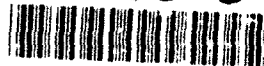


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Restoration and Conservation of Islamic Monuments in Egypt
The American Research Center in Egypt
Egyptian Antiquities Organization
The Getty Conservation Institute

12 - 15 June 1993
The Jameel Center
The American University in Cairo

DATA 45-93-M-024

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AMERICAN RESEARCH CENTER IN EGYPT; BACKGROUND
ENGINEERING CENTER for ARCHAEOLOGY and ENVIRONMENT; BACKGROUND
THE PRESENT STRUCTURE of the EGYPTIAN ANTIQUITIES ORGANIZATION

ABSTRACTS (AVAILABLE AS OF 8 JUNE 1993)

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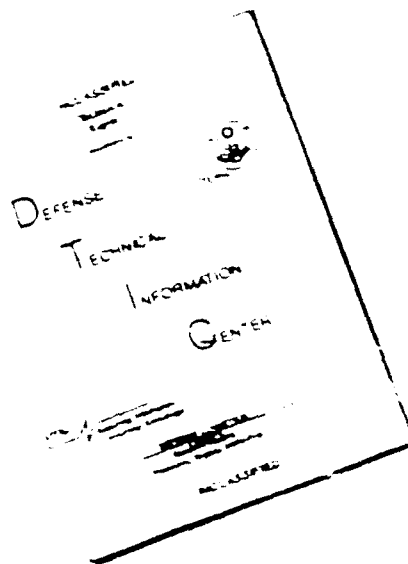
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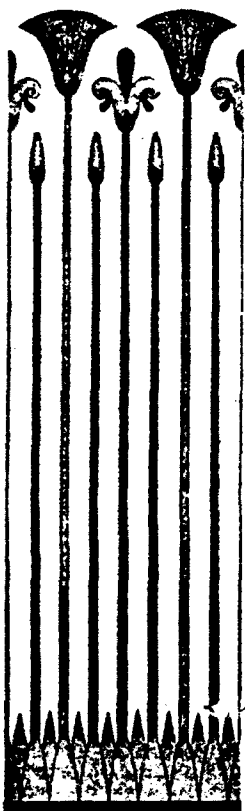
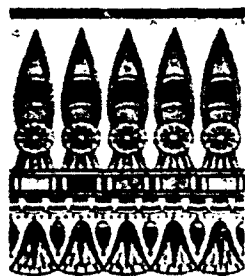
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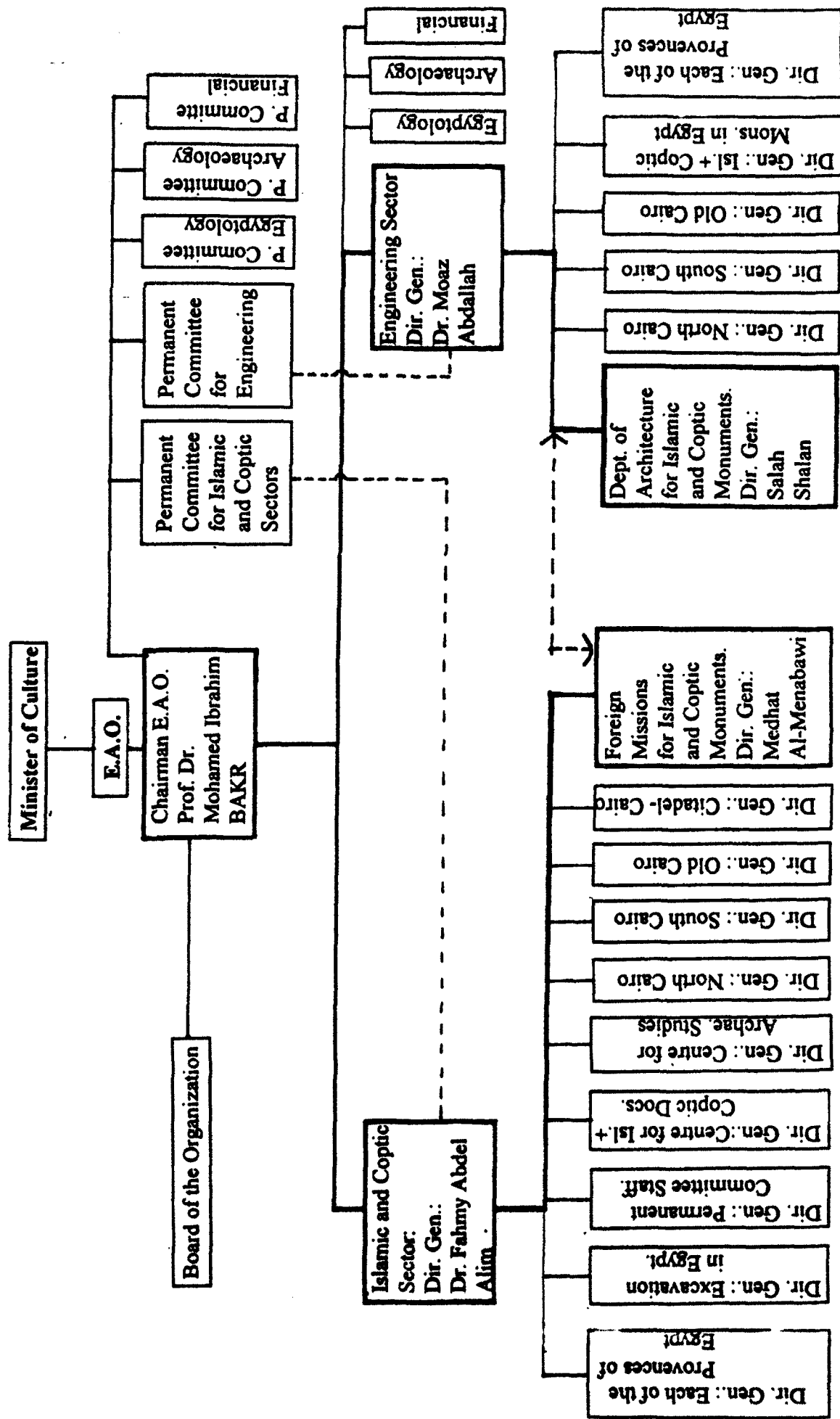
The American Research Center in Egypt is a private, nonprofit organization founded in 1948. Originally, its purpose was to serve as an outpost in Egypt for American institutions with archaeological programs. ARCE established a permanent office in Cairo to assist expedition teams who were in Egypt for the excavation season only, representing their interests on a year-round basis.

