PN-AAZ-593
55005

ADAUA EARTHEN CONSTRUCTION TECHNIQUES

By

Carlos R. Lola

Washington, D.C.

September 8, 1983

TABLE OF CONTENTS

I	INTRODUCTION
II	ADAUA: DESCRIPTION
III	STABILIZED ADOBE BRICKS
IV	STRUCTURAL SYSTEM OVERVIEW
V	CREATION OF COLLECTIVES
VI	ADAUA: INTERESTING FEATURES
VII	APPENDIX

INTRODUCTION

Implementation of earthen construction projects is a critical element to promote low cost earthen construction projects throughout the world. In Africa, ADAUA stands out as an implementor and innovator of earthen construction technologies. The purpose of this article is to present a brief appraisal of the ADAUA Earthen Construction Techniques in Ouagadougou, Upper Volta. At the beginning a description of ADAUA is presented, followed by stabilized adobe bricks, structural system overview, creation of collectives and ADAUA's interesting features.

Upper Volta, with about 274,000 square kms. and about 6.6 million inhabitants is situated in the heart of Western Africa and on the edges of the Sahara Desert (see Map 1). The climate is Sudano-Sahelian (arid region) and Ouagadougou has a precipitation of less than 900 mm/year. Upper Volta became independent from France on August 5, 1960 and its annual per capita income (World Bank 1978) was 160 dollars.

In the construction project presented in this article, soil cement stabilization principles and a Belgian machine technology production are used to improve earthen construction in Upper Volta.

ADAUA: DESCRIPTION

ADAUA is an international non-profit organization headquartered in Ouagadougou, Upper Volta (see Map 1). It was founded in the early 1970s with central offices in Geneva, Switzerland. When projects began to spread particularly in West Africa, it moved to Ouagadougou. ADAUA (Association pour le Developpement d'une Architecture et d'un Urbanisme Africains) aims at

facilitating low cost construction techniques with stabilized adobe. The principal elements are the use of locally available soils, the adaptation of an innovative roofing technology, and the creation of collectives by training and supporting local artisans.

The staff of ADAUA and its various national affiliates is composed of African engineers, architects, social promoters, head masons, brickmakers, local artisans and administrative officers.

STABILIZED ADOBE BRICKS

o **Production**

At the present time portland cement type I is the only stabilizer in use at the various construction projects. ADAUA produces five different types of bricks as follows:

29.5 cms x 14 cms x 9 cms
22 cms x 14 cms x 9 cms
29.5 cms x 14 cms x 5 cms
21.5 cms x 10.5 cms x 5 cms
40 cms x 20 cms x 10 cms

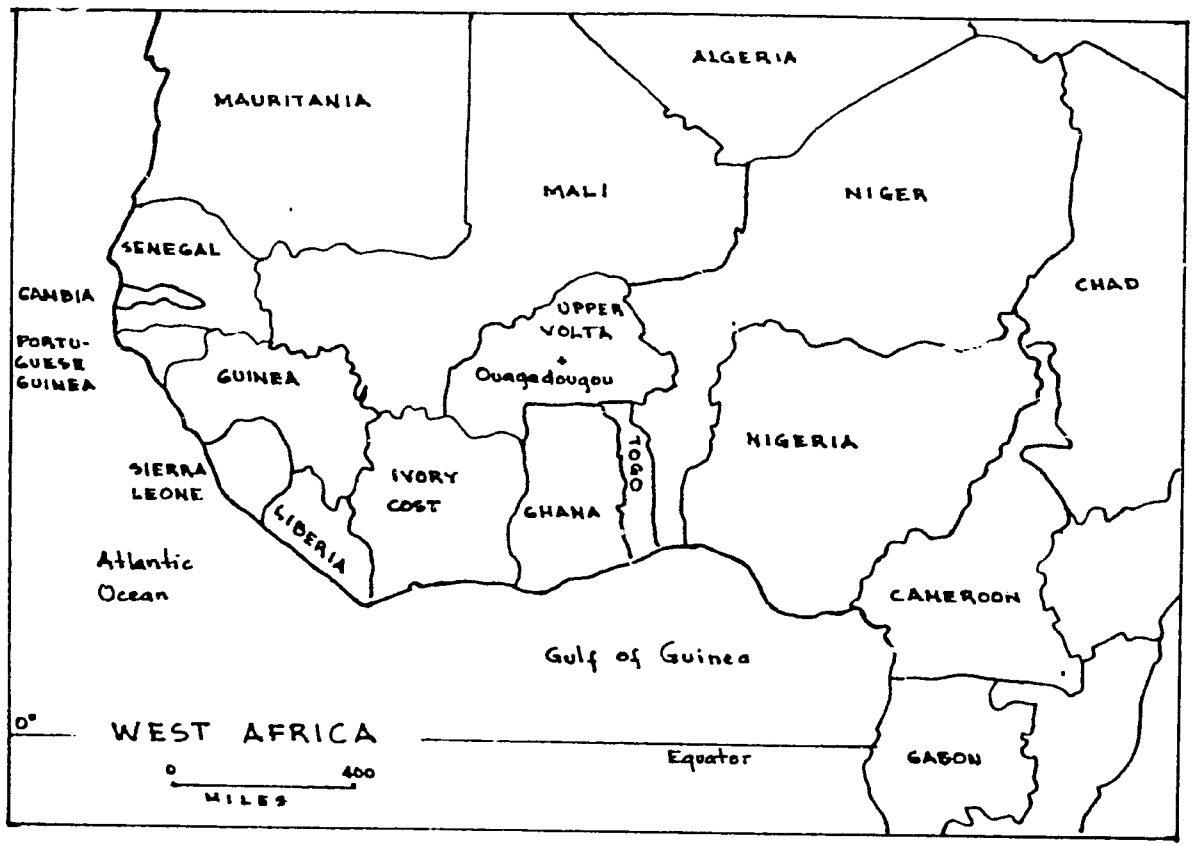
A five to six man crew using a manually operated Belgian machine can produce from 800 to 1200 bricks per day. The cost of the machine is 800,000 CFA (350 CFA = $1) of which 40% represents transport costs.

