MUD BRICK BUILDINGS
THE MASMAK FORTRESS IN RIYADH-SAUDI ARABIA
GENERAL CRITERIA OF RESTORATION

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SUMMARY

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INTRODUCTION

The work of restoring the Masmak at Riyadh represents an important cultural experience concerned with the conservation of the architectural tradition of the country and of local customs.

In recent years there has developed in some countries of the Middle East, Arabia, Africa and South America a greast interest in the conservation of mud architecture.

The conservation of mud architecture is today an important problem: in fact the abandoning of traditional system of construction in favour of importedtechniques and an organization of cities inspired by Western models has favoured the depopulation of old urban fabrics and their replacement.

It is important, therefore, that attention should be paid above all to those exemplar which, for architectural, historical or typological reasons, constitute a significant documentation.

GENERAL DESCRIPTION OF THE MASMAK

It is a large building of two floors, constructed in mud bricks covering an area of about 50 m. x 50 m.

It was originally used as a private residence, a citadel, barracks and jail, all at the same time.

Accordingto information it was erected at the end of the 17 th century and has been abandoned since the beginning of our century.

Constructed probably in several stages according to the needs and in accordance with local architecture and system prevailing at that time.

It is the place where a famous battle between King Abdul Aziz father of actual King and the Governor of Riyadh took place in 1902.

From the Masmak the unification of the Kingdom started after that date by King Abdul Aziz who was the first King of Saudi Arabia.

The predominant features which draw the attention are the four high towers positioned at the four corners.

Traces of bullets can still be seen in the tower walls and also part of a broken lance is embedded in the only outside door.

Inside the building and centrally situated is another tower higher than the other four and which was probably used for the simultaneous surveillance of the internal and external areas.

The drainage of rain water from the terraces is by means of timber shutes, inserted in openings and adjusted to take the flow of water a short distance away from the walls.

Walls of the first floor do not always coincide with the walls of the ground floor. They are often off set.

There is very little possibility that [illegible] part of the floors of the Masmak had been paved, as original methods suggest that floors generally were of compacted soil and often covered with straw matting. By spraying the straw matting with water one obtained a freshness which lasted for a certain period of time.

However, if few rooms had stone or any other form of pavement, this pavement does not exit today.

DISTRIBUTIVE CHARACTERISTICS OF THE MASMAK

The Masmak today differs to a great extent from its original distributive organization.

The building must have consisted of a greater number of nuclei of rooms round open courtyards generally protected by arcades.

The connections between one nucleus and another were characterized by covered passageways, protected against the sun.

The rectilinear staircases indicate, even on the upper storeys, directrices which traverse the palace longitudinally, while the connections with the towers or entrance to the guard walk (nearly completly destroyed or buried under debris) are so narrow that they permit the passage of only one person at a time.

The columns and walls and their arrangement correspond to recurrent constructional techniques connected with the characteristics of the materials, the climate and the way of life.

The soffits are made with main and secondary Tamerix wood beams, irregular in arrangement and section. They thus have the flexibility typical of wooden soffits and great chiaroscuro as a result of the irregularity of the material.

The ends of the wooden beams are not aligned but project in an irregular manner, since, wood being considered a constructional material of great prestige the beams were used in their full lenght.

The crenellation of the internal walls which do not extend as far as the soffit varies in design according to period. It is more or less elaborate according to the thickness of the mud and the formal characteristics of the merlons.

The openings in the walls, furthermore, play a very significant functional and decorative role.

The rooms are ventilated and kept cool by means of an efficacious distribution of air passages.

The openings, built on the basic of the dimensions of the mud brick, disposed obliquely so as to form a triangle generally in the upper part of the wall, form a geometrical pattern which is sometimes very elaborate and gives a solemn dignity both to the interior and to the exterior.

In other cases the openings in the walls serve to provide a view of the exterior; a view which is limited by the need to keep out the heat and to maintain privacy.

Often we found triangular openings placed at low level in the wall separating two rooms, both for ventilation purposes and for allowing verbal communication between rooms without being seen.

THE DECORATIONS

The beams often reveal bright geometrical painted decorations, as also the doors. The door heads carry more complex decorations; in some cases they are carved and acquire greater relief.

In room No. 68 on the first floor there are wall decorations, the remains of more extensive works, which could throw light on the origins of the palace and on the stylistic influences of the period.

RESTORATION CRITERIA TO BE ADOPTED FOR THE MASMAK

A careful examination of the plans and of the palace in its present conditions has led us to the conclusion that the palace should maintain all its recognizable distributive characteristics, those of the materials employed that form part of the tradition of mud architecture.

We think that the aim should be not to reconstruct the palace in a fanciful way but rather to conserve what remains, foreseeing the addition

of the parts necessary to make the building usable and suitable in the future to serve a purpose. It is in fact important that the restoration should enable the palace to serve a purpose and that, in the parts conserved, it should be possible to read its history and to observe the main architectural elements defining its particular characteristics.

IMMEDIATE PHASE OF EXECUTION (DEMOLITIONS)

The first phase of restoration foresees the demolition of the more evident additions: walling that occludes doors, arcades, openings in general.

2nd PHASE: SAMPLING

We are carring out an experimental sampling in order to test certain technical solutions and materials. Restoration works in general require great prudence and pratical verifications.

New materials to be used with old materials are in general tested under the real atmosperic and climatic conditions in order to ascertain the behaviour and performance of the materials over a period of time.

A restoration sempling in some of the rooms permit the carrying out of experiments which would provide important information and serve subsequently as a term of reference for the execution of the works.

The test assembly structure that we are carrying on includes the following:

Mud brick feature

Bricks are fabricated using soil cement mixture 1 portion of cement on 8 of soil and straw as indicated in Mr. Chiari report and tested in compression tests and water resistance.
Dimensions of the bricks are 45 x 22 x 12 cm. so that the total thickness of new walls is equal 50 cm. The compression test gives a result of 60 Kg/cm2 on 3 samples used after accurate manufacture.

Columns

Columns are made in the same traditional techniques using round stone blocks plastered with local fast hardening material called "jass" which correspond to gypsum. Once mixed with red sand or soil without straw gives a sandy colored smooth and hard surface which is indicated for detailed jobs and for the capping on top of walls.
Actualy this technique is applied in the local traditional houses to protect the top of walls from rain and gives the characteristic white fascia of the old villages.