But in the aftermath of World War II, ARCE's founders also recognized the importance of Egypt in a modern context. The emergence of the Arab world, with Cairo at its center, underscored the need for a broader understanding of Egypt that encompassed its more recent history and aspirations. Responding to that need, ARCE expanded its role to include the study of medieval and modern Egypt, as well as the country's ancient past.

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THE PRESENT STRUCTURE OF THE EGYPTIAN ANTIQUITIES ORGANIZATION

ENGINEERING CENTER for ARCHAEOLOGY and ENVIRONMENT

- 1- The Center was established in August 1992.
- 2- Staff of Faculty of Engineering of various fields together with Faculty of Archaeology form the backbone of the center.
- 3- Full cooperation and exchange of experts, knowledge and technical supports with:
 - INERIS (National Institute for Industrial Environment and Risks) - France.
 - National High School of Mines- Nancy- France- (Strata Mechanics lab.)
- 4- Several well established laboratories within Cairo University serve to fulfill the goals of the center, e.g. :
 - Rock Engineering Lab..
 - Geotechnical Lab..
 - Computer Center.
 - Lab. of Fine Restoration.
 - Lab. for Climatic Measurements and Aerodynamics.

- Goals and Functions:

Engineering Center for Archaeology and Environment aims mainly to:

- 1- Provide the authorized personnel dealing with maintaining and restoring the archaeological sites and monuments with scientific and engineering facilities.
- 2- Provide engineering and scientific consultation to all organizations and institutes involved in conservation, preservation and restoration of historical sites.
- 3- Conduct technical and engineering studies including engineering designs, preparation of tender documents for restoration, protection and environmental projects.
- 4- Organize training programs for those working in the field of archaeology and environment.
- 5- Participate in environment protection projects related to historical sites.