The amount of cement used ranges from 4% to 6% based on bearing or non-bearing wall function in the structural design.

Extensive testing programs were undertaken in November 1977 for the popular housing project in Rosso, Mauritania. Procedures for simplified soil classificaiton methods, determination of proper amout of stabilizer, and stabilizer selection were established for future projects.

o **Physical Mechanical Properties**

The average compressive strength has been found to be from 40 kg/cm^2 to 70 kg/cm^2 using 4% to 6% of cement. Brick water absorption, durability tests, diagonal compression or direct


MAURITANIA
ALGERIA
MALI
NIGER
SENEGAL
CAMBIA
PORTU-
GUESE
GUINEA
CHAD
UPPER
VOLTA
Ouagadougou
GUINEA
NIGERIA
TOGO
SIERRA
LEONE
IVORY
COST
GHANA
LIBERIA
Atlantic
Ocean
CAMEROON
Gulf of Guinea
0°
WEST AFRICA
Equator
GABON
0
400
MILES

Map 1

shear data are not available. A full scale test to determine the ultimate strength for a dome 3.55 mt x 3.55 mt was conducted in November 1978. These results are now used as parameters for the structural design in new projects.

STRUCTURAL SYSTEM OVERVIEW

Foundations

In the three different projects visited in the Ouagadougou area, a very hard laterite layer was present at approximately 20 to 30 cms from the surface, making ideal the use of shallow foundations. A 5 cms sand layer is generally placed on the bottom of the foundation trench. The foundation consists of quarry-stone bonded with a mortar with a cement content of 250 kg/m^3. Four layers of stabilized adobe (sub-base) with 6% cement are then placed on top of the quarry stone base. The thickness of the sub-base is a function of the wall thickness.

Walls

The bearing structure is integrated essentially by cement stabilized adobe loading walls, arcs, and domes. The minimum compressive strength of the bricks is usually 20 kg/cm^2. The cement content of the bricks is 6% (by weight). In general, thickness of non-loading walls is 14 cms and loading walls in 29 cms and 20 cms. The mortar is a mix of sand, soil, and cement content of 225 kg/m^3.

Arcs

The thickness of the arcs placed on top of the wall openings is generally 29 cms.

Roof Systems

ADAUA has adapted and extend the vaulting and dome roof technologies rediscovered by the Egyptian architect Hassan Fathy. Six percent stabilized adobe bricks are used for the vaults and domes.

Vaults:

The vault thickness if 10.5 cms. The height of the vault is directly related to the radius and circular sector width. See Fig. Coupe C-C and Coupe E-E.

Domes:

The thickness of the domes is usually 10.5 cms. The domes are built with bricks of 21.5 cms x 10.5 cms x 5 cms, which are composed of 6% cement stabilized adobe.