Roof:

Roofs are made with tamerix props covered by palm leaves on doubl
On top of this a layer of soil is added at present.
One test assembly foresees the use of soil cement layer with an intermediate waterprofing membrane to protect the soil from rain and to avoid maintenance in the future.
The top soil cement should be compatted in order duc cracking.

Plaster

Samples have been made using soil cement plaster but the result is a deep change of appearance,withish color and cracking.
Therefore the normal mud plaster with straw is used and when needed protected with Ethylsilicate 40.
Testing of spraying Ethylsilicate 40 are under study at present and results may be collected within two months.

SCRIPTION OF THE PROJEC

The project envisages the reorganization of the rooms round the courtyards, the reconstruction on the ground and first floors of the nuclei clearly revealed by a study of the plans (and verified on the spot).

While in the rooms round the courtyards A,B and C, by means of the demolitions proposed in the outline of the project, the original organization of the palace is revealed with sufficient clarity, in the case of the courtyard D and the rooms round it we have hypothesized, in the absence of many elements, an organization similar to the nuclei already mentioned, on the basis of the traces of debris of destroyed walling.

The proposal to complete some of the missing parts of the Masmak is made above all with a view to its future utilization.

The courtyard E has not been recostructed: the absence of elements has led it to be suggested that this ample space be planted with palmtrees and the perimetrical walling be reinforced by a ring of perimetrical buildings to serve in the future for storage and to house hygienic services and possibly a cafeteria.

It is foreseen that the restoration of ling and of the exiting vertical communications will be carrie n accordance with the imensions and materials already existing in

Great importance will be given to the p ng of the system of rain water removal from both vertical and horizontal urfaces. For the good maintenance of the walling and the terraces it necessar that the water should be coveyed away according to a pre system i order to avoid infiltration, puddles and splashing, which can ve rise t dangerous erosion phenomena.

The existing paintings on woc will be preserved, as also any other ation that may come to light.

We think that the beaten earth floors should be retained, to be covered with palm matting in the traditional manner.

The wetting of the mats and floor in the periods of greatest heat leads to a lowering of the temperature as a result of the evaporation of the water: this usage, very common in the country, confirm the reason for many of our choices with regard to materials and constructional solutions, which we wish to reconfirm.

PROTECTION OF THE MUD BUILDING STRUCTURE

The aim of restoration work process in the case of Masmak is to avoid as much as possible the heavy maintenance work that any mud brick building usually needs.

Therefore we take particular care of the protective treatment of the walls both the existing ones and the new ones against the deterioration process caused by the rain.

This requires 3 tipes of intervention:

1) Total control of rainwater and ground water, even in the event of exceptional rainfall. This in turn implies an elaborate study of the hydrogeological situation of the whole area surronding the monument.

Protection of the top of the walls by capping system to prevent rain penetration into the cracks and formation of streams running on the surfaces. Capping materials for mud brick walls must satisfy the same requirements specified above for repairs in the wall structure.

Surface tratment of mud brick walls to s considered only after the problems of repairs, roofing, capping, ain disposal and ground water control are satisfactorily solved.

Concerning surface treatment a serious limitation to any protective reatment of mud bricks is that unless the material is completely permeated and modified by the solution applied, the adhesion of the treated layer to the untreated core material is rather low, as it is not greater han the cohesive force of the material itself

Actually a surface crust formed by a co ation treatment is attached to the core of the wall by the sum of a ces attaching the last reated particles to the first untreated one

Water can easily overcome them and, by detaching the particles from one another, cause the separation of the entire crust from the core. Thus if water can gain access to the interface between the treated crust and the core, the whole treated surface is easily lost and the rate of damage suffered by the wall may be larger than it would have been if no protective treatment had been applied.

The danger can be reduced if the surface of the trated part is as irregular as possible, achieving a kind of keying effect.

If on the other hand proper material (some sort of chemical that produces a crust with properties as close to the core as possible) is used, the risk of detachement of the crust itself is reduced, and the need to have treatment that goes very deeply into the wall can be avoided.

It is left then to the capping techniques to inhibit acces of water behind the crust particulary by protecting the all-important superior edge of the wall.

The collaboration of Prof. Giacomo Chiari of the University of Turin has been very helpful in the determination of the recommended treatment. Prof. Chiari is following the restoration work and testing on site the different techniques. Herewith I am summarizing parts of his report for the site.

Among chemical products existing in the market ethyl silicate was then selected and tested on the field on the basis of the general considerations quoted above. Inside clayish materials ethyl silicate is known to create silica bridges, after hydrolysis, between the individual plates, inducing a kind of polymerization of the clay that sharply reduces swelling in the presence of water and completely inhibits dispersion of the clay in water (R.E. Bisque "Clay polymerization in carbonate rocks; a silification reaction defined", 9th National Conference on Clay Materials, USA, pp. 365)

Since the quantity of ethyl silicate sprayed on the surface is small, and the alcoholic part of it evaporates after hydrolysis, the actual amount of material that remains in the wall is minimal.

This allows the wall to keep, more or less , the same properties it had before the treatment (color, porosity, capillarity, thermal expansion coefficient). A treated surface is not water-proof, in the sense that water can still penetrate into it; but it is water resistant, in the sense that the particles of clay are no longer dispersed in water. This is certainly an advantage of the ethyl silicate impregnation, because it does not inhibit the breathing of the wall, and the possibility of another future treatment, even with other completely different materials. Normally any treatment of art objects or monuments must be reversible.

The ethyl silicate treatment is not reversible but at least it allows the possibility of further intervention with any kind of material that could possibily be discovered in the future. The use of resins or plastic substance, on the contrary, not only is not reversible, but does not allow, for example, the subsequent use of ethyl silicate.

Finally, since there is a gradient of penetration due to the spraying technique of ethyl silicate application, the separation surface between the treated and untreated parts is not so sharp as for resins etc. Furthermore, if some parts of the wall are more ruined (i.e. greater quantity of cracks) than other, the liquid will penetrate more deeply into them, achieving that desirable keying effect I delt with above.

