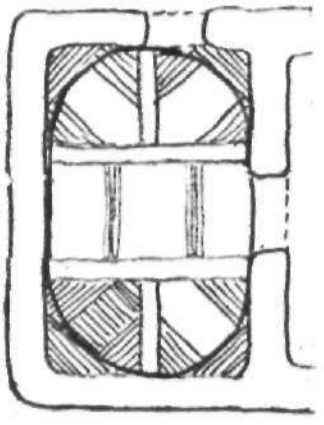


Fig. 12.11g

two tauyi panels are laid perpendicular and onto this first tauyi with their other ends resting on the adjacent arches. A third level of azara is created when the remaining central span of the compartment is covered with a final panel of azara. The central and highest portion of the compartment is covered last. Thus, these panels contribute to the rounded form of the vault by their upward sloping angle and by their layered placement.

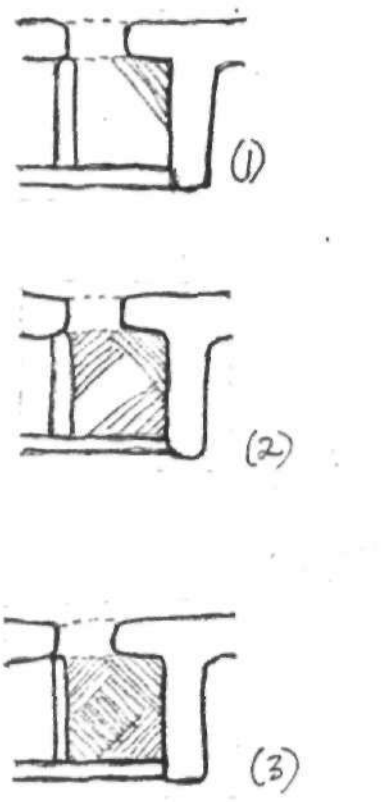


Fig. 12.11h

8.32 Superimposed Tauyi Panels

Superimposed panels of tauyi were designed to form the transition between the rectilinear plan of the bays in the Zaria Mosque and their domical roofs. Approximately 1.25m (4'0) was spanned by the superimposed tauyi panels in each corner of the central bays. To superimpose the tauyi, they are alternated with flanking wall-tauyi. These ceiling panels are all horizontal or incline slightly in the direction of the crown of the dome. The lowest

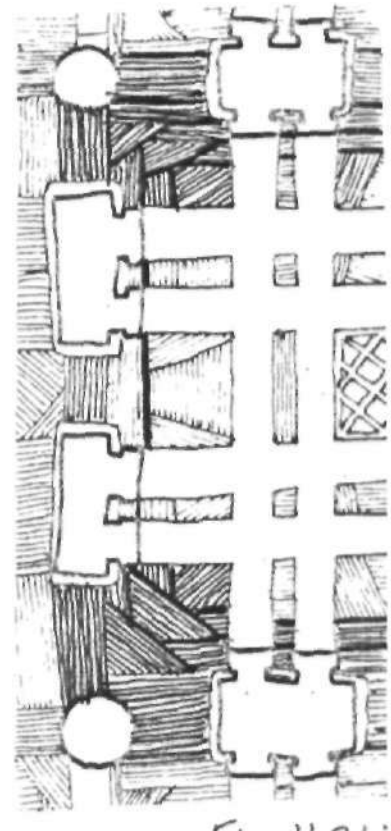


Fig. 11.21j

tauyi are resting on the lateral lashed-azara beams which span from the piers to the corners of each bay in lieu of walls. Wall-tauyi span from the tauyi to the arches which support and form the dome. In the central bays, a tauyi is alternated with a pair of wall-tauyi two or three times. The extra tiers assist in the formation of the upper curvature of the dome. This superimposition of tauyi panels results in a progressive, stepped increase in the height of the ceiling. Simultaneously, the tauyi transform the angular corners of each bay into the sides of an octagon, albeit an extremely uneven-sided octagon, but nonetheless an octagon upon which the circular form of the dome rests smoothly.

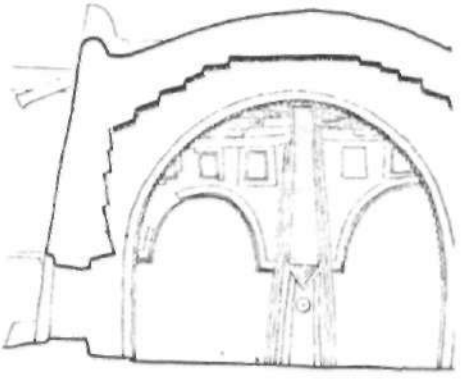


Fig. 11.21s

The superimposed tauyi panels in the oblong, lateral bays of the Zaria Mosque form a cloistered vault. The tauyi are very carefully alternated to form a neat transition from the rectilinear to the curvilinear base.

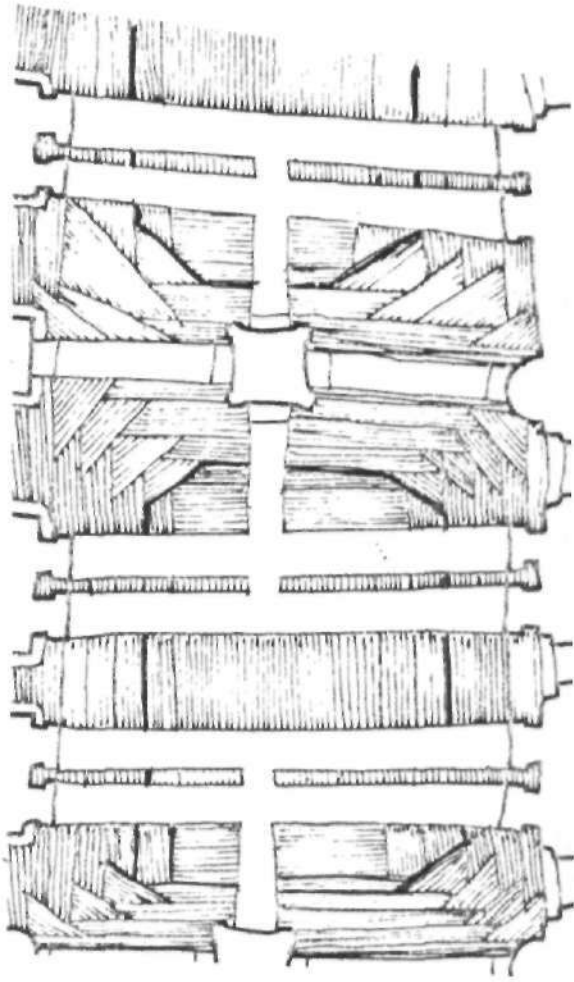


Fig. 11.21t

Even at the corners of the domed bays in the Yangoro Mosque, the vertical infilling members rise only towards the apex but the vertical members in the other two domes mentioned above rest on the diagonal arches as well as the lateral supports.

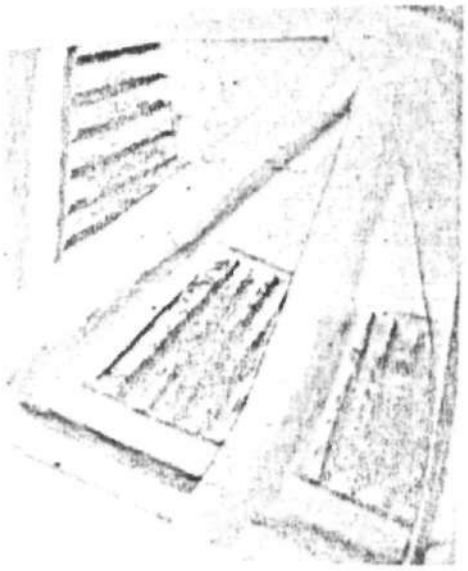


Fig. 10.43d

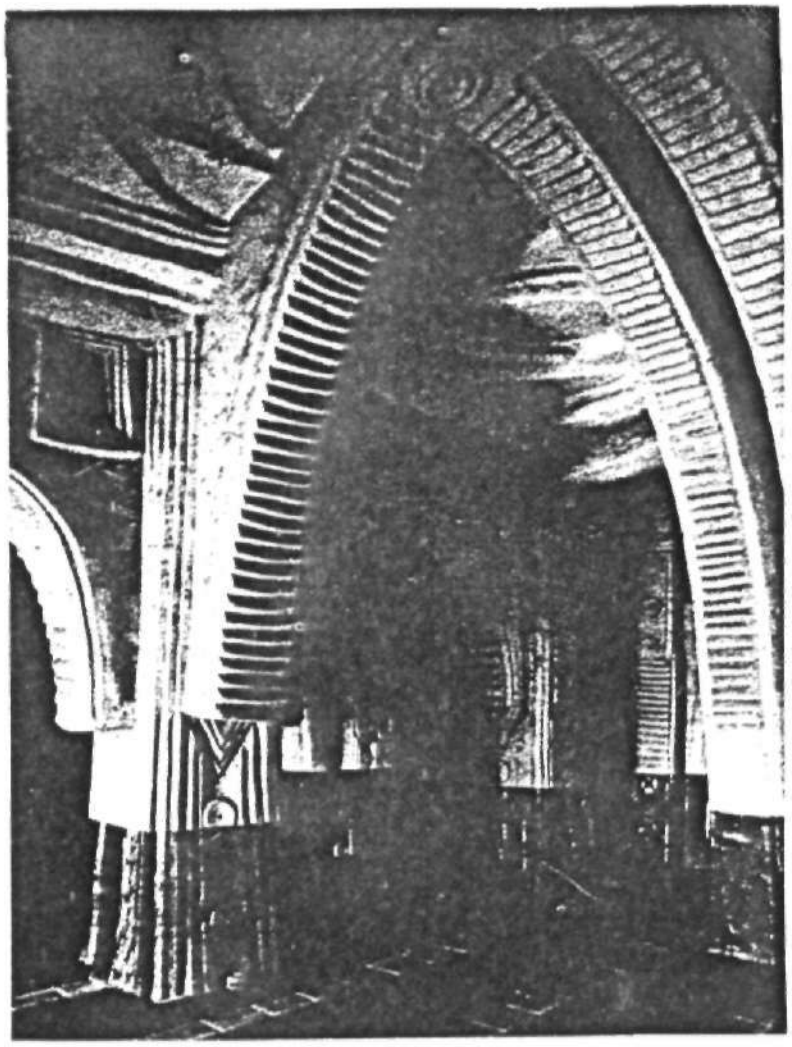


Fig. 11.21q

8.33 Multiple, Small Tauyi Resting on Many Arches

The provincial school of Birnin Kebbi is represented by a substantial number of domes built in Niger using tree branches for infilling members. Because linear tree branches are only readily available in short dimensions, small tauyi panels span from the arches to the walls and then from tauyi to tauyi. The slightly greater size of the tauyi in the corner functions with the many arches to create the uniform base for the domical form.

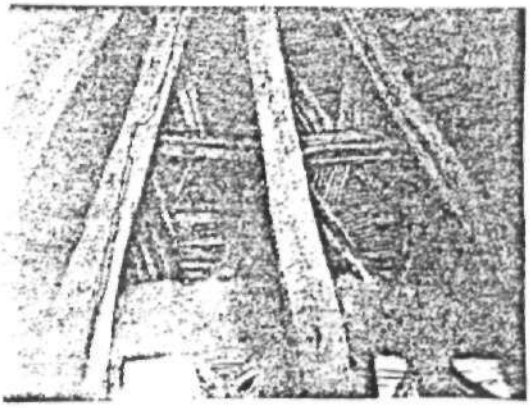


Fig. 13.20c

8.34 Vertical Members Rising on an Octagonal Frame

The transition from square plan to domical roof can also be effected with a combination of diagonal arches and the octagonal armature that the diagonal arches help to support. This framework may be lateral joists or beams, or both, as in Gidan Madawaki or even crown-tauyi as in the relatively small domes of Yangoro Mosque.[2]

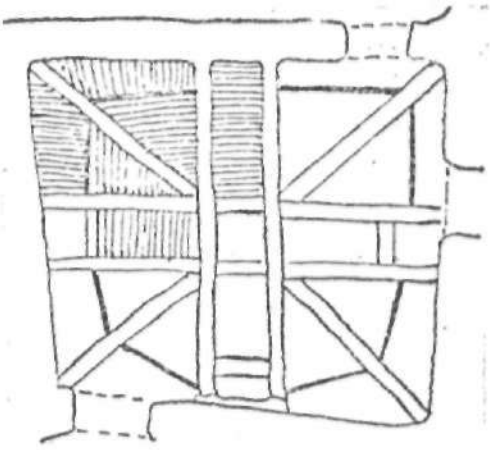


Fig. 11.51c

[2] See above Section 8.22 and below Section 10.11.

CHAPTER 9

THE VERTICAL SUPPORTS

9.00 Introduction

The same types and arrangements of articulated supports used for flat slabs[1] are found in domed spaces. Supports create a central bay surrounded by an ambulatory or a series of adjacent bays thereby increasing the span which would otherwise be beyond the structural capacity of the available materials. The supports simultaneously create vistas as the viewer's eye perceives the additional spaces of the ambulatory or bays. The central space or bays is cooler than the peripheral spaces which receive the direct solar heat.

The distinctive structural features of dome technology have generated an arrangement of structural supports which is restricted to dome technology and another which is restricted to use in conjunction with arches. The arrangement of supports in circular formation to create the necessary circular base for a dome is a response to the problems peculiar to dome construction.[2] Therefore such formations are not found in connection with flat slabs. The arrangement of closely spaced supports in rectilinear plan to support four load bearing walls creates a distinct central space surrounded by an ambulatory. The ambulatory increases

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[1] See above Section 5.00.

[2] See above Section 7.20.

the functional square metres in the plan. More importantly, it forms part of a symmetrical hierarchical design. The lower-ceilinged ambulatory precedes and flanks the central space thereby contributing to the grandeur of the central space. Access is only achieved by passing through two doorways, an ambulatory doorway and a central space doorway. Those not invited into the central space, may walk through the ambulatory to gain access to other spaces within the complex. Guests may be received less formally in the smaller, less imposing ambulatory. Thus, the ambulatory of the Birnin Kebbi Council Chambre is sometimes used by the emir to receive guests. Such a hierarchical organization of space would be less appropriate surrounding a space supported on beams because of the necessarily small dimensions of such a space. Walled central spaces have only been documented in conjunction with a lofty central dome which sheds the rain water onto the flanking flat roof of the ambulatory although theoretically the same plan could be achieved using a large, lofty slab roof supported on arches.

9.10 Columns Placed in Circular Formation Supporting a Dome with an Ambulatory Surmounted by a Gallery Overlooking the Dome

9.11 The Amini, Gidan Sarkin Kebbin Yabo (Yabo)

The shigifa called Amini was

commissioned by Sarkin Kebbin Mamman Yelli prior to his death in 1878. When Yelli succeeded his father in 1818, the Sarkin's control over Yabo District was already established. Yelli had also won the respect and friendship of the new Sultan Bello by repulsing Tuaregs who were trying to invade Sokoto. It is very possible that Gidan Amini dates back to the early 1820s when the second generation of Fulani rulers were acquiring some of the conspicuous symbols of power. Its spatial concept and form appears to have been influenced by one of Sulton Bello's reception rooms which was seen and described by Clapperton (1826) as a lofty domed hall surrounded by a low balcony that could be seen through the columns. In any case it predates 1878 and is therefore one of the oldest extant examples of traditional Hausa architecture.



Fig. 9.11a

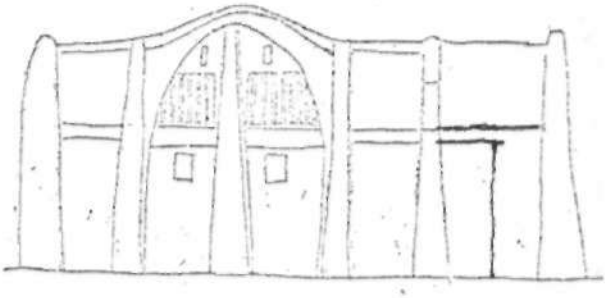


Fig. 9.11b

The Amini is named after the master mason who designed and built it as recognition for the quality of his work. The present Sarkin Yabo suspects Amini came from Zaria but oral tradition relates only that he came from someplace east of Zaria. It is standard practice for a district head to request for assistance from the emir, in this case from the Sultan, in order to have the services of a master mason.[3] Since the master mason who designed and built the Sokoto Mosque came from Zaria (Clapperton, 1826), it is probable that Amini did come from Zaria. It is however, conceivable that Amini came from Daura because the Yabo people are Walarbawa Fulani who migrated from Daura in the second half of the eighteenth century. Zaria and Daura had established traditions of Hausa architecture which are reflected in the sensitivity of the design of the Amini.

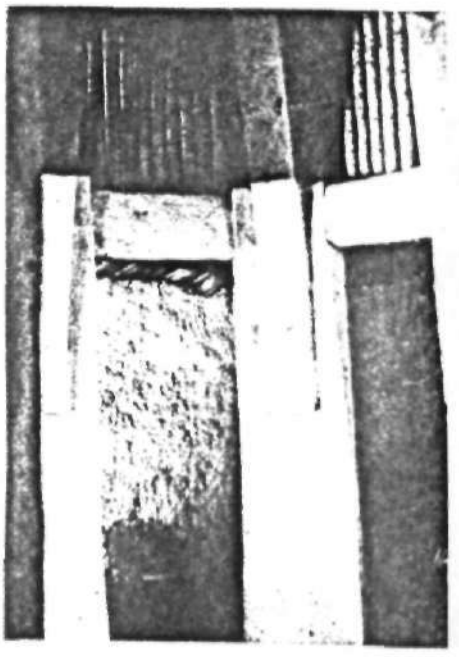


Fig. 9.11c

[3] See above Section 2.51.

The Amini is a roughly square space 7.50m x 7.70m (25'5"x 25'6") and rising to 5.30m (16'6") at the apex of the four arches which form the central dome. These arches spring from eight columns placed in a roughly circular formation. They span an average diametre of 4.25m (13'10"). The diametre of each column is approximately 80cm (2'8") but the portion facing the central space has been sliced off to present a flat surface approximately 60cm (2'0") wide. At a height of 2.75m (8'0"), lashed-azara beams link the columns to each other and to the walls. The floor of a gallery rests one these beams. A stairwell is located in a small space entered through a door in the back of the ambulatory. The gallery space is only 1.80m (6'0") high and thus provides barely enough headroom. It measures 1.10m (3'7") at its narrowest dimension between the centre of the wall

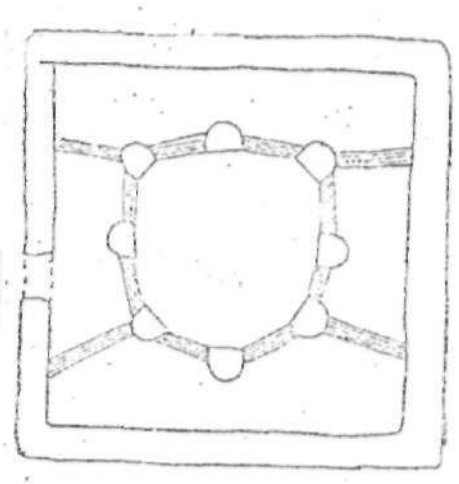


Fig. 9.11a

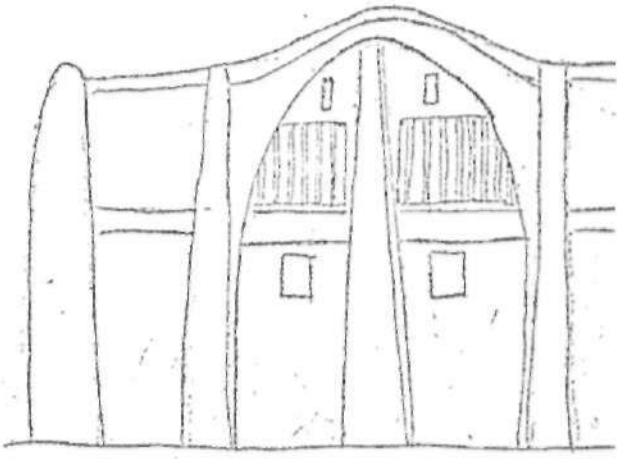


Fig. 9.11b

and the central space. This gallery receives indirect light and sound through a vertical grille extending from column to column and rising 1.10m (3'7") from its base on the gallery floor. The grille is made of vertical balks of carefully selected straight, round tree branches 8cm (3") in diametre. Above these large grilles, the skin of the dome follows the steeply rising contours of the backs of the arches.

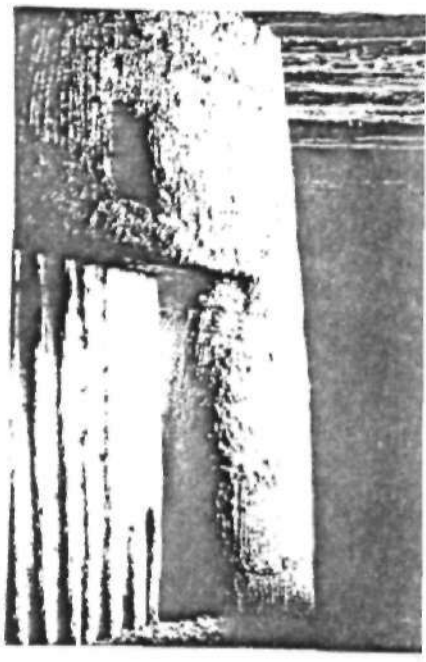


Fig. 9.11e.

Although the ambulatory, especially with its gallery space, greatly increases the effective floor space, the central space under the dome is actually quite narrow measuring only 4.25m (13'10") in diametre. Moreover, the ambulatory is truly a peripheral space separated by fairly narrow openings which in most cases measure only slightly more than a metre. Nonetheless, the elongated proportions and the

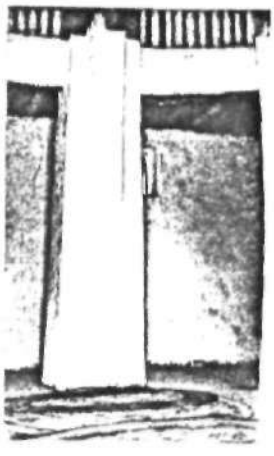


Fig. 9.11f

fine detailing of the central space are enhanced by the flow of space into the ambulatory and by vistas generated by the ambulatory.

9.20 Engaged Columns Protruding Varying Distances to Create a Circular Base for the Dome

9.21 Sharia Court, Friday Mosque Complex (Zaria), (10.61)

The dome of the Sharia Court of the Zaria Mosque rests on six arches which spring from protruding engaged piers. Along three sides of the square room, the arches spring from piers which protrude a considerable distance from the walls to which they are engaged. Along the remaining eastern side, Babban Gwani designed an additional space for the women's section. This section enables women to attend court discretely behind a lattice-work barrier extending between freestanding columns. The dome arches also spring from these three freestanding piers.

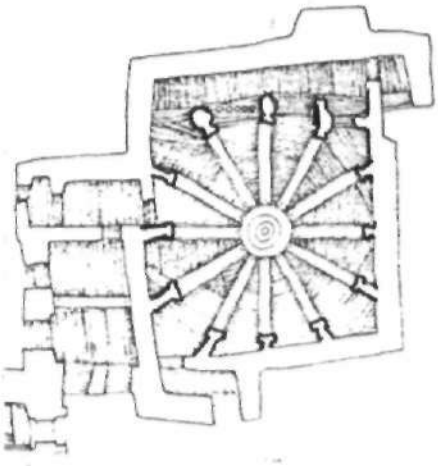


Fig.10.61b

The protruding elements of the engaged piers vary in distance from the approximately square wall extending as far as 1.06m (3'6") for the protrusion facing the men's entry. These protrusions transform the space to be spanned by the arches into a circle. This solution obviates the need for tauyi or diagonal arches and, in fact, almost no use has been made of tauyi and there are no diagonal arches.

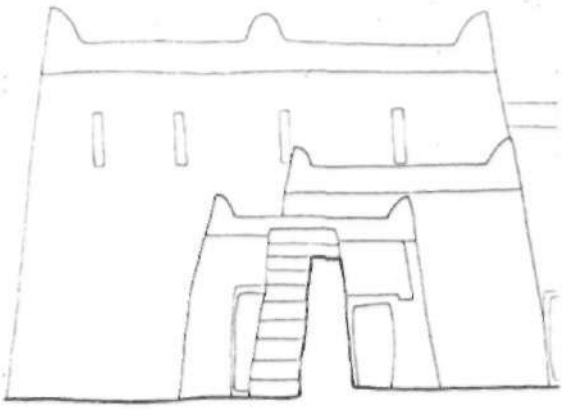


Fig. 10.61a

9.30 Load Bearing Partition Walls Supporting the Intersecting Arches of a Central Dome with Flat-Roofed Spaces Surrounding the Dome

9.31 Senior Wife's Room, Gidan Ubandoma (Birnin Kebbi)

This small domed room supported on four arches which spring from pilastres at the ends of partition walls was built for the senior wife of the Ubandoma. It is much more impressive than the rooms built subsequently for other wives. The main room is roughly a square 6.72m x 6.43m (22'1"x21'1"). The apex of the



Fig. 9.31a

dome rises to 5.00m (16'5") while the lower flat-roofed ceiling spanning the spaces between the partition walls and the dome rises to 4.30m (14'1").

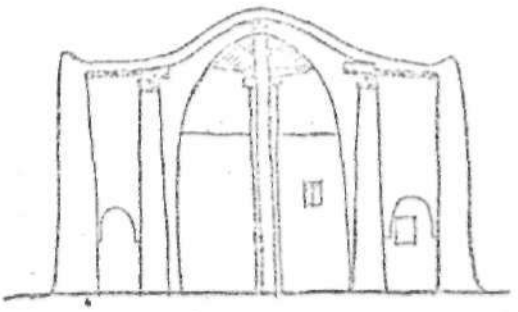


Fig. 9.31b

The viewer perceives the room as a single space since only four arches support the dome and the space between each arch is substantial, approximately 1.75m (5'9"). The unity of the space is further established by the presence of doorways 1.80m (6'0") high cut into the partitions. Thus, in plan the dome rests on four piers. The piers are articulated to reflect the ceiling structure. Pilastres facing the centre rise to become the arches which support the dome while pilastres rising from the sides of the piers support the lashed-azara beams which span between the partitions.

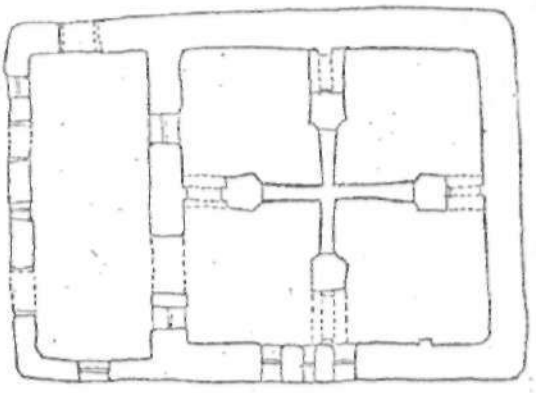


Fig. 9.31c

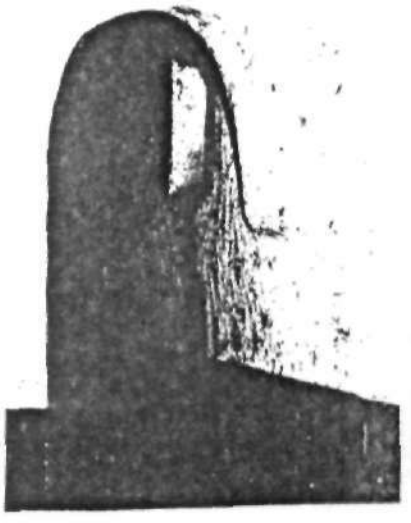


Fig. 9.31d

The space appears loftier and more domical than it really is because the arches dominate our awareness of the space. These tall,

tapering, parabolic arches rise out of the pilastres without any transition. Their span is short in proportion to their height which makes them appear even taller.

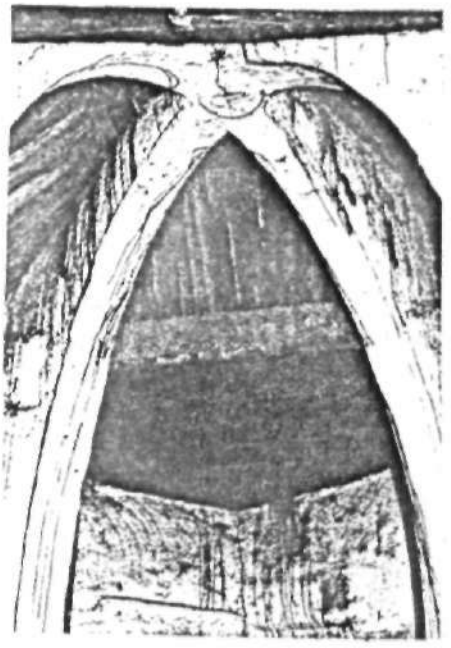


Fig. 9.31e

The dome skin is actually formed by four steeply pitched panels. The angular skin of the dome is recessed 30cm (1') above the arches at the apex. Each panel consists of vertical infilling members resting on a crown-tauyi at the top and a beam spanning between the partitions at its base. Nonetheless, the viewer perceives a domical space because of the prominence of the white arches against the recessed dark background of the dome skin.

9.40 A Square Room Supporting Arches for a Dome and Pierced by Many Doorways Opening Onto an Ambulatory

9.41 Outer Zaure, Gidan Chef de Canton (Dosso), (11.71)

A Birnin Kebbi master mason came to design and build this impressive zaure with its domed central space, approximately

5.40m (16'9") square and rising to 5.65m(18'7") at the apex, surrounded by a square ambulatory. This ambulatory significantly increases the dimensions of the facade which measures 11.45m (37'7") wide. So many doorways pierce the wall of the central space that in plan it appears to be supported on columns. On each wall, six doorways pierce holes 50cm (1'8") wide and 1.50m (4'11") high in the wall. These openings are treated decoratively. Some end in pointed forms and others in horseshoe arches. They are spaced to form an integral part of the overall design.

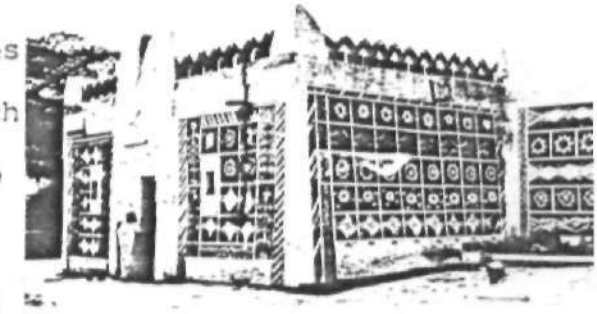


Fig. 11.71e

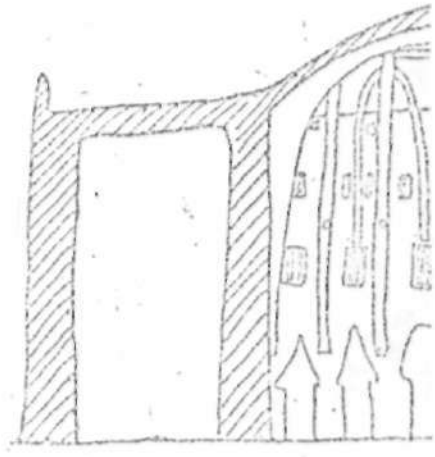


Fig. 11.71f

Despite the amount of floor space devoted to the doorways, the central space is experienced as a separate space from the ambulatory. The thick walls and the low height of the doorways, some of which are so pointed that the effective height is even lower, clearly separate the two spaces. Moreover the ambulatory is sufficiently wide 1.80m (6'0")

and high 4.50m (14'9") to constitute a space in its own right.

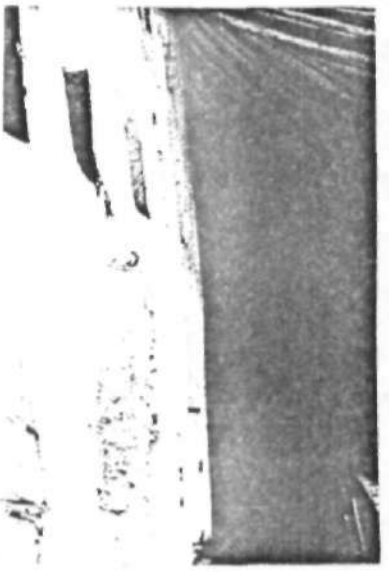


Fig. 11.71g

The ambulatory solution responds effectively to realities of the climate and society. For much of the year, Dosso is extremely hot and dry. The mud walls and roof of the ambulatory absorb the sun's radiant heat so that the central space remains relatively cool. The ambulatory also allows members of the family and children to enter the dwelling of the chef de canton through the sole entry without disturbing the chef and his visitors. Moreover, the ambulatory substantially increases the dimensions of the facade making it much more impressive than the size of the inner domed space would warrant if it were to stand alone.