The domes are built without using wooden forms. A unique technique using a wooden pole fixed to a central point on the floor of the room, and with a rotating capability is the only guide used in making the regular curve of the dome. Particular attention has to be given to the brick-laying in order to achieve an aesthetically pleasing appearance on the interior surface of the dome. When domes are to be used as floor systems for a two-story section, light-weight materials such as empty glass bottles are used to reach a level surface upon which the flooring of the second story is laid.

The exposed exterior surface of vaults and domes is covered with various types of weatherproofing layers, including:

1) "colle + ecran" (asphalt emulsion; adhesive and water resistent);
2) a second layer "special toiture", an imported waterproofing substance.

ADAUA has made considerable effort to find a local sealing product but results have been negative.

CREATION OF COLLECTIVES

ADAUA has created collectives in Senegal, Mauritania and Upper Volta and is currently in the preparation phase to create one in Mali. ADAUA is also undertaking a cooperative effort with ALAHUA (Latin American Association for the Promotion of Habitat, Architecture and Urbanism), a Latin American Collective beginning to function in Ecuador. The ADAUA collective is usually

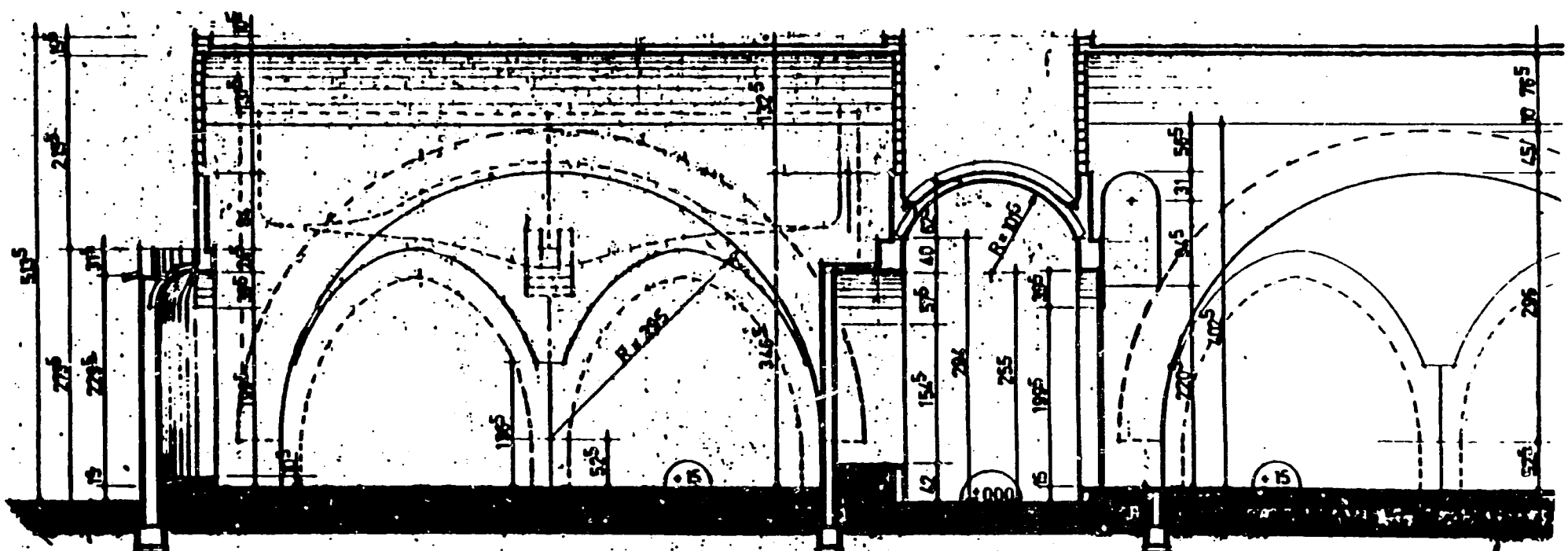
ADAUA

Design : Gerard Woba

Architect : Djibril Diagne

Engineer : Ladji Camara

May 1983 Upper Volta

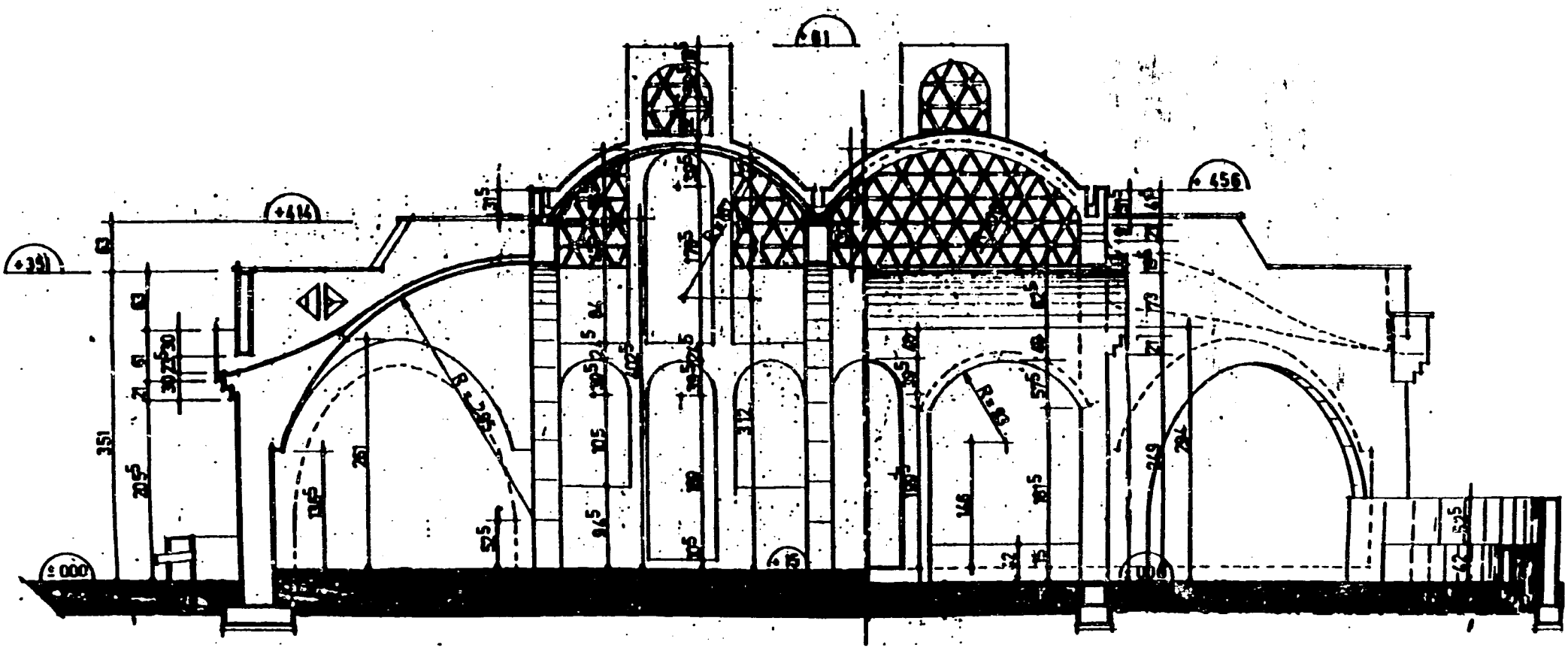


coupe E-E

6

ADAUA

Design : Gerard Wabai
Architect : Djibril Diagne