Tests done with all three types of ethyl silicate showed that the least expensive one, the Ethyl Silicate 40, proved to be the most efficient in the formation of a weather resistant surface.

Two commercial types, more or less with the same characteristics, are availables: the Monsanto Silester, produced by the Monsanto Co, and the Ethyl Silicate 40, produced by the Union Carbide Corporation (the second one was used in Perù with comparable results to those obtained in Iraq with the Monsanto Silester).

Laboratory and field tests led to the following formulation of ethyl Silicate for spraying:

Ethyl Silicate 40	66.6 %	(in volume)
Ethanol 96 %, commercial	32.6 %	(in volume)
Hydrochloric acid (conc.)	0.8 %	(in volume)

This solution is mixed throughly and left to stand for a short time (it warms up spontaneously during this stage because of the hydrolysis reaction).

The small amount of HCl is added as a hydrolysis catalizer, and the dosage should carefully be checked to avoid a too quick reaction on the surface, which would inhibit further penetration of the liquid. The reaction speed is also influenced by other factors like temperature, salt and water content of the wall.

For spraying the stock solution is diluted 1:1 (volume) with 96 % commercial ethanol. Normal garden sprayers, in plastic and without iron parts, which contain 5 to 7 liters of solution have been proved most effective.

articular care should be devoted to cleaning the sprayer after its use
lcohol, not water.

hile applying the solution, the force of the spray should be regula-
Small droplets (but not so small as to be dispersed in the air) are

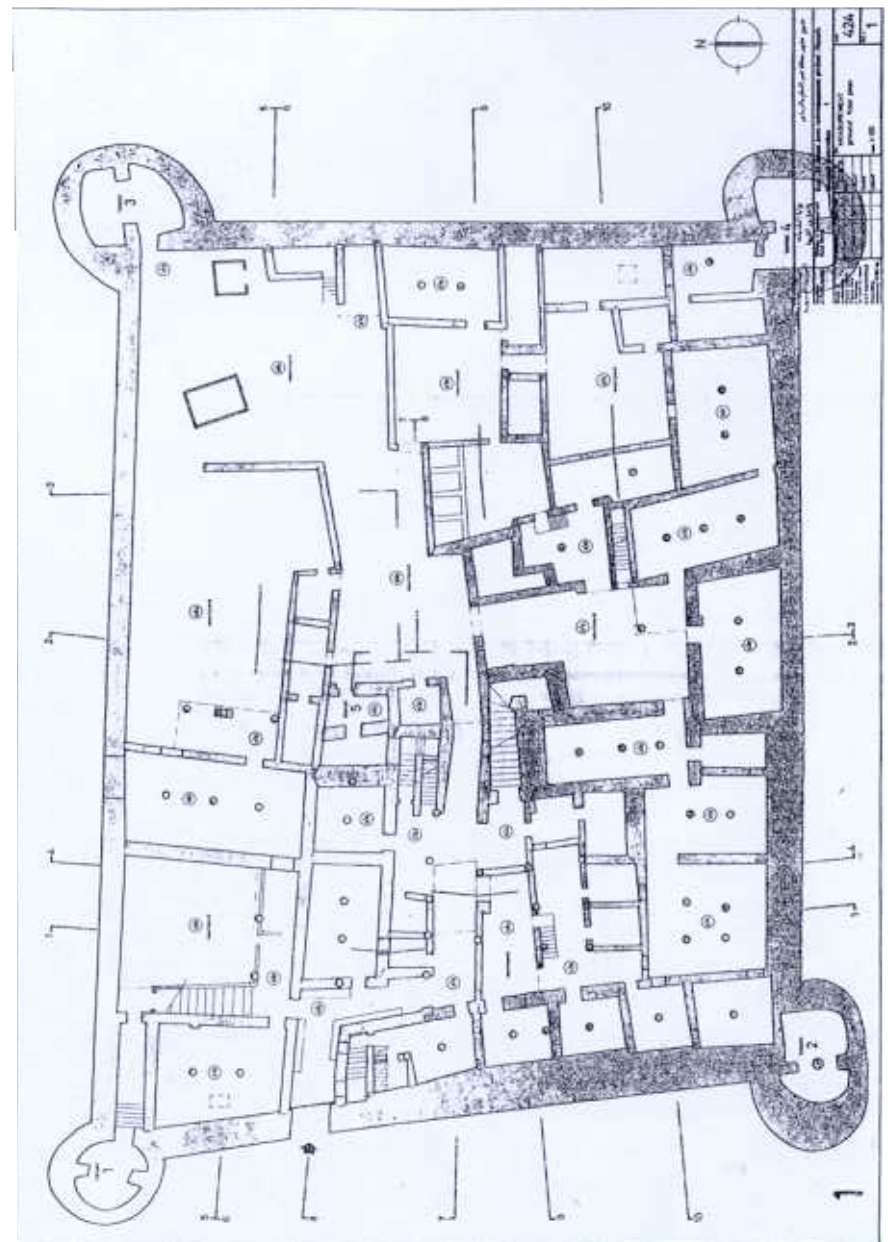
desirable to reduce the impact of the liquid and to avoid dripping. The liquid should be equally distributed over a predesignated area of the wall, on which the entire content of the sprayer should be applied. In choosing the area to be sprayed it should be remembered that about 2 liters per square meter of surface are required to form a weather resistant layer of sufficient consistency.