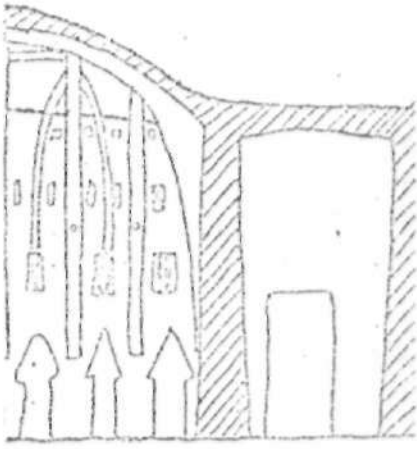


Fig. 11.71h

9.50 Piers in Square Formation Supporting the Arches of a Central Dome and the Arches of an Ambulatory

9.51 Council Chambre, Emir's Palace (Birnin Kebbi)

This massive structure encloses a large council chambre 7.70m (25'3") square within a large

ambulatory 3.00m (10'0") wide and extending 15.40m (50'6") along each wall. The lofty, central dome rises approximately 7.30m (24') on sets of three intersecting arches. These arches rest on massive piers. Pilastres which protrude up to 50cm (1'8") into the space reduce the span. These pilastres also articulate the piers by indicating the arches they support in the elevation and ground plan. Despite appearances at eye level, the structure depends on the wall as well as the piers. The recessed doorways linking the central space and the ambulatory take up the full width of the space between the piers and rise to 2.05m (6'9"). These large openings and the huge, articulated piers dominate our impression of the space which actually relies on lateral reinforcing azara within the walls to counteract the thrust of the arches.

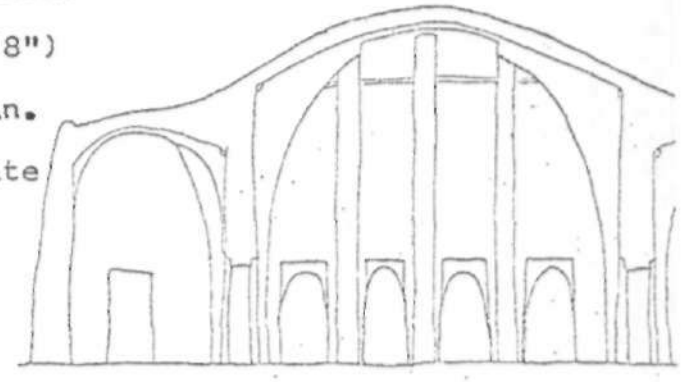


Fig. 9.51a

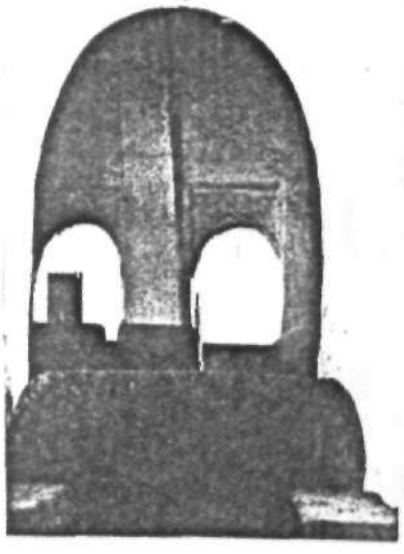


Fig. 9.51b

The ambulatory space is lower, approximately 5.00m (16'5"),

and narrower, 3.00m (10'), but it too is supported on arches that rise out of the piers. The piers divide the ambulatory into bays some without arches and others with intersecting diagonal arches. The arches are double-tiered arches. A lattice-work of vertical azara joists encased in mud joins the two levels of arches.



Fig. 9.51c

The base of each pier rises to 1.07m (3'6") before it recesses to the pilastre form. The wall is recessed even further. Despite their awkwardness, these bases convey the impression of structural stability by virtue of their bulk. The pilastres which spring from these bases lead the eye directly to the two-tiered arches.



Fig. 9.51d

The ceiling patterns and arches are unusually well lit. Sets of imported glass windows are placed between all the pilastres along the walls and at regular intervals, openings are placed high up to

light the arch-work as is standard Hausa practice. Since the windwos and the large doorways to the council chambre are aligned, the chambre is also well lit. The ambulatory ensures that this spacious hall remains comfortable despite scorching external temperatures. Thus, the ambulatory and the central space it surrounds combine some of the best features of both the traditional and modern.



Fig. 9.51e

9.60 Piers, Columns, and a Freestanding Partition Wall Supporting the Arches for Six Contiguous Domes

9.61 The Friday Mosque (Zaria), (11.21 and 12.21)

The various supports found in flat-ceilinged rooms have been exploited by Babban Gwani in his design for the Zaria Mosque complex. The arches and beams of the mosque rest on piers, columns, pilastres, walls and a freestanding partition wall, each of which is sometimes supplemented with brackets. Babban Gwani relied heavily on the use of deep

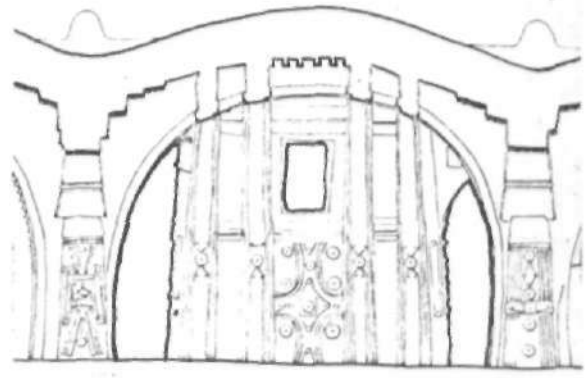


Fig. 11.21j

pilastres, more aptly termed engaged arches because they spring directly from the floor. These pilastres are engaged to and actually form a significant extension of the walls, the piers and the freestanding partition wall. As we have seen, the arches in the Sharia Court are engaged in the same manner to protruding piers which resemble partition walls abutting a wall.

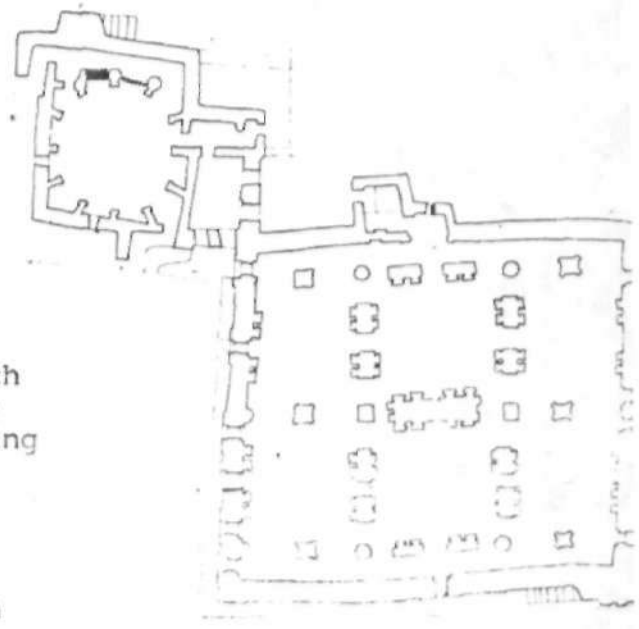


Fig. 11.21b

Given the central position of the freestanding partition, this support merits further consideration. This partition resembles two massive piers which have been joined together. It divides the two central bays and receives the thrust of their primary transverse arches. The main body of the partition measures 4.70m x 1.22m x 5.50m (15'6"x4'x18'). It is abutted on all sides by engaged arches which project between 30cm and 45cm (1' and 1'6") from the main

body. Thus, it is approximately 1.80m (6') thick at each point where it is abutted on both sides by primary transverse arches.

Unfortunately, this massive partition almost completely obstructs the view of the worshippers in the western, central bay. The upper, central portion of the partition is pierced by a large "window" 70cm (2'4") wide and 1.20cm (4') high, but since this opening is placed 2.75m (9') above the floor, it is well above eye level and can not be expected to provide more than a glimpse of the east-central bay. The openings between this central partition and the flanking piers are not large. A 1.00m (3'4") space has been allowed on the northern side and only a 60cm (2') space on the southern side.

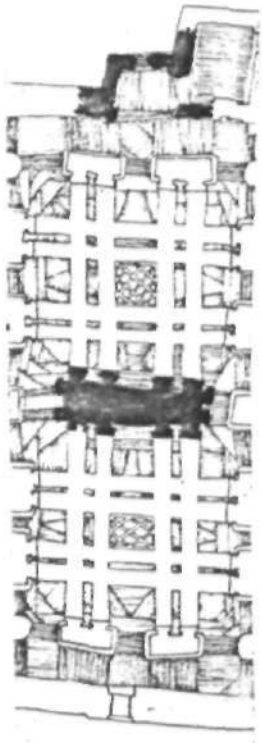


Fig. 11.21k

The forces generating Babban Gwani's decision to place this huge freestanding partition wall in the centre of his mosque are not clear. Perhaps Babban Gwani felt the need to provide extra

buttressing for the piers that receive the thrust of primary transverse arches from both sides. He appears to have experienced no difficulty with the smaller unjoined piers that separate the central bays from the side bays even though these piers also receive the thrust of arches from both sides. This thrust is transferred from the primary arches of the side bays and from the secondary arches of the central bays. Perhaps also Babban Gwani felt the need to build a strong partition wall to encase the opening he created in the exact centre of his mosque. His window is more than a window. It provides the opening for a ventilation/ light opening to the sky. The lower portion of this skylight which is set above the interior window measures 90cm (3') out of the 1.20m (4') window breadth and possibly 60cm (2') out of the window width. It tapers in

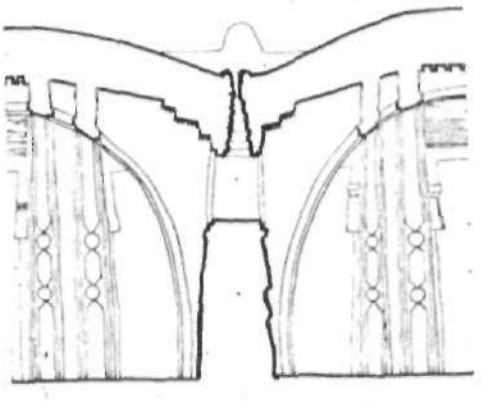


Fig. 11.21m

stages to create a pyramidal void 10cm (4') wide at the roof line. Tradition holds that this opening serves as a passage-way for the angels who descend to worship in the Mosque and therefore no one dares look up this opening for fear of treading on the territory of the angles (Gadzama, 1976). However according to Saad, this colourful bit of folklore is of doubtful veracity and needs further confirmation.

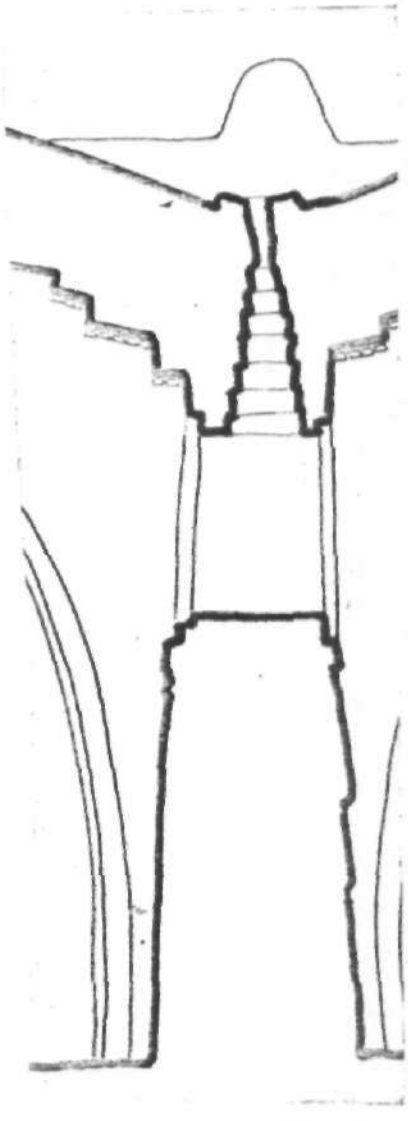


Fig. 11.21n

It is also conceivable that Babban Gwani designed the mosque without the partition and that the partition was added later in response to a real or imagined need for buttressing. The possibility arises because of the awkward location of the partition and window. However, it seems doubtful that the need for buttressing was limited to the base of the arch. Horizontal reinforcing azara are normally placed on the backs of all the sets of cantilevered azara to

spread the thrust through the wall.[4] Thus to be effective, the entire partition should have been filled with buttressing elements. Moreover, the integration of the embossed designs within the framework of the partition is extremely well-handled which suggests that the partition formed part of the original design.

9.70 Four Coloumns Supporting Arches Which Divide the Space Into Nine Bays

9.71 Wudil Palace Mosque

The Wudil Palace Mosque was designed and built for the Emir of Kano, Sarki Abdullahi Bayero, by Bala Gwani (Saad, 1981). This mosque bears testimony to Bala Gwani's artistic sensitivity. Double-tiered arches spring from the cardinal points of our central columns to divide the small mosque into nine bays. The three central bays which are directly in line with the mihrab are domed while

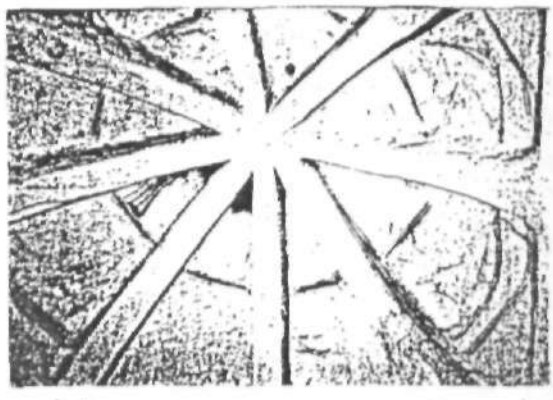


Fig. 9.71a

[4] See above Section 3.51.

the flanking bays have flat roofs. The columns support both the peripheral double-tiered arches which define the bays and the diagonal arches which appear to be the principal arches for the small domes. The domes are also supported on transverse arches, which spring from the peripheral arches. The side bays have flat roofs supported on intersecting sets of two transverse arches. These small side bays, approximately 2.80m (9'2") square, appear overstructured. They would be structurally sound if they rested on a single arch. Bala Gwani masterfully distributes the load more evenly and creates a pattern in the struts which link the two levels of arches. Viewed from under dome, the arches which support the dome have a flat face which slopes to the apex while those supporting a side aisle have the rounded, straight form of a strut. Viewed from under a side aisle, the form of these verticals takes on the reverse

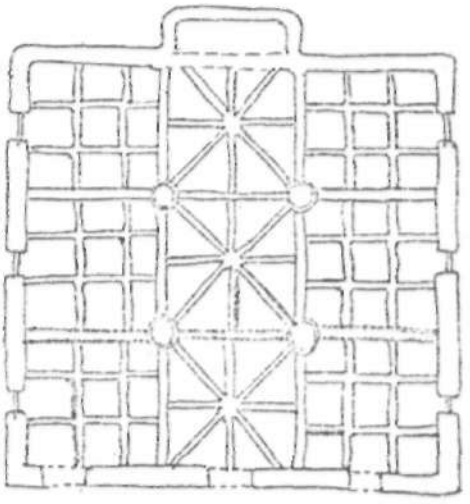


Fig. 9.716

character to correspond with the reversal in their structural roles.

Tapered columns support these bays with slender arches springing elegantly from four and sometimes six sides. Their round, tapered form is further modulated and enlivened by a series of slight projections. The openings between the double-tiered arches create vistas in the ceiling space. The complexity of these multifaceted columns vitalizes this lofty, elegant mosque space.

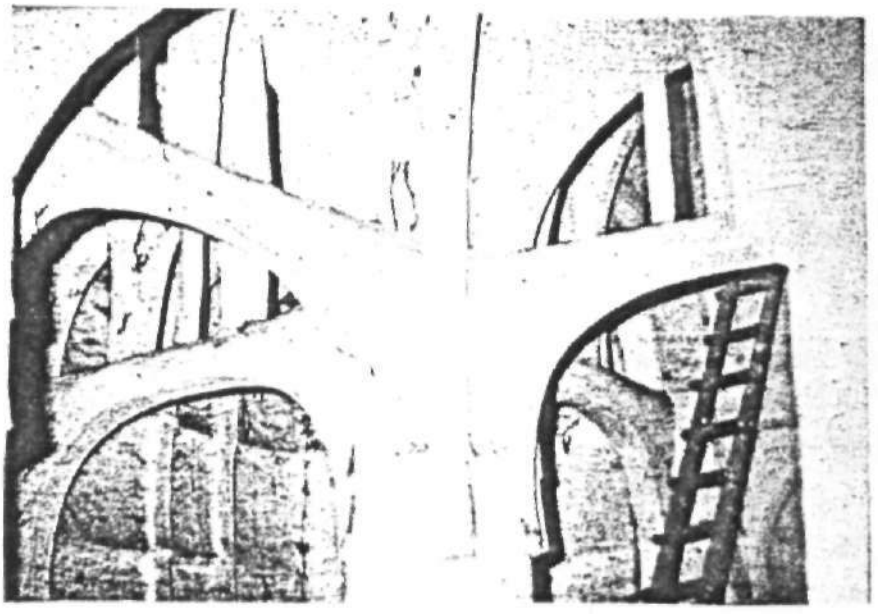


Fig. 9.11c

CHAPTER 10

ARCHES MEETING AT THE CROWN

10.00 Introduction

The arch configuration composed of arches meeting at central point like the ribs of an umbrella provides a fine solution to the problem of creating a well-rounded dome. Hausa master masons supplement intersecting transverse arches with diagonal and intermediate arches. Sometimes using one, sometimes the other, and occasionally using both in the same dome. In the large domes with twelve or more arches intersecting, highly skilled master masons create a polygonal well, a rigiya, at the apex so that the arches intersect with the permanent formwork of the sides of the well rather than with each other.[1]

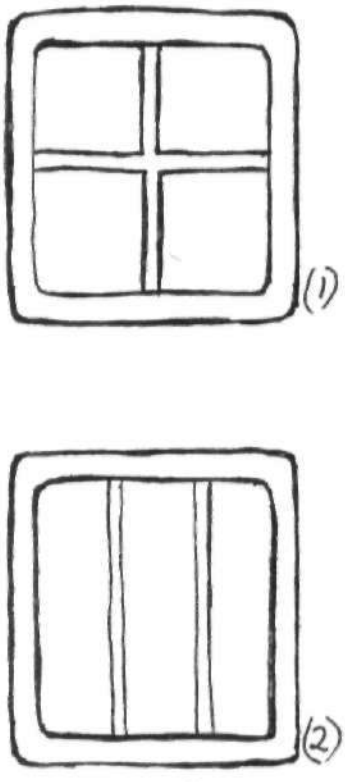
The junction of the intersecting arches is sometimes rather uneven and awkward. Whether the arches intersect at the apex or at the permanent formwork of the well, the junction is often hidden because the entire soffit is plastered. Some domes have a circular area plastered only around the crown of the dome. Often a plate is imbedded in this area as in the outer zaure at Dosso. The colourful, enamelware plate is more than decoration. It acts as a safety alarm because it will fall out prior to any collapse of the dome.

10.10 Two Intersecting Transverse Arches

The intersection of two arches in the centre of the ceiling is a device frequently used to lend an aura of grandeur to a very small, flat-roofed zaure. The intersecting arches evoke associations with larger, dome

[1] See above Section 3.50.

spaces. They seldom span spaces as large as four metres (13'2") square which could be easily spanned by a pair of parallel arches (Gadzama, 1976). Although the intersecting arches do not improve the structural possibilities, they make it possible for the master mason to vary the structural detailing of the infilling members of the ceiling and therefore enhance the aesthetic possibilities which the master mason can explore in terms of his ceiling pattern.



Figs. 10.10a

10.11 Upper Floor Room with Staircase, Old Treasury (Kano)*

Two intersecting arches support a moderate-sized, but especially lofty room on the upper floor of the Old Treasury, in Kano. The builder has enlivened this simple solution and created a well-balanced ceiling design. His ceiling rests on the four arches and the walls. Most of the ceiling consists of white, plastered tauyi. Four large tauyi cover a major portion of the ceiling space supplemented by centre-tauyi

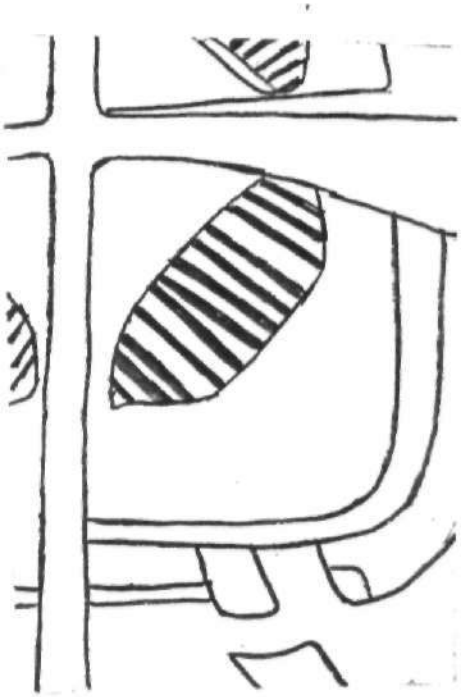


Fig. 10.11a

spanning the spaces immediately surrounding the centre of the ceiling. Each tauyi extends from the base of one arch to the base of an adjacent arch thereby projecting well into the room. The master mason continues to build up his ceiling with the use of much smaller triangular tauyi shapes to create the actual shape of his revealed ceiling, an elongated boat-like hexagon placed in the centre of each of the ceiling quarters. The revealed ceiling hexagons rest on the plastered tauyi near the centre and on the arches. The revealed ceiling consists of 7cm (3") wide azara joists placed perpendicular to the plastered centre-tauyi in each compartment of the ceiling. The mats which directly support the mud roofing show through the interstices between the azara joists.

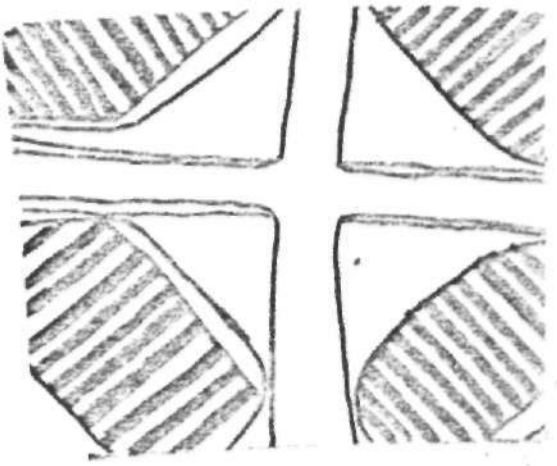


Fig. 10.11b

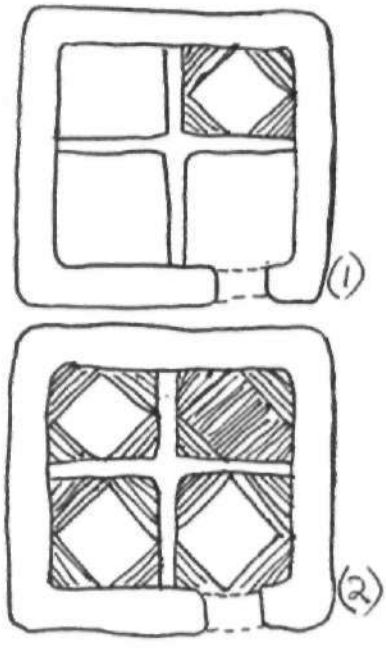
The introduction of the revealed ceiling tranforms a standard ceiling pattern into a

good design. Instead of a single focal point, our eyes are forced to move from the centre to the contrasting revealed hexagons and back. The perpendicular, revealed azara also lead our eyes out to the peripheral tauyi and back, while the pointed ends of the hexagonal shape direct our eyes in a more circular movement. This well-balanced design is further enhanced by the contrasting colours and texture. The tactile qualities of the grainy azara and interwoven mats are highlighted against the smooth, plastered surfaces. By confining the soft, burnt umbre of the azara and the yellow ochre of the mats to small portions of the ceiling, the master masons focusses on them and encourages the viewer to enjoy them. Had the entire ceiling been revealed, the viewer's eyes would have been distracted by the multiplicity of azara of varying dimensions. As it is, his eyes can easily ascertain the ceiling structure. The level changes are readily

apparent in the white ceiling and the revealed ceiling allows the viewer to intellectually imagine the structural details hidden behind the white-washed tauyi sections.

10.12 Room in Kabomba Village, North of Bakori (Zaria Emirate)

In villages in Zaria Emirate it is fairly common to find very small, domed rooms known as tulluwa (dome) or hayin tsaiko (simulation of a thatch roof) (Saad, 1981). The contours of these domes are sometimes but not always, more angular and pointed than domical. They are usually constructed with tree branches as reinforcement for the arches and tree branches or more commonly reeds for the infilling members.



Figs. 10.12a

Their awkward contour is partially the result of the need to economize. The arches used for these rooms often fail to ensure a rounded contour for the domes.

In some cases the arches are spaced too far apart to maintain the proper roundness for the soffit. In other cases, the arches themselves are awkwardly fashioned and therefore lack the required curvature on their upper side. Sometimes both the spacing and the form of the arches are inadequate. It is faster and easier to fashion arches which look like the rafters of a pitched roof. Thus angular "domes" are more economical. Furthermore, a smooth, round contour is only possible with a considerable amount of high quality clay for covering the infilling members. This special mud costs money and it also increases the weight of the roof. This increased load requires stronger supporting arches and hence better reinforcement for the arches.

Once a small dome has been divided into four bays by the intersecting transverse arches, tauyi are used to reduce the

space to be spanned. Each corner of each bay is spanned by a set of tauyi. The immediate result creates a diamond in the centre and zigzag patterns around the contours. The remaining spaces are then filled in with sticks or reeds placed perpendicular to the sides of the central diamond; these sticks or reeds rest on the sides of the central diamond and the tauyi in each corner of the room.

10.13 Small Zaure Built by Sarkin Gini Alhaji Abdu (Bauchi)

This little zaure has a beautifully designed revealed ceiling. A shallow dome spans a space approximately two meters square. The Sarkin Gini Alhaji Abdu selected three materials, each with its own texture and colour, to create his ceiling. The change in materials corresponds to a change in their structural importance. The reinforced-mud arches support the ceiling; the azara tauyi and vertical joists assist

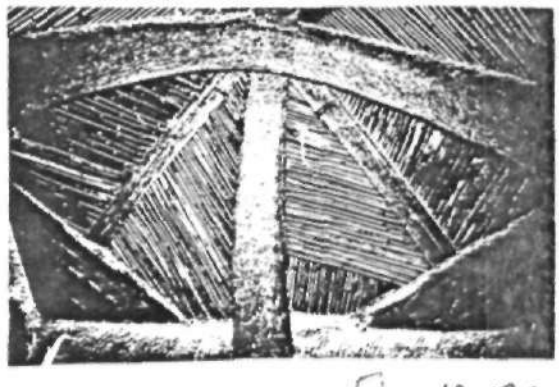


Fig. 10,13a

in supporting the ceiling but function principally to create a domical shape for the ceiling upon which the mud roof will rest.

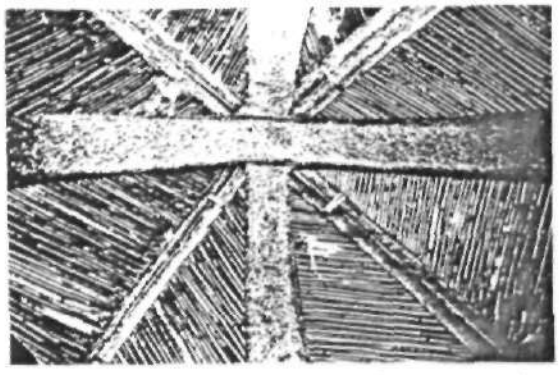


Fig. 10.13b

The ceiling rests on two transverse, reinforced-mud arches which intersect at the crown. The Sarkin Gini has smoothly plastered his arches so that they widen slightly as the viewer's eyes follow their movement from the crown to their spring line. The plastering reveals that one arch is lower and hence supporting the other mud arches. The mud arches spring from 40m (1'4") below the top of the wall and only rise approximately 1.50m (4'11") from their spring line to the crown.

The azara which constitute the next layer of materials from tauyi resting on the mud walls at each of the four corners. They are grey-brown in colour with a grainy, abrasive texture in contrast to the smoothly

plastered, soft brown, mud arches. Since the upper side of each tauyi is 45cm (1'6") above the spring line of the principal arches in the dome, these tauyi simultaneously raise the height of the effective base of the domical form and transform the square room into an octagon. Pairs of azara are tied together and used in place of diagonal arches. However, they spring from the tauyi rather than from the walls at the corner of the room. The infilling reeds pass from these paired azara beams to the reinforced-mud arches. These reeds have become black from smoke and glisten even in the dim light. Their diagonal patterns appear to radiate from the azara beams rather than from the mud arches. Sometimes they radiate up towards the crown and other times they radiate down towards the wall. Thus the master mason seems to have evolved his pattern progressively, beginning with large arches which he then bisected with the paired azara

beams and ending with the small reeds which form symmetrical patterns generating from the azara beams.

10.14 A Round, Thatch-Roofed Room Emir's Palace (Abuja)

This small round, room which measures only 300m (9'10") in diametre and 1.75m (5'10") high at the crown of the intersecting arches is actually a very comfortable room. The thick, mud walls, 50cm to 60cm (1'8" to 2') thick, provide insulation but the most effective insulation is derived from the ventilation holes and 30cm (1') wide air space between the split timber ceiling and the thatch roof.

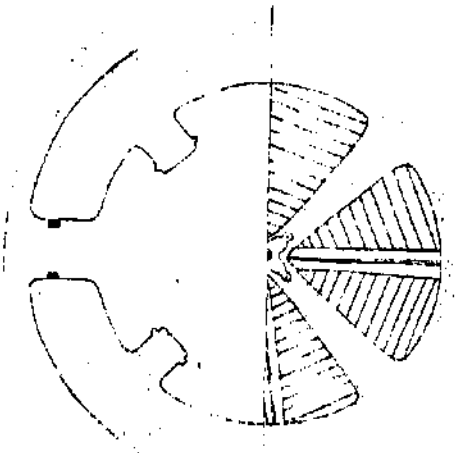


Fig. 10.14a

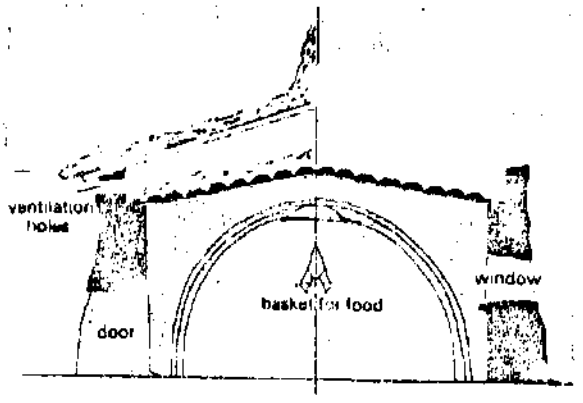


Fig. 10.14b

Although the room temperature is pleasant and well adapted to the climate, the room itself is small and the space taken up in the room by the arches reduces the space even more. The two intersecting mud arches spring from the floor where they

project 40cm (1'4") from the wall into the room. They are 40cm to 44cm (1'4" to 1'7") wide at the base and gradually taper becoming 26cm (11") wide near the crown. These massive arches are supplemented with long azara used as beams to ensure a circular form for the ceiling. Closely spaced pairs of 10cm (4") wide azara bisect each ceiling compartment thereby creating eight sections in the ceiling. The sections are spanned by contiguous azara of progressively diminishing dimensions to create a circular pattern.

10.20 Intersecting Transverse Arches Supplemented by Subsidiary Kafar Kaza

10.21 Outer Zaure, Gidan Sarki (Kurfi)

This moderate-sized zaure was commissioned by Sarkin Mohammed Sani, the grandfather of the present Sarkin Kurfi, in the late nineteenth century. The transverse arches support an irregularly shaped dome with the entry wall measuring only 4.40m

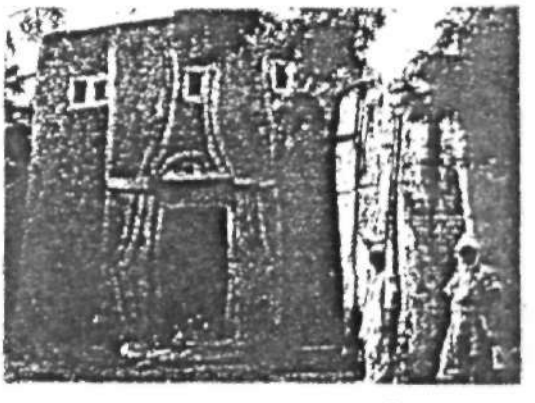


Fig. 10.21a

(14'5") while the opposing wall measures 5.65m (18'6"). The transition between the rectangular base and the domical form is crudely handled but the viewer's eyes focus on the supplementary arches which create a complex, revolving design in the soffit. A kafar kaza arch configuration spans the ceiling within each compartment created by the intersecting transverse arches. A kafa spans between the wall and abuts one of the transverse arches and is itself abutted by a shorter kafa springing from the adjacent wall. Tree branches are used for the infilling members. Those in the small, elongated spaces flanking the transverse arches span in the direction of the adjacent transverse arches. Those left over in the corner revolve in the counterclockwise direction. These latter infilling members rise to the third kafa of the kafar kaza

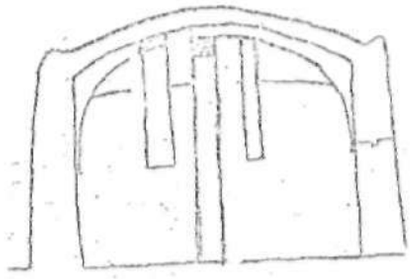


Fig.10.21b

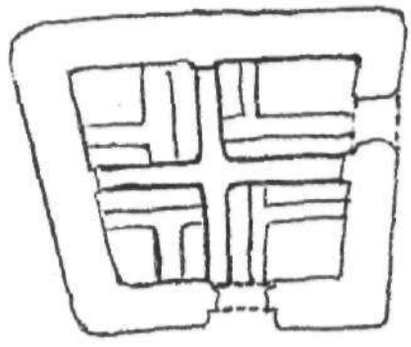


Fig.10.21c

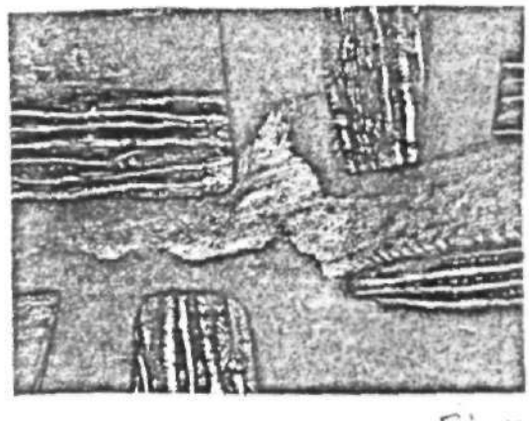


Fig.10.21c

in an awkward transition from the square corners to the curving dome. Soot from the many fires that have been lit in this zaure has left a glistening, black patina on the revealed ceiling.