- Some Studies Achieved by E.C.A.E.:

- 1- Engineering study of the stability of Saqqara plateau and present status of tombs.
- 2- Restoration project of Sirapium temple.
- 3- Survey and architectural registration of Sirapium, tomb of Sekhem Khet and the Southern tomb, El-Baboon tomb, Agormy hill and El-Wahy temple (Alexander The Great) at Siwa Oasis.
- 4- Primary environmental and geotechnical studies for El-Dair El-Bahari and Memnon Statues and Marumbe temple related to the stability and restoration of a monument.
- 5- Finalizing a project for the restoration and maintenance of Wadi El-Melouk tombs.
- 6- Member of the restoration consultants of El-Azhar Mosque.
- 7- The survey and the design of the Giza Plateau Grading Project under supervision of UNESCO (Giza Plateau Master Plan).
- 8- Stone tests and treatments, description and cause of deterioration for the restoration projects of Wakkalat Bazarra and Gamal El-Din El-Dahabi House at Gamaleya.
- 9- Restoration project and studies of the Sphinx.

- 10- Contributions of experts and equipment for the North Sinai Salvage Project.
- 11- Studies of the Pharaonic Copper Mines at Wadi Dara (eastern desert) in collaboration with the French Mission.

- Board of Directors of E.C.A.E.:

- Dean of the Faculty of Engineering - Cairo Univ.
Prof. Dr. Farouk Ismail.....Chairman of the Center
- The Governor of Giza.
- The Chairman of E.A.O.
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- Prof. Dr. Saleh Ahmed Saleh
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Session 1
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Restoration of the Mausoleum of
as-Sultān as-Saleh Nagm ad-Din Ayyūb

In the last 50 years, the rising water table, the serious lack of maintenance, the new transportation means in the old city, and other newly introduced factors all accelerated the deterioration of the monuments which now all need "special care". These and a wide range of criteria were taken into consideration on the selection of the monuments that were restored since 1973 by the German Institute of Archaeology in Cairo in collaboration with the Egyptian Antiquities Organization. The program included restoration of one monument followed by a chain of others, resulting in the revitalization of one whole street with all the monuments therein, then approaching another neighboring street, and so on. The ultimate aim is the preservation of a whole district. The arena of the restoration projects was intentionally centered in the heart of al-Qamaliya district on the ground formerly occupied by the great Fatimid Palaces - an area with the highest density of monuments within historical Cairo. This German-Egyptian "rescue program" has already realized the restoration of seven buildings. The eighth restoration project, which is the mausoleum of as-Sultān as-Saleh Nagm ad-Din Ayyūb built in 1250 by his wife Shagarat ad-Dur which started in August 1990 and was completed in May 1993, is the object under examination in the lecture.

In the lecture light will be thrown on:

1. The personality of the Šultān buried in the mausoleum, the character of Shagarat ad-Dur, his wife who built it, and the historical context behind the erection of the building. Accordingly, both the importance of the monument and the architectural analysis of the original borders separating the mausoleum from madrasa as-Šālihiya to the south and madrasa az-Zāhiriya to the north, will be highlighted.
2. Ancient and modern intrusions on and around the mausoleum.
3. Newly discovered architectural and decorative elements which made it possible to reconstruct theoretically the texture of the internal walls.
4. The twin problems threatening all Cairene monuments: the rising ground water table and the overloaded sewage system. The obvious solution would seem to be the lowering of the water table and the

creation of a fundamental solution to the sewage system in the whole of the old city. The Egyptian Government is now exerting every effort to rectify the sewage system. Meanwhile, we have created an emergency action envisaging the problem in order to reduce the capillary attraction through the walls to a minimum and to isolate completely some areas in the mausoleum such as the mihrab, the burial chamber, the western facade, the cenotaph, and the external horizontal platform on the dome proper.

5. The fine restoration works carried out on the decorative elements such as the mihrab, the stucco windows, the cenotaph, the two wooden inscription friezes, and the inscription in the burial chamber

6. Results of the excavations carried out under the marble floor of the interior of the mausoleum, in the outermost court, and in the passage leading to the madrasa as-Şālihiya. In all three excavation sites, we found remains of the Eastern Fatimid palace, pottery, and carved blocks of az-Zāhiriya madrasa.