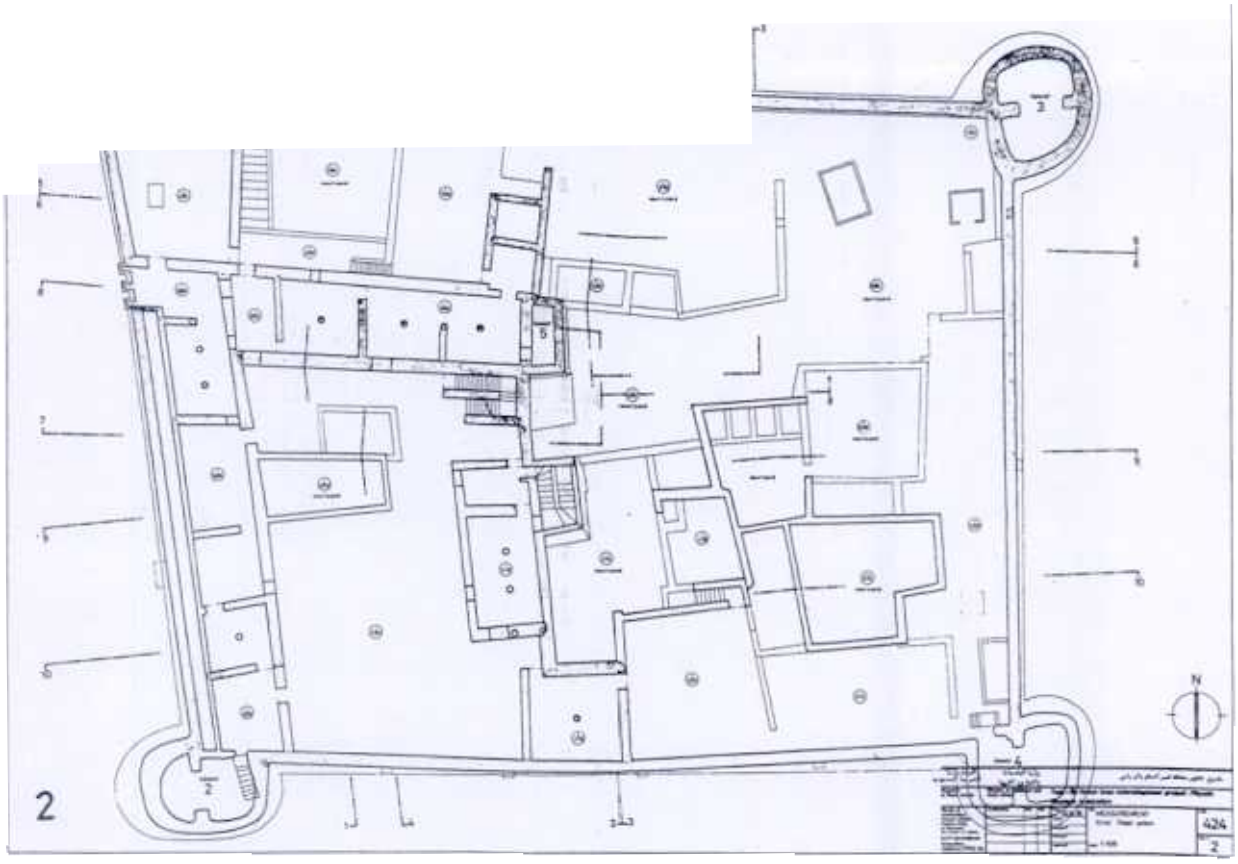
Even better results could be obtained by two applications ten or fifteen days apart. This lenght of time allows the silica gel which is formed after spraying to contract, reinstating porosity in the crust.

The treatment is rather expansive: the ethyl silicate costs about $ 4 per liter (depending also upon importat. cost); a considerable addition to cost is the price of the erhanol, variable from country to country (cost of the alcohol is comparable to the cost of ethyl silicate).

REFERENCES TO ILLUSTRATIONS

N° 1	drg. 424/1 Measurement ground floor plan
N° 2	drg. 424/2 Measurement first floor plan
N° 3	drg. 424/3 Measurement sections through the building
N° 4	drg. 424/11 Measurement sections through the building
N° 5	drg. 424/12 Measurement sections through the building
N° 6	Outside view of a corner tower
N° 7	Inside views showing existing situations and deterioration of structure
N° 8	Detail of a tower
N° 9	Details of decorations on doors and on walls for ventilation purpuses
N° 10	Tipical column and capitel made with stone and plastered with gypsum





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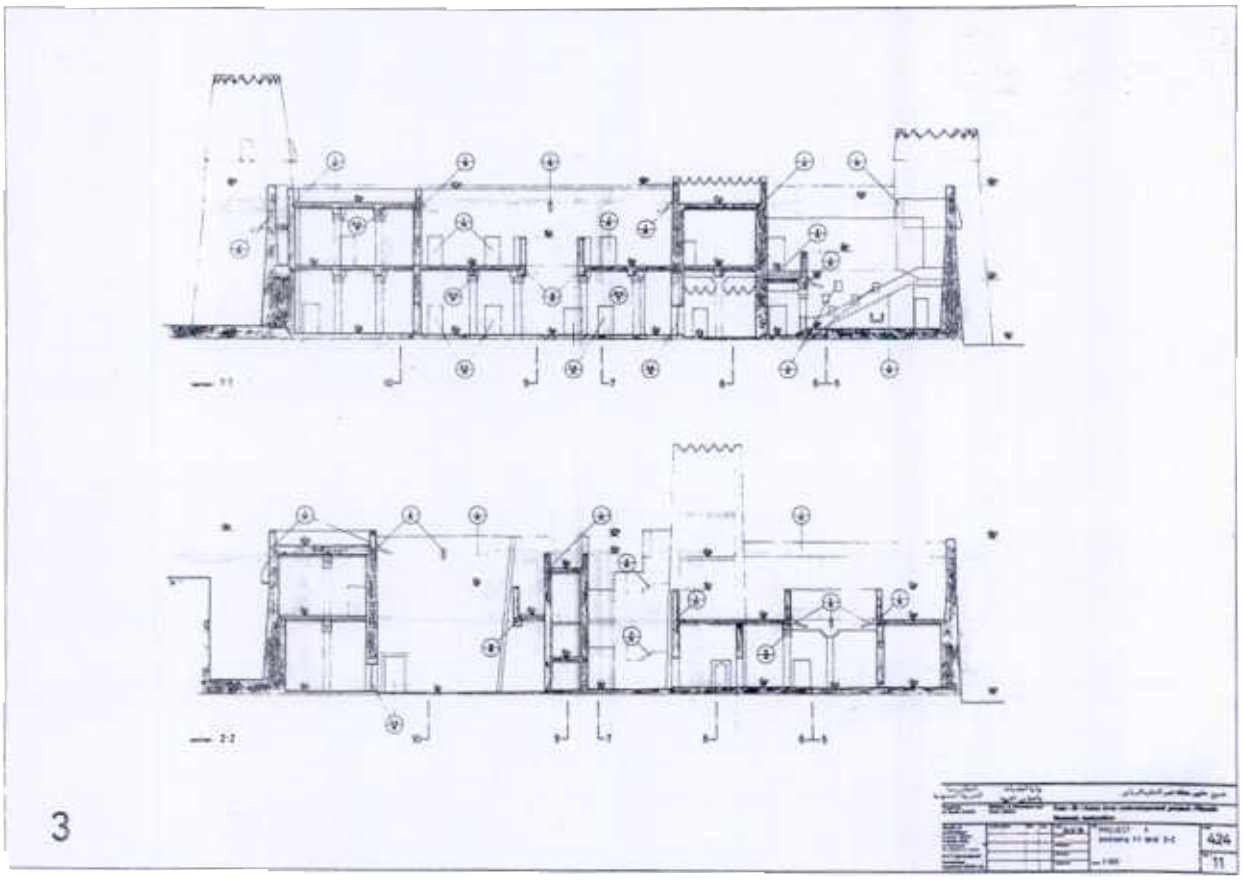