10.30 Intersecting Transverse and Diagonal Arches

10.31 Inner Zaure, Gidan Makama, Kano

The reconstruction of Gidan Makama is a fine example of a dome resting on four arches which meet at a single point at the crown. The inner, domed zaure measures 5.19m x 5.55m (17'1"x18'2") and approximately 5.30m (17'5") high at the crown which is decorated with an imbedded tin plate.[2] The arches have been sufficiently plastered to ensure smooth soffits with uniform depth regardless of the actual depth structurally necessary.

Judging from contemporary construction methods, the first kafa to be joined were those

[2] Approximate measurements taken at the museum site in Kano.

forming the primary transverse arch which spans the shorter 5.19m (17'1") dimension followed by those forming the secondary transverse arch. Next, the kafa forming the diagonal arches were joined. The curvature of these diagonal arches ensures that the final form taken by the roof will be a dome rather than a cloistered vault.

The revealed ceiling provides an excellent example of one basic procedure the Hausa master master masons have adopted for transforming straight azara members into the webs of a dome. Two sets of tauyi are placed at each corner, each set resting on the diagonal arch and one of the adjacent walls. Wall-tauyi span the distances between these tauyi and the wall-tauyi. Thus the effective circumference and diameter of the space to be spanned is significantly reduced by tauyi. Short azara also form crown-tauyi spanning

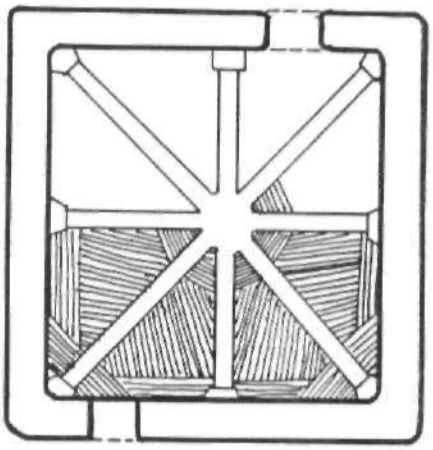


Fig. 10.31a

the space between adjacent arches near their meeting point. The space between these crown-tauyi and the perimeter wall-tauyi is spanned by azara placed at a vertical angle so their uppermost ends rest on the crown-tauyi or the diagonal arches.

10.32 Shigifa Nufawa, Emir's Palace (Birnin Kebbi)

. The Shigifa Nufawa is so named because it was originally used as the guest room for the Emir of Bida, the emir of the Nufawa (Nupe peoples). Six lofty arches support the dome for this room which measures 6.80m x 7.00m x 7.90m (22'4"x23'x25'11") The arches spring from huge, trapezoidal bases which project 55cm (10") into the space and rise to 1.80m (5'11"). The ornamental transverse arches are the focal point of the space. They are two-tiered arches joined by a lattice-work. The soffit of the lower portion rises to 5.00m (16'5") while the soffit of the upper arch which directly supports the permanent formwork of the dome skin rises to 6.50m (21'4"). To create the lattice-

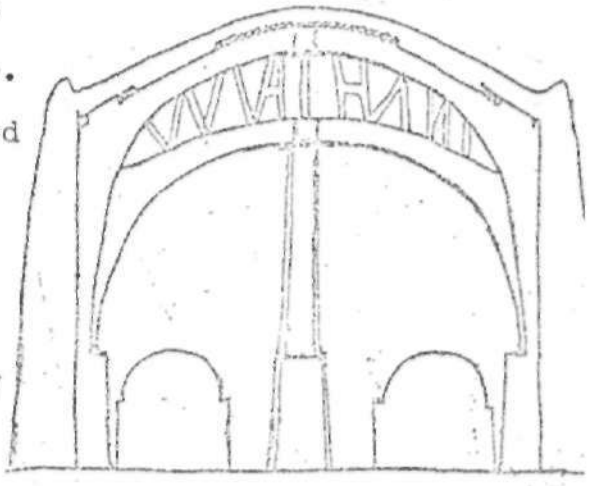
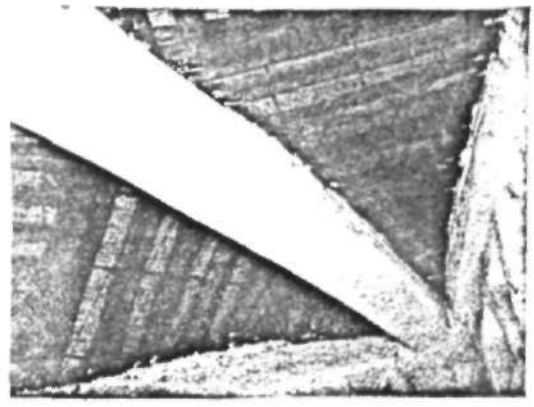


Fig. 10.32a

work, azara are wedged in place at an incline between the permanent formwork of the two arches. Then both the arches and the azara are plastered, creating soft contours.



The soffit of the dome skin reveals its structure, forming variegated circular patterns in the ceiling. Contiguous wall-tauyi span from arch to arch. Sets of twelve contiguous azara constitute the crown-tauyi. The dark brown colouring and texture of these inner and outer azara frames for the ceiling pattern are repeated by exposed, lateral beams which pass from arch to arch 1.80m (6'0) from the apex. These lateral beams create the octagonal base which enables the dome to take on a uniformly curved form and thus they play a vital role. Vertical, infilling members rise from the wall-tauyi to rest on these exposed beams. To distinguish the infilling members that



Figs. 10.32b
10.32c

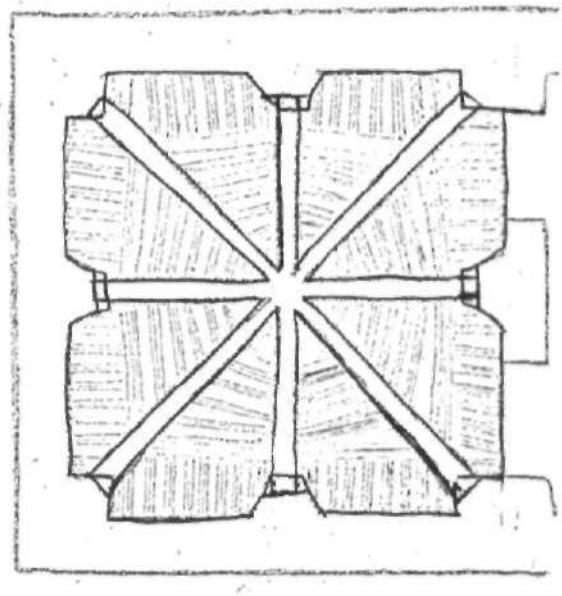
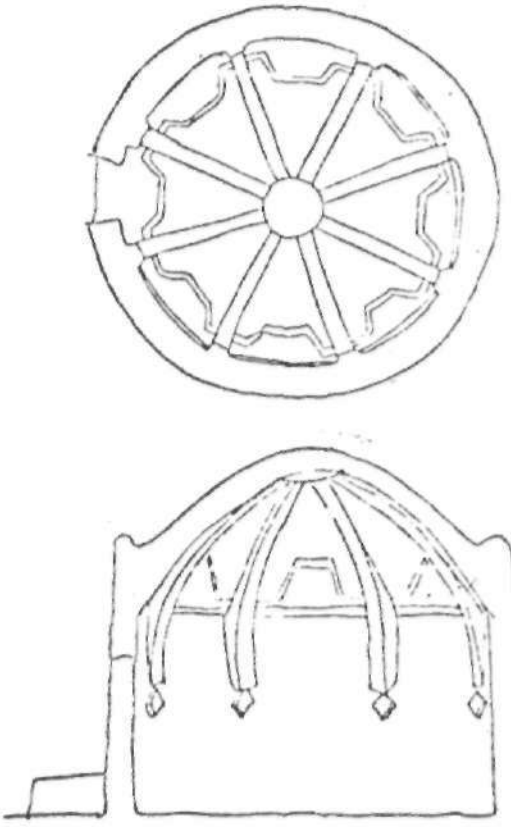


Fig. 10.32a

circle the dome above the beam from the beam itself, these azara are laid in sets of two with the soft yellow mat showing through the spaces between the sets. The careful workmanship coupled with the soffit and arch patterning create a simple but elegant ceiling pattern.

10.33 Round Zaure, Gidan Chief Imam (Zaria)

The lovely, round zaure of the head imam of Zaria measures 4.10m (13'4") in diameter and 4.26m (14'1") to the crown. It is supported on four intersecting arches in a configuration resembling intersecting transverse and intersecting diagonal arches. We have, therefore, grouped this zaure with those supported on intersecting and diagonal arches even though, strictly speaking, there are no diagonal arches.



Figs. 10,33a
10,33b

Simple relief work enhances the dome. Each of the arches

is embellished by a raised diamond shape placed immediately below the spring line. The lower portion of the soffit of the dome is decorated with a broad, fret motif. A large circular form covers the junction of the arches at the crown.

10.40 Intersecting Transverse and Diagonal Arches Supplemented by Lateral Beams

10.41 Small Livingroom, Gidan Magajin Gari (Katsina)

The Magajin Gari of Katsina, who has since become the emir, had a livingroom, bedroom and kitchenette suite constructed with a veranda in 1959. The pleasing contour of the small white dome over the livingroom attracts the eye of the passerby. The livingroom is basically a 400m (13') cube topped with a dome which adds an additional meter to reach the apex. The dome transforms what would have been a cramped livingroom into an elegant room which appears larger than it really is. The

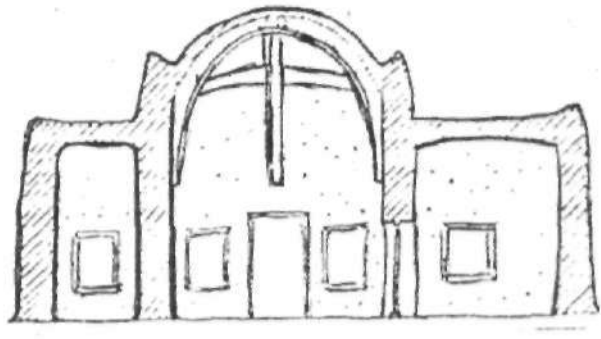


Fig. 10.41a

room measures 3.80m x 4.05m x 5.50m (12'6"x13'4"x18') to the central plate.

The dome rests on four arches, two transverse and two diagonal arches, just as in Gidan Makama; however, in this instance lateral azará beams, 5cm x 15cm (2"x6"), divide the dome two thirds from its crown. This subdivision formed by the beams which encircle the dome articulates the transition between the lower transitional and the upper domical portions of the dome. It also facilitates filling in the dome webs with the required curvature. Although the beams all meet their respective transverse arches 45cm (1'6") from the wall, they meet the diagonal arches at distances from the wall ranging from 90cm (3') to 70cm (2'4"). These variations are not surprising since the master mason has not considered it necessary to make the room a perfect square.

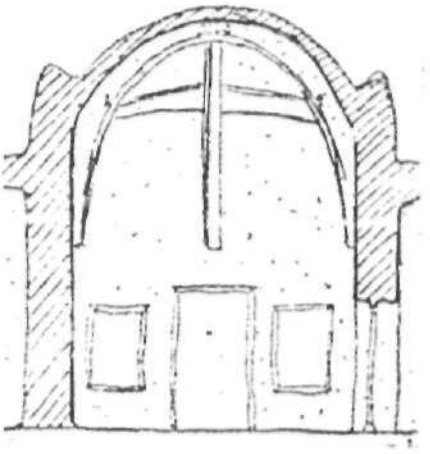


Fig. 10.41b

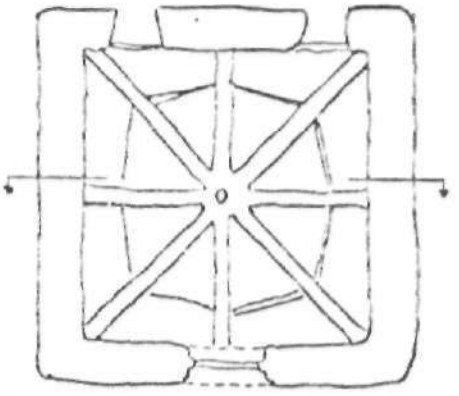


Fig. 10.41c

10.42 Maqsura, Friday Mosque (Dosso, Niger)*

In mosque architecture the maqsura is the bay adjacent to the mihrab which is reserved for the temporal ruler and the imam. Usually, it is screened off from the rest of the interior of the mosque and given special architectural treatment. In the case of the Dosso Mosque, the maqsura is a domed, bay double the size of the surrounding flat-ceilinged bays of the rest of the mosque. The double bay is partially supported on the articulated piers used throughout the mosque. These piers have been linked with a partition wall on the west side of the maqsura and by a broken partition wall on the south side. It is not clear whether the partitions were part of the original design or whether they were added in the fifties when many of the piers were awkwardly buttressed by encasing them in a huge mass of mud masonry.

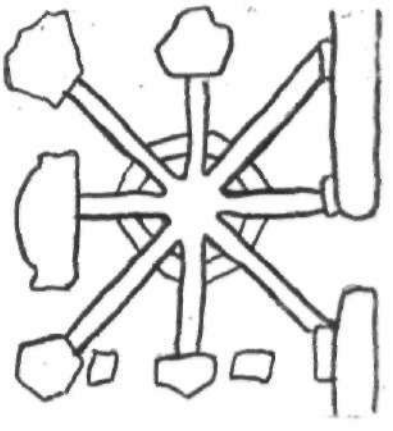


Fig. 10.42a

The dome of the maqsura rests on arches which are articulated as heavy ribs 30cm (1') deep forming a clearly delineated pattern against the background of deeply recessed coffers. The coffers are defined by these ribs in conjunction with lateral, lashed-azara beams which run parallel to the walls abutting the ribs about one third of their rise from the crown. They form an octogonal pattern which is criss-crossed by the diagonal and transverse ribs. The patterning of the ribs and these lateral beams, rather than the curvature of the dome, dominates our impression of the ceiling.

Although the heavy plastering of the arches makes it impossible to visually distinguish the primary transverse arch from the other arches it is probable that the primary transverse arch spans from the east wall to the opposite partition wall since the wall and partition are well suited to

absorbing the thrust of the arch. This east-west dimension is also the shortest dimension in this roughly shaped square bay which measures 4.00m by 4.50m (13'2"x 14'9").

10.43 Central Dome, Yangoro Mosque (Kano)[3]

Stark white ribs and smaller partially, whitened azara joists radiate from the large, pure white centre of the most important dome in the Yangoro Mosque. The impression given is one of stark beauty and purity. Pure white arches, two transverse and two diagonal, intersect to support the dome structure. Tauyi have been laid across adjacent arches to create a large octogonal backdrop to the intersecting arches. These centre-tauyi have been plastered and painted white. The soft, white azara joists emanate from the white centre like rays of the sun. These vertical two-by-threes have been partially whitened by a single coat of paint to stand out against

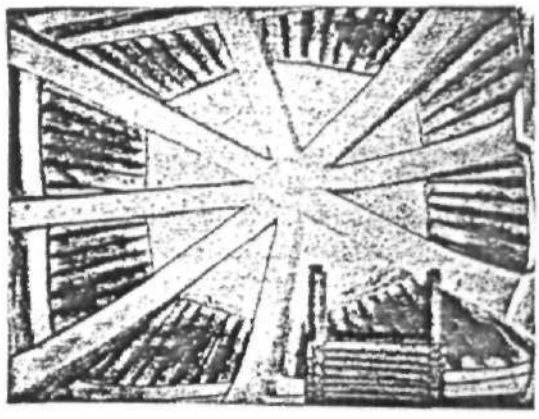


Fig. 10.43.

[3]The dome soffit is now hidden by a dropped ceiling

the soft, yellow ochre background formed by matting. They rest on a whitewashed, mud cornice which projects from the walls and upon the central "sun".

The dome itself is raised high above the floor on four huge columns which support a two-tiered systems of arches. Four flat, **baskethandle** arches spring from eye level to link the four columns. The arches are finished with a flat topped surface which forms the base and springline for the second tier of these superimposed arches. The diagonal arches supporting the dome spring from the junction of the huge columns and this flat surface. The transverse arches spring from a point on this surface mid-way between the columns. This second, tiered system includes the arches spanning from column to column along the periphery of the domical bay. These **peripheral** arches perform the usual structural functions of walls. They are surmounted by a double cornice

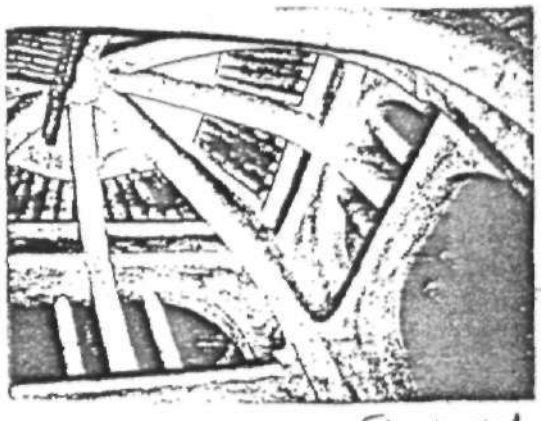


Fig. 10.43b



Fig. 10.43c

which forms the baseline for the dome. The "wall" arches are reinforced by whitewashed struts flanking each of the transverse ribs. The other bays of the mosque also rest on this light, airy two-tiered structure.

10.50 Intersecting Transverse and Diagonal Arches Supplemented by Arches Springing from the Base of the Transverse Arches to Abut the Diagonal Arches in the Dome.

10.51 Outer Zaure, Emir's Palace (Birnin Kebbi)

The structure or the construction of this extra large zaure which measures 7.90m (25'7") square and 7.90m (25'7") high ultimately proved inadequate. The free span has since been interrupted by the introduction of a central column to butress the apex. A non-structural 3.65m (12') high partition wall also divides the space. A large opening in this wall allows people to pass through the zaure to the inner parts of the compound.

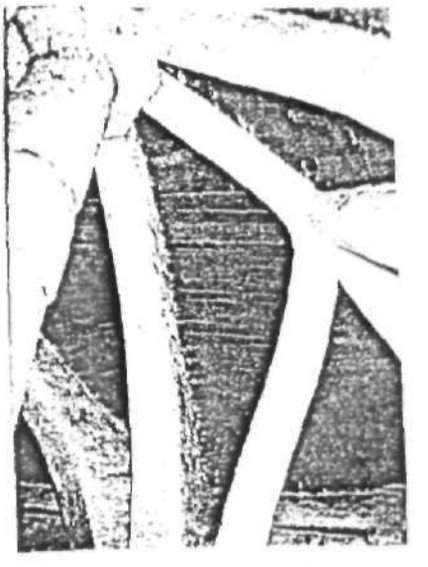


Fig. 10.51a

The basic structure of this

zaure space ressembles the Shigifa Nufawa[3] with one significant difference. Instead of having exposed, lateral beams reduce the distance to be spanned by infilling members, subsidiary arches spring from the bases of the transverse arches and rise to the upper half of the diagonal arches. These subsidiary arches gracefully embellish the dome and impress the viewer with their originality.

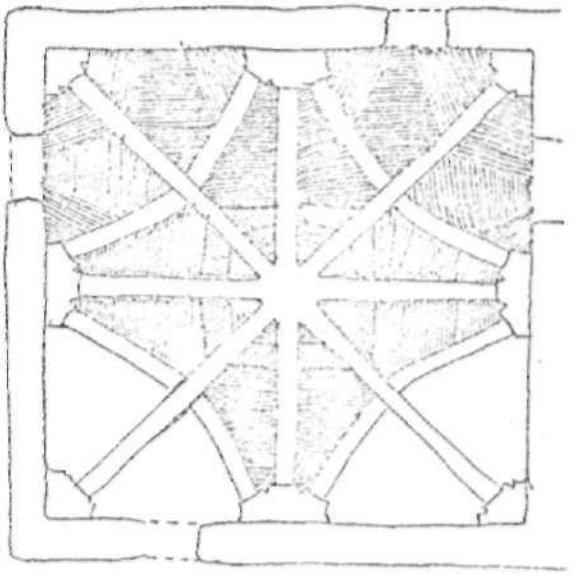


Fig. 10.51b

Although the play of intersecting arches is the highlight of this dome, the revealed soffit at the apex was handled with good taste and originality. The standard centrepiece of crown-tauyi has been encased in a rectangular framework of vertically aligned tauyi.

10.60 Intersecting Transverse and Intermediate Arches

10.61 Sharia Court, Zaria Mosque Complex (Zaria)

Depending on where the dimensions are taken, the Sharia Court measures 7.48m - 7.87m x 9.37m - 9.60m

[3] See above Section 10.33.

(24'7"-25'9"x30'9"-31'6") or an average of 7.70m x 9.20m (25'2"x 30'2"). It is therefore one of the largest rooms to be constructed with Hausa technology. Six arches intersect at the crown to form the dome. They rise from a circular base created by extending piers at varying distances from the square walls.

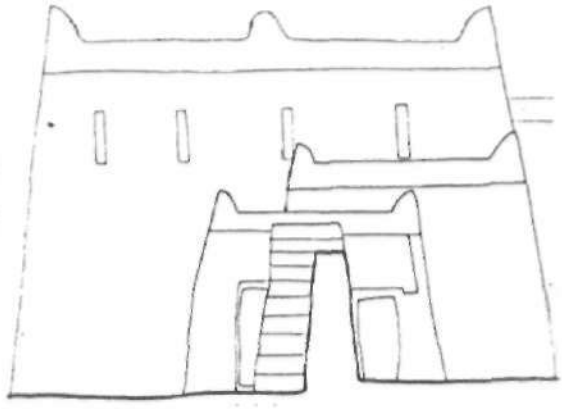


Fig. 10.61a

Babban Gwani chose to omit diagonal arches, presumably because they would have had to spring from piers that protruded very far into the space if the piers were to satisfy his requirement that they conform to the circumference of his dome. Intermediate arches served his purpose just as well, if not better. Two of these arches were placed adjacent to each transverse arch. This arrangement produced six arches which were all approximately equidistant from each other. The maximum distance between these arches is 1.52m (5'); consequently, it is never too great to be spanned by

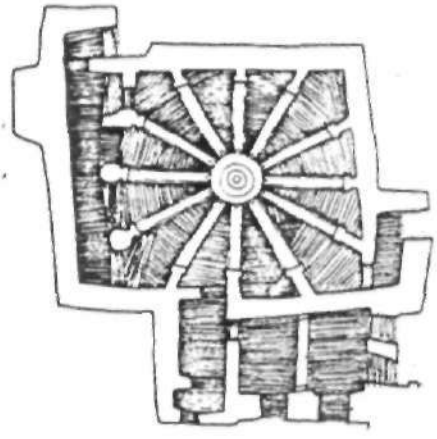


Fig. 10.61b

horizontally placed azara. The resulting ceiling pattern is simple and uncluttered with all the arches radiating like spokes on a wheel and virtually all the azara conforming to a twelve sided, circular, repeat pattern.

The focal point of the Sharia Court is the decorative boss which simultaneously embellishes the apex of the domes and masks the details of the junctures of the arches. Three levels of plaster encircle this boss which held a brass plate in the centre. The centre piece is fringed with triangular elements evoking sun rays. This theme is reinforced by the radiating structural arches.

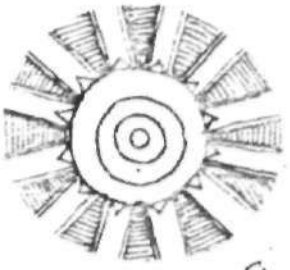
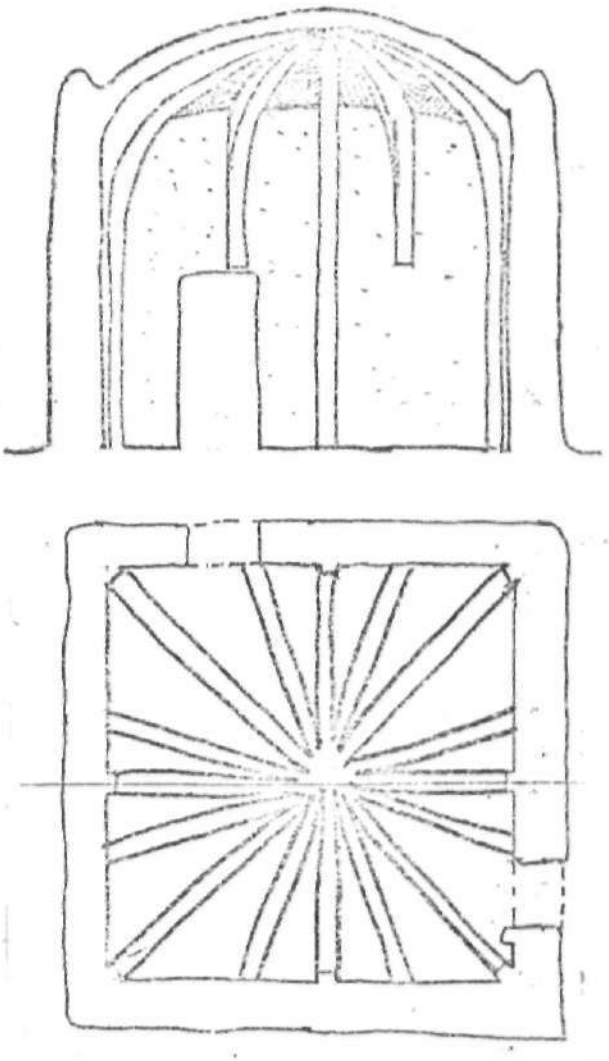


Fig. 10.61c

10.70 Intersecting Transverse and Diagonal Arches Flanked by Shorter Intermediate Arches

10.71 Inner Zaure, Gidan Chef de Canton (Dosso)

This moderately large zaure **5.50m x 5.62m x 5.70m (18'x18'2"x18'9")** rests on twice as many arches as the **inner** zaure of Gidan Makama which is only slightly smaller, 5.19m x 5.55m (17'1"x 18'2"). The additional ribs are valued for their decorative attributes rather than for any structural function they perform. The master mason has distinguished his essential arches from his decorative arches by carrying their bases all the way down to the floor. Thus both the transverse and the diagonal arches spring from the floor, as pilastres which taper gradually becoming arches at about 3.00m (9'10"). The intermediate arches bisect the spaces between these essential arches. They spring from just above eye level at 2.50m (8'2"). The master mason has used these intermediate arches in place of wall-tauyi and lateral beams; their form



Figs. 10.71a
10.71b

ensures that the dome assumes its proper curvature and their close spacing reduces the distances the infilling tauyi must span. Taking advantage of the short distance between arches, the master mason built up the curvature of the lower portion of his dome with short tauyi placed between the wall and an arch. Then he placed other azara infilling members on the edges of these tauyi. This uppermost level of azara rises above the tauyi giving a little fullness to the base of the dome.

At the apex, the arches have been narrowed in order to retain their separate identity; otherwise, they would have abutted each other below the crown. An alternative solution is to plaster the crown into the form of a circle as was done in the Sharia Court (10.61).

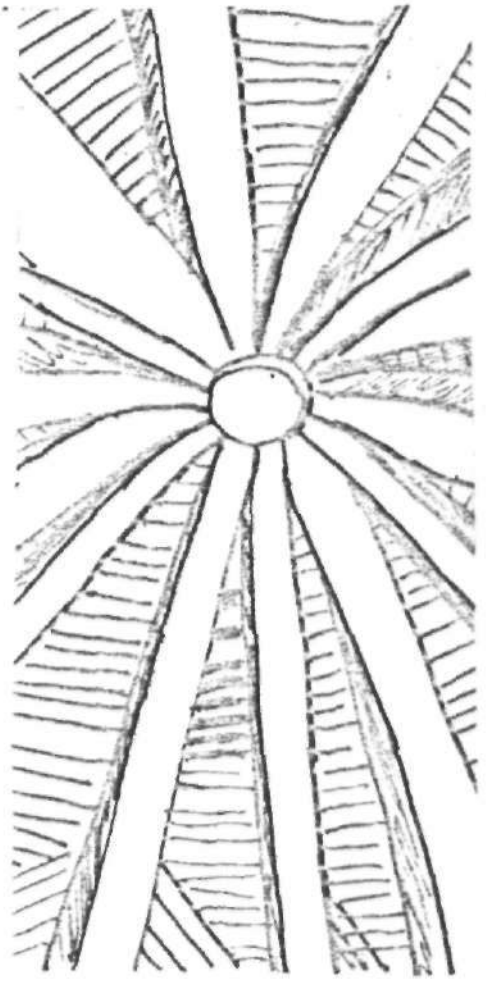


Fig. 10,71c

10.80 Intersecting Intermediate and Diagonal Arches

10.81 Inner Zaure, Gidan Chef de Canton (Dogondoutchi)*

This zaure is roughly a square measuring 4.80m x 5.06m (15'9"x16'7"). Although the floor plan of this room is slightly smaller than the approximately 5.50m (18') square floor plan of the inner zaure of the Gidan Chef de Canton at Dosso (10.71), the walls of both zaure are 4.50m (14'9") high. The Dogondoutchi inner zaure rests on six arches rather than eight as is the case for the Dosso inner zaure. The omission of transverse arches in Dogondoutchi is the key to the difference in their ceiling configurations.

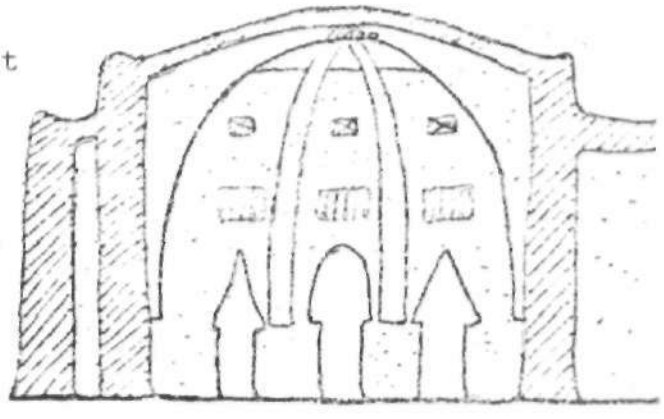


Fig. 10.81a

The Dogondoutchi zaure is a domed room within a larger, flat-roofed ambulatory surrounding the domed room. This more complex room was built in 1912-13 for Goah, the chef de canton, by Umaru, a son of the Sarkin

Gini Birnin Kebbi.[4] He was assisted by three Dogondoutchi masons as well as many labourers.

The scope of the architectural commission was doubtless inspired by the Dosso chef's outer zaure (11.71) which must have been visited by the patron. All four sides of the zaure are pierced by sets of three decorative doors topped by two rows of windows, three on each level. The symmetrical placement of these openings has forced the master mason to forgo the standard transverse arches. Instead, two intermediate arches spring from each wall in the space between the doors. Thus, these intermediate arches are structurally more important than their Dosso inner zaure counterparts. One of the intermediate arches must be the primary transverse arch even though it spans the distance on an angle. Although

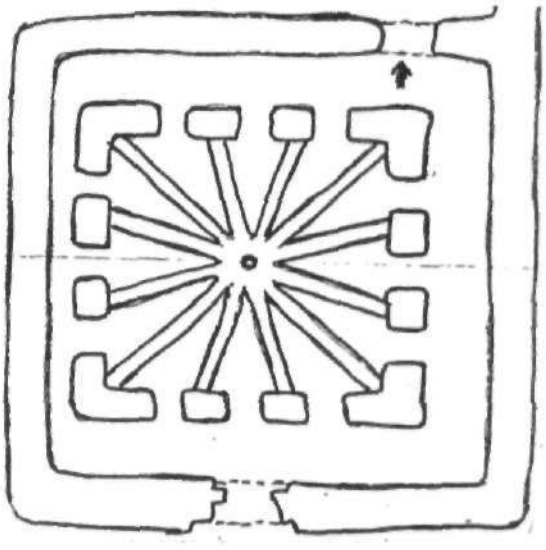


Fig. 10.816

[4] See above Section 2.51.

the triangular web between the arches is 30cm (1') wider at the base of Dogondoutchi zaure than at the base of the Dosso inner zaure, basically the same infilling patterns are used for the soffit permanent formwork.