Engineer : Ladji Camara
May 1985 Upper Volta



constituted by a core staff of an architect, engineer, community coordinator, masons, brickmakers, and administrative officers. They are usually trained at other ADAUA work sites and then are assisted in training other members and in undertaking building programs with the community. The masons and brickmakers are developed into independent enterprises.

ADAUA: INTERESTING FEATURES

- **Structural Design**

By using stabilized adobe bearing walls, the use of reinforced concrete frames is eliminated with considerable savings in total cost. Introducing the efficient use of vaults and domes (designing them to work under compressive stresses) makes the use of steel reinforcing unnecessary.

- **Imports Reduction**

Upper Volta and several countries in West Africa depend greatly on imports to have access to cement, lime, steel bars, timber and other construction materials. The use of these essential building materials is reduced to a minimum by introducing the structural design described above.

- **Use of Local Raw Materials and Uskilled Labor**

The primary raw materials is the locally available soil; and the simplified techology allows unskilled labor to be incorporated into the construction process.

- **Architectural Design in Harmony with Cultural Pattern**

ADAUA's building architecture presents an outstanding example of introducing local cultural elements into construction design. ADAUA utilizes earthen construction which has a long historical tradition in West Africa, circular and square volumes and vaults and domes all with an appropriate Islamic touch.