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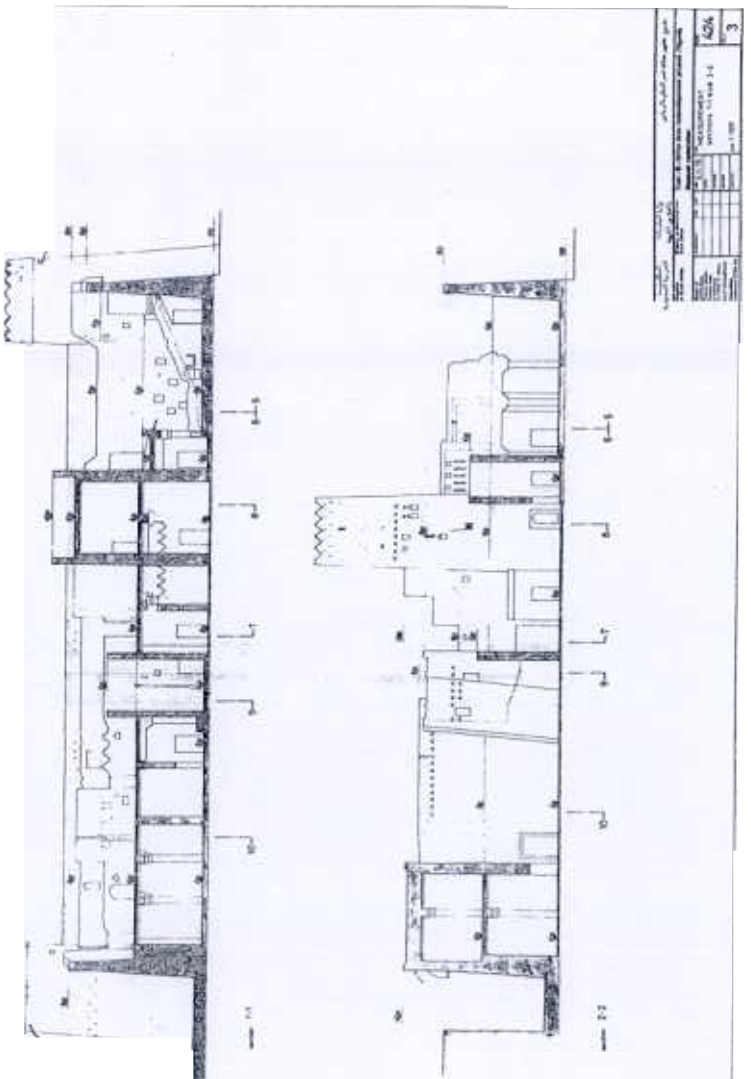

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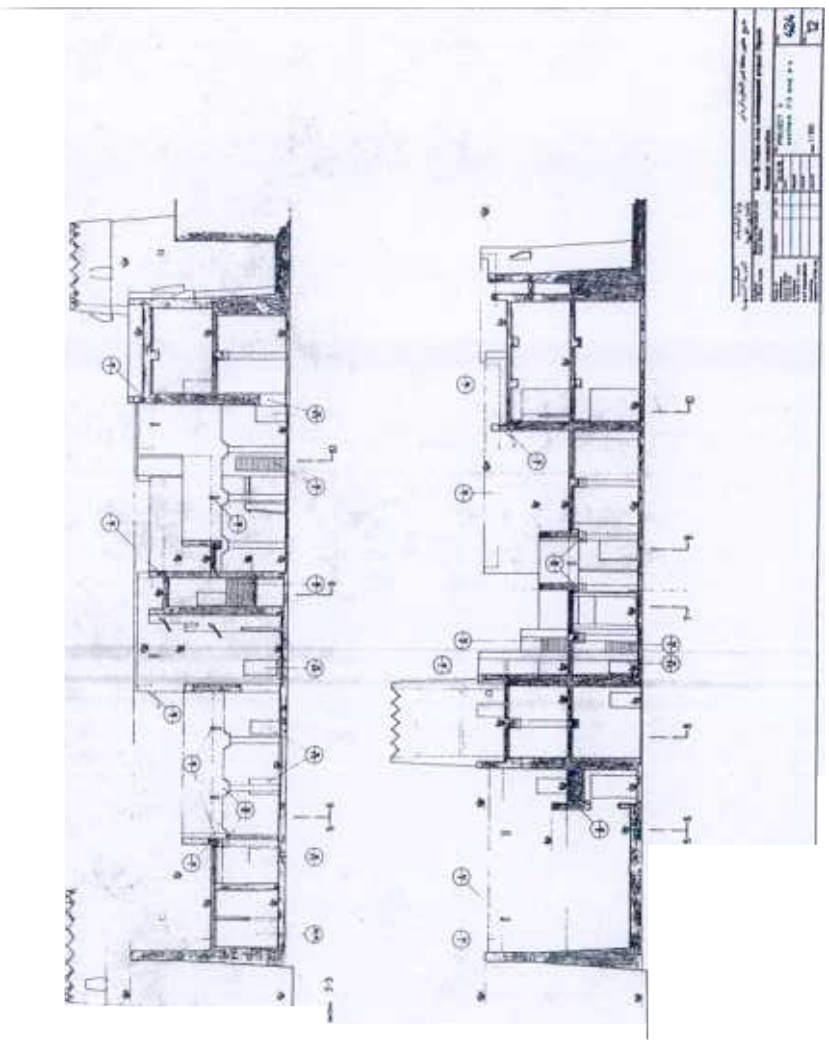