10.82 Former Audience Chamber, Lugard Expedition Photographs, Emir's Palace (Kano)*

When Lord Frederick Lugard captured Kano in 1903 he was highly impressed by the Emir's Audience Chamber. He published a description of this domed room (Lugard, 1904) which provides an impression of the size of the room. It was approximately 7.60m (25') square and 5.50m (18') high. Twenty arches (He must have meant kafa not arches.) converged on the centre to support the dome which was decorated in black, white, pale green and glistening yellow. Alan Leary (1977) has published a reconstructed, scaled section

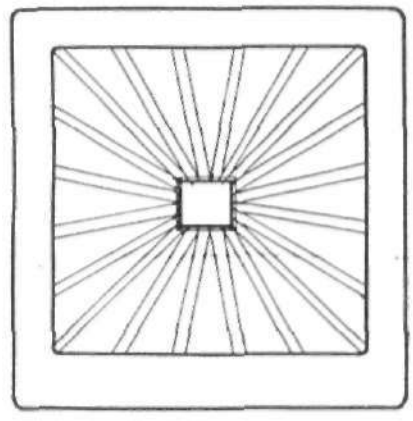


Fig. 10.82a

of this Audience Chambre based
on photographs taken in 1903
and now in the possession of
the Royal Geographical Society.
The twenty kafa were formed
by four intermediary kafa
springing from each wall
making a total of sixteen kafa
plus the four diagonal kafa.
This solution successfully
spans such a large space because
the distance between arches at
their bases is only a little
greater than 1.22m (4'-0) after
allowing for the width of the
arches themselves.

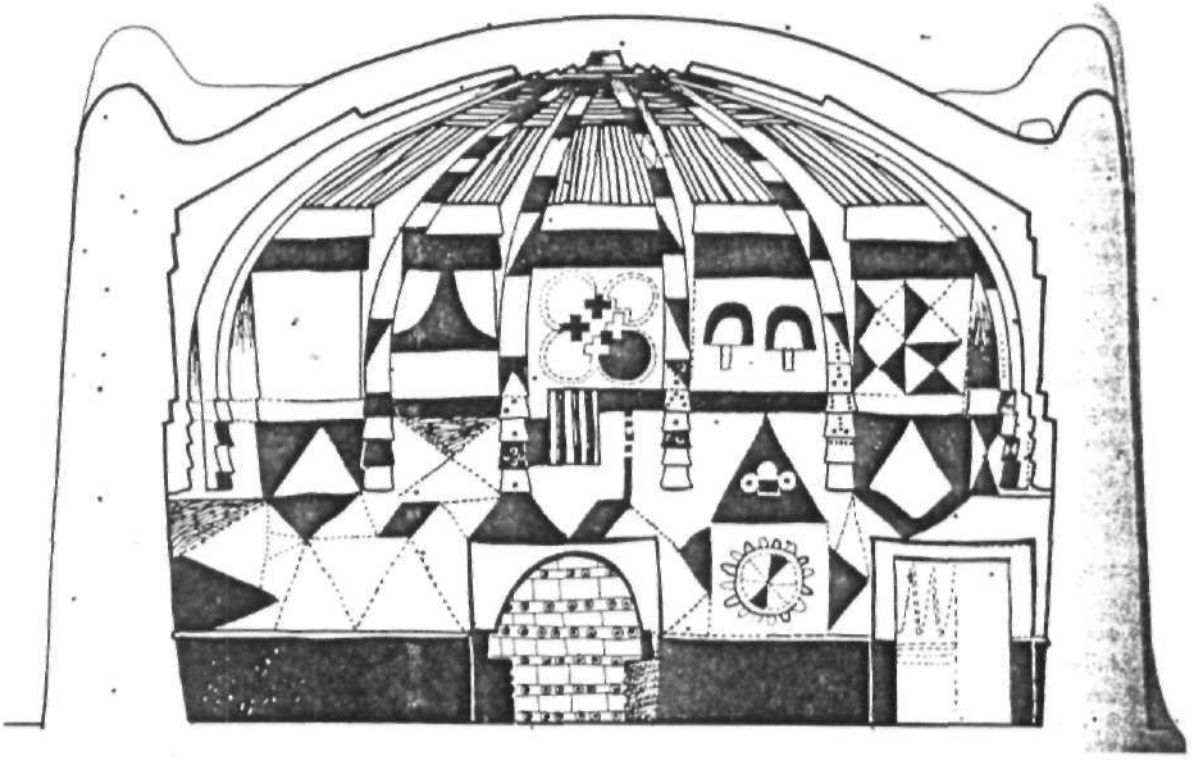


Fig.10.82b

CHAPTER 11

ARCHES FORMING CENTRAL COFFERS

11.00 Introduction

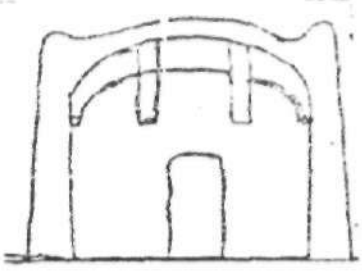
The curvature of many domes rests on intersecting arches which form coffers in the central portion of the soffit. As in domes based on arches meeting at the crown, the spacing of the arches is partly determined by the constraints of the domical form. Once the transition has been made to the uniform rising curvature, the arches are seldom more than a metre apart. Therefore larger domes rest on a greater number of arches. Soron Inglia (11.32) has sixteen coffers resting on two sets of five intersecting arches.

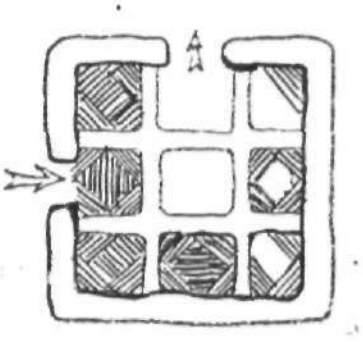
Since the peripheral transitional portion of the dome does not form part of the uniform curvature, the span between the coffer arches and the wall can be greater than one metre. In most cases, the peripheral area is handled with tauyi and wall-tauyi as in Gidan Magajin Gari, Maska (11.11) and in Soron Guga in the palace of the Emir of Kano (11.14). In some cases, diagonal arches form the transition to the circumference of the dome as in Gidan Madawaki, Katsina (11.51) and Gidan Mohammed Galadima (11.72). Lateral joists are also used to reduce large spans in the corner compartments. Infilling members can then span these sub-compartments, without creating a pitched contour in the lower part of the dome. Peripheral infilling members rise vertically to rest on these beams as in Gidan Madawaki (11.51).

11.10 Intersecting Pairs of Transverse Arches

11.11 Outer Zaure, Gidan Magajin Gari (Maska)

This small zaure supported on paired transverse arches has an unplastered ceiling which reveals the tauyi configurations the master mason used to achieve the domical form. Actually the dome is rather shallow. All four sides of the central coffer are 3.40m (11'2") from the floor at all points. Thus the central portion of each arch is flat, resulting in baskethandle arches. The arches are 43cm (1'5") deep near their apexes and about 25cm (10") wide so that they visually dominate our perception of the ceiling. These arches in conjunction with the tauyi patterning generate the slight curvature which forms this very shallow dome. Our impression that the ceiling is domical derives more from the form of the arches which recall many loftier domed rooms than from the actual form given to the ceiling.





Figs. 11.11a
11.11b

The compartments of the dome between the arches are built up with short azara and tree branch infilling members. The same system is used in each of the rectangular compartments located in the corners of the dome. A sloping tauyi builds up the corner of the dome. A crown-tauyi rests on the uppermost corner of each rectangular compartment. A pair of opposing tauyi span the remaining corners in the compartment resting partially on the first set of tauyi. Finally short members span the remaining space.



Fig. 11.11c

A different pairing of the tauyi is used for the four rectilinear compartments between the paired arches. Here all tauyi are built up simultaneously in each corner of the compartment with none superimposed on any of the others. The remaining infilling azara members are laid parallel to the outer walls.



Fig. 11.11d

11.12 Turaka in Village Compound (Zangon-Aya via Kaduna)

Domed room erected with tree branches rather than azara for reinforcement often use the coffer-forming arch configuration instead of relying on two intersecting arches.[1] Our example comes from a village house which was undergoing construction on the southern fringes of Zangon-Aya, 52km from Kaduna on the Zaria-Kaduna Road. The tree branches are locally available whereas the azara have to be imported from outside the area resulting in a significantly higher price for azara. In most instances the dome arches are designed and constructed to enable them to support the required roof without incorporating sufficient cantilevered branches and mud to create a truly rounded arch. In domes resting on two pairs of intersecting transverse arches, the dome is flattened at the crown. The masons are able to support a



Fig. 11.12a



Fig. 11.12b

[1] See above Section 10.12.

60cm (2') square coffer on their rough arches. A 60cm (2') square coffer high up on a lofty dome with a large span also results in a fairly flat, outer surface of the dome at the crown but this surface can be, and in better construction usually is, built up by the judicious placing of sets of tauyi corbelling out into the span and by ample use of mud to fill in, and round out the contours. The masons working in villages span the coffer efficiently without attempting to make it convex; hence, the domes are not really domes at all. They look like cloistered vaults.

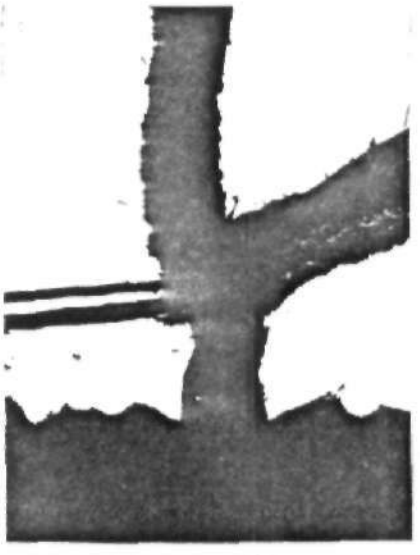


Fig. 11.12c

In our example, the room measures approximately 2.45m (8'0") square and rises to 2.55m (8'4") on the interior below the arches forming the coffer. Upon completion, the crown will only rise about 12cm



Fig. 11.12d

(4") more to 2.67m (8'9") at the soffit apex. The arches themselves are braced with tiers of reinforcing tree branches tied together in groups of three. One tier is virtually parallel to the wall, the next cantilevers out at a slight angle, and the third rises at a greater angle to meet the transverse arch rising from the adjacent wall from which point horizontal sets of three branches form the coffer. The first two tiers bring the arch 30cm (1') into the space and 20cm (8") above the wall height. The third tier spans the greatest distance and creates the pitch for the roof which rises to the flat crest of the central coffer.

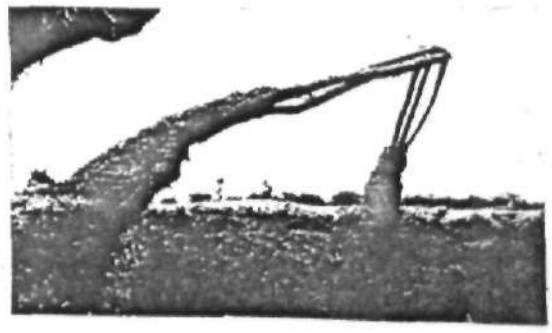


Fig. 11.12e



Fig. 11.12f

11.13 Zaure, Gidan No. 135, Mandarawa Quarter (Kano)

This moderate-sized zaure was built by Mallam Lawani who is still a practicing master mason conversant with both traditional and modern techniques. It is embellished with embossed

patterns; however, the entire room is painted white resulting in a relatively subdued atmosphere. The spring line of the pairs of intersecting transverse arches which support the dome is clearly defined. Not only is the spring line indicated by a string course of plain white moulding which encircles the room, but also the moulding is corbelled out about four inches at the base of each arch to form a visual support for the arch. In reality the arch is supported by slanted azara cantilevered out of the wall above the visual spring line. The string course which articulates this visual spring line is set off against elaborate embossed patterning on the walls above and below it so that it receives more attention than it would in a less decorative room.

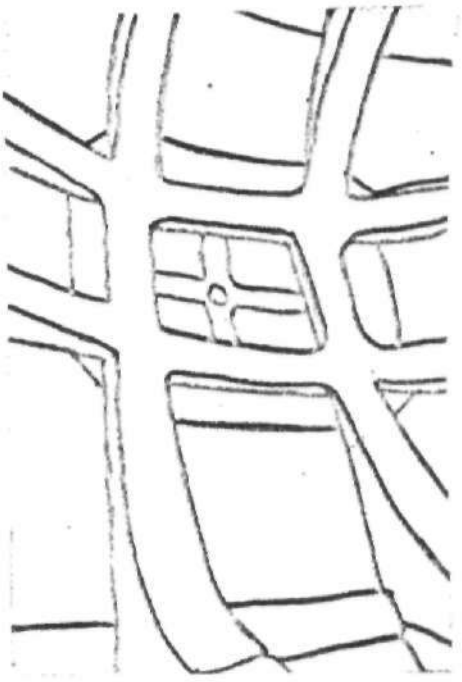


Fig. 11.13a

This string course is echoed by a set of wall-tauyi of similar

dimensions which encircles the base of the dome to form a visual cornice. This visual cornice is only interrupted by the tauyi which help to support it and to fill in the gap between the lower starting point of the dome at each corner as compared with the starting point of the dome at the centre of each wall. The master mason reiterates his string course imagery by providing a slightly raised plain moulding all around the edges of the central coffer. The entire visual imagery is climaxed with an embossed Greek cross formed out of intersecting, slightly raised strips that recall all the mouldings previously discussed.

11.14 Soron Guga, Emir's Palace (Kano)

The brilliant, multicolored embossed patterning of Soron Guga, the Emir's former throne room, dominates our perception of this lofty dome. The dome's structural system is not immediately apparent and yet closer inspection reveals

that the patterning conforms to the structural organization. The dome is supported on two pairs of intersecting transverse arches. The skin of the dome rests on large sets of corner and wall-tauyi. The dome of this moderate-sized room, 5.00m x 5.50m (16'3"x18') has been raised up on high walls so that its crown rises 8.00m (26'3") above the floor.



Fig. 11.14a

The spring line of the arches is articulated by superimposed cornices which function as string courses. The structural importance of the arches is underscored by the placement of windows in two corners immediately under the tauyi and high up on the walls between the arches. Another projecting cornice passes around the room to mark the junction between the walls and the ceiling. The tauyi are deeper than usual and would have interfered with our perception of the dome as a curved architectural

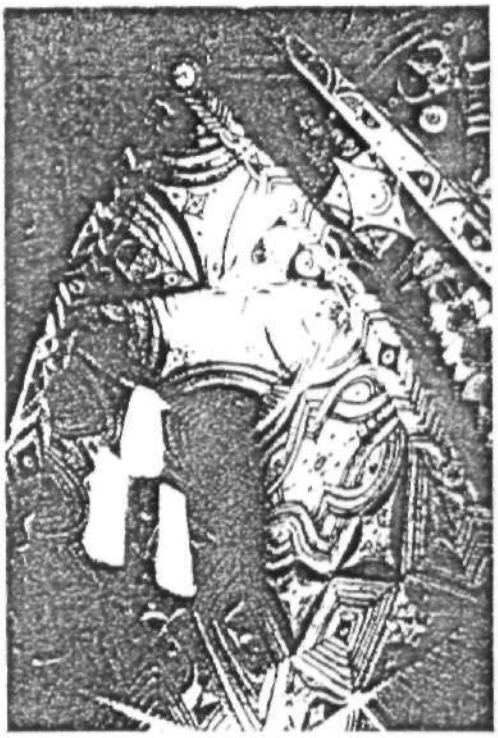


Fig. 11.14b

expression if the horror vacui decor had not been so over-powering. The shallower depth of the wall-tauyi renders them less perceptible. They rest on the arches and the tauyi.

The entire dome and wall surface had been heavily plastered with curvilinear embossed patterns The positioning of the patterns in the dome itself is approximately symmetrical although the patterns and colours on the parallel curving forms of the arches are so varied that the symmetrical nature of the overall pattern is diffused.

The unity of the overall design is achieved through the repeated use of a single basic design approach. Each motif is repeated with a series of parallel lines echoing the motif in ever larger dimensions somewhat like the ripples of water generated by a dropped stone. These multiple outlines are gouged out of a thickly plastered



Fig. 11.14c

surface to create the embossed effect. The hollows and ridges are each painted in one of a limited number of bold, bright colours— red, black, green, yellow, and off white. This combination of multiple outlines and solid colours unifies the entire soffit by creating a bold, harmonious ceiling pattern.

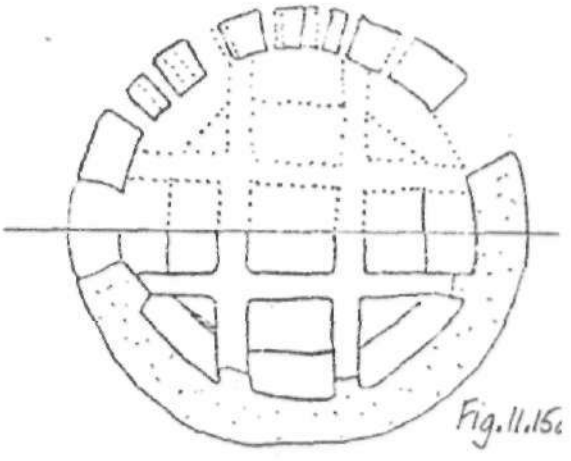


Fig.11.15c

11.15 Round Zaure, Gidan No. 101 (Limam Quarter, Zaria)

This round zaure in Limam Quarter demonstrates that intersecting arches forming a central coffer are also used to support domes resting on round spaces. The lower portion of this dome is well lit by narrow openings and by the two doors. One leads to the street and the other leads to the interior of the compound.

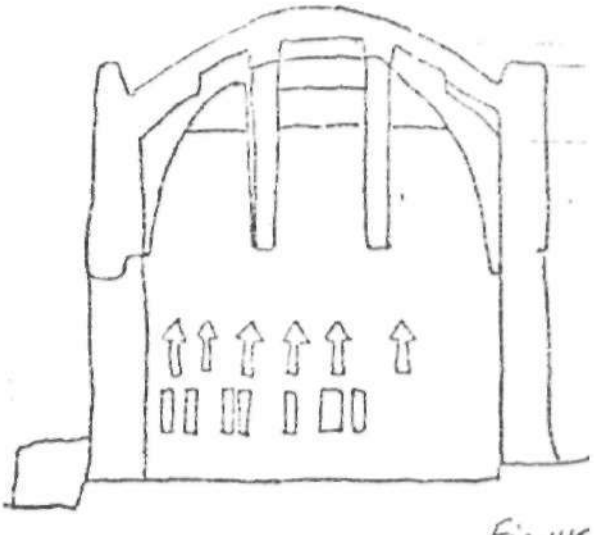


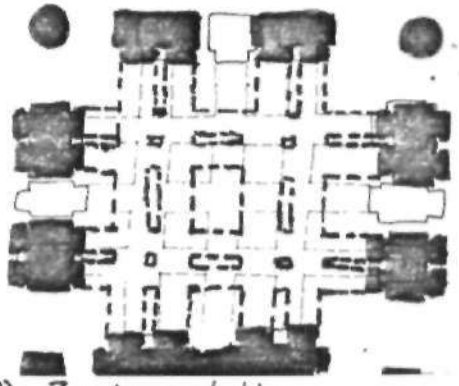
Fig.11.15

11.20 Intersecting Pairs of Twin Transverse Arches

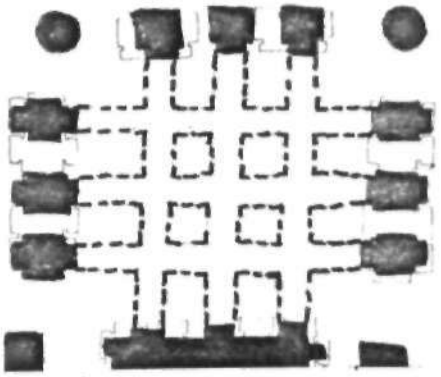
11.21 Central Bays Friday Mosque (Zaria)

Babban Gwani has taken the doubling of the arches to increase

the dome span as a distinctive feature of his design for the Zaria Mosque. It is especially evident in the domes of the two central bays which each span spaces more than 6.40m (21') square. Columns and piers support the lashed-azara beams which define each bay. They also support the dome armature which consists of two sets of twin intersecting transverse arches forming a coffer. This doubled twin arch configuration results in the intersection of our arches in each direction. Moughtin (1972) argues cogently that the use of pairs of twin arches frees the portion of the bay facing the mihrab. Intersecting sets of three arches is the standard solution for 6.40m (21') square spaces. If the standard solution had been used, the middle pier supporting one of the three arches would have blocked the view of the mihrab.



(1) Zaria solution



(2) standard solution

Fig. 11.21a

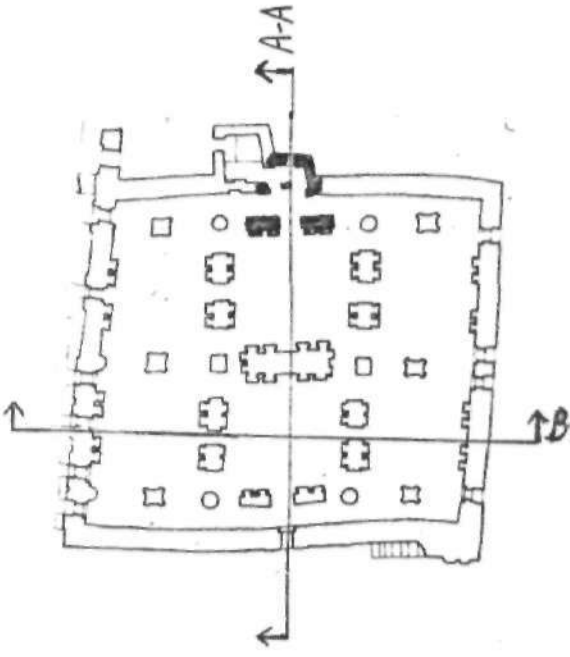


Fig 11.21b

For Section A-A, see Fig. 11.21e, p. 242.
For Section B-B, see Fig. 11.21h, p. 244.

Babban Gwani's unique solution provides a better articulation of the space. It is also safer because the weight of the dome is more spread out on the arches and piers. The central, freestanding partition helps to support the weight of both of the large central domes. Exposed lashed-azara beams link all the piers in each central bay to form approximately square bases for the domes, each measuring roughly 7.00m x 7.30m (23'x24') if the projections resulting from the engaged column/arch structures are disregarded. All the arches rise out of their respective piers as engaged columns which project about 41cm (1'4") from the core of the pier. In both domes, the arches which rise from the huge freestanding wall partition to span in the east-west direction appear to be the primary transverse arches. The spans of these arches vary from 6.30 (20'8") to 6.40m (21')

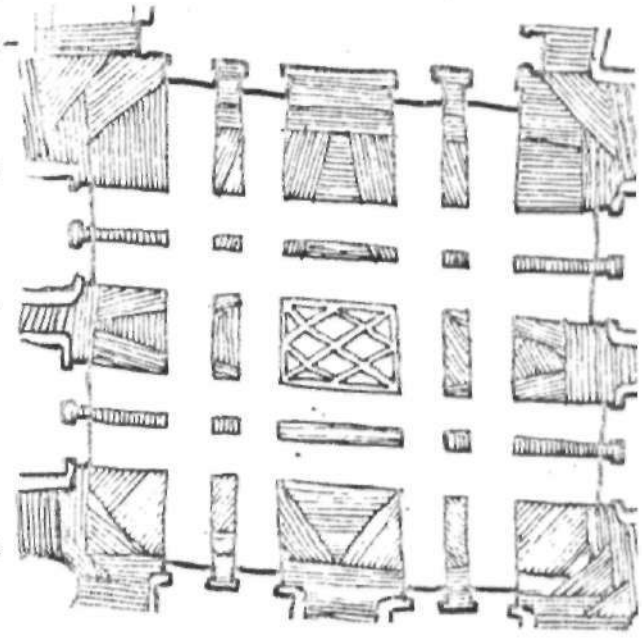


Fig. 11.21c

in the east-west direction. The north-south arch spans also vary but each span is greater than 6.40m (21') and some spans attain 6.70m (22'). Thus the east-west spans are shorter and they have more substantial support, the huge partition, than the north-south spans.

The weight of all the sets of twin arches rests on composite piers except for the four sets of twin arches which rest on the freestanding wall partition between the two domes. The composite piers adjacent to the lateral bays are double-faced with engaged columns rising from both sides. The engaged columns on one side support the central domes while those on the other side support the lateral vaults. In accordance with the extra weight they support, the main body of these piers measures 90cm (3') thick by 1.50m (5') long whereas the piers at the far ends of the central

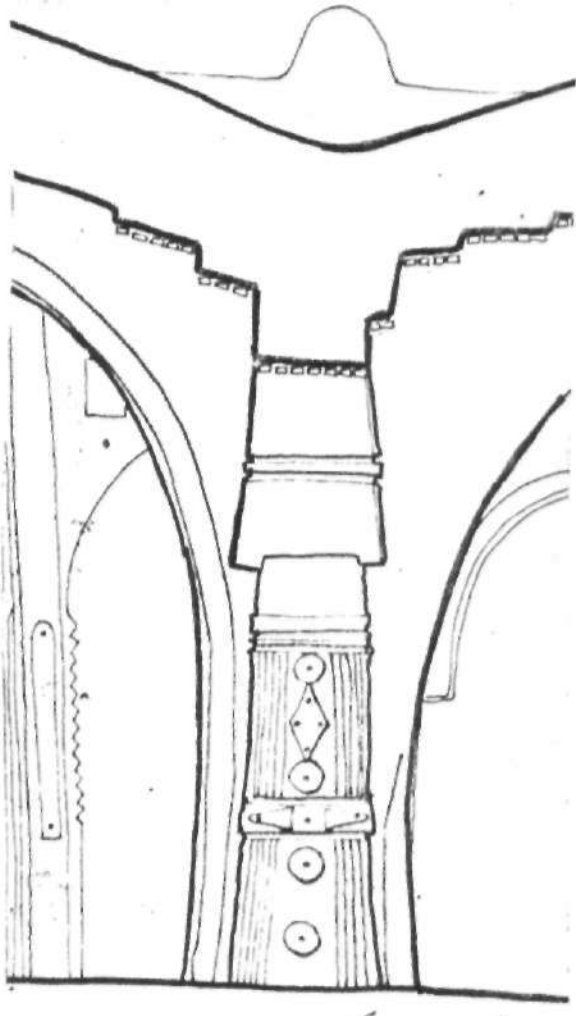


Fig. 11.21d

section only measure 60cm (2') thick each.

The arches dominate our impression of these domed spaces. They form slightly flattened, hemispherical arches which rise to their crowns 5.00m (16'5") above the ground as stilted arches. The primary transverse arches and the secondary transverse arches spring from their engaged column/arch base at 1.50m (5') and 1.80m (6') respectively. The centremost arches are actually 60cm (2') deeper than the soffit permanent formwork. Their flanking twin arches descend even lower into the room to form a smooth soffit with the arches which they intersect.

Unlike the hemispherical soffit of the arches, the soffit of the dome skin forms a shallow stepped arc. In Section A-A which shows the span

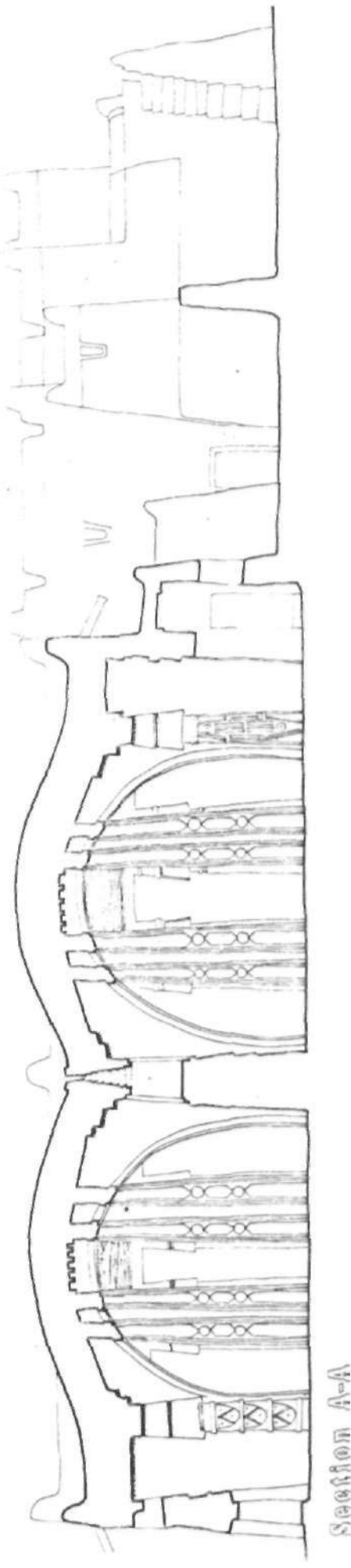


Fig. 11.21e

of the primary transverse arches, the formwork only rises 90cm (3'-0) above the height of the initial brackets. This 90cm (3'-0) rise occurs over a 7.31m (24') span. It is effected in staged corbelling out from each side of the dome. First, brackets project from the tops of the piers. Next, wall-tauyi are placed on the backs of the arches. This is followed by the most dramatic rise. The 46cm (1'6") span between the wall-tauyi and the intersecting arch rises 30cm (1') by means of superimposed tauyi. The remainder of the rise occurs on the backs of the intersecting arches. The coffer itself is flat.

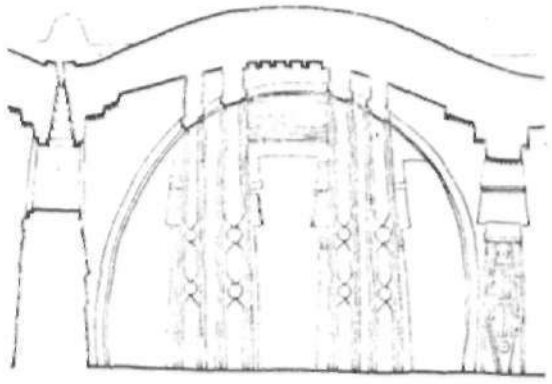


Fig. 11.21f

The superimposed tauyi at the corners act in conjunction with the wall-tauyi between the central arches to transform the square base into an octogonal form which allows for a uniform slope in the dome up to the crown. Although the available sections

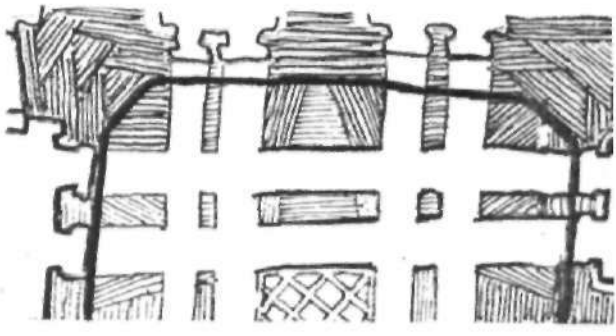


Fig. 11.21g

are not cut through the corners, it would appear from the reflected ceiling plan that the superimposed tauyi rise in regular steps approximately 15cm (6") at a time until they are flush with the intersection of the flanking arches. The vaulting rise in Section B-B is similarly constituted. These tauyi also support the weight of the portion of the ceiling/roof directly above them; however, they do not receive the weight of a great deal of the dome itself. Most of the weight of a Hausa dome is transferred to the arches and through the arches to the walls or in the case of the Mosque, to the piers.

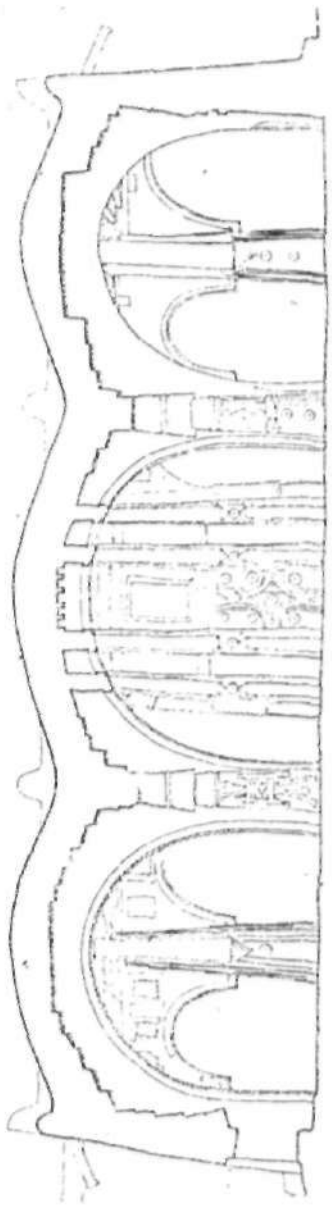


Fig. 11.21h

The patterning of the infilling members in the soffit permanent formwork has been skillfully handled to create a four pointed star pattern emanating from the central coffer. Babban Gwani also highlights this central coffer by changing the finishing. In contrast to the revealed formwork in the rest of the ceiling, the central coffer is embellished with an embossed diamond pattern.

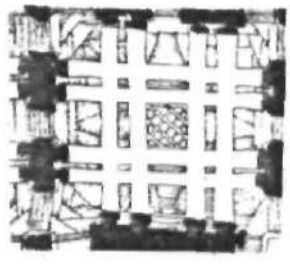


Fig. 11.21i

11.30 Intersecting Multiple Transverse Arches

11.31 Sets of Three

Princess's Upper Storey Room, Old Treasury (Kano)*

In the early nineteen seventies, it was possible to view a three dimensional "section" of a Hausa dome by visiting the ruins of the Princess's Room in the upper storey of the Old Treasury in Kano. Unfortunately, before measurements could be taken, the room was completely destroyed to make room for the major road which now cuts through the old city. Photographs provide us with a clear understanding of the structure because the room on the upper floor was virtually sliced in half when it caved in.