7. Maintenance project for the restored monument

16th May 1993

Nalri Hampikian

7117-EN-03
DTIC

Restoration and Conservation of Islamic Monuments in Egypt

12 - 15 June 1993

The Jameel Center

The American University in Cairo

American Research Center in Egypt

Egyptian Antiquities Organization

The Getty Conservation Institute

In cooperation with

The American University in Cairo

With special thanks to:

European Research Office, U.S. Army

The Getty Conservation Institute

Egyptian Antiquities Organization

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Restoration and Conservation of Islamic Monuments in Egypt
The American Research Center in Egypt
Egyptian Antiquities Organization
The Getty Conservation Institute

June 12, 1993

9:00 - Registration

10:00 - Welcoming Ceremony

Chairman of Session: Dr. Jere L. Bacharach, University of Washington, USA

Dr. Terry Walz, Executive Director, American Research Center in Egypt
Prof. Dr. Mohammed Ibrahim Bakr, Chairman, E.A.O.
Ms. Jane Slate Siena, The Getty Conservation Institute
Mr. Mark Easton, Director, ARCE

11:30-1:00 Session 1: Case Studies and General Guidelines

Chairman of Session: Dr. Bernard O'Kane, American University in Cairo

1. Dr. Irene Bierman, University of California, Los Angeles
"Monuments in the Wake of the Quake"
2. Mr. Daryl Fowler, UNESCO Team Head, The Conservation Practice, England, Vice
President of The Icomos International Historic Towns Committee
"Integrated Management and Urban Conservation in Historic Towns"
3. Miss Nairy Hampikian, Architect, German Archaeological Institute
"Mausoleum of al-Salih Ayyub Complex"

1:00-2:30 LUNCH

2:30-4:00 Session 2 Engineering and Technical Problems

Chairman of Session: Prof. Dr. Hasan Fahmy Imam, Director,
Engineering Center for Archaeology and
Environment, Cairo University

1. Prof. Giorgio Croci, University of Rome, Italy
"Criteria for Safety Evaluation of Islamic Monuments"
2. Prof. Erhan Karaesmen and Prof. Engin Karaesmen, Middle East Technical
University, Ankara, Turkey
"An Overview of the Structural Assessment of the Old Masonry with Domes in
Seismic Zones"

- + Abdel El-Hady
3. Dr. A. A. Abdel Gawad, Egyptian Group for Engineering Consultation and College of Engineering, Cairo University
"Structural Aspects of Damage in Islamic Monuments"

BREAK 4:00 - 4:30

4:30-6:00 Session 3 PANEL DISCUSSION

Representatives of Engineering Center
for Archaeology and Environment, Faculty
of Engineering, Cairo University

1. Dr. Mamdouh Ali Sabri, Engineering Center for Archaeology and Environment, Cairo University
"Foundations and Soil Mechanics in Islamic Monuments"
2. Dr. Taha Abdullah, Engineering Center for Archaeology and Environment, Cairo University
"Controlling and Monitoring Archaeological Monuments"
3. Dr. Ahmed S. Ouf, Engineering Center for Archaeology and Environment, Cairo University
"Priorities in Selecting Restoration Sites: an Urban-Conscious Approach"

June 13

9:30-11:00 Session 4 Case Studies and General Guidelines

Chairman of Session: Dr. Miguel Angel Corzo, Director, The Getty Conservation Institute

1. Prof. Dr. Eng. Saleh Lamei, Centre for Conservation & Preservation of Islamic Architectural Heritage
"The Mosque of Az-Zahir Baybars"
2. Prof. Ing. Guiseppe Fanfoni, Istituto Italiano di Cultura
"Restorations in the Dervish Theatre Area"
3. Mr. Jaroslaw Dobrowolski, Architect, Polish Center of Archaeology, Cairo
"Polish-Egyptian Restoration Project at the Eastern Cemetery in Cairo"

11:00-11:30 BREAK

11:30-1:00 Session 5 Case Studies and General Guidelines

1. Prof. Dr. Saleh Ahmed Saleh, Faculty of Archaeology, Cairo University
"Structural Building Materials and Deteriorating Phenomena with Reference to Amir Shaikhou Mausoleum"
2. Dr. Neville Agnew, Director, Special Projects, Getty Conservation Institute
"Getty Conservation Institute Progress in Disaster Preparedness and Responsibility for the Cultural Heritage"

3. Dr. Mohammad Abd Al-Sittar Osman, Chairman, Department of Islamic Archaeology, Assiut University
"Registering and Preserving Islamic Monuments at Tahta and Other Cities in Upper Egypt"