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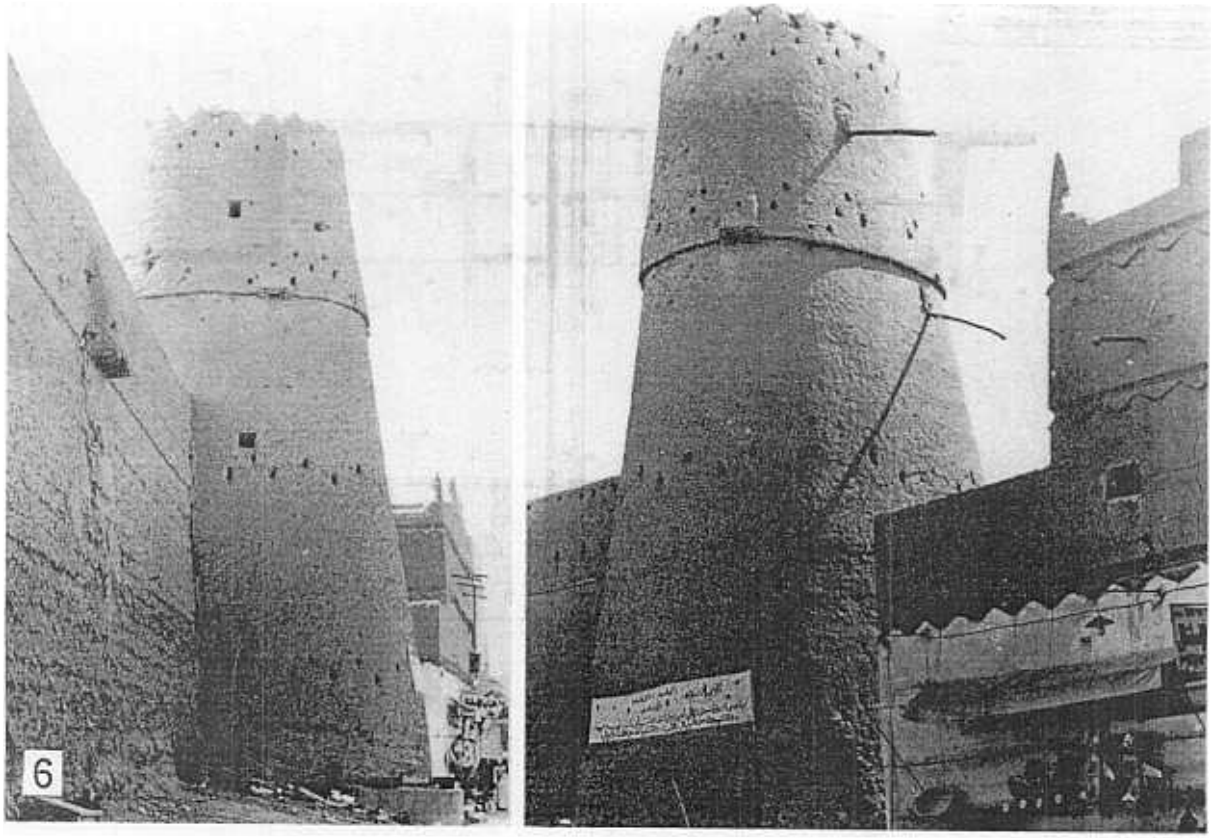
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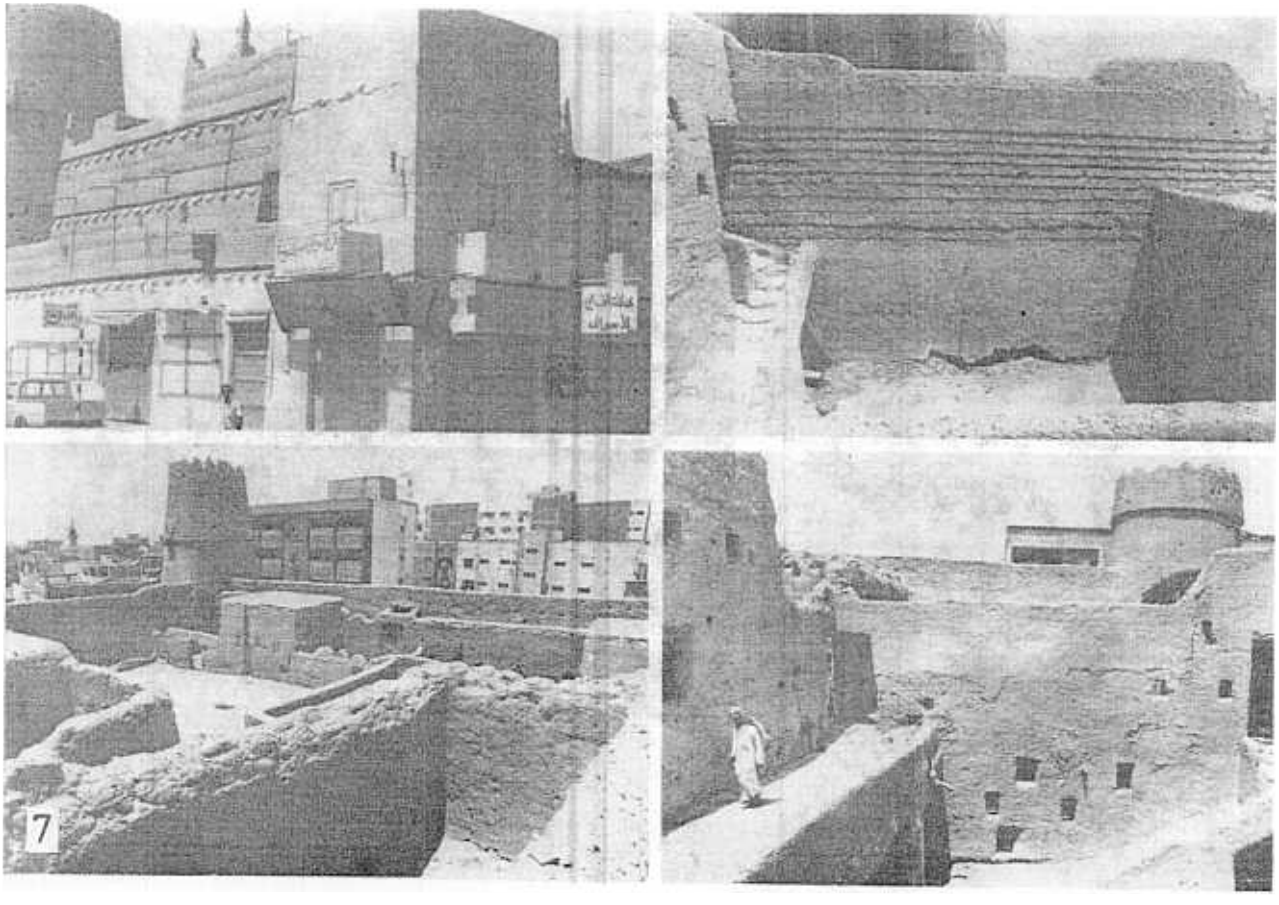