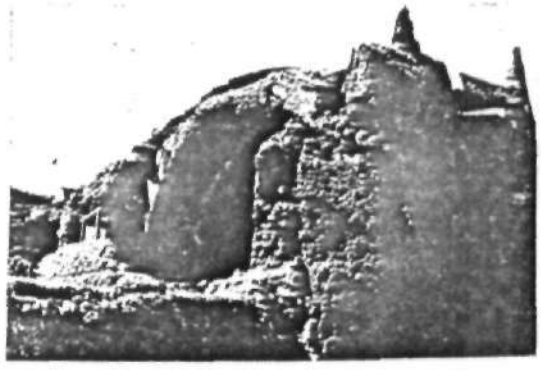


Fig. 11.31a

The photographic section shows that the dome was supported on intersecting sets of triple transverse arches. These arches have taken on a flattened, basket handle form; they do not appear to rise once they

have intersected with another transverse arch. Their intersections form four square coffers in the centre of the room all framed by horizontal segments on approximately the same plane.

The slight transition required to raise this shallow dome above the square walls is achieved by tauyi and wall-tauyi. The Princess' Apartments are also noteworthy for their elaborate embossed, coloured interior patterning which has been discussed at length by Heathcote (1973).

11.32 Sets of Five

Soron Inglia, The Throne Room, Emir's Palace (Kano)

Soron Inglia is the largest of the Emir of Kano's official reception rooms measuring 7.50m x 8.25m x 9.00m (24'7"x27'1"x29'6"). This relatively shallow dome raised high upon two sets of five transverse arches was built in 1934. The large span of Soron Inglia is a direct result of this

multiplicity of intersecting transverse arches. The flattened basket-handle arches are stilted to achieve greater height in the dome.

Despite the large dimensions of this dome, tauyi play a minor role in its formation; the arches adequately support the skin of the entire dome except for the peripheral base and the corners. The backs of the arches dome up to form the curved portion of the dome. The lower portion of the dome exhibits the greatest pitch. The skin of the dome is built up in this portion with sets of tauyi. Deep tauyi span between the corners of the room abutting the adjacent transverse arches. At the base of the dome, wall-tauyi start from the centre of these tauyi and pass behind the arches all the way to the next tauyi. The coffers which act as the crown are completely surrounded by a narrow 30cm (1') rim of tauyi except at the



Fig. 11.32a



Fig. 11.32b

corners where tauyi extend more than twice that far into the corner web. The entire dome sits visually on a flat, 30cm (1') high cornice which projects 8cm (3') from the wall. The arches supporting the dome appear to spring from a series of three cornices each projecting 5cm (2") from the wall and spaced about 30cm (1') above one another.

Two sides of the room are illuminated and ventilated by double rows of windows placed between the arches. The windows contribute significantly to our sense of scale and also allow us to appreciate the designs in the ceiling of this room. The windows are ensconced in the wall surface between the two string course mouldings, one above eye level at the height of a normal room and the other at the junction between the dome and the walls.



Fig. 11.32c

The entire wall and dome soffit is covered with horror

vacui patterning. The decor is much more subdued than the patterning in Soron Guga. The decoration is painted rather than embossed and appears to be painted onto a grey background rather than covering the entire surface. The designs are rendered in black and white with the grey background often being handled as though it is a third pattern colour.

11.40 A Single Transverse Arch Intersecting Multiple Arches

11.41 Guest's Room, Panisau Palace (via Kano)

This arch configuration is a rare version of the standard coffer-forming arch configuration. No coffer in formed because the three parallel arches only intersect a single arch. Thus, the master mason has created a variation on the standard theme for this room which measures 5.90m x 6.50m (19'4"x21'4"). Corner-tauyi assist in the transition to a shallow domical form and centre-tauyi flank both

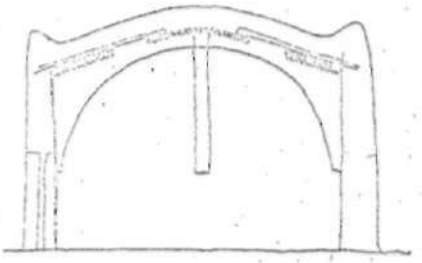


Fig. 11.41a

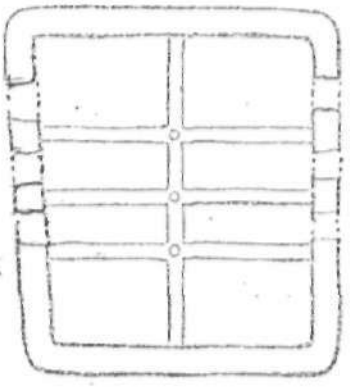


Fig. 11.41b

sides of the single transverse arch as through they were the outer edges of a central set of coffers. Only the arches and the edges of the tauyi have been plastered and whitewashed so they contrast starkly with the dark, azara infilling members. The arch junctures are further highlighted with brightly coloured, embedded enamelware plates.

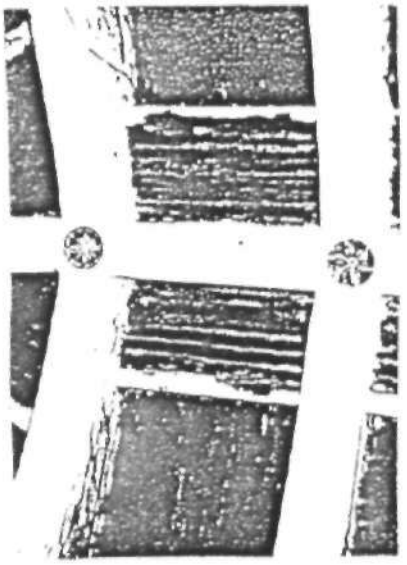


Fig. 11.41c

11.50 Intersecting Pairs of Transverse Arches Abutted by Diagonal Kafa

11.51 Outer Zaure, Gidan Madawaki (Katsina)

In contrast to many of the zaure belonging to titled officials, the outer zaure of the Madawaki of Katsina is "modern" in its clarity of lines and lack of decoration. It was designed and built in 1960 by Alhaji Muazu the talented master mason who also built the flat-ceilinged zaure for Gidan Alhaji Yusufu Danburimi (6.31). Muazu designed a domed zaure for the Madawaki of Katsina. Six

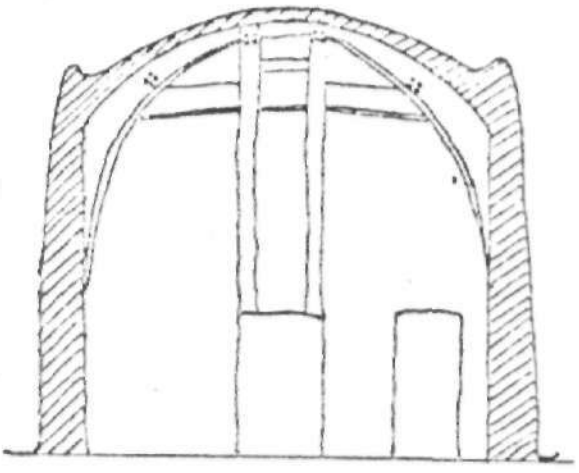
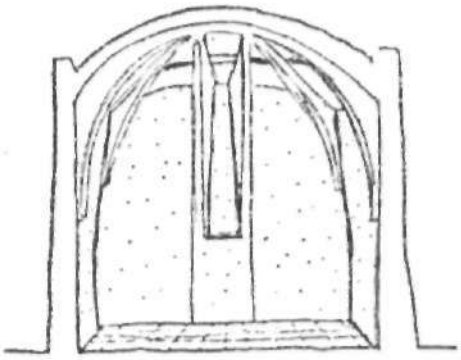
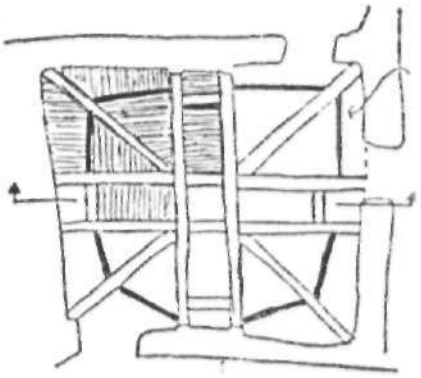


Fig. 11.51a

arches meet to form a coffer over this domed space which measures approximately 5.10m x 5.70m x 5.95m (16'9"x18'8"x19'6") As in Gidan Alhaji Yusufu Danburimi, the pair of primary transverse arches which form the main support are visually united; however, here the recessed, stepped moulding is omitted. The arches are merely joined by a slightly protruding dado.





Figs. 11.51b
11.51c

Muazu has thinly plastered the interior surface of the dome allowing the basic structural divisions of the dome to be revealed. A horizontal break in the smooth inner surface of the dome is left visible to articulate his use of a 2"x6" (5cm x 15cm) azara joists to span the space between the diagonal arches and the arches adjacent to them. Although not essential structurally, these horizontal joists permit Muazu to use shorter infilling members in the lower portion

of the dome. The minimal pattern formed by these beams on the ceiling is unobtrusive and yet pleasing to the eye as it accentrates the dome form.

The master mason springs the backs of the arches supporting his dome from a lower height at the corners because the distance to be spanned from the wall to the apex of the dome is greater from the corners than from the wall centres. The greater distance generates a larger arc which would bulge out beyond the surface of the dome if the master mason had not lowered the spring points of each diagonal arch. The slight curve of the moulding at the top of the walls as it rises from the corners towards the wall centres serves to highlight this architectural refinement.

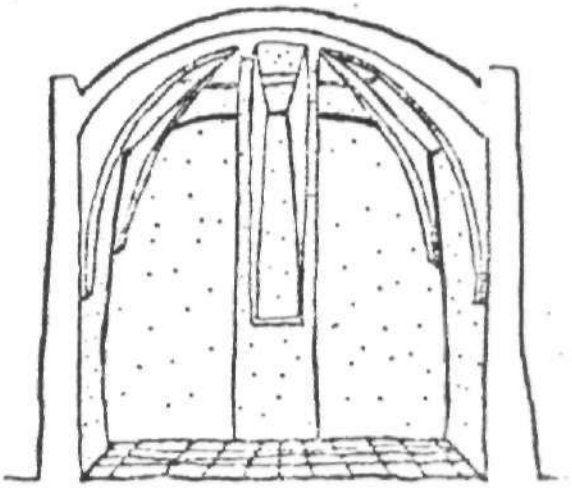


Fig.11.51b

11.60 Intersecting Multiple Transverse Arches Abutted by Diagonal Kafa and False Ribs

11.61 Outer Zaure, Gidan Alhaji Barmo Makudawa (Katsina)

This is a moderate-sized zaure, especially considering the complexity of the arch configurations and the supplementary, recessed beams. It measures 4.65m x 5.00m (15'3" x 16'5") and rises to approximately 3.66m (12') at the juncture between the wall and the dome and to 4.27m (14') at the apex of the dome. Sets of three transverse arches intersect each other to create four central coffers. The coffers are about 25cm (10") deep. Recessed diagonal arches abut the corners of the coffers to ensure the proper transition from the square walls to the domical form. Both the junctures of the intersecting arches and the diagonal arches are embellished with colourful enamelware plates which stand out brightly against the stark

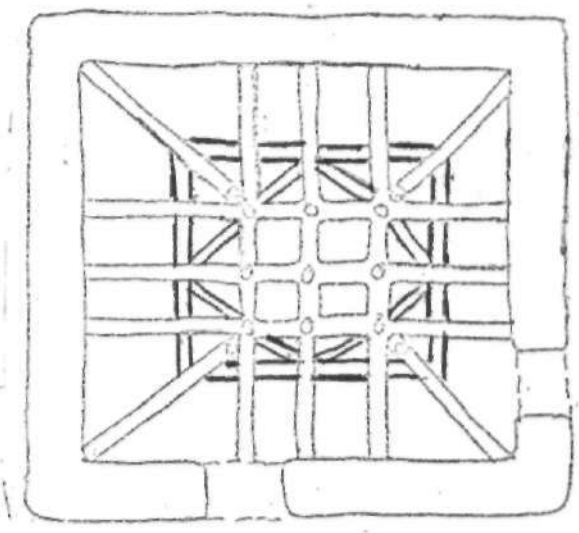


Fig. 11.61a

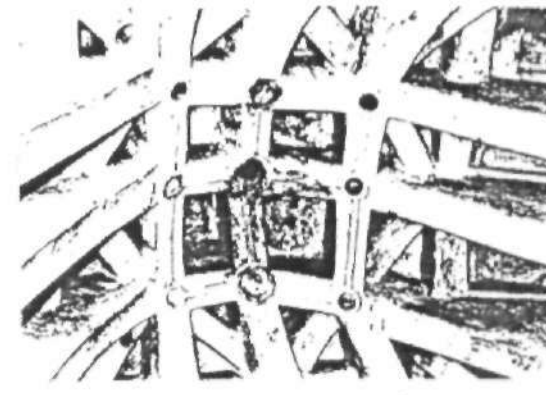


Fig. 11.61b

white of the dome soffit.

Recessed, lateral beams are incorporated into the soffit as a form of embellishment and as a means of bracing the rising arches.[2] These beams are laid parallel to the outer edges of the central coffers. In the ceiling plan, they create a base beam which surrounds the central coffers. In addition, a set of recessed, false ribs bisects the supplementary coffers to form a large square which encases the central coffers on the diagonal. Thus two large sguares encase the central coffers, an inner one on the diagonal formed by the false ribs and an outer one parallel to the edges of the coffers.

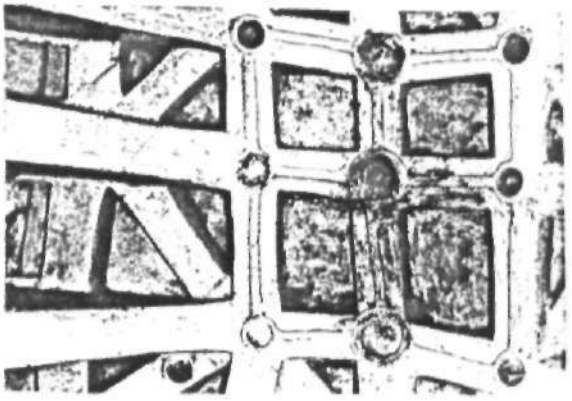


Fig. 11.61c

11.70 Intersecting Multiple Transverse Arches and Diagonal Arches in Conjunction with a Central Coffer

11.71 Outer Zaure, Gidan Chef de Canton (Dosso)

In order to achieve a highly decorative and imposing

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[2] See above Section 8.13.

effect in this official zaure, the master mason designed a dome supported by many more arches, than structurally necessary. The dome spans a moderately large space measuring 5.28m x 5.35m x5.65m (17'5"x17'7"x18'6"). The main structure of the dome consists of three transverse arches and the diagonal arches supplemented by subsidiary ribs which abut most of the principal arches. These subsidiary ribs spring in pairs from either side of both coffer-forming arches and of the diagonal arches. They abut these principal arches about half-way between the wall and the dome crown. Structurally these ribs ensure that the dome maintains a domical form by providing closely spaced supports for the tree branches which constitute the permanent formwork of the dome skin.

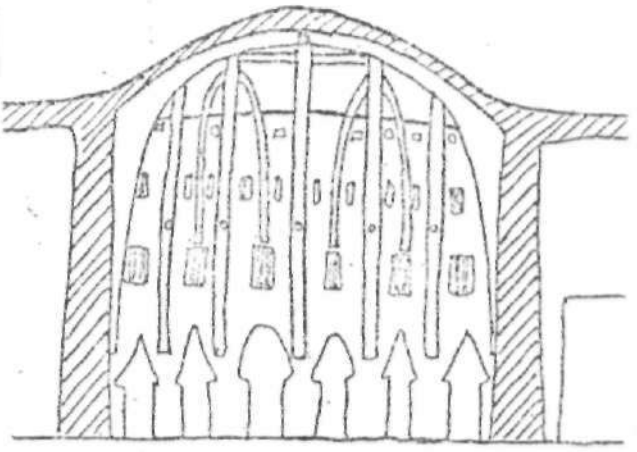


Fig. 11.71a

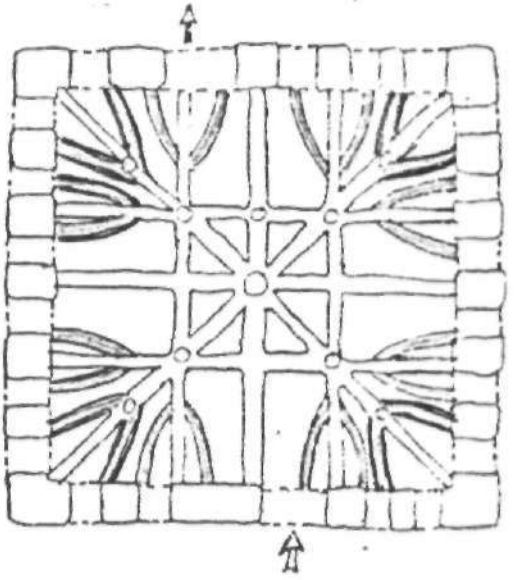


Fig. 11.71b

The pattern formed by the multiplicity of arches and supplementary ribs was of paramount importance in determining the size and position of the arches. The principal supporting arches spring from much lower on the walls of the room than is structurally necessary; they form vertical mouldings which rise between the numerous low, decorative door openings which open out into the outer ambulatory surrounding the domed room. The narrower, subsidiary arches descend only two thirds of the length of the principal arches, terminating immediately above grille-filled windows which are located between each of the principal arches. Fifty centimetres above the window grilles another two, long, narrow windows flank each of the subsidiary arches. Just under the transition between the wall and the dome, a final row of tiny openings more irregularly spaced is barely visible.

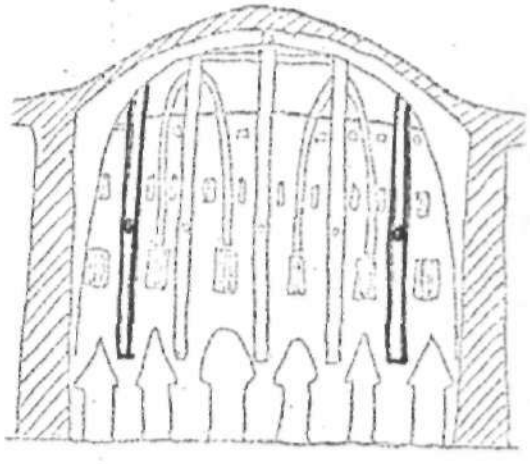


Fig. 11.71c

Note that the subsidiary arches flanking the diagonal arches are handled like pseudo-principal arches. They are treated visually as though they were of the same structural importance as the transverse arches and the diagonal arches. They have a comparable breadth and appear to spring from the same low height. Thus they create the impression that the dome is supported on intersecting sets of five arches. These subsidiary arches also serve to embellish the dome and play a minor role in helping to ensure the domical shape of the dome. The master mason's subtle play between principal subsidiary arches lends the aura of grandeur associated with intersecting sets of five arches to this moderately large zaure.[3]



Fig. 11.71d

11.72 Zaure, Gidan Mohammed Galadima (Tondobu Quarter Dosso)

The ceiling pattern for this

[3]See below Section 13.60.

zaure is clearly derived from the arch pattern of the outer zaure of the Dosso chef de canton. The zaure was built by Mohammed Galadima, a successful Hausa trader who emigrated from near Bauchi in Nigeria and finally settled in Dosso where he runs a profitable small, shop selling an assortment of tinned goods and other imported items. He had his zaure and the rest of his compound built and embellished by Hausa master masons from Nigeria.



Fig. 11.72a

Although clearly inspired by the outer zaure of the Dosso chef de canton, the master mason designed and built a much less pretentious zaure. It measures only 4.45m x 5.17m x 4.25m (14'7"x16'11"x14'1") to the tin plate imbedded in the crown as compared with 5.28m x 5.35m x 5.65m (17'5"x17'7"x18'6") to the centre plate of the Dosso chef's zaure. Thus Mohammed's

zaure is a rectangle with the width almost a metre (3') less than the chef's. More significantly, the crown of Mohammed's dome is 1.40cm (4'7") lower than the **chef's.** Most of the differential in the heights of the domes is accounted for by a corresponding differential in the wall height of Mohammed's zaure which only measures 3.35m (11') as against **4.50m** (14'9") for the wall of the **Dosso chef's** zaure. The actual rise of Mohammed's dome above the wall is only 35cm (1'2") less than that of the Dosso chef's. Despite the rather small difference in the actual rise of the domes, the zaure of the Dosso chef appears much more imposing. The comparison of the two domes depends a great deal on the height of the walls and the dimensions of the room; the domes themselves are in fact rather shallow.

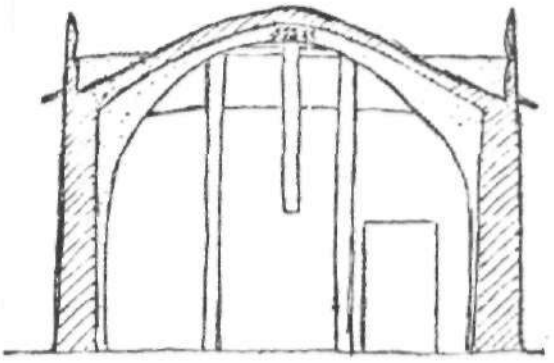


Fig. 11.72b

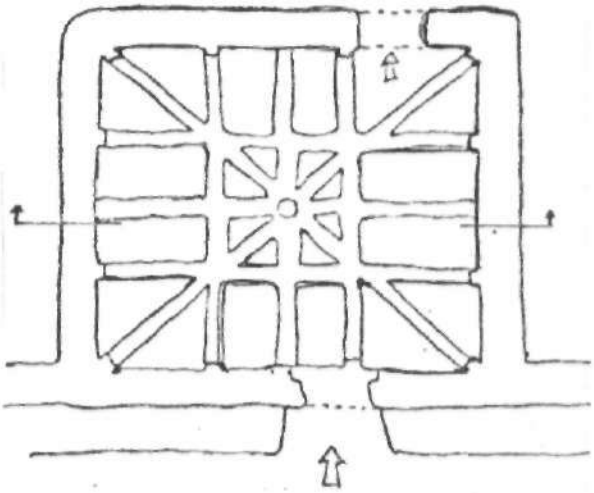


Fig 11.72

Although the arch patterns in Mohammed's zaure are more

complex than the patterns in most zaure already discussed, they constitute a less elaborate version of the Dosso chef's outer zaure arch patterns. As in the Dosso chef's zaure, the most essential arches are distinguished by their relative simplicity. Here the primary and secondary transverse arches which are the basic structural arches spring only from eye level in contradistinction to all the other arches which spring from the floor. A central plate is embedded in the underside of the junction of these essential arches. Also, as in the Dosso chef's outer zaure the transverse arches are supplemented by diagonal arches and pairs of transverse arches forming a large square coffer. At Mohammed's, however, they lack the flanking subsidiary ribs. The walls of Mohammed's zaure are also much plainer being punctuated only by two entirely

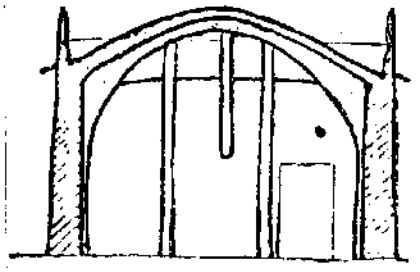


Fig. 11.72b

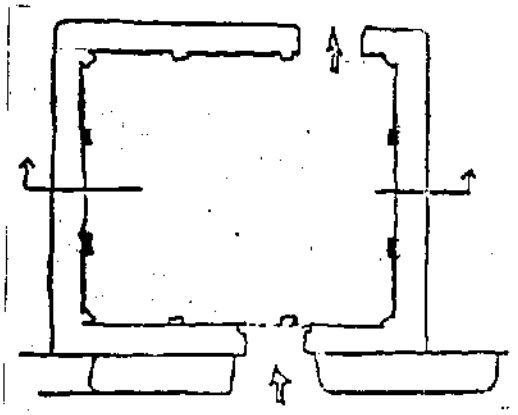


Fig. 11.72d

functional openings, the access door from the street and the door on the opposite wall leading into the rest of the compound.

11.73 Zaure, Gidan Boubakar Fulan (Kouremaria, Niger)

This zaure of average dimensions, 4.60m (15'1") square, is completely decorated with arches, both supplementary and essential. Like the slightly larger outer zaure of Alhaji Barmo Makudawa (11.61), this Kouremaria zaure rests on intersecting sets of three transverse arches supplemented by diagonals. However, the walls are articulated as though the dome was structured on intersecting sets of five arches. As in Dosso, the subsidiary ribs flanking the corners are not full. They are handled like the transverse arches even though they only abut the diagonal arches. All these subdivisions in the dome are functional as well as decorative. They allow the



Fig. 11.73a

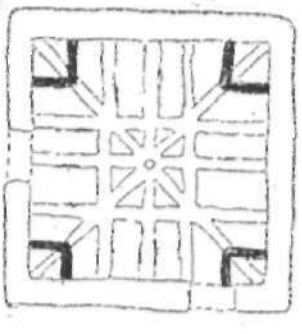


Fig. 11.73 b

master mason to use the locally available branches which must be in very short units. In this hot, dry savanna location, it is rare to find long straight branches. To import azara would significantly add to the cost.

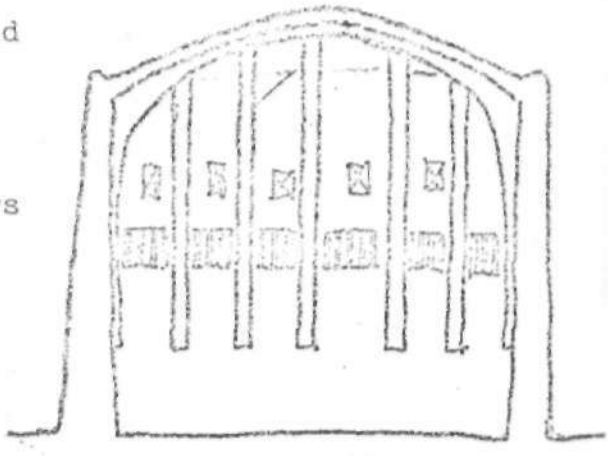


Fig. 11.73c

The handling of the windows forces the viewer to recognize the crucial structural role of the arches. The wall space between the spring points of these arches and ribs is broken up by two rows of windows. The upper openings serve to light the intricacies of the arch configurations in the dome. The lower, wider row completely fills the space between the arches.



Fig. 11.73d

CHAPTER 12

ARCHES ABUTTED BY KAFA (HALF-ARCHES)

12.00 Introduction

This final chapter of the classification of domes focusses on oblong vaults resting on kafar kaza arch configurations. Two kafar kaza, one at each end of the room, suffice to effect the oblong vaulted form. The transverse arches ensure the curved form on the long sides of the vault and the half-arches ensure the curved form at the ends of the vault. In some cases, additional transverse arches are constructed between the two kafa which ensure the basic form. The more transverse arches supporting the vault, the longer the vault can become.

12.10 Two Transverse Arches, Each Abutted by a Kafa

12.11 Inner Zaure, Magajin Gari (Maska)

This small, rectangular inner zaure rests on opposing kafar kaza. The room measures 4.28m x 2.65m (14'x8'8") and the crown of the dome rises to 3.59m (11'9"). The arches themselves are 22cm (9') wide and spring from 1.95m (6'6").

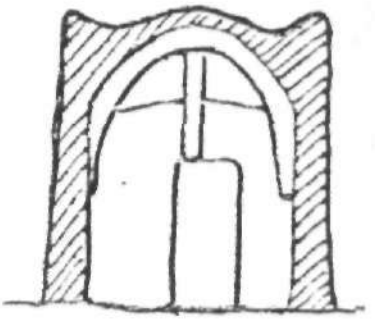


Fig. 12.11a

The dome is actually a cloistered vault with a fairly large, flat crown. The vault rises .85m (3') above the 2.75m (8'9") high walls. The kafar kaza effectively divide the vault into five compartments. The central compartment between the two transverse arches is 1.25m (4'1") wide. At the centre, two exposed beams rest on the full arches to form a coffer .80m x 1.25m (2'7"x4'1").

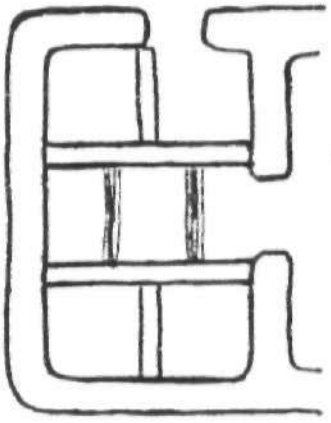


Fig. 12.11b

12.20 Two Pairs of Twin Transverse Arches, Each Abutted by a Kafa

12.21 Lateral Bays, Friday Mosque (Zaria)

The lateral bays of the Zaria Mosque rest upon two opposing kafar kaza. These kafar kaza arch configurations support four especially long vaults averaging 800m (26') by virtue of the distinctive feature which repeats itself throughout the mosque; the transverse arches are doubled.

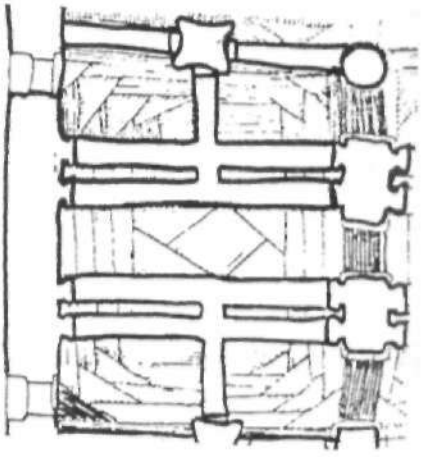


Fig. 11.21c

This doubling of the transverse arches increases the lengths of the vaults by adding both the width of the extra arches and the width of the spaces between each set of twin arches. This amounts to an additional 1.52m-1.57m (5'-5'4") for each bay length. In all the lateral bays except the north-east bay, the span between the two opposing kafar kaza is covered with contiguous azara joists approximately 1.20m (4') long. The central portion of the north-east bay which spans 1.50m (5') is filled in with tauyi which support a small azara panel.

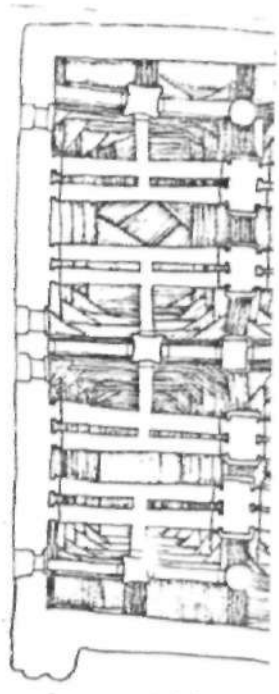


Fig. 11.21p

The width of the lateral bays ranges from as little as 5.80m (19') to as much as 6.70m (22') from pier to wall. The effective visual width of the space, however, is somewhat less because the transverse arches impinge upon and visually frame the space. The

transverse arches spring from the floor. These twin arches spring from projections emanating from the piers and wall somewhat like engaged columns. These projections extend from 30cm (1') to 60cm (2') into their respective bays. Thus the spans of two of the transverse arches in the south-west bay have been reduced by a total of 1.05m (3'6"). The free span between the transverse arches ranges from 5.20m (17') to 5.80m (19') depending partly on the extent of the projections.

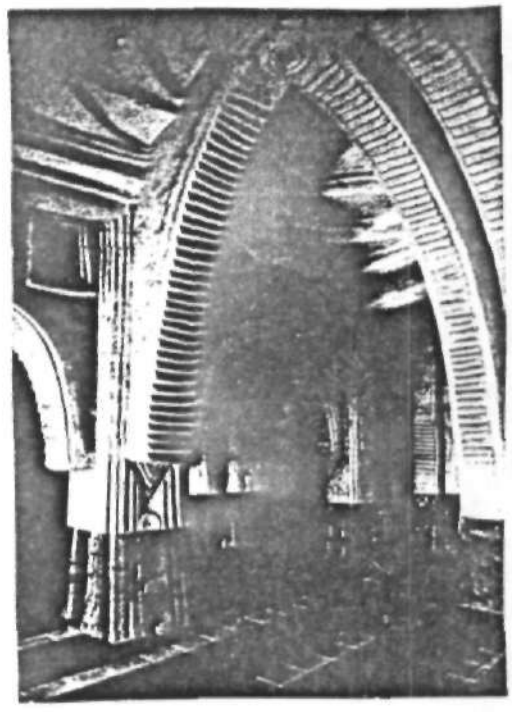


Fig. 11.21q

The ends of each lateral bay flow into an adjacent corridor space under two arches which emanate from a central pier. This pier also supports the half arch of each of the kafar kaza. These end piers are .90m square (3') with slight projections at each corner and taper gradually towards the ceiling. The ends

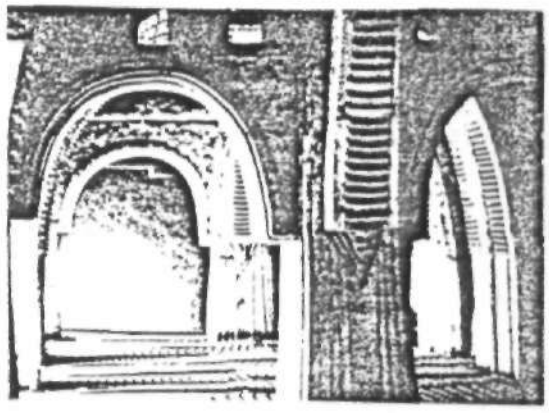


Fig. 11.21r

of each bay are visually defined by the wall above the end arches. These end arches spring smoothly from brackets that jut out from the piers at 1.80m (6') from the floor rather than springing directly from the floor as is the case with the twinned transverse arches. This discrepancy is reflected and accentuated by the heights of the crowns of the arches themselves. Those in the southern portion being as low as 3.05m (10') from the ground and those in the northern portion being as high as 3.65m (12') from the ground. The walls above these arches are pierced by rectilinear window openings to diminish any impression of a solid division between the bays. It is perhaps noteworthy that the master mason has chosen to emphasize the structural importance of his piers and arches by refraining from supporting the outer ends of the lateral bays on his solid east and west walls. Instead

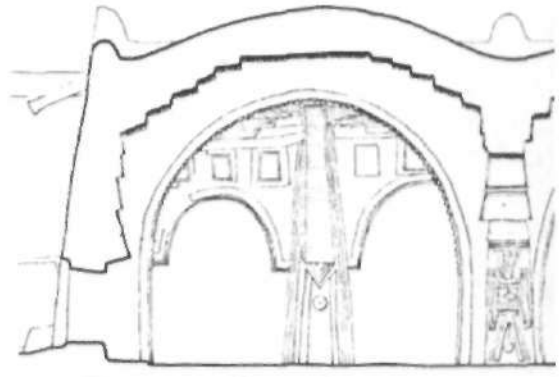


Fig. 11.215

they are freestanding and an open corridor separates them from the walls.