1:00-2:30 LUNCH

2:30-4:00 Session 6 Technical and Engineering Problems

Chairman of Session: Prof. Dr. Saleh Ahmad Saleh, Head,
Department of Restoration, Faculty of
Archaeology, Cairo University

1. Dr. Mohammed Abd al-Hady, Department of Restoration, Faculty of Archaeology, Cairo University
"The Effect of Groundwater on the Deterioration of Islamic Buildings in Egypt"
2. Dr. Abd el-Zaher A. Abo el-Ela, Department of Restoration, College of Archaeology, Cairo University
"The Environmental Deterioration of Islamic Monuments with Reference to al-Azhar Mosque and al-Ghuri Complex"
3. Mr. Richard Swift, UNESCO Consultant, Gifford Consulting Engineers, England
"Structural Problems of Cairene Monuments"

* *Please note that the auditorium MUST be vacated by 4:00 today*

June 14

9:30-11:00 Session 7 The Role and Efforts of the EAO

Chairman of Session: Jack Josephson, Cultural Property Advisory Commission, United States Information Agency

1. Dr. Fahmy Abd Al-Aleim, Director, Islamic and Coptic Architecture Section, E.A.O.
"Main Problems of Islamic Monuments in Cairo and Some Proposed Solutions"
2. Prof. Dr. Ezzat Abd El Shafi, Consultant, Egyptian Antiquities Organization
"Restoration of Islamic Monuments: an E.A.O. Perspective"
3. Mr. Medhat Al Minabbawy, E.A.O.
"Coordinating the Activities of Foreign Missions"

11:00-11:30 BREAK

11:30-1:00 Session 8 *Engineering and Technical Problems*

Chairman of Session: Eng. Ibrahim Sadek, Assistant Director,
American Research Center in Egypt

1. Mr. David Look, National Park Service, USA
 "The Preservation and Seismic Retrofit of Damaged Islamic Monuments in Cairo"
2. Dr. James Wight, University of Michigan, USA
 "Field Investigation of Damage to Islamic Monuments Caused by the Egyptian
 Earthquake of October 12, 1992"
3. Mr. David Sykora, U.S. Army Corps of Engineers
 "Soil Stabilization to Mitigate Damage to Historic Monuments in Cairo from
 Earthquake and Groundwater"

1:00-2:30 LUNCH

2:30-4:00 Session 9 *Preserving and Restoring Islamic Monuments*

Chairman of Session: Prof. Dr. Salah Eldin Sayed El Beheiry, Faculty of Archaeology,
Cairo University

1. Prof. Dr. Hassanein Rabie, Dean, Faculty of Arts, Cairo University
 "Dar Al-Qadi Ibn Luqman at Al-Mansurah"
2. Dr. Hamza Abd Al-Aziz Badr, Department of Islamic Archaeology, Sohag Branch,
 Assiut University
 "Registering and Preserving Islamic Monuments in Manfalut, Upper Egypt"
3. Dr. Philipp Speiser, Architect, Conservation Department,
 County of Fribourg, Switzerland
 "The Restoration of the Darb Qirmiz, a German-Egyptian Project"

4:00-4:30 BREAK

4:30-6:00 Session 10 *Preserving and Restoring Islamic Monuments*

1. Mr. Mohammad Hussam al-Din Ismail, Historian
 "The Zaghlul Mosque in Rashid/Rosetta and Amr Ibn Al-As Mosque in Damietta"
2. Dr. Bernard O'Kane, American University in Cairo
 "Documenting the Past: The Photographic and Other Resources of A.U.C.'s Rare
 Book Library"

June 1

9:30-11:00 Session 11

Workshops

	<i>Topics</i>	<i>Chairman</i>	<i>Rapporteur</i>
5 \ I.	Urban Management, Training Programs, Institutional Strengthening	Speiser	* Mabbitt
3 II.	Buildings as Archaeology, Sustainable Use	Walz	Fowler
2 III.	Identification of Historical Buildings, Documentation as a Public Resource	O'Kane	Bierman
\ IV.	Technologies for Repair	Josephson	Agné <i>Swift</i>
* Richard Mabbitt, UNESCO Consultant and The Conservation Practice, England			