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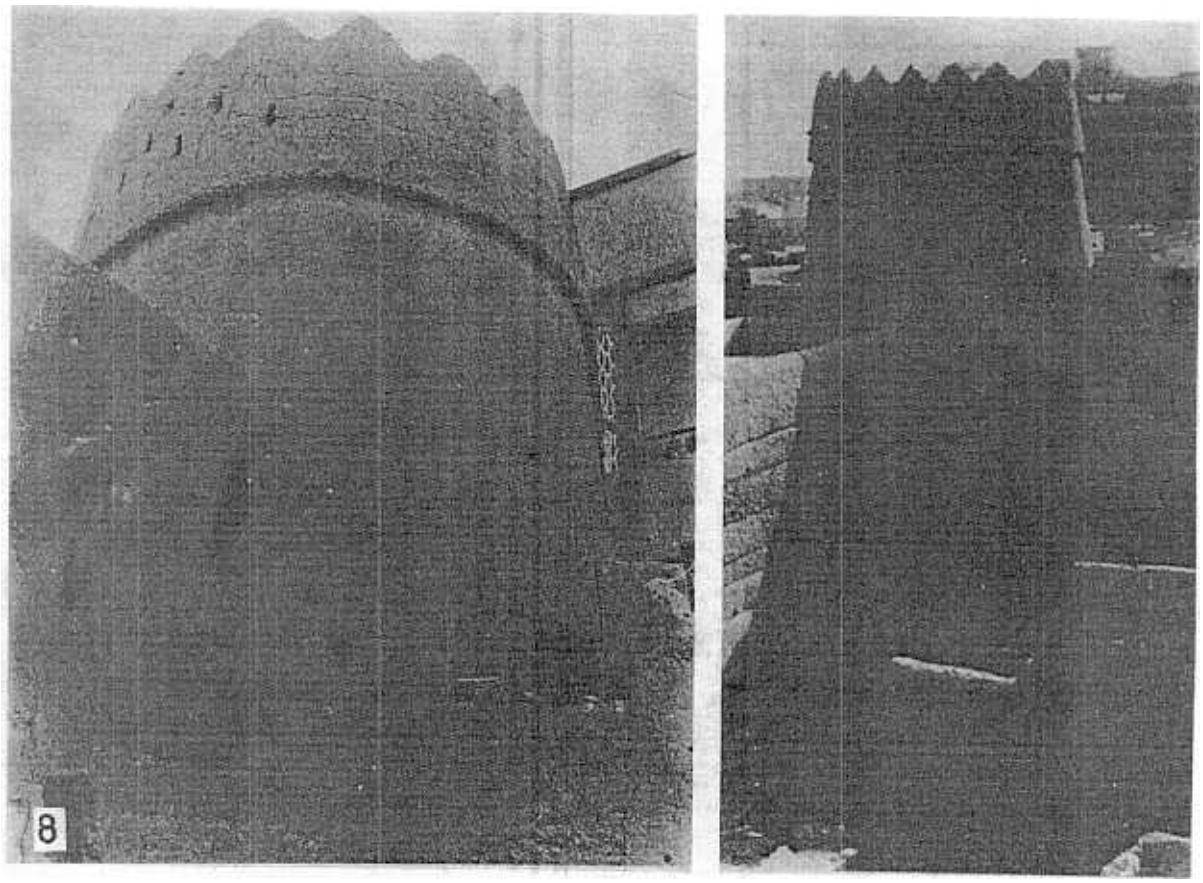
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