12.30 Two Transverse Arches, Each Abutted by Two Kafa

12.31 Ground Floor Room in Soron Sanda Maiganari (Kano)*

Although this space has been demolished Saad's (1981) sketch plan reveals that it was effectively supported on two kafa kaza. Hassan Mai Bayani[1], the master mason responsible for Sanda Maiganari's dwelling, was renown for his use of kafar kaza configurations because they allowed him the freedom to exploit the decorative possibilities of differing shaped compartments (Saad, 1981). In the ground floor room to the right of the shigifa, Hassan has designed two opposing kafa kaza. He has further embellished the kafar kaza solution by abutting each transverse arch with two kafa rather than the standard single kafa. Thus he has created seven compartments in the ceiling

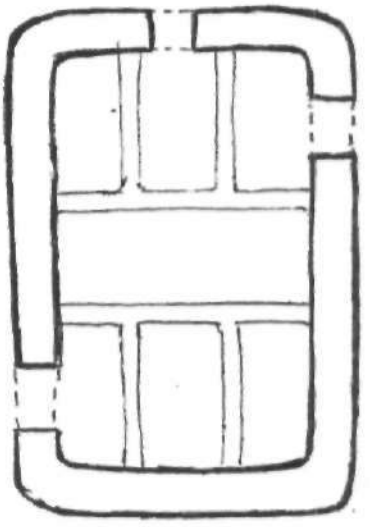


Fig. 12.31a

[1] See above Section 2.54.

allowing himself considerable scope for decorative expression.

12.40 Two Transverse Arches, Each Abutted by a Kafa, and Supplemented by a Central Transverse Arch

12.41 Women's Common Hall, Schwerdtfeger's House Plan No. 78 (Zaria)

The rooms of four wives open onto this elongated, trapezoidal room which measures 6.20m (20'x3") long. At the entry it measures 1.95m (6'4") wide while at the opposite end it expands to 2.90m (8'5") wide in order to maximize the meaningful space in this awkward site. By association with elegant spaces, the kafar kaza enhance the stature of this hall. The central arch provides additional support which is necessary because of the length of the room.

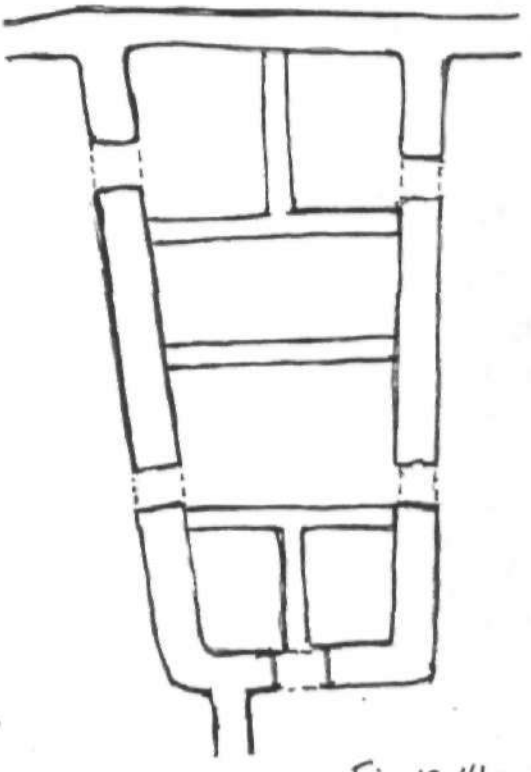
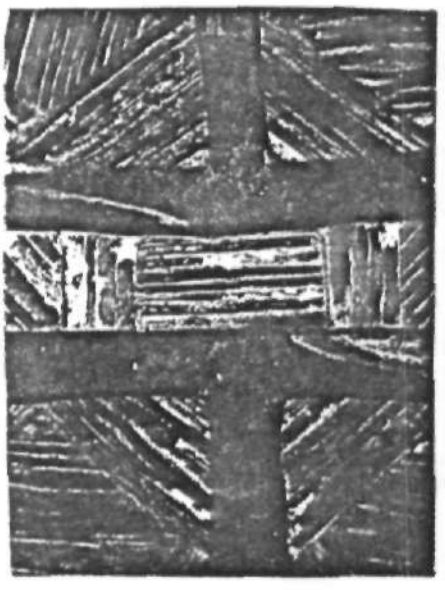
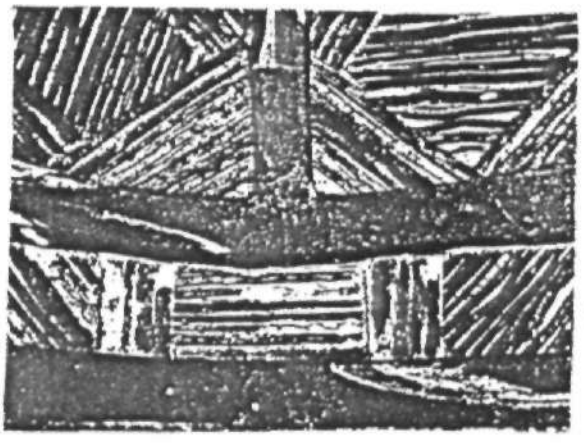


Fig. 12.41a

These oblong vaults constitute still another approach Hausa master masons have explored in their attempt to create spacious rooms with limited

resources. They testify to the creativity of Hausa master masons. The conclusion which follows explores the ways in which master masons have demonstrated this creativity in their solutions to the structural and aesthetic problems encountered in designing and building spacious mud buildings.



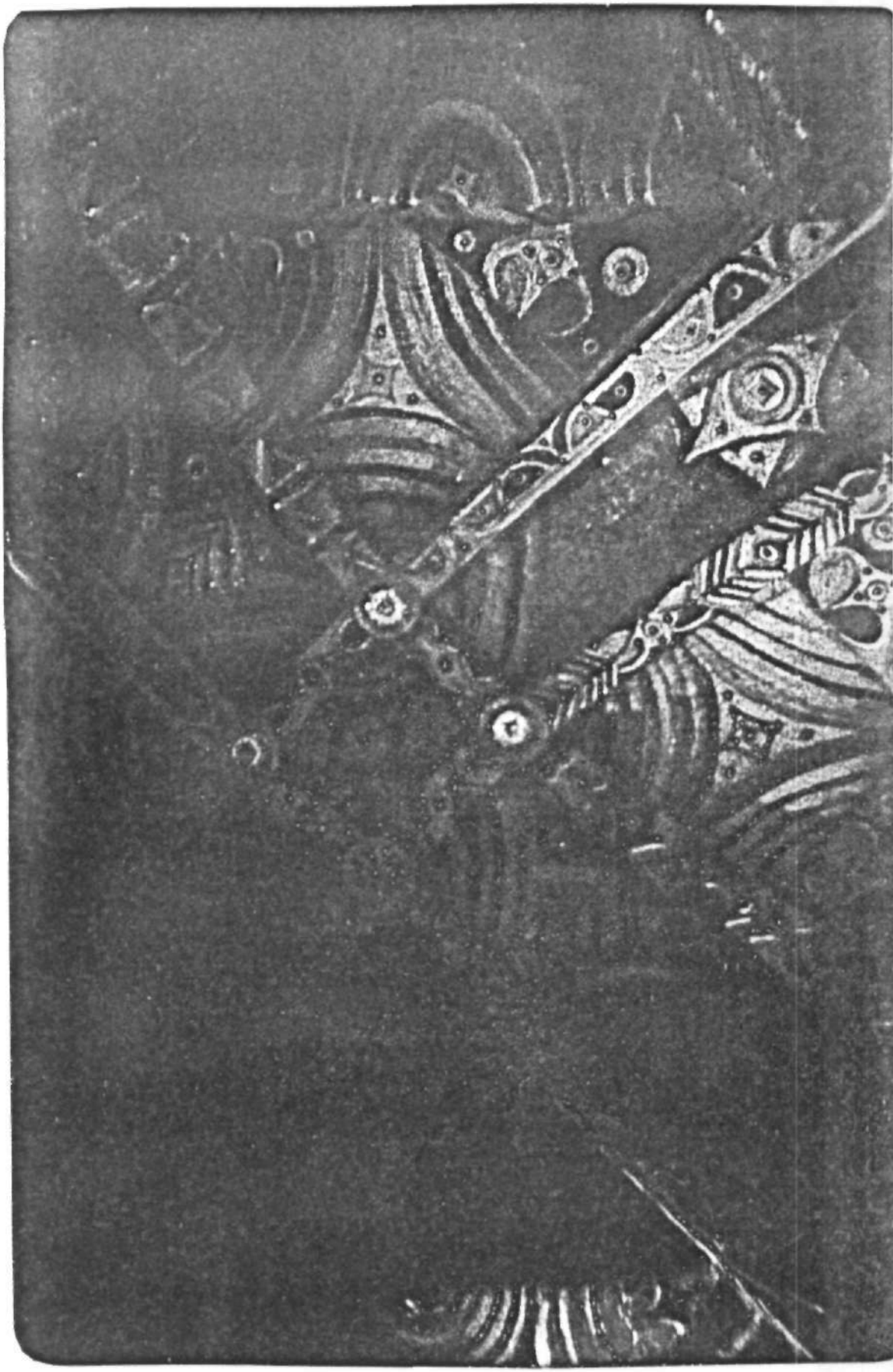




Figs. 12.11c
12.11d
12.11e

PART IV

CONCLUSION



CHAPTER 13

THE INTERFACE BETWEEN STRUCTURE AND DECORATION

13.00 Introduction

Recognising the architectural virtuosity of their ceiling structures, master masons exploit the structural and decorative possibilities of their limited materials to create a variety of aesthetically pleasing effects in the soffits. The following analysis of the interface between structure and decoration in the ceiling/roofs described in the typology demonstrates that structure is revealed and expressed as an integral part of the architectural aesthetic in most traditional Hausa architecture. This analysis focusses on domes since most flat-roofed spaces are handled in a similar, albeit less elaborate, manner.

13.10 The Embellishment of Junctures

Hausa master masons articulate the architectural elements by embellishing their junctures. Multiple cornices decorate the junction between the vertical, load bearing wall and the curved, dome soffits. Several cornices highlight the spring line of the arches which themselves jut out from the wall surface. A painted or slightly projecting dado dis-



Fig. 11.61d

tinguishes the walls and bases of piers from the floor. Cruciform capitals transfer the load from beams to columns or piers even where half of the cruciform projections perform no structural function as in Shigifar Tambura of the Kanta Museum. The apex of the arches are decorated with inverted glittering, brass bowls or, more recently, colourful enamel bowls. Bosses of mud are also known. The apex of the Zaria Sharia Court is embellished with a particularly elaborate boss in the form of a sunburst. The surrounds of doors receive a layered treatment on the exterior which both announces the entry and protects it from weathering and from human wear and tear.

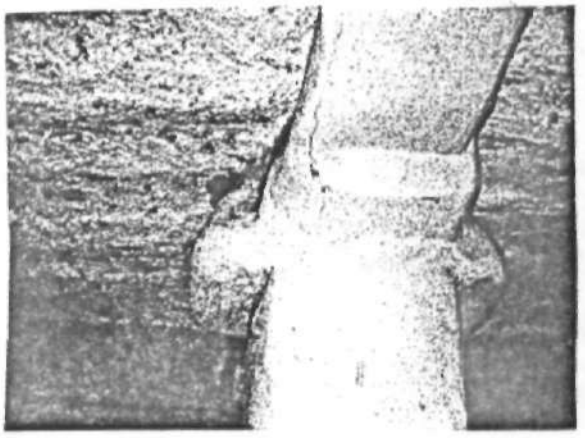


Fig. 3,33a

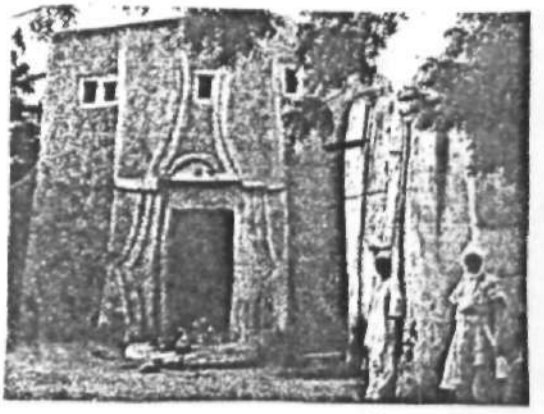


Fig. 10,21a

13.20 The Embellishment of the Soffit Permanent Formwork

The structural features of the soffits are treated sensitively in order to achieve an aesthetic effect. Skilled master

masons reveal the permanent formwork in the soffits in order to expose the potentialities inherent in the formwork. Often within a soffit compartment, pairs of azara are placed 20cm (8") on centres to create an alternating rhythm with the superimposed matting or with the smaller reeds or branches used as infilling members. The contrast between the warm, yellow mats and the deep brown azara is particularly striking. To enhance revealed, infilling members which may be tree branches or reeds, they are laid on the diagonal. This creates a lively herringbone pattern, alternating with the rigid azara members as in the Kazaure Mosque and in the Reception Hall at the Kanta Museum. Several bays are often linked in a revolving pattern around a central pier or the apex of intersecting transverse arches as in Gidan Yarima and Gidan Alhaji Yusufu Danburimi.



Fig. 13.20a

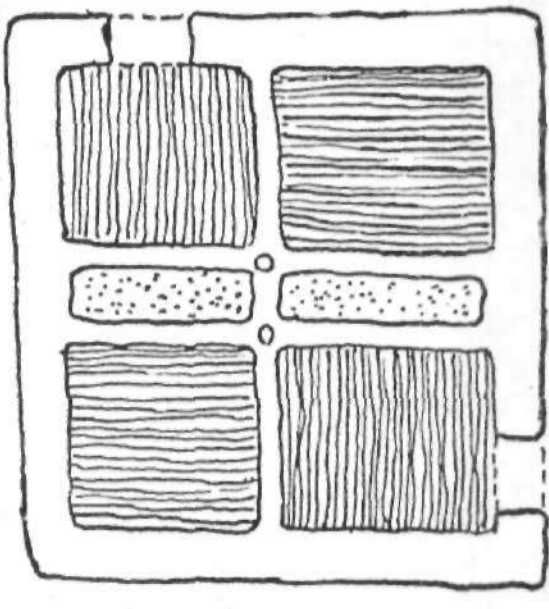


Fig. 6.21c

The permanent formwork in domed soffits lends itself to similar decorative treatment although sometimes the soffits are plastered smooth to contrast with the arches. Skillful master masons have juxtaposed natural materials highlighting their differing colours and textures to create subtle designs. In a small space in Bauchi, Sarkin Gini Alhaji Abdu created a pin-wheel pattern of glittering reeds set off against the rough-textured, dull, azara tauyi and joists and the smoothly plastered, curving mud arches. The central domes in the Zaria Mosque build up the tiers of revealed tauyi panels culminating in a coffer with a plastered soffit. The crisscross design in the coffer is based on crossing azara members which have been plastered. The design stands out since the crisscrossing members are raised against the background of the flat soffit.

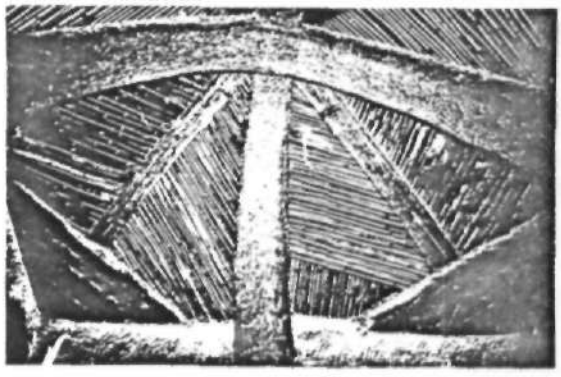


Fig. 10.13a

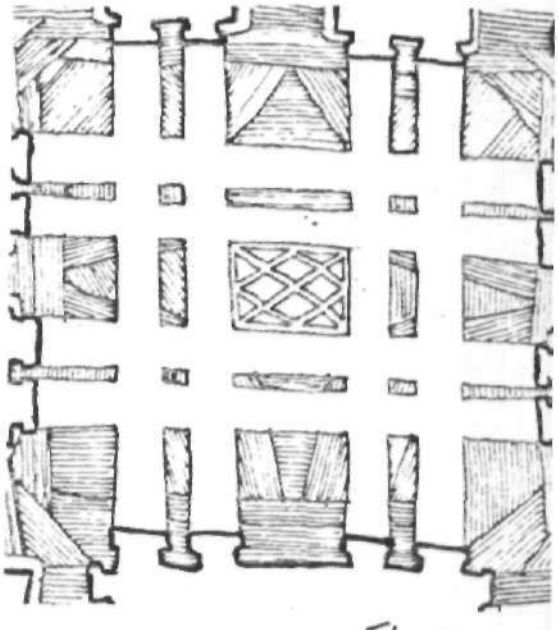


Fig. 11.21c

The domes in Panisau Palace illustrate how master masons play with the contrast between coloured plaster and revealed azara members. In the Mallam's Room the intersecting arches forming deep coffers are plastered with soft, red clay earth. All the tauyi and the crown-tauyi flanking the coffers are also plastered with this red earth. The plastering has been used to build up the form at the corners. These tauyi have become softly curving frames for the vertical, infilling members which focus attention on the coffers with their colourful enamelware plates. The plasticity of the curving tauyi forms, enhances the domical effect. Even less plaster is used in the Guest Room at Panisau. Only the arches and the edges of the tauyi panels are whitewashed. They stand out in sharp contrast to the deep azara that cover the soffit. They also constitute a perfect setting for the enamelware plates. Thus

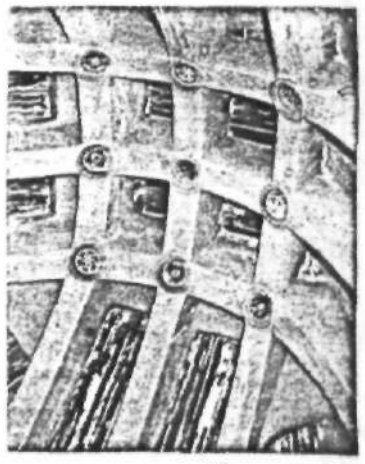


Fig. 13.20b

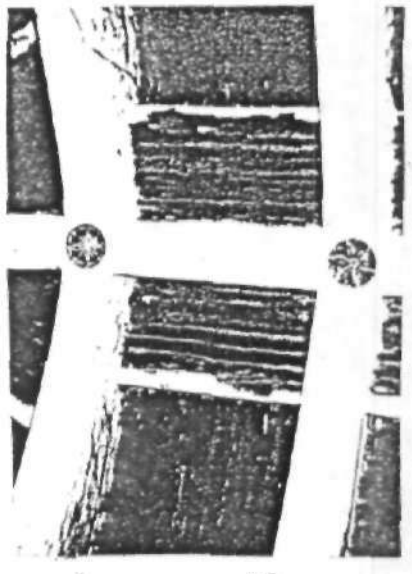


Fig. 11.41c

with minimal means, the master mason has skillfully embellished his ceilings.

In the finest examples of revealed soffit design, this play of contrasting colours, textures and forms is transformed into an integrated, abstract design. Bala Gwani[1] perfected this type of abstract design. Such is the case with his revolving, revealed ceiling patterns for the upper storey staircase room in the former Kano Treasury. His domes for the Yangoro Mosque are also distinguished by his skillful handling of the partially revealed formwork as part of a dramatic over-all pattern emanating from the crown of the dome like rays of the sun.

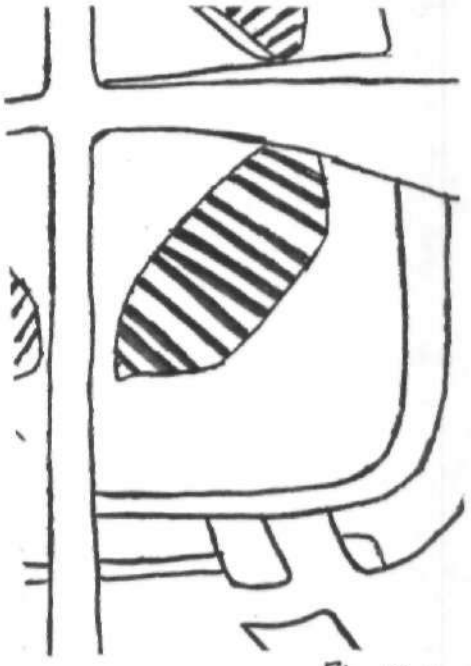


Fig. 10.11a

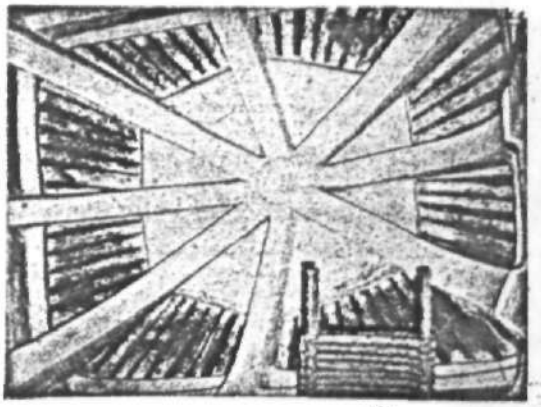


Fig. 10.43a

In general, the master masons respect the integrity of the level-changes resulting from the superimposition of azara panels. The revealed formwork in the soffits

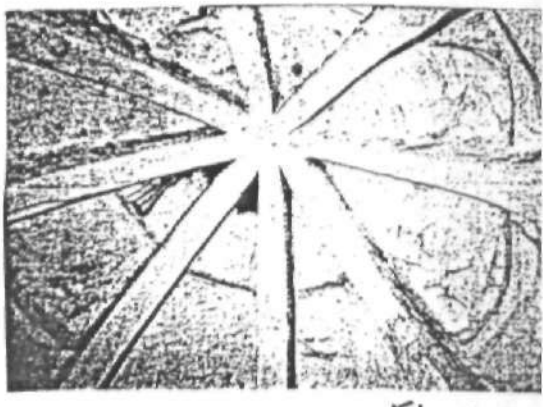


Fig. 9.71a

[1] See above Section 2.54.

of the zaure designed by the Birnin Kebbi master masons working in Niger are composed of small, straight tree branches grouped into small tauyi panels abutting each other at various angles. Despite the roughness of the finish, the crisscrossing patterns create a pleasing effect.

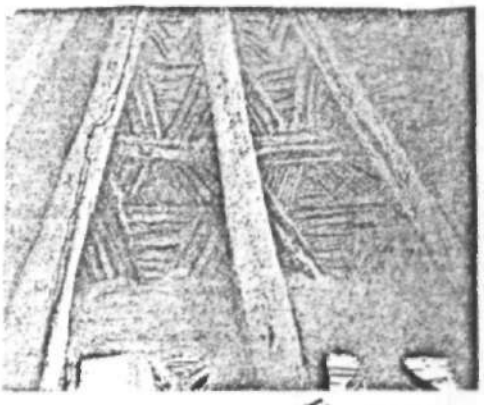


Fig. 13.20c

Even the heavily embossed, polychrome soffits of magnificent reception rooms reflect the tiering of the tauyi. In the Soron Guga at the palace of the Emir of Kano, the tauyi panels have been plastered to form shapes with curved edges but the various levels have not been obscured. Instead each tauyi panel is decorated as a unit reflecting the structure of the soffit and all the tauyi together create a brilliantly coloured design. The principal unifying element in the soffit design is the repetition of the outlines of a motif several times like ripples in a pond and the repetition of



Fig. 11.14a

entire motifs throughout the wall and soffit. The effect of these unifying elements is magnified in the polychrome designs. The use of a single, background colour further unifies the design.



Fig. 11.14c

The embossing and colouring of the soffits of domes appears to be a twentieth century phenomenon. Of all the nineteenth century and pre-nineteenth century documented buildings only one, the Babban Gwani at Kafin Madaki, has a plastered soffit. Significantly, this space has been renovated since independence. The mud plaster is devoid of embossed designs and merely whitewashed as are the walls and arches. Three other spaces possess embossed patterns on the crucial structural members but the soffit permanent formwork is unplastered: the Bawan Dodo, the Zaria Mosque[2] and the Audience Chambre photographed by Lugard's contingent in Kano. Of these, only the latter is rendered in colour and exhibits

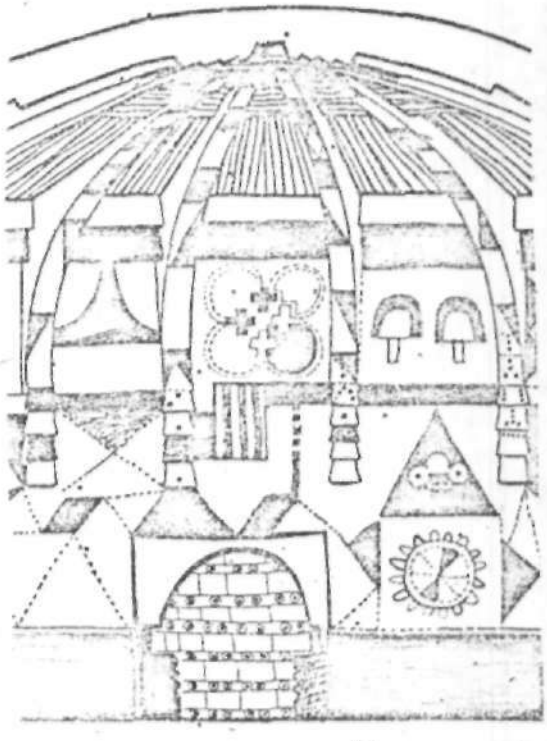


Fig. 10.82b

[2]The soffits of the Zaria Mosque spaces were plastered in the early 70s but the soffits in the Jos Museum replica are revealed.

a proto-horror vacui stage of wall and arch decoration.

13.30 The Embellishment of Arches

The arches are also designed so that their form is aesthetically pleasing. Even where the soffits of the arches are smooth, the plastering is non-essential as is clear from the structural durability of the arches whose permanent formwork is revealed in the Reception Hall for District Heads at Doraye Palace. The master masons perfect the final form of the arch and simultaneously protect the permanent formwork azara by applying tabo, swamp mud, as plaster to the undersides and sides of the azara.



Fig. 3.52b

The design of the basic curve of the arch also gives the master-mason scope for self expression. The central domes of the Zaria mosque are supported on virtually hemispherical arches. In contrast, the arches supporting the dome of the Amini at Yabo are parabolic in section. The arches in the

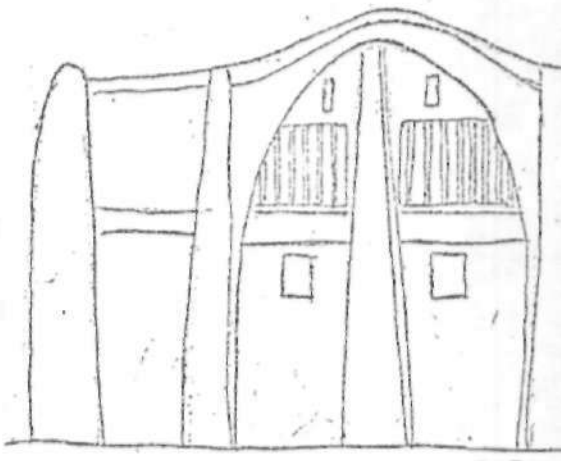


Fig. 9.11b

Princess' Upper Storey Room in the Kano Old Treasury are basket-handle arches while the unplastered arches of the District Heads' Hall at Doraye are pointed.

Mouldings on the soffits of the arch provide an additional aesthetic focal point. As already mentioned, the base of the arches may be handled as a stepped, slightly flared and inverted moulding.[3] The point at which the arch form-work sharply cantilevers out into the room may also be marked by cornices as in the inner zaure of Gidan Alhaji Barmo Makudawa. In the lateral bays of the Zaria Mosque, this motif is exaggerated and applied to the entire surface area of the arches. Their soffits have a "washboard" horizontal fluting. In the central bays of the Zaria Mosque, the paired arches have identical embossed designs on the soffit. The design visually reduces the breadth of the arch by making it appear as if the edges of the soffits have been

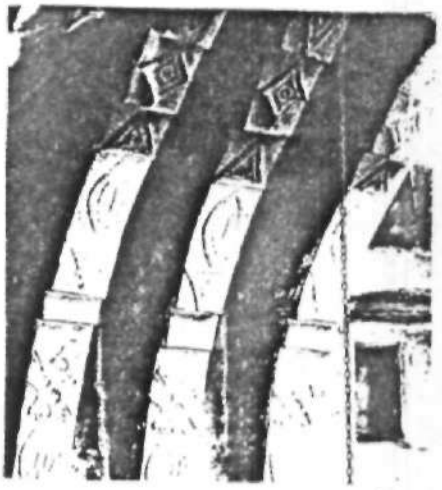


Fig. 13.30a

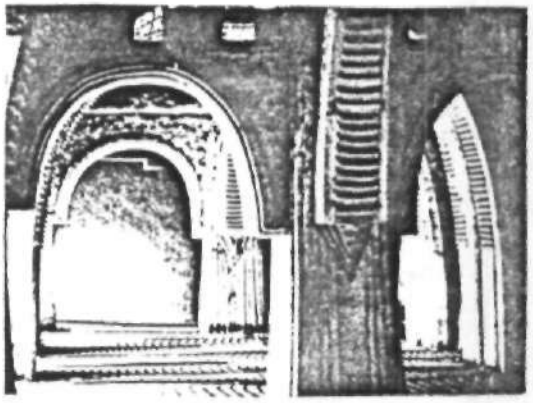


Fig. 11.21r

[3] See above Section 13.10.

cut away so that the spectator focusses on the narrower, raised surface. A more elaborate design on the pilastres below the structural spring line of these arches, a motif comprising an elongated lozenge flanked above and below by larger circles, clearly defines the separate identity of each of the arches in the pairs of arches.

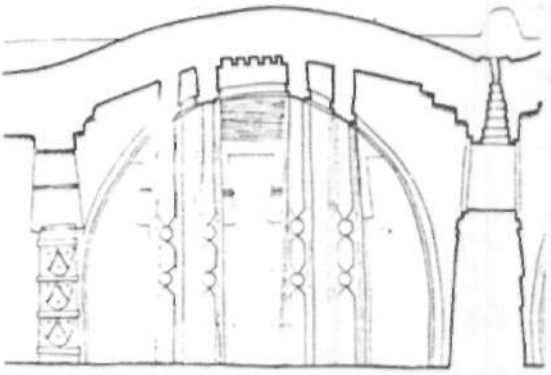


Fig. 11.21j

Twentieth century embossed work is often extravagant, covering the entire soffit of the arch to correspond with horror vacui embossing of the walls and soffit. In Alhaji Barmo Makudawa's inner zaure, the monochrome, embossed designs on the arch soffits consist of a series of superimposed motifs placed one above another and occasionally separated by a horizontal cornice. Although the formwork of the soffit is revealed, the completely embossed walls provide a background for these intricate arch designs. The motifs on the sets of arches are identical. In contrast, the polychrome, embossed



Fig. 13.306



Fig. 11.14d

motifs on the arches supporting the public reception rooms of the Emir of Kano differ from arch to arch. In both cases, embossed decoration on the walls and arches are covered with distinct, motifs which have been integrated with other elements to create a whole design.



Fig. 11.32c

Virtuoso experimentation with arch construction has led to the design of two-tiered arches. In the Shigifa Nufawa at the emir's Palace in Birnin Kebbi, the transverse arches are two-tiered. A lattice-work of mud-encased azara gracefully unites the superimposed arches. In the Wudil Mosque the double-tiered arches are both more delicate and more structurally significant.



Fig 10.32e

13.40 <u>The Articulation of the Relative Structural Role of Arches</u>

Principal structural arches are frequently distinguished from arches whose primary function is form-giving and/or decorative. Sometimes the distinction is made

as in the inner zaure at Dosso by springing the arches from different levels. At Dosso, the last kafa to meet at the apex were the intermediate arches which spring from just above eye level, 2.50m (8'2"). These intermediate arches are not essential to support the apex. By providing the armature for very short infilling members, they ensure that the dome curves gradually rather than being a series of adjacent, flat panels. However their primary role is symbolic and decorative. They embellish the moderately large zaure 5.50m x 5.62m x 5.70m (18'3"x18'6"x18'8") and lend it the aura of prestige attached to a larger dome. The supplementary arches are visually distinguished by their lack of a 20cm (") deep pilastre. Since this distinction is insignificant structurally, we can assume that the master mason intended to visually express the difference in their structural roles. Those arches connected last to the apex play a secondary role.