11:00-11:30

BREAK

11:30 Session 12

Plenary Session

Chairman: Jere L. Bacharach, University of Washington

Rapporteur Reports and Resolutions

In cooperation with The American University in Cairo

With grateful acknowledgement to the following organizations:

Egyptian Antiquities Organization
European Research Office, U.S. Army
The Getty Conservation Institute
United States Information Agency

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Mrs. Dalia Samir Zaki
Ms. Nagwa Wahby Gebrael

Ibrahim Megahed
Hassan H. Soliman
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Session 2
Crocì p. 1

CRITERIA FOR SAFETY EVALUATION AND INTERVENTIONS ON MONUMENTS

GIORGIO CROCI

The monuments of Cairo suffer from damages and deterioration related to two main groups of causes: the first is related to the structural behaviour, such as insufficient connections between the walls and floors, the effects of seismic actions, ancient soil settlements, etc.. The second category is linked to the environment and specifically to the changes that have been created by anthropic activity, such as the problems related to the high density of people, the inappropriate re-use of buildings, the vibration and pollution produced by traffic, the problem of rising ground water due to the overloading of the subterranean hydraulic and sewage systems.

The main question we have now to answer is how to evaluate the present safety levels and thus to decide whether restoration works are required, and, if so, of what type and extension.

However the safety evaluation of a monument is a very difficult task and it is not satisfactory to follow the traditional approach (historical survey + direct observation), nor the most up to date method of structural analysis (mathematical models); in fact each of these methods has some objective aspects and subjective interpretations, so that it is only from a synthesis of all information that it is possible to give the best judgement.

A very useful support for the diagnosis is provided by different tests and investigations: flat-jacks can be used to discover the actual stress levels in the materials, the deformability and the ultimate strength. Pull-out tests are used to evaluate the shear and tensile strength of the material. Sonic tests determine the speed of waves passing through the structural elements which may be correlated with the presence of discontinuities and thus the strength of the materials. Endoscopic tests allow us to actually look within the structural elements. Finally monitoring systems that consist of the application of a network of sensors positioned in order to periodically or continually record physical parameters such as deformation, displacements, stresses and inclinations and to allow us to judge whether the different phenomena have stabilised or are in evolution.

OF. ING. GIORGIO CROCI

Session 2
Crocì p.2

OGGETTO

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This data is then used both to improve the qualitative evaluation and as the basis for the construction of mathematical models in order to reproduce the actual behaviour and to analyse how this behaviour can be improved with restoration interventions.

After the decisions have been taken, the restoration works usually deal with two kinds of problems. The first is related to the improvement of the structural behaviour; it will be necessary often to assure the connections between the walls and between the floors and the roof. For this purpose besides the traditional techniques, new use of materials, such as synthetic fibres may also be appropriate like. This philosophy however must come under careful reflection when the damages are linked to earthquakes or soil settlements: in the first case we must also look at the overall ductility and deformability, while in the second case, when it is impossible or not economically convenient to stop the soil settlements, the possibility of further relative movements must be taken into account (i.e. the creation of joints between parts of the building). The other group of problems is related to the regeneration of the materials' characteristics and the protection against further deteriorations. As for the moment the general problem of rising water can not be radically resolved, however it is possible to prevent the effects of deterioration of the masonry, by cutting the walls and inserting a waterproof layer.

AN OVERVIEW OF THE STRUCTURAL ASSESSMENT
OF OLD MASONRY BUILDINGS WITH DOMES
IN SEISMIC ZONES

Engin KARAESMEN

Erhan KARAESMEN

Engineering Science Department
Middle East Technical
University (M.E.T.U.)
ANKARA, TÜRKİYE

Civil Engineering
Middle East Technical
University (M.E.T.U.)
ANKARA, TÜRKİYE

Public assembly buildings are representative of the places whose architectural and structural features have particular meanings. They reflect practical and artistic being of people for given periods.

This gathering purpose required through the history of spaces of a solemn character especially at Islamic sections the religious edifices.

The "dome" constitutes a structural component fitting well to this requirement and it also creates effect of "cupola" and others proper to curved forms. Within this context, buildings with domes were considered rather as specific buildings.

The protection of architectural heritage has started recently to gain some momentum and a new discipline of the "structure" and which comprises the area of structural assessment for historic buildings. Within this framework of extensive structural evaluation work with contemporary components such as material science studies on the mortared masonry, detailed structural investigations including seismic analysis and backed by mobilization of non-destructive testing techniques, had to be assumed.