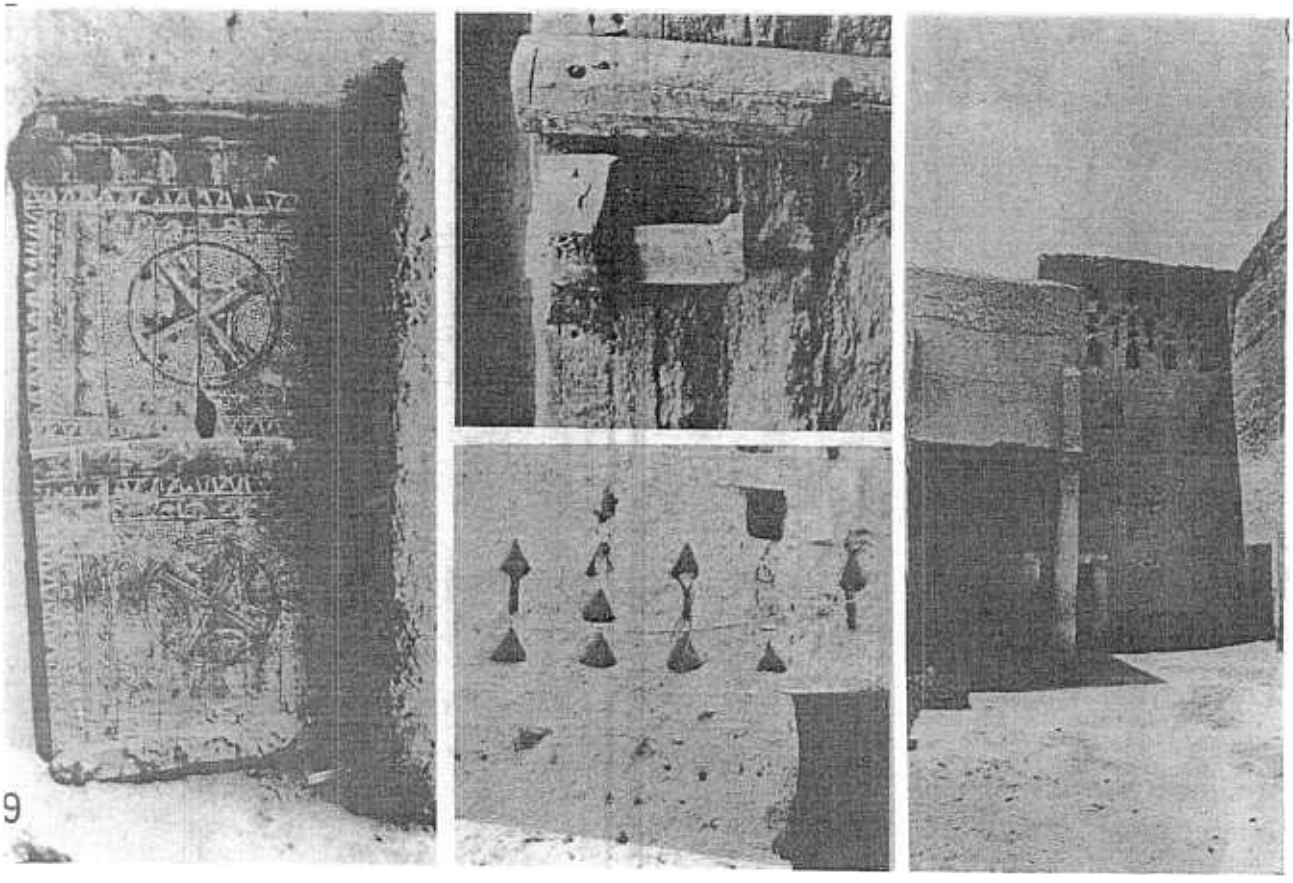
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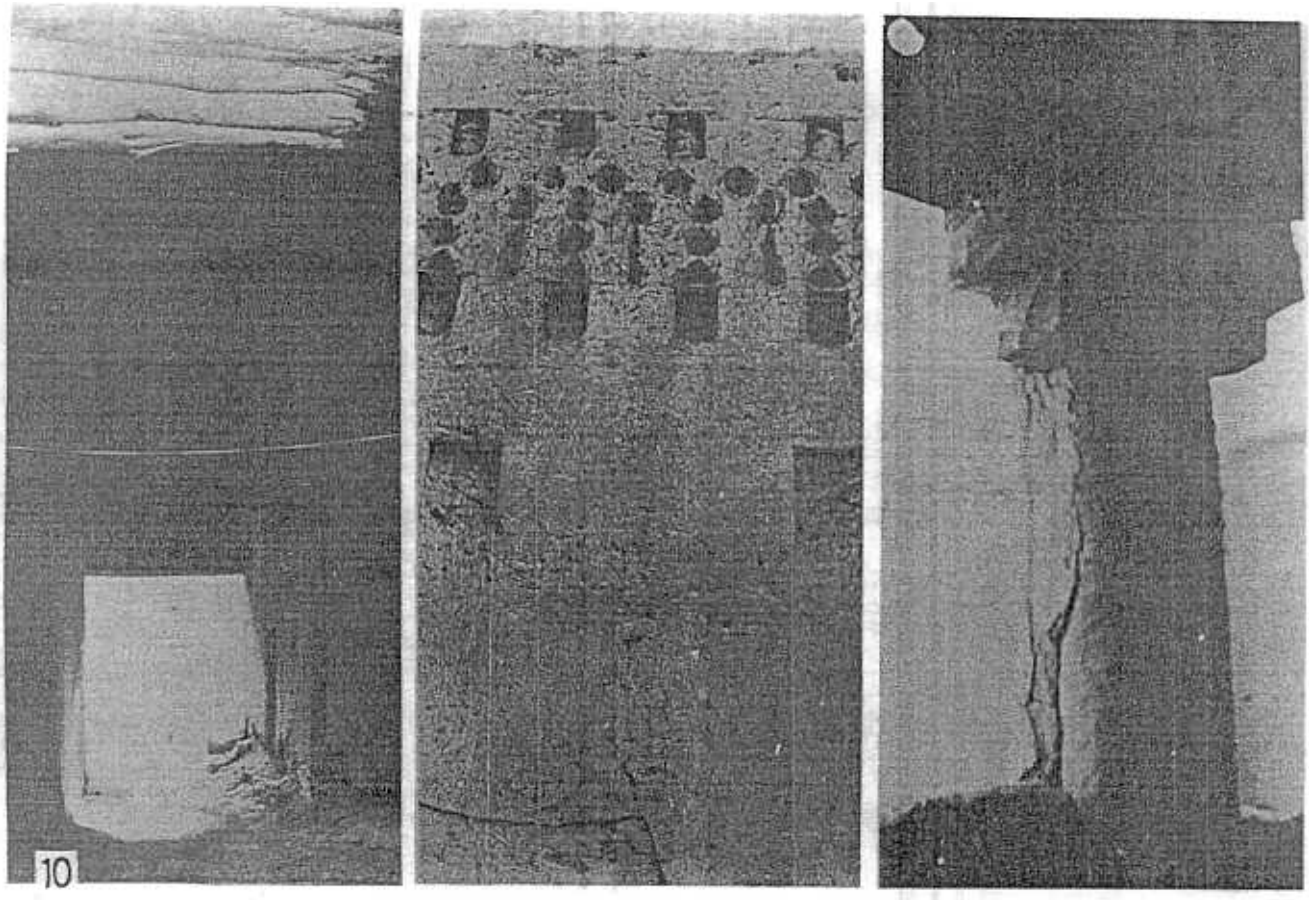
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