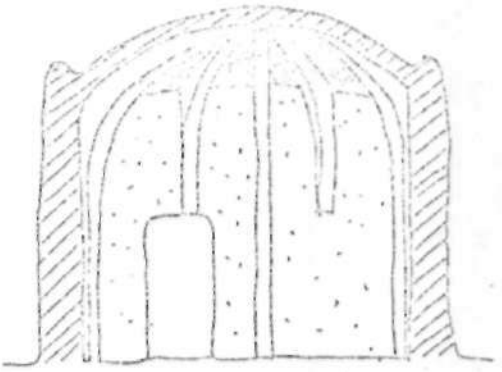


Fig.10.71a

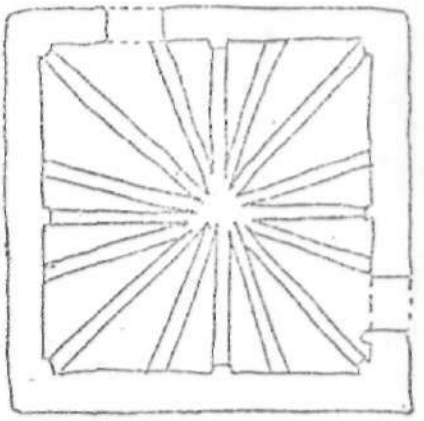


Fig.10.71b

The same distinction occurs in another Dosso zaure, the zaure of Gidan Mohammed Galadima. Here the first arches to be joined are those rising from slender pilastres to form a coffer. The central transverse arch is handled as a supplementary arch and therefore springs from eye level rather than from the floor.

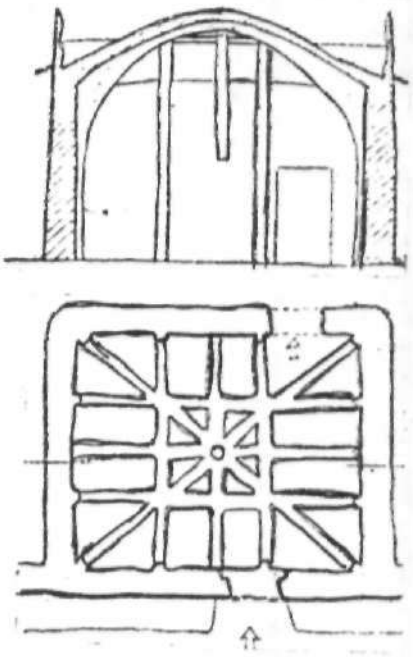


Fig. 11.72b
11.72c

A variation of this distinction is still visible in the ruins of the outer zaure of the Gidan Ubandoma at Birnin Kebbi. The transverse and diagonal arches are treated as pilastres whereas the intermediate arches spring from higher up. These intermediate arches are embellished with huge, embossed circular motifs surrounding their spring points. Thus these intermediate arches also have acquired a frankly decorative role.



Fig. 13.40a

The principal and supplementary arches are sometimes distinguished by recessing the less important arches or kafa so that

they appear less boldly in the play of arches in the ceiling. The diagonal kafa of the zaure at Gidan Mani Yanshuni were relegated to the background in this manner. In the outer zaure of Alhaji Barmo Makudawa, both the diagonal kafa and the decorative, lateral ribs surrounding the central coffers were recessed. As a further refinement, the apex of these diagonal kafa is embellished with a small, colourful, enamelware plate just as are the principal arches. Thus the diagonal kafa which are essential to ensure that the dome curves up from the corners have been set apart from the lateral ribs since the latter lack imbedded enamelware.

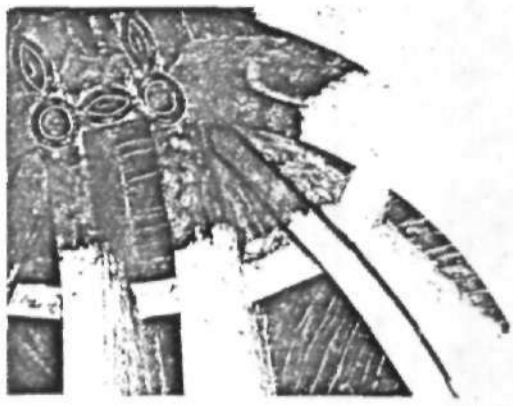


Fig. 13.406

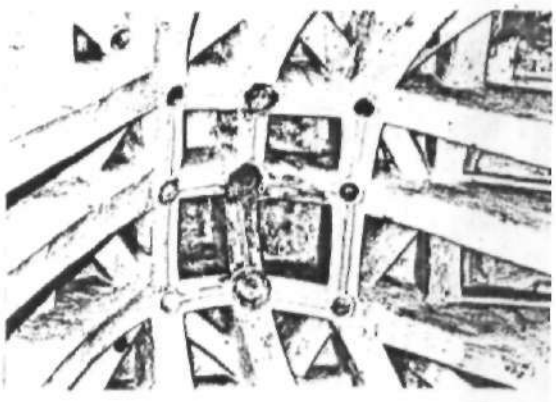


Fig. 11.61 b

The forms of the crucial structural arches and of the form-giving arches differ radically in the Shigifa Nufawa at the emir's palace in Birnin Kebbi. The transverse arches have been designed as two-tiered arches whereas the diagonal arches were left as

standard arches. This distinction also performs an aesthetic role. If all the arches had been double-tiered, the spectator would not have had a full and unencumbered view of the lattice-work joining the superimposed arches.

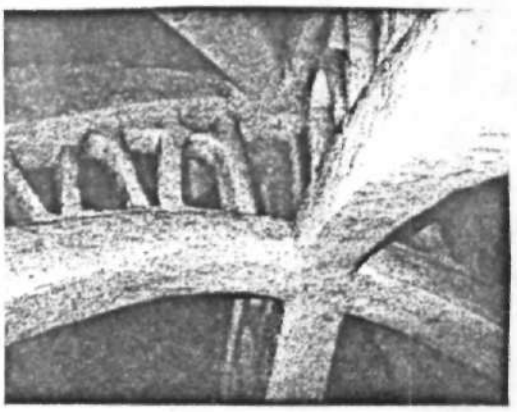


Fig. 10.32b

13.50 Structural, Form-giving, and Decorative Handling of Arch Configurations

The typology has established only three basic types of arch configurations. Of these, the kafar kaza is a decorative solution, a fact which according to Saad (1981) is fully recognized by the master masons and especially exploited by Hassan Mai Bayani, the renowned twentieth century Kano master mason.[4] Wherever a kafar kaza is used, one or two arches could be substituted. The latter solution is simpler to construct because it avoids the problem of joining three kafa; however, the kafar kaza solution is more elegant. Similarly, the design of a single set of intersecting

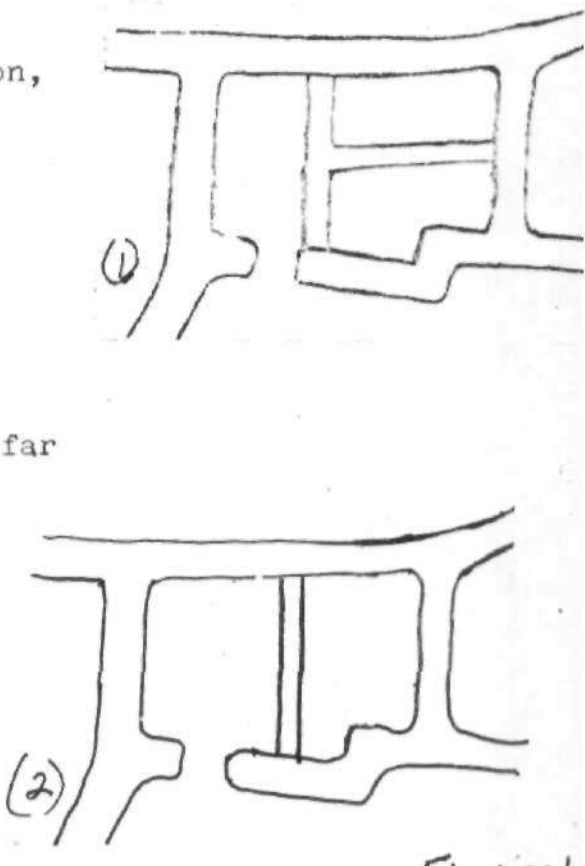
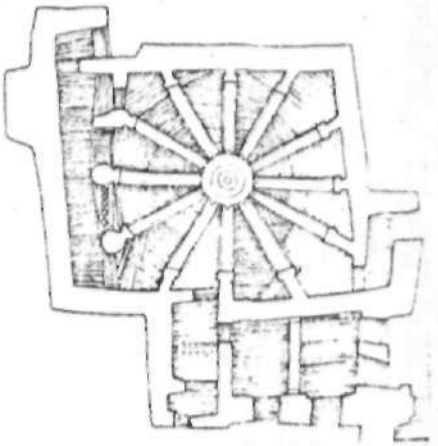


Fig. 6.32b

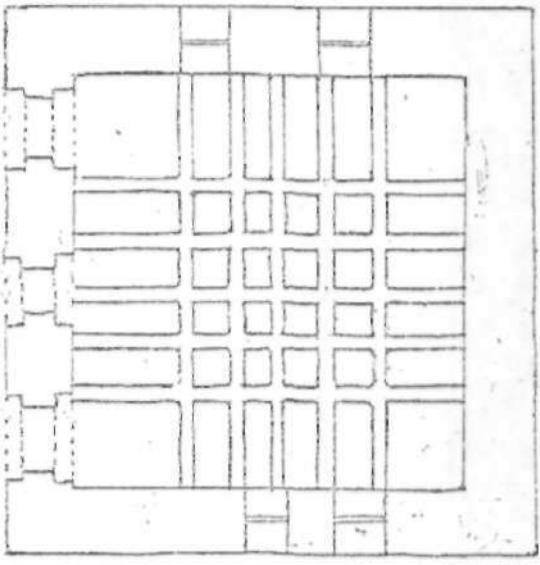
[4] See above Section 2.54.

transverse arches is based on aesthetic choice. Any space spanned by a these intersecting arches could just as easily be spanned by two parallel arches.

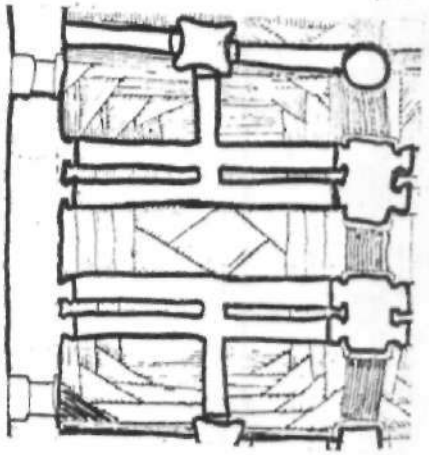
Within these three basic types of arch configuration, numerous variations have been developed. Sometimes these variations are a direct consequence of the structural requirements. Such is the case for the multiplicity of arches in the extra-large spaces like the Zaria Sharia Court, Soron Inglia and the lateral bays of the Zaria Mosque. Where diagonal arches are added to a basic configuration, they resolve the structural requirement of forming a transition between the square base and the domical form. The doubling of the arches in the Zaria Mosque appears to address both structural and functional concerns. The greater girth of the doubled piers allows for slightly longer, horizontal reinforcing members (those members normally



(1) (10.61b)



(2) (11.32b)



(3) (11.21o)

Fig. 13.50a

imbedded in the walls to hold the permanent formwork of the arches rigid) than would be possible with the standard solution of three separate arches. In addition, the placement of the double piers allows a free space immediately in front of the mihrab which would otherwise have been blocked by one of the three piers as already discussed.[5]

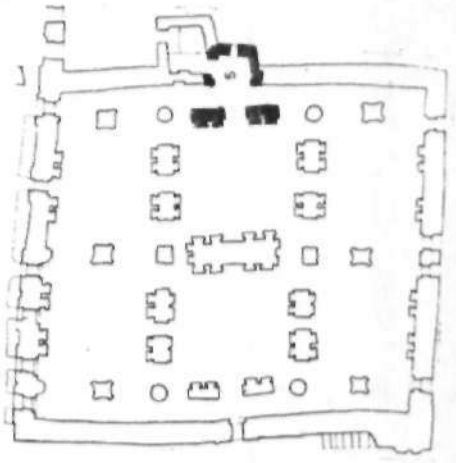


Fig. 11.216

Variations of the three basic arch patterns frequently consist of supplementary arches or kafa which are basically form-giving although they also contribute to the support of the load of the webs of the dome. Because of the rigid nature of the infilling members, if the horizontal or vertical span between two arches in a dome surpasses one and a half metres (or less for a small dome), then the skin of the dome will approximate a multi-sided, pitched roof or the apex will be flat. Often supplementary arches are designed

[5] See above Section 11.21.

to reduce the span between the crucial structural arches, thereby ensuring that the dome's skin will be curvilinear. In the eight metre (26'3") square outer zaure at the emir's palace in Birnin Kebbi, the supplementary arches provide the curving framework for the infilling members. The supplementary arches in the two Dosso zaure also serve to reduce the span of the infilling members which were available only in reduced dimensions.[6] In the Kurfi zaure, each web of the basic intersecting arch configuration is transformed by a kafar kaza arch configuration. These subsidiary arch configurations create a dramatic revolving pattern on the ceiling while they support the infilling members.

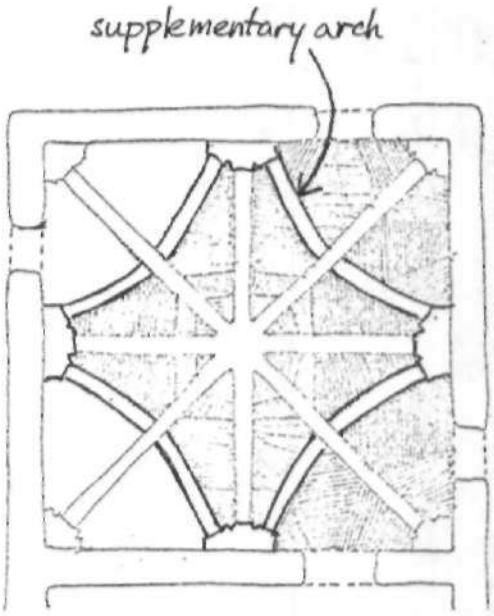


Fig. 10.51b

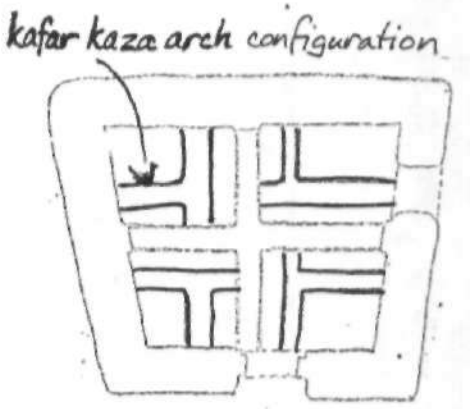


Fig. 10.21c

Sometimes the number of arches is a function of financial constraints and lofty aspirations. Many smaller spaces appear overstructured when compared with the prestigious domes constructed for

[6] See above Section 8.33.

emirs. In these cases, the same number and configuration of arches supports a smaller space because the arches are more closely spaced, because they themselves are slightly narrower and because the distance between the walls and their adjacent arches has been reduced. These reduced dimensions can probably be partially correlated with reduced technical proficiency on the part of the master mason. However, the reduction also reflects the desire to design a magnificent space with insufficient funds. As a compromise solution, the ribs associated with grandeur are confined in a moderate-sized space. Such is the case with the umbrella arches in the zaure of the Dogondoutchi chef de canton and the coffer forming arches of the outer zaure of Alhaji Barmo Makudawa.

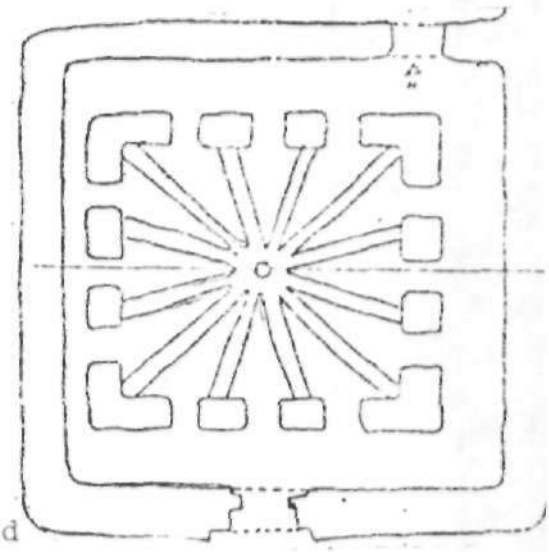


Fig. 10.81b

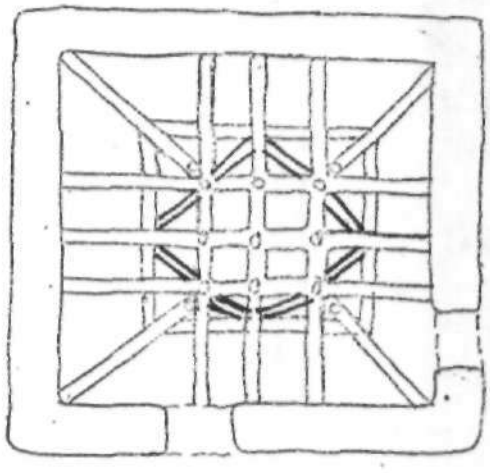


Fig. 11.61a

A further variation of the basic pattern involves the incorporation of "false ribs" into the dome as in the Barmo zaure.[7] False ribs

[7] See above Section 8.14.

bisect infilling panels merely to achieve a decorative effect both in the arch patterning and in the placement of infilling members.

13.60 Trompe L'Oeil Handling of Arch Configurations

Occasionally master masons exploit our expectancy that the relative structural importance of the arches will be articulated by differences in size. They are well aware that the viewer attributes to a large arch, a more important structural role than the role attributed to a smaller arch. The Birnin Kebbi master mason who designed and built the outer zaure of the Dosso chef de canton skillfully created the impression that his dome is supported on the intersecting sets of five arches supplemented by the diagonals when in fact it is only supported on intersecting sets of three arches supplemented by the diagonals. If the viewer looks only at the wall, he sees what looks like a symmetrical pattern of five

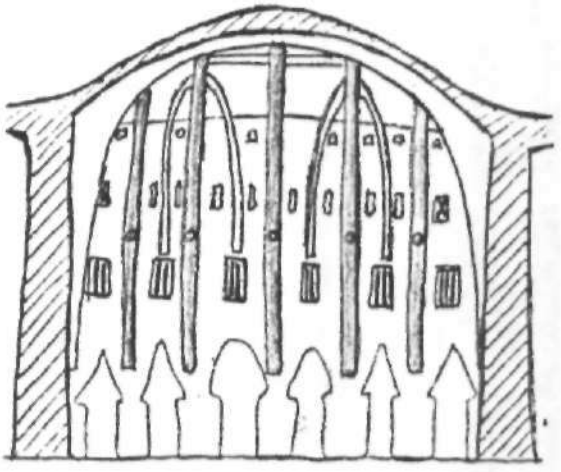


Fig. 11.11a

principal arches with the second and fourth arches being flanked by subsidiary arches. He must turn his head up to the dome and study it in order to realize that the outer two principal arches are in reality subsidiary arches attached to the diagonal arches.

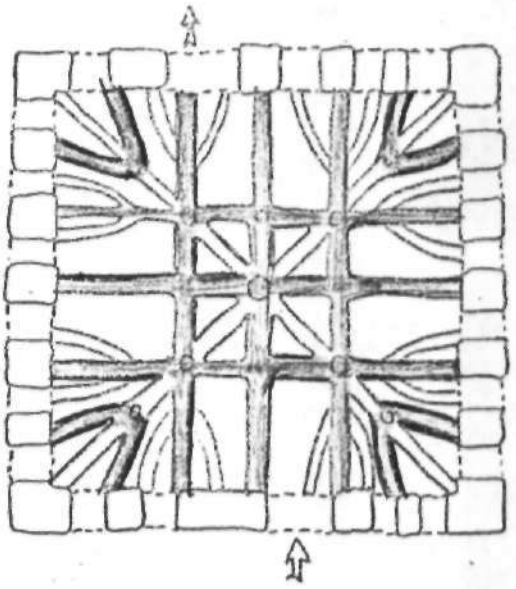


Fig. 11.71d

The subsidiary arches which abut the diagonal arches near each corner are treated like principal arches. These corner area subsidiary arches are 40cm (1'4") wide as opposed to 30cm (1') for the other subsidiary arches. Like the principal arches, they apring from 1.18m (3'10") instead of springing from above the lattice window at 2.70m (8'10") along with the other subsidiary arches.

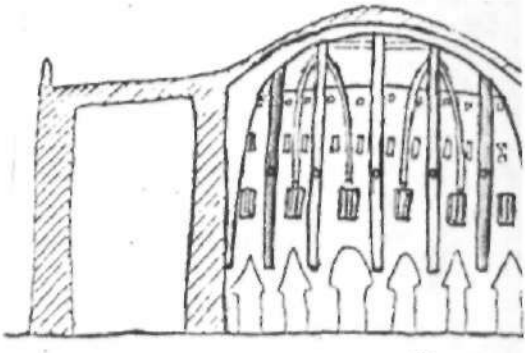


Fig. 11.71c

This transformation of the subsidiary arches flanking the corners into pseudo-principal arches successfully resolves aspects of the design problem assuming that the master mason desired the affect he achieved.

He created a relatively flamboyant but symmetrically ordered pattern which leads the viewer to rest his eyes on pseudo-principal arches at each side. The pattern would have become incomplete and open-ended, if these arches had been treated as subsidiary arches because then they would have led the viewer's eyes to the corners. As it is the pseudo-principal arches lead his eyes back up towards the lofty dome which unites the entire space.

The dome centrepiece which ties together the entire composition is based upon the intersection of all the full arches in a large coffer. This coffer is subdivided by the central transverse arches and the diagonal arches which all intersect at the apex of the dome. The pseudo-principal arches rise too close to the corners of the room for their apexes to come within the grid of the centre-piece. Moreover, because they are located only 1.10m (3'7") from the

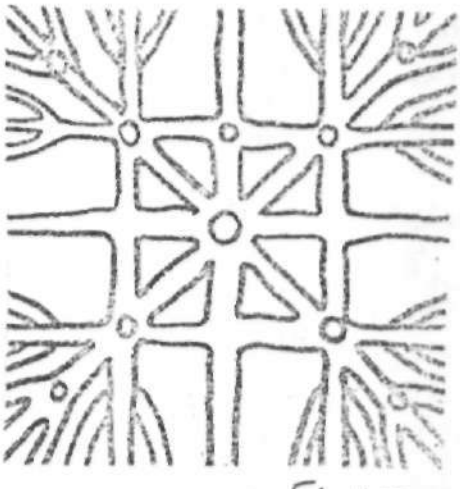


Fig.11.71e

nearest walls, their apexes abut the soffit of the dome as it rises rather than at the full height of the soffit. Thus the lower height of these arches at their apex and their location within the dome automatically distinguish them. They can be neither true subsidiary arches nor true principal arches.

Since our eye associates sets of five arches with extra-large and impressive domes designed only for the most powerful rulers, the master mason has subtly magnified, in our minds' eye, the size of his dome and the prestige of his client. This trompe l'oeil effect was also exploited in a slightly less complex ceiling pattern for a merchant's zaure in the town of Kouremaria. This zaure was also designed and built by a Birnin Kebbi master mason. It appears to be directly inspired by the outer zaure of the Dosso chef de canton. However, it lacks the ambulatory so the two tiers of



Fig. 11.32a

of windows are open to the sunlight. Because of the zaure's reduced dimensions, the true subsidiary arches have been omitted. The pseudo-principal arches are retained and continue to create the optical illusion that they are transverse arches essential to the dome structure rather than basically playing a form-giving role. According to the owner, Boubakar Fulan, the master mason boasted with some justification that people would stop to see this small, but impressive zaure when they passed it on the road.

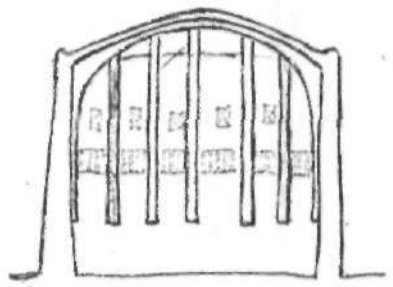


Fig. 11.73c

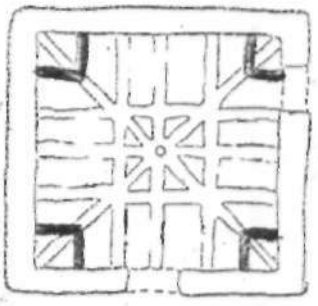


Fig. 11.73b.

13.70 The Aesthetic Expression of Structure

Having mastered the structural and constructional aspects of traditional architecture, the finest master masons concentrate on designing spaces for their aesthetic effect. Their architectural designs are based on the conceptural integration of structural and aesthetic considerations. The ceiling patterns in these designs reveal and enhance the structure.

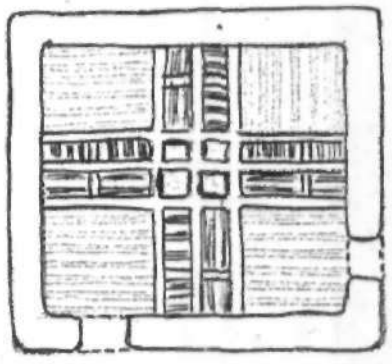


Fig. 6.23a

The structural elements themselves are treated sensitively in order to achieve an aesthetic effect. All the decorative features are architectonic with the exception of the applied colour and the applied embossed designs. Even in the handling of these purely decorative features, the master masons highlight the architectural subdivisions in the wall and soffit.



Fig. 11.146

The permanent formwork in the soffits of most ceilings is revealed or partially revealed to simultaneously embellish the soffit and reveal the structure. Even the heavily embossed soffits respect the level changes derived from the superimposed azara panels. Thus their structure is evident to the cultured spectator. In the rare cases, where the level changes in the soffits have been plastered into smooth curvilinear surfaces, the structural arches are distinguished from the soffits they support.

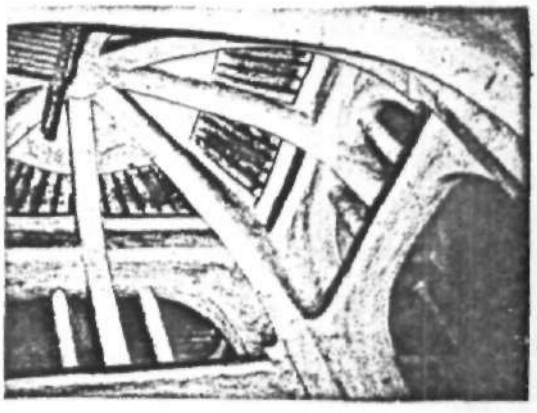


Fig. 10.43a

The arches perform structural, form-giving, and decorative roles. Often the articulation of the arches expresses their relative structural significance and simultaneously embellishes a space. Even where the arch configurations falsify the structure, the actual structural system remains visible to the discerning eye. Where master masons have exploited trompe l'oeil effects to create a more impressive and elegant space, the desired effect is dependant on a knowledge of Hausa structure. Whether sumptuous or restrained, Hausa ceiling patterns respect and enhance the structure.



Fig. 10.32e

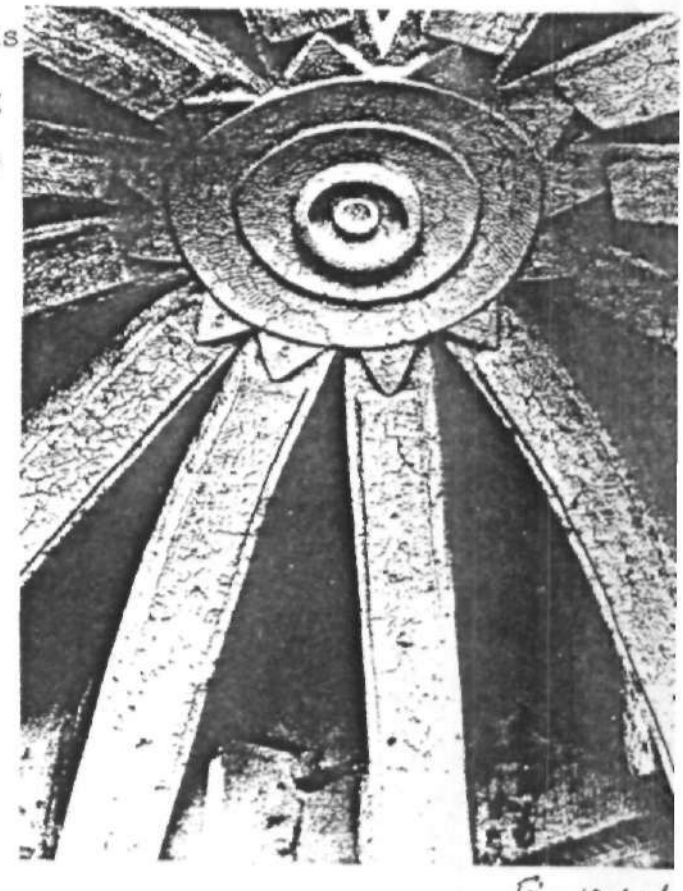


Fig. 10.61d

SUMMARY AND CONCLUSIONS

This provisional classification of Hausa structural systems and their resultant ceiling patterns has demonstrated how Hausa master masons have overcome the structural limitations of the available construction materials in order to create spaces with larger clear spans than is common in mud-roofed architecture. The master masons have used the combination of specially selected mud and azara to its durability and structural limit (Cleszkiwicz, 1977). The reference in Daldy (1945) to Hausa architecture as temporary buildings must be rejected. Even forty years ago when Daldy wrote, some of these buildings, the Zaria Mosque for example, were already 100 years old. They are still standing but their life span depends partly upon proper maintenance. Unfortunately this may become more difficult to achieve as fewer and fewer master masons possess or acquire the requisite skills.

The technical achievements of Hausa master masons are noteworthy. They have perfected a reinforced-mud arch which can elegantly span 8.00m (26'3"). By placing these arches parallel to each other they have designed long, lofty spaces. Moreover, they have evolved three types of arch configuration for supporting lofty domes: arches intersecting at the crown like the ribs of an umbrella, arches intersecting to form coffers, and arches abutted by half-arches. To ensure the proper

transition from the walls of a square room to the circular base of a dome, they have perfected tauyi, diagonal arches, and intermediate supports in circular formation. The ceiling/roofs for flat slabs and for domes both rest on a permanent formwork of split palm timber, although the spacing of beams and arches as well as the appropriate patterning in the soffit varies for slab and dome technologies.

Hausa master masons have succeeded in creating large spans by structuring them on the use of arches which support the soffit permanent formwork initially, and eventually operate as a monolithic structural system once the mud has hardened on the formwork. The horizontal thrust and tensile stresses are taken by the azara in the arches and the permanent formwork (Cleszkiewicz 1977). The largest documented free span, 8.25m x 8.55m (27'x28') is approximately 120 years old and still in good condition. A variety of arch configurations are used to support approximately 7.30m (24') square domes. These spans are very large considering the construction materials. The master masons who constructed these spaces (and many other similar spaces) have exhibited an extensive understanding of the properties and structural potential of their construction materials.

The reinforced-mud arch is the distinguishing feature of Hausa architecture. Large dimensions would

not have been attainable in mud without its cantilever action. The Hausa arch can span much greater spaces than beams. Even when used in conjunction with brackets and pilastres, lashed-azara beams have difficulty in spanning more than 3.00m (10').

Hausa architecture is also distinguished by its full exploitation of the structural potential of tauyi in order to create domes. Other peoples both north and south of the Sahara use these tauyi to reduce the spans in flat-roof construction. Available evidence indicates that only Hausa master masons superimpose tauyi on the backs of arches so that they simultaneously reduce the span from the corner to the crown, raise the height of the successive permanent formwork members, and create an octagonal base for the domical form.

When designing and constructing flat ceiling/roofs, the master masons are also forced to work within the constraints of a maximum span for the azara members of the permanent formwork. This maximum span is determined by the structural capacity of azara joists to carry the dead load of the mud-roof slab above them rather than by the need to ensure a uniformly curving soffit as is the case for domes. Master masons operate on the principle that 1.80m (6') is an accepted safe span although they have sometimes exceeded this span in order to achieve an aesthetic effect in the soffit. As in dome construction, they

also make full use of brackets and tauyi to increase the span of a flat/ceiling roof or of a compartment within the soffit of the roof slab.

Various types of internal, vertical supports are exploited to increase the dimensions of the rooms. They support arches or beams which in turn support additional compartments in the soffit. Not confining themselves to columns, piers, and pilastres, the master masons also expand their room sizes with internal load-bearing partition walls. In domes these internal supports are restricted to the periphery of each domical bay.

Because of the structural efficiency of Hausa dome technology, all large prestigious spaces are domed except those designed with Bauchi arches and those created by the duplication of flat-ceilinged bays. The distinctions between the architectural designs for flat slabs and domes are the direct result of the differences between their form and structural requirements. In response to the more complex structural problems encountered in designing and building domes, master masons have created a great variety of aesthetically pleasing structural solutions, greater than for flat roof slabe.

The major structural problem in the erection of a dome is the need to ensure a transition from the walls defining square or rectilinear floor plans to the circumference of the domical form. Most Hausa architectural

designs solve this problem with tauyi and/or diagonal arches or kafa. The need to maintain a uniform curvature in the dome is also an essential feature of dome technology which further distinguishes it from flat-roof technology. Both these technologies depend on rigid azara for the permanent formwork of their soffits; however, the azara in domes must be arranged to effect a curvilinear form despite their own rigid linear form.

The structural solutions used for domes involve the creation of more compartments, which are each consequently smaller, than would be warranted in a flat slab spanning the same space. To achieve these subdivisions, master masons vary the basic arch configurations by duplicating the transverse arches, twinning the arches, incorporating diagonal arches or kafa, incorporating intermediate arches and adding subsidiary kafar kaza. They also create lateral subdivisions in each soffit with lateral joists and beams as well as tiers of tauyi. Many of these structural solutions involve the creation of compartments which are triangular or wedge-shaped rather than rectilinear like the compartments of a flat-slab.

