SUMMARY

This thesis is divided into five chapters as follows:

Chapter one

This chapter studies the linguistic meaning of the term “minaret”. It also deals with the birth of the archaeological minarets as well as its first appearance in the Islamic architecture. The functions of the archaeological minarets and the architectural origin of the minarets in Egypt are also analyzed. The chapter sheds light on the development of Islamic minarets in Egypt throughout the different Islamic periods. It includes the structural system of the minarets, and its components which include the basis, the transition zones, the entrances, the holes, and the tops which cover the minarets of Cairo and the balconies as well as the decoration of the minarets.

Chapter two

This chapter deals with the building materials of the minarets which include the geological study of Cairo and EL- Emam Al-Layth area which includes the minaret of Yashbak from Mahdy- the applied part of the thesis. The chapter studies the limestones used in building the minarets including its kinds and its mechanical and physical properties as well as the relation between these properties and the deterioration of minarets. It studies the fired bricks and its methods of manufacture and its preparation and use in building minarets. The chapter studies marble and its sources, its kinds, and its role in building the minarets.

Woods and its kinds and sources and the use of lead sheets in covering the tops of Ottoman minarets are also talked. The mortars and used in building minarets are studied.

Chapter three

This chapter deals with the factors and phenomena of minaret deterioration. It includes physiochemical factors which include moisture, temperature changes, ground water, salt crystallization, the effect of winds and air pollution in addition to studying soil deterioration and its effect on minarets as well as loads and its impact on deterioration whether the vertical or horizontal ones. The natural disasters, the biological deterioration, and man- made deterioration are studied with examples of the phenomena of deterioration caused by the previous factors.

Chapter four

This chapter sheds light on the methods of treatment, conservation and restoration of minarets. This includes the studies that precede treatment, conservation, and restoration processes as well as a historical and archaeological study, registration, and documentation of the present state of the minarets. The survey work and the balance and verticality of minarets, the diagnosis and analysis of the minaret building materials are tackled. The chapter includes the study of soil and foundations and the structural analysis using the digital models of computer. It also deals with the treatment, conservation and restoration of minarets, which include reducing the ground water level and the structural restoration. It tackles treating difficult soils and consolidation of foundations, architectural restoration including completing the lost and missing parts, undoing and reconstruction processes, and replacement of damaged stone blocks as well as completing decoration and engraving parts in addition to fine restoration for minarets including cleaning processes of minarets, the horizontal isolation of foundations and walls, the removing and extraction of salts, isolation and consolidation of surfaces to conserve the minarets from further

deterioration.

Chapter five

This chapter is the practical part of the thesis. It deals with the treatment, conservation, and restoration of the Yashbak from Mahdy minaret in the mosque of El- Emam Al- Layth (monument No. 286) this is studied as follows:

First

A historical, architectural and archaeological description is made, registering the present state of the minaret and the archaeological documentation by photographically recording, architectural recording and survey work.

Second

The survey recording of the minaret by using total station unit. The result is finding little inclinations that doesn't affect the structural balance of the minaret. The minaret balance is watched carefully by differential micro accelerometer titmeter unit. The result is that a horizontal movement in direction [X] was found [X=north-east/south-west] by 0.9 centigrade. As for the direction [y] it is 1.12 centigrade.

Third

Diagnosis and analysis for building materials, the soil, the foundations and deterioration phenomena of the minaret is conducted as follows:

(1) When the limestone is diagnosed by the polarizing microscope, it is found that it is a numulite limestone containing mainly the fine grained calcite and including foramenifera and numulite fossils, iron oxides, clay minerals, algae, and some fine grained quartz.

(2) When the limestone is diagnosed by [SEM], it is found that the calcite crystals were worn out by the effect of the dissolving of some

components. The stones lost the binding materials between the grains by the effect of salt crystallization, moisture effect, and air pollution.

(3) Samples from limestone, mortar, and salt are diagnosed by [XRD] and the result is as follows

A- The limestone consists of Calcite mineral, card No. (5-0586) in addition to Quartz mineral, card No. (5-0490) and Halite mineral, card No. (5-0628).

B- The mortar used consists of gypsum mineral, card No. (6-0046), In addition to Calcite mineral, card No.(5-0586), Quartz mineral, card No.(5-0490), Dolomite mineral, card No.(11-078), and Halite mineral, card No.(5-0628).