- **ADAUA Training for Architects and Engineers**

ADAUA contributes to training of architects and engineers in earthen design and construction techniques. The program is

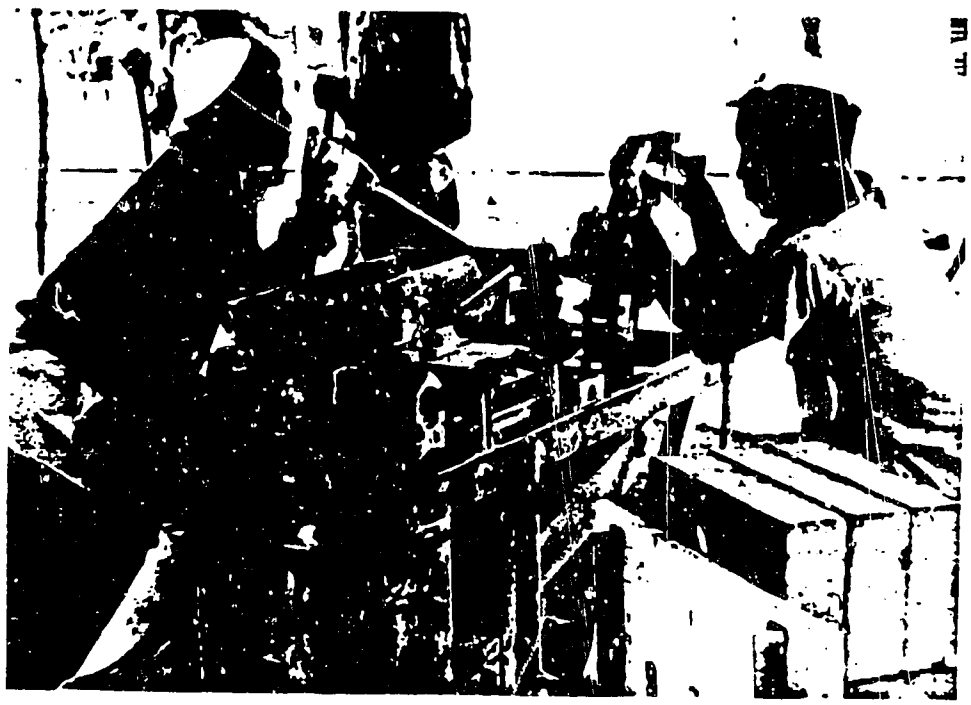
carefully structured to provide trainees with actual field experience in on-going projects.

- **Development of Small Enterprise for Production of Low Cost Building Materials**

The projects incorporate local residents on the worksites as masons and brickmakers and encourage them to develop into small enteprises. Once the training phase is completed and they have costituted a small enterprise they become building materials suppliers for ADAUA projects.