All Hausa master masons use the systems described in this provisional classification but their handling of the systems in their own buildings reveals their architectural sensitivity. The articulation and embellishment of the soffit permanent formwork and the beam or arch configuration in ceiling/roof structures demonstrate that Hausa architectural designs are based on a conceptual

integration of structural and aesthetic considerations.

The best master masons fully exploit the aesthetic possibilities of the permanent formwork. They create patterns with the joists and infilling members. They enhance their ceilings with contrasting materials, textures, and colours to create distinctive patterns. They play with the structural members of revealed soffits, with structure reflected in the embossed plaster, with smooth plaster, with mouldings, and with embossed decorative designs.

Master masons also exploit the formal and aesthetic potential of arches and arch configurations. The arches themselves may be shallow or deep, wide or slim, tapered or splayed; they may spring from the floor or above eye level, dominate the space or slightly accentuate the domical form. Arches perform structural, form-giving and decorative roles. Often the arches are articulated to reflect their relative structural role. Some domes are over-structured. In these cases, an arch configuration associated with grandeur is confined in a moderate-sized space. The selection of the arch configuration is itself an aesthetic statement since most of the arch configurations are interchangeable.

The great variety of ceiling patterns studied in the preceeding classification as well as their integral relationship to the complex structural systems casts doubt on the notion that the Hausa copied their

arched systems and domed ceiling/roof technology. The ceiling patterns are integral to the architecture performing structural, form-giving and decorative roles. If such complex and varied architectural solutions were in fact copied, the source should be available in the literature of indigenous architectures. A survey of the literature reveals no similar arch and dome structures. It therefore seems probable that the Hausa master masons developed these distinctive features of their architecture without recourse to outside imitation.

The literature has only revealed some much less structurally sophisticated use of tauyi for flat slabs and of palm timber for short span, arch construction. The use of tauyi and tiers of superimposed tauyi to construct flat ceiling/roofs has been documented for the medieval city of Djenne in Mali and for some Berber architecture in North Africa (Prussin, 1974) but even in these instances the direction of cultural diffusion has not been established. The use of palm timber to create a permanent formwork for arches has also been documented for the architecture of the Mzab in the Algerian Sahara (Etherton, 1971). However, the formwork consists of two sets of palm frond ribs rather than azara cut from the trunk of the palm tree. Moreover, the palm ribs are bent over and tied together rather than being built into a system of palm timber members

cantilevered to the crown of the arch in progressive stages.

Our study of Hausa ceiling patterns generates as many questions as it answers. The exact nature of the relationship between Hausa architecture and other architectures using sun-dried mud bricks and mud roofs needs to be clarified. The full range of approaches to the handling of the ceiling patterns deserves fuller study to establish more clearly stylistic distinctions and aesthetic qualities. More historical and geographical data on the distributions of styles and changes in fashion would be of great value to an overall understanding of the evolution of Hausa architecture. Precise data on master masons, including their movement and their individual styles is also essential. Further information on erectional procedures is vital for a fuller appreciation of the architecture itself as well as for our understanding of the evolution of Hausa architecture. Similarly, sociological studies are needed to define more clearly the role of domes, of lofty spaces, of elaborately embellished soffits, of embossed pictorial facades, and of substantial multi-roomed and/or multi-storeyed dwellings as indicators of status. Despite great gaps in our knowledge, this introductory study of Hausa ceiling/roof systems and their resulting patterns offers a basis for appreciating the qualities of Hausa architecture.

REFERENCES

Adamu, Mahdi, (1976), The Hausa Factor in West African History. Zaria: Ahmadu Bello University Press.

Abraham, R. C. (1962), Dictionary of the Hausa Language. London: University of London Press, Ltd.

Adeleye, R. A. (1971a), 'The Sokoto Caliphate in the nineteenth century', in J. F. A. Ajayi and Michael Crowder, eds. (1971) History of West Africa, Vol. II London: Longman Group Ltd., pp.57-92.

_____, (1971b), 'Hausaland and Bornu 1600-1800', in J. F. A. Ajayi and Michael Crowder, eds. (1971) History of West Africa, Vol. I. London: Longman Group Ltd., pp.485-530.

Adeyemi, E. A. (1976), "Changing Traditional Culture and Modern Architecture", Archiforum, No.1, pp.12-19.

Aniakor, Chike Cyril. (1979), Igbo Architecture: A Study of Forms, Functions and Typology. Unpublished Ph.D. thesis, University of Indiana at Bloomington. Ann Arbor (Michigan): University Microfilms.

Aradeon, David (1971), "A Propos ('Sudanese Architecture and the Manding')" African Arts, Vol. 4, No.4 (Summer), pp.76-78.

Aradeon, David. (1976), 'Architecture', in Saburi O. Biobaku, ed.(1976), The Living Culture in Nigeria. London: Thomas Nelson and Sons, pp.38-43.

Aradeon, Susan B. (1980a), "Moufou Architecture", African Arts, Vol. XIV, No. 1. (November), pp. 58-60.

_____, (1980b), "Traditional Hausa Architecture: Builders Adapt to Changing Life-Styles in Katsina", Proceedings of the International Conference of the Association of Housing Corporations of Nigeria (Kaduna, 17-24 August, 1980), Forthcoming.

d'Azevedo, Warren L., ed. (1973), The Traditional Artist in African Society, Bloomington. Indiana University Press.

Baldwin, T. H. (1933), "Kano Province", Nigeria Magazine, No.15 (September), pp. 183-187.

Barth, H. (1965), Travels, and Discoveries in North and Central Africa. 3 Vols. Reprint of 1857 edition. London: Frank Cass and Co.Ltd.

Beguin, Jean-Pierre, et. al. (1952), L'Habitat au Cameroun, Paris; Editions de L'Union Francaise.

Biebuyek, Daniel, ed. (1969), Tradition and Creativity in Tribal Art. Berkeley: University of California.

Biver, A.D.H. and Shinnie, P. L. (1962), "Old Kanuri Capitals", Journal of African History, Vol. 3., No. 1, pp. 1-10.

Brasseur, Gerard. (1968), Les Establishments Humains au Mali. Memoire No. 83, Dakar: IFAN.

Campbell, M. J. (1959), "The Walls of a City", Nigeria Magazine, No. 60, pp. 39-59.

Clapperton, H. (1966), Journal of a Second Expedition into the Interior of Africa. Reprint of the 1829 edition. New York: Frank Cass.

Cleszkiewicz, S. (1977), "Zaria Massallaci Juma'a: An Example of Hausa Structures", Public Lecture, Department of Civil Engineering, Ahmadu Bello University, Zaria, February, (Mimeographed).

Cohen, Abner. (1969), Custom and Politics in Urban Africa. Berkeley: University of California Press.

Crowder, Michael. (1956), "The Decorative Architecture Northern Nigeria", African World, p. 9.

Curtis, William J. R. (1983), 'Type and Variation: Berber Collective Dwellings of the Northwestern Sahara' in Oleg Grabar, ed. (1983) MUQUARNAS: An Annual on Islamic Art and Architectures. New Haven: Yale University Press, pp. 181-209.

Dalby, D. (1975), 'The Concept of Settlement in the West African Savannah', in Paul Oliver, ed. (1975) Shelter Sign and Symbol. London: Barrie and Jenkins Ltd., pp. 197-205.

Daldy, A. F. (1945), Temporary Buildings in Nigeria. Technical Paper No. 10, Lagos: Public Works Department.

Dankoussou, Issaka. Katsina: Traditions Historiques des Katsinaawaa après le Jihad. Niamey: Centre Regional de Documentation pour la Tradition Orale et Centre Nigerian de Recherche en Sciences Humaines. n.d.

Denyer, Susan. (1978), African Traditional Architecture. London: Heinemann Educational Books Ltd.

Didillon, Henriette and Jean-Marc Didillon. Catherine Donnadieu and Pierre Donnadieu.(1977), Habiter le Desert/Maisons Mozabites. Brussels: Pierre Mardaga, Editeur.

Dubois, Felix, (1897), Timbuctoo The Mysterious, trans. by Diana White. London: William Heinemann.

Echallier, J. C. (1966), "Sur Quelques Habitations Rurales du Souf," Travaux de I'Institut de Recherches Sahariennes, Vol. 25, pp. 129-136.

Echard, N. L. (1967), "L'habitat traditionnel dans l'Ader (pays hausa, Niger)", Homme, Vol. 7, No. 3.

Etherton, David. (1977), Algerian Cases', in Paul Oliver, ed. (1977) Shelter in Africa. London: Barrie & Jenkins Ltd., pp. 172-189.

Fairweather, Leslie and Jan. A. Sliwa. (1969), VNR Metric Handbook. New York: Van Nostrand Reinhold Company, p.198.

Federal Department of Antiquities. (1978), 25 Years of Jos Museum. Jos: National Museum, Jos.

Fitchen, John. (1961), The Construction of Gothic Cathedrals; A Study of Medieval Vault Erection. Oxford: The Claredon Press.

Foyle, A. M. (1951), "The House of a Merchant in Kofar mata Street, Kano", Nigeria Magazine, Vol. 37 pp. 29-35.

Foyle, A.M. (1952), "European Houses in Mud, Kano", Nigeria Magazine, No. 39, pp. 261-266.

Foyle, A. M. (1959), "The Development of Architecture in West Africa." 2 Vols. Un-published Ph.D. dissertation, University of London.

Fraser, Douglas, ed. (1968), Village Planning in the Primitive World. New York: Braziller.

Gabus, Jean. (1958), Arts et Symboles: Au Sahara, Vol. II. Neuchatel: A la Baconniere.

Gadzama, D. J. Daniel. (1976), "The Zaria City's Old Friday Mosque". Un-published M.Sc. Arch. thesis, Ahmadu Bello University, 1976.

Gardi, Rene. (1974), Indigenous African Architecture. Trans. by Sigrid MacRae. New York: Van Nostrand Reinhart.

Greenburg, J.H. (1941),"Some Aspects of Negro-Mohammadan Culture Contact Among the Hausa", American Anthropologist, Vol. 43, pp. 288ff.

Heathcote, David. (1973), "Notes and Comments: The Princess's Apartments in Kano Old Treasury", Savanna, Vol. 2, No. 1, pp. 61-65.

Heathcote, David. (1979), The Embroidery of Hausa Dress. Un-published Ph.D dissertation. Zaria: Ahmadu Bello University.

Hoag, John D. (1977), Islamic Architecture. New York: Harry N. Abrams, Inc.

Hogben, S. J. (1979), An Introduction to the History of the Islamic States of Northern Nigeria. Ibadan: Oxford University Press.

Hull, Richard W. (1976), African Cities and Towns Before the European Conquest. New York: Norton and Co.

Hunwick, John, (1971), 'Songhay, Bornu and Hausaland in the sixteenth century', in J.F.A. Ajayi and Michael Crowder, eds (1971), History of West Africa, Vol.I, London: Longman Group Ltd., pp. 202-239.

Keita, Brigitte.(1981), "Habitat Traditionnel Hawsa a Birnin Konni-Niger", Un-published Memoire de Maitrise, University Paris VII, U.E.R. Anthropologie Ethnologie Science des Religions.

Kirk-Greene, A.H.M. (1961), "Decorated Houses in Zaria", Nigeria Magazine, Vol. 68, pp. 53-78.

_____, (1963), Decorated Houses in a Northern City Kaduna: Baraka.

Last, Murray. (1971), 'Reform in West Africa: the Jihad movements of the nineteenth century', in J.F.A. Ajayi and Michael Crowder, eds. (1971), History of West Africa. Vol. II. London Longman Group Ltd., pp. 1-29.

Leo Africanus. (1963), The History and Description of Africa. Trans. by John Pory 1600 from the 1526 original Italian. New York: Burt Franklin. 3 vols.

Leary, A. H. (1966), "The Development of Islamic Architecture in the Western Sudan". Un-published M.A. thesis. University of Birmingham, 1966.

_____. (1977), "A Decorated Palace in Kano", Art and Architecture Research Papers, No. 12 (December), pp. 11-17.

_____. (1978), 'West Africa', in George Michell, ed. (1978), Architecture of the Islamic World. London: Thames and Hudson, pp. 274-277.

Levtzion, Nehemia. (1973), Ancient Ghana and Mali London: Methuen and Co. Ltd.

Lovejoy, Paul E. (1979), "The Characteristics of Plantations in the Nineteenth Century Sokoto Caliphate (Islamic West Africa)", The American Historical Review, Vol. 84, No. 5 (December), pp. 1276-1292.

Lugard, F. D. (1904), "Northern Nigeria", "Geographical Journal, Vol. 23, pp. 1-29.

Macmillan, Allister, ed. (1968), The Red Book of West Africa. Reprint of the 1920 edition. London: Frank Cass and Co. Ltd.

Mauny, Raymoud. (1961), Tableau geographique de l'ouest africain au moyen age d'apres les sources ecrites, la tradition et I'archeologie. Memoire No. 61., Dakar: IFAN.

Mainstone, Rowland. (1975), Developments in Structural Form. Cambridge, Massachusetts: The M.I.T. Press.

Mercier, Marcel. (1922), La civilisation urbaine au Mzab. Alger: E. Pfister.

_____. (1928), "Note sur une architecture berbere saharienne", Hesperis, Vol. 8, pp. 413-429.

Michell, George, ed. (1978), Architecture of the Islamic World. London: Thames and Hudson.

Moody, Johanna E. (1967), "Paul Staudinger: An Early European Traveller to Kano", Kano Studies, No. 3, (June), pp. 38-52.

Moody, H. L.B. (1967a), "Ganuwa - The Walls of Kano City", Nigeria Magazine, No. 92, pp. 19-38.

_____. (1967b), "The Walls and Gates of Kano City", Kano Studies, No. 3, pp. 12-26.

Moughtin, J.C. (1964), "The Traditional Settlements of the Hausa People", Town Planning Review, Vol. 35, No. 1, pp. 21-34.

_____. (1965), "Traditional Architecture of the Hausa People". Un-published M.A. thesis, University Liverpool.

_____. (1968) "Housing in an Old Society", Journal of the Town Planning Institute, pp. 72-77.

_____. (1972), "The Friday Mosque, Zaria", Savanna, Vol. 1, No. 2, pp. 143-163.

Moughtin, J. C. and Leary, A.(1963), "Hausa Mud Mosque", Architectural Review, Vol. 137 No. 816 (February), pp. 155-58.

Mount, Sigrid Docken. (1978), "Hausa Architectural Decoration: A Selected and Annotated Bibliography," Paper submitted for course A650, Department of Art History, University of Indiana, Bloomington, Indiana, (Mimeographed).

Oliver, Paul, ed. (1971) Shelter in Africa. New York: Praeger Publishers.

_____. (1978), 'Part One' in Paul Oliver, ed. (1978), Shelter and Society. London: Barrie & Jenkins Ltd., pp. 7-29.

Paden, John N. (1973), Religion and Political Culture in Kano. Berkeley: University of California Press.

Palmer, H. R. (1928), Sudanese Memoires. 3 Vols. Lagos: Ministry of Education.

Perani, Judy. (1983), "The Interface Between Structure and Decoration in Nupe Architecture". Paper presented at the Sixth Triennial Symposium on African Art, University of Oklahoma, Norman, Oklahoma, 6 April,

Portch, J. H. (1980), "Minarets in Nigeria", The Nigerian Field, Vol. 45, Part I, p. 7-20.

Prussin, Labelle. (1968), "The Architecture of Islam in West Africa", African Arts, Vol. 1, No.2, pp.32-35.

_____. (1974), The Architecture of Djenne: African Synthesis and Transformation. Ann Arbor: University Microfilms.

_____. (1974b), "An Introduction to Indigenous African Architecture", Journal of the Society of Architectural Historians, Vol. 23, No.3, pp. 183-200.

_____. (1976), "Fulani - Hausa Architecture", African Arts, Vol. 10. No. 1, (October), pp. 8-19.

_____ and David Lee (1973), "Architecture in Africa: An Annotated Bibliography, Part I: North and West Africa", Africana Library Journal. Vol. 4, No.3 (Autumn), pp. 2-32.

Rapoport, Amos. (1969), House Form and Culture. Englewood Cliff, (New Jersey): Prentice Hall.

Robinson, Henry Charles (1897), Hausaland or Fifteen Hundred Miles Through the Central Soudan. London: Sampson Low.

Saad, Hamman Tukur. (1981), Between Myth and Reality: The Aesthetics of Traditional Architecture in Hausaland, 2 Vols. Un-published Ph.D. dissertation, University of Michigan. Ann Arbor (Michigan): University Microfilms International.

Salvadori, Mario and Robert Heller. (1963), Structure in Architecture. Englewood Cliffs (New Jersey): Prentice-Hall. Inc.

Schacht, J. (1954, 1958), "Sur la diffusion des formes d'architecture religieuse musulmane a travers le Sahara", Travaux de L'Institut de Recherches Sahariennes, New York: Praeger, pp. 58-71.

Schwerdtfeger, F.W. (1971), 'Housing in Zaria' in P. Oliver, ed., (1971) Shelter in Africa. New York: Praeger Publisher, pp. 58-79.

_____. (1982), Traditional Housing in African Cities, New York: John Wiley and Sons.

Shea, Philip. (1975), The Development of an Export - Oriented Dyed Cloth Industry in Kano Emirate in the Nineteenth Century. Un-published Ph.D. dissertation, University of Wisconsin. Ann Arbor (Michigan: University Microfilms.

Siegel, Curt (1962), Structure and Form in Modern Architecture. Trans, by Thomas E. Burton. New York: Reinhold Publishing Company.

Smith, Baldwin. (1972), The Dome: A Study in the History of Ideas. Princeton: Princeton University Press.

Smith, H. F. C. (1971), 'The Early States of the Central Sudan', in J.F.A. Ajayi and Michael Crowder, eds. (1971), History of West Africa, Vol. I, London: Longman Group Ltd., pp. 158-201.

Smith, Michael G. (1959), "The Hausa System of Social Status", Africa, Vol. 29, pp. 239-252.

Smith, Myron. "The Vault in Persian Architecture: A Provisional Classification with Notes on Construction". Un-published Ph.D dissertation, The Johns Hospkins University, 1947.

Sokoto History Bureau. "History of Yabo". n.d. (Typewritten).

Stevens, Phyllis, (1968), Aspects of Muslim Architecture in the Dyula Region of the Western Sudan. Legon: Institute of African Studies.

Taylor, F. W. and A.C.G. Webb, ed. (1932), Labarun Al'Adun Hausawa Da Zantatu Kansu: Accounts and Conversations Describing Certain Customs of the Hausas (in Hausa and English). Oxford: Oxford University Press.

Tremearne, A. J. N. (1910), "Hausa Houses", Man, Vol. 10, No. 99, pp. 177-178.

Trevallion, B.A.W. (1967), Metropolitan Kano: Report on the Twenty-year Development Plan, 1963-83, Vol. 2, London.

Urbanowicz, Barbara Andrezejewska. (1979),"Selected Aspects of House Form in Zaria Urban Area". Un-published Ph.D dissertation, Ahmadu Bello University.

Urquhart A. W. (1977), Planned Urban Landscapes of Northern Nigeria. Zaria (Nigeria): Ahmadu Bello University Press.

Urvoy, Y. (1955), L'art dans le territoire du Niger. Etudes Nigeriennes 2. Dakar: Institute Fondamentale d'Afrique Noire.

Williams, Geoffrey J. (1972), "Notes and Comments: The Juma'a (Friday Mosque), Zaria City," Savanna, Vol. 1, (June), pp. 103-105.

APPENDIX I

THE CATEGORIES IN THE PROVISIONAL CLASSICIATION AND THE DOCUMENTED CEILINGS USED AS EXAMPLES

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14.15 Round Zaure, Gidan No. 101 Limam Quarter (Zaria)

11.20 Intersecting Pairs of Twin Transverse Arches 238

11.21 Central Bays, Friday Mosque (Zaria; Jos)

11.30 Intersecting Multiple Transverse Arches 245

11.31 Sets of Three

Princess's Upper Storey Room, Old Treasury (Kano)*

11.32 Sets of Five

Soron Ingila, the Throne Room, Emir's Palace (Kano)

11.40 A Single Transverse Arch Intersecting Multiple Arches 249

11.41 Guest's Room, Panisau Palace (via Kano)

11.50 Intersecting Pairs of Transverse Arches Abutted by Diagonal Kafa 250

11.51 Outer Zaure, Gidan Madawaki (Katsina)

11.60 Intersecting Multiple Transverse Arches Abutted by Diagonal Kafa and False Ribs 253

11.61 Outer Zaure, Gidan Alhaji Barmo Makudawa (Katsina)

11.70 Intersecting Multiple Transverse Arches and Diagonal Arches in Conjunction with a Central Coffer 254

11.71 Outer Zaure, Chef de Canton (Dosso, Niger)

11.72 Zaure, Gidan Mohammed Galadima (Tondobu Quarter, Dosso, Niger)

11.73 Zaure, Gidan Boubakar Fulan (Kouremaria, Niger)

CHAPTER 12: ARCHES ABUTTED BY KAFA (HALF-ARCHES)

12.10 Two Transverse Arches, Each Abutted by a Kafa 263

12.11 Inner Zaure, Magajin Gari (Maska)

12.20 Two Pairs of Twin Transverse Arches, Each Abutted by a Kafa 264

12.21 Lateral Bays, Friday Mosque (Zaria; Jos)

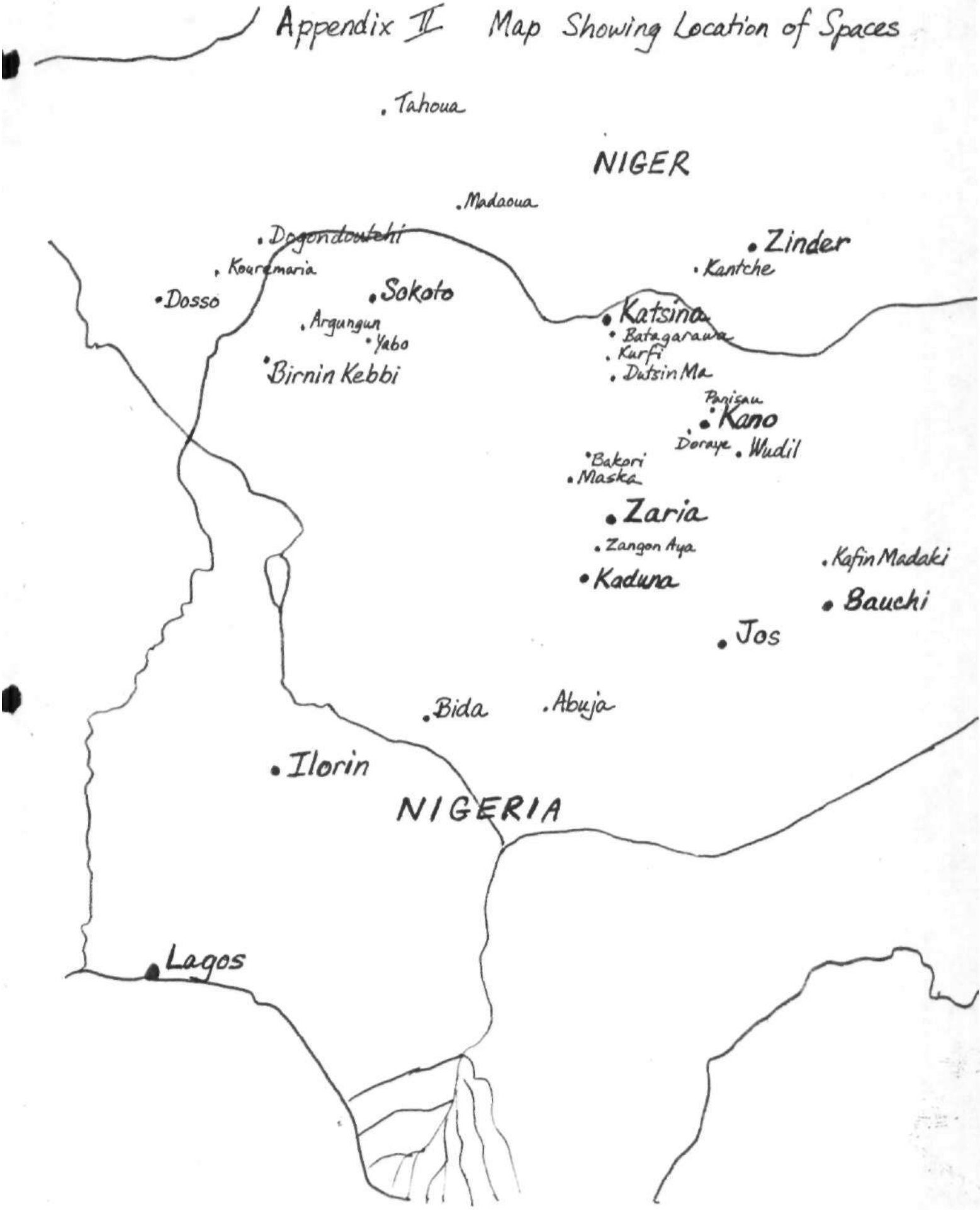
12.30 Two Transverse Arches, Each Abutted by Two Kafa 268

12.31 Ground Floor Room in Soron Sanda Maiganari (Kano)*

12.40 Two Transverse Arches, Each Abutted by a Kafa and Supplemented by a Central Transverse Arch 269

12.41 Women's Common Hall, Schwerdtfeger's House Plan No. 78 (Zaria)

Appendix II Map Showing Location of Spaces



APPENDIX III

SOURCES OF MEASURED CEILING PLANS AVAILABLE IN LIBRARIES

A. BOOKS

Denyer, Susan (1978), African Traditional Architecture.

Gidan Hassan Jamil, Kofar Mata Street (Kano)* (p. 179, Fig. 277)

Round, Thatched Room, Emir's Palace (Abuja; Jos Museum) (p. 148, Fig. 237)

Gabus, Jean. (1958), Arts et Symboles: Au Sahara, Vol. II

Gidan Captini (Tahoua, Nigeria) (pp. 374-375)

Schwerdtfeger, Friedrich. (1971), 'Housing in Zaria,' in Paul Oliver, ed., Shelter in Africa.

House Plan No. 78 (p. 65)

B. JOURNALS

Foyle, A. M. (1951), "The House of a Merchant on Kofar Mata Street, Kano", Nigeria Magazine.

Gidan Hassan Jamil (Floor Plan showing arches, p. 30)

Leary, Allan (1977), "A Decorated Palace in Kano", Art and Architecture Research Papers.

Public rooms of Emir's Palace (Kano) including Soron Bello, Soron Giwa, Soron Guga and Soron Inglia (Plan and Section showing ceiling, p. 13)

Former Audience Chamber (Reconstructed on the basis of photographs from the Lugard Expedition), Emir's Palace (Kano) (Section showing ceiling details, p. 12)

Moughtin, J. C. (1972), "The Friday Mosque, Zaria City", Savanna.

Zaria Mosque (Section with ceiling details, opposite p. 144)

Kazaure Mosque (p. 148, Fig. 5)

Moughtin, J. C. and A. H. Leary. (1965), "Hausa Mud Mosque" Architectural Review.

Zaria Mosque (p. 156)

Williams, Geoffrey. (1972), "Notes and Comments: The Juma'a (Friday Mosque), Zaria City", Savanna.

Zaria Mosque Complex (p. 104, Fig. 1)

Zaria Sharia Court (frontcover)

C. DISSERTATIONS

Foyle, A. M. (1959), "The Development of Architecture in West Africa" (available only in microfilm or microfiche).

Gidan Hamidu Bayero (Kano

Gidan Hassan Jamil (Kano)

Gidan Mofi (Kano)

Gidan Dan Hausa (Kano)

Gidan Resident (Kano)

Gidan Abdullahi (Niamey)

Leary, A. H. (1966), "The Development of Islamic Architecture in the Western Sudan".

Maska Mosque (opposite p. 56).

Saad, Hamman Tukur. (1981), Between Myth and Reality: The Aesthetics of Traditional Architecture in Hausaland (Volumes I and II).

Gidan Hamidu Bayero (Kano) after Foyle (p. 76)

Gidan Hassan Jamil (Kano) after Foyle (p. 76)

Gidan Mofit (Kano) after Foyle (p. 76)

Gidan Dan Hausa (Kano) after Foyle (p. 77)

Gidan Resident (Kano) after Foyle (p. 77)

The Bawan Dodo (Kano) after Leary (p. 28)

Southern Zaure, Emir's Palace (Daura) after National Commission for Museums and Monuments (p. 28)

Urbanowicz, Barbara A. (1979), "Selected Aspects of House Form in Zaria Urban Area".

Round Zaure, Gidan Limam (Zaria) (p. 183, Fig. 79)

Round Zaure, Gidan No. 101, Limam Quarter (Zaria) (p. 184, Fig. 80)

APPENDIX IV

INACCESSIBLE SPACES OF ARCHITECTURAL SIGNIFICANCE

A. Measured Drawings of Hausa Architecture in the Jos Museum Collection.*

Argungun:	Friday Mosque Emir's Palace
Bauchi:	Soron Tala Tala, Emir's Palace Gidan Madaki Kofar Dami
Bebeji:	Friday Mosque
Birnin Kebbi:	Friday Mosque
Daura:	Gidan Ahmadu Galadima Gidan Mallam Husaini Ibrahim
Deba (Gombe):	Emir's Palace
Fika:	Emir's Palace
Kafin Madaki:	Gidan Madaki* Friday Mosque
Kano:	Gidan Makama Kofar Duka Wuya Emir's Palace, Nassarawa Birni Mosque (plan only) Stages in reconstruction of permanent formwork of the arches in the Soron Fadanci of the Gidan Makama
Katsina:	Emir's Palace* Gidan Yarima Kafar Saurei Kofar Waziri Gobirau Minaret
Maigana:	Friday Mosque (ruins)
Potiskum:	Emir's Palace
Zaria:	Emir's Palace Friday Mosque Gidan Sarkin Magina Mallam Balarabe Gidan M. Liman Kona Gidan M. Liman Mohamadu Murtala Gidan Baki Gidan Alkalin Jae Gidan Alhaji Bo Alhaji

* Drawings made available to me by Professor Dmochowski.

Wusasa: Church

B. The private spaces of all palaces and the summer palace at Wudil.**

C. Demolished Spaces

1. Friday Mosque, Kano
2. Friday Mosque, Katsina
3. Habe Friday Mosque, Zaria
4. Friday Mosque (visited by Clapperton), Sokoto
5. Pre-twentieth century reception halls, Emir's Palace, Kano
6. Old Treasury, Kano
7. Gidan Sultan Bello, Sokoto
8. Palace, Kirfi
9. Gidan Sanda Maiganari, Kano

** The notable exception is the palace of the Emir of Zaria which was measured by Ahmadu Bello University students. The drawings are in the NCMM collection at Jos.

Appendix V

Diagrams Illustrating Architectural Technology

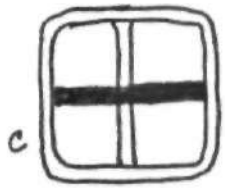
Arches



a kafa



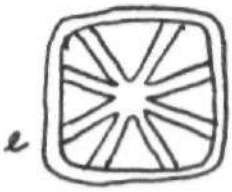
b primary transverse arch



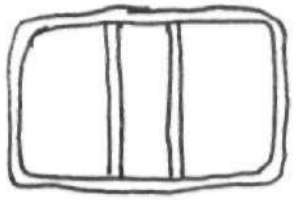
c secondary transverse arch



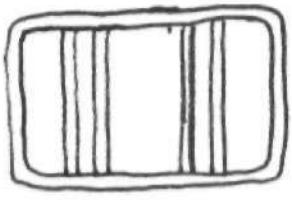
d diagonal arches



e intermediate arches



f a pair of transverse arches



g two pairs of twin arches

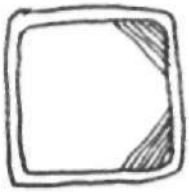
Permanent Formwork



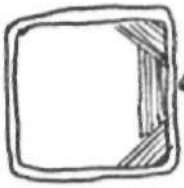
h contiguous joists



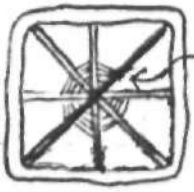
i joists with infilling members



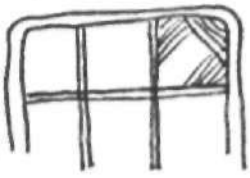
j tawyi



k wall-tawyi



l crown-tawyi



m tawyi

APPENDIX VI

IDENTITY OF INFORMANTS

A. TRADITIONAL OFFICIALS

Bauchi - Baraya Umaru

Birnin Kebbi - Magajin Gari Alhaji Yahaya

Kafin Madaki - Madaki of Bauchi, Ibrahim Aliyu

Kurfi - Sarkin Kurfi Mohammed Sani

Maska - Magajin Gari Alhaji Umar

Yabo - Sarkin Kebbin Yabo Mohammed
Mai turzae

B. HEADS OF THE MASTER BUILDERS

Argungun - Sarkin Gini Sahabi

Bauchi - Sarkin Gini Alhaji Abdu

Birnin Kebbi - Sarkin Gini Alhaji Ibrahim Dan Karima

Kano - Sarkin Gini Ibrahim

Katsina - Sarkin Gini Mallam Sani

C. OTHER MASTER MASONS

Bauchi - Mallam Maidawa, son of former Sarkin Gini Baba

Katsina - Alhaji Muazu, retired master mason

Katsina - Mahman Sani, retired master mason

Kano - Mallam Lawani, master mason and contractor

Maradi - Alhaji Abudu Djibril, master mason