C- We found Halite salt, card No.(5-0628) and gypsum salt, card No. (6-0046).

(4) We recorded the physical properties and we found the bulk density of limestone is 2.14 gm/cm3, water absorption is 9.18.%, and the porosity is 19.48%. As for the compressive strength of stones, if reached 270 kgm/cm2 and the tensile strength 24 kgm/cm2. It is measured by using ultrasonic technique. Concerning the moisture content, it is between 0.4% and 7.8%

(5) A microbiological study for the limestones is conducted and we acknowledged cocci bacteria and two kinds of fungi, namely, Aspergitlus Sp. And pencilium Sp. The total account of bacteria is (98x104) cell per gm and frngi (12x103) cell per gm.

(6) For soil studies we discover that the depth of the minaret foundations is 3,3 metres in the natural ground level. The ground water level is measured by Besometer in the minaret. It is found to be 3.2 metres.

The mechanical analysis of soil grains measuring the soil texture, the liquid, flexibility , shrinking limit, percentage of calcium carbonate, total dissolved salts concentration, the [Ph] value, the concentration of ions of dissolved salts. The results varied from layer to layer in the soil. This

reflects that filler soils on which, the minaret is built are different and heterogeneous in properties so its structural behavior is different.

(7) A structural analysis for the minaret is conducted by digital models of computer to detect the stresses caused by the vertical and horizontal loads. The maximum compression stress was 28 kgm/cm^2, and the maximum tension stress was 9.6 kgm/cm^2. In the case of completing gawsak area and the top of the minaret. The result was that compression stress was 9.6 kgm/cm^2 and the tension stress was 1.7 kgm/cm^2. These are safe loads and don't affect the minaret balance as the minaret stones can bear compressive strength up to 270 kgm/cm^2. And tension strength up to 24 kgm/cm^2.

(8) By conducting a study of the surrounding environment of the minaret. There is no drainage network and no fire machine the area is poor in services, the roads are narrow and rough there are random buildings in the area.

Fourth

An experimental study for treatment and conservation is carried out to choose the best materials and methods for application in treatment, conservation, and restoration of Yashbak from Mahdy minaret as follows:

(1) A study was carried out for cleaning and removing soot. We found that two solutions gave the best results the first solution consists of Ethyl alcohol, Tuluin, acetone and tri- chloroethylene by 2:1:2:1 successively, the second solution consists of tuluin and acetone by 1:2 successively in addition mora poultice

(2) A study for evaluation the materials used in consolidation and isolation of stones and mortars. Ethyl silicate is the best material for stone consolidation, the best material for vertical isolation of the stone surfaces is

poly methyl hydrosiloxane. Silo 111 is the best material for both consolidation and, isolation. As for horizontal isolation for moisture sources, the Waker SMK 550 is the best material.

Fifth

A plan was made to restore, treat and conserve the minaret of Yashbak from Mahdy as follows:

(1) The architectural restoration includes building exterior stairs connecting the ground and the minaret door, completing the stones under the minaret door, and replacing damaged blocks.

(2) Fine restoration which includes

A- Mechanical cleaning processes for dust and salt efflorescence crystals on the surface

B- Removing soot by chemical cleaning by using two solutions, the first solution consists of Ethyl alcohol, Tuluin, acetone and tri-chloroethylene by 2:1:2:1 successively, the second solution consists of tuluin and acetone by 1:2 successively in addition mora poultice, tri- chloro ethylene and xylene.

C- Removing grease, oil, and stains by using di-methyl formamide solution and methylene chloride for removing color stains.

D- Horizontal isolation of minaret walls against moisture sources by injection method using Wacter SMK 550.

E- Using paper polutices in extracting dissolved salts from the minaret walls.

F- Consolidating the disintegrated and damaged stone surfaces of the minaret using Ethyl silicate by flooding method.

G- Cleaning and filling the joints between stone blocks using mortars consisting of lime and limestone powder by 1:2 using lime water in mixing mortar.

H- Vertical isolation of stone surfaces of the minaret by using poly methyl

hydro siloxane by flooding method for the conservation of the minaret from further deterioration