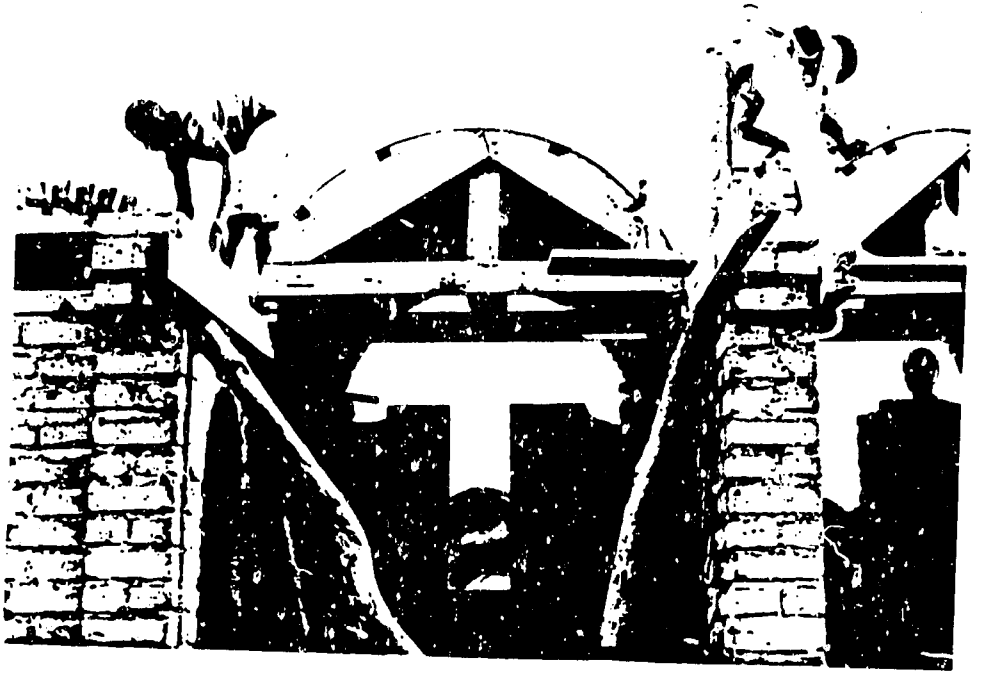
APPENDIX

ADOBE PRODUCTION

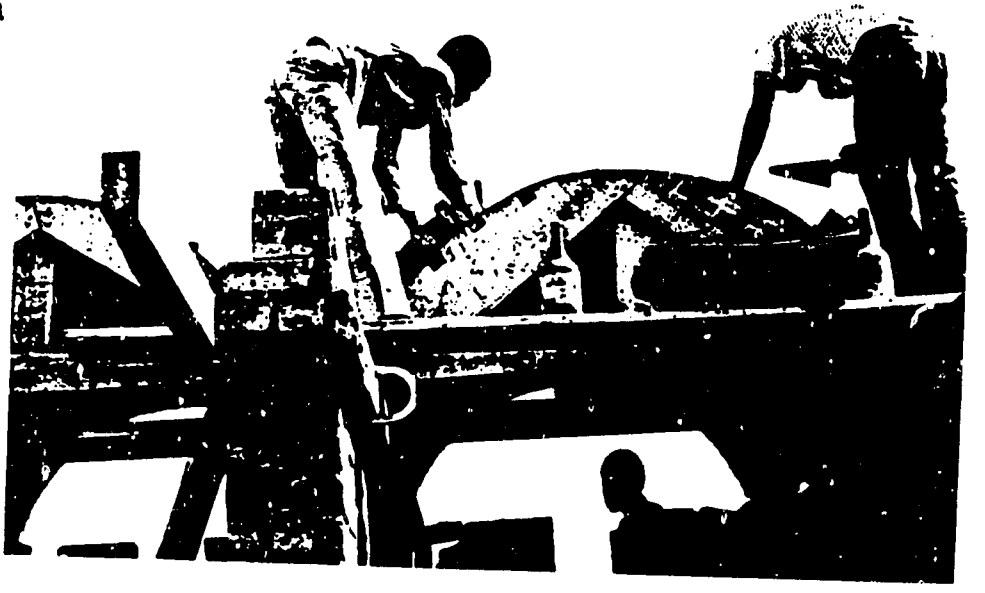


ADOBE

PRODUCTION



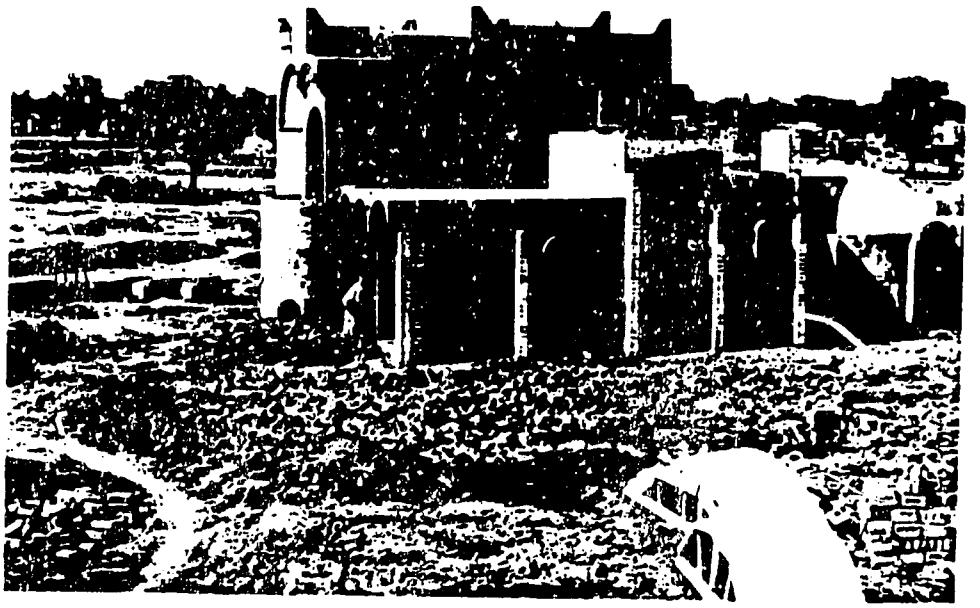
VAULTS
CONSTRUCTION
PROCESS



CONSTRUCTION

GENERAL

VIEW



TRADITIONAL
NON-STABILIZED
ADOBE HOUSING