The authors were involved at various occasions to structural assessment work of domed masonry buildings of major size in seismic zones. They mostly focused on the 16th. Century Ottoman buildings. They also had opportunity of making site observations on the behaviour of other edifices and monuments of various periods at different countries including Egypt.

The preliminary findings of an ongoing research work on the subject and some observational remarks will be summarized in this report which would give place to interpretation of past, present results and to recommendation for further studies.

Indeed, sophisticated computation techniques and advanced systems considered as behaving elastic in the assessment work contributes to get an overall assessment. But, for the purpose of precise informations are needed for details of the assessment and protection operations. A more systematic approach is needed to evaluate behavioural features of domed masonry structures, with domes. International attention is focused by complete research work formed by the following steps: i) Examination of geotechnical features, conditions of soil and elements. ii) Determination of detailed system identification of the building including foundation components and structural system. iii) Monitoring system with systematic permanent measurement of deformations. iv) Material science studies on masonry materials intensified on mortared masonry behavior. v) Evaluation of a detailed structural model and full structural analysis of the bearing system with system identification work, if necessary, including all parameters of dynamic response. vi) Experimental studies, if considered necessary, on a laboratory model of the structure. vii) Remaining in close contact all through the studies with architecture historians and art philosopher to ensure usefulness of findings for them, to give interpretation of engineering results with objective of contributing to preservation practice.

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Paper proposal for the international conference on:
RESTORATION AND CONSERVATION OF ISLAMIC MONUMENTS IN EGYPT

**PRIORITIES IN SELECTING RESTORATION SITES:
AN URBAN-CONSCIOUS APPROACH.**

Ouf, Ahmed S., Ph.D.
Staff member, Dept. Architecture,
Faculty of Engineering, Cairo University

Abstract

Monuments , in any culture, are important embodiments of the people's heritage as they document ideas, craftsmanship, and evidence of the people's behavior that might have otherwise been lost. Islamic monuments in Egypt, and specifically in Cairo, are the essence of her charm as they symbolize a flourishing past that needs to be regained and continued.

Surveys of the Islamic monuments since October 12th Earthquake by members of the Engineering Center of Archeology (ECA) and the Department of Civil Engineering at Cairo University showed that the number of monuments in need of immediate intervention is substantial and that the rest need good amount of restoration work. Faced with the limited resources set for restoration; the selection of which monument is to be restored first becomes a handicap of any proposed restoration efforts even when funding avails.

This paper proposes that restoration priorities need to be set within a wider perspective than that of the urgency of the structural needs of each building. Islamic monuments need to be restored according to their cultural value, their historic importance for their periods of construction, their possible current uses, as well as their location within the city.

- 1- Introduction
- 2- The current situation of Islamic monuments
- 3- Architectural priorities for restoration
- 4- Community participation
- 5- Urban priorities in Cairo
- 6- Epilogue

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CONSERVATION AND PRESERVATION OF ISLAMIC ARCHITECTURAL HERITAGE

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The Restoration of az-Zāhir Baybars Mosque in Cairo

Prof Dr. Eng. Saleh Lamei
Architectural Historian and Restorer

In the middle of az-Zahir square stands one of the major congregational mosques in Cairo built in Bahrīt era (Index n°. 1) by the Sultan al-Malik az-Zāhir Ruknaddīn Abūl-Faṭḥ Baybars aṣ-Ṣāliḥī an-Nağmī al-Bunduqdārī, born 620 H /1223 in Kipchak. He reigned from 16. Duḥ-qi'da 658 H /23. Oct. 1260 until his death on 28. al-Muḥarram 676 H/ 1 st. July 1277.

The site of the mosque was chosen by the Sultan himself in the area, known at that time, as Qarāquṣ ground in the Ḥusainiyya district.

Baybars visited the site on 8th. Rabī' II 665 H/6th. Jan. 1267 and the design concept has been represented to him. He ordered that the entrance door should be similar to his school entrance door in an-Naḥḥāsīn and the wooden maqṣūra in front of the mihrab should be similar to that of the mausoleum of Imām aṣ-Ṣāfi'ī.

According to the inscription on the marble slab in the tympanum above the three entrance doors the construction of the mosque was ordered on 14th. Rabī' II 665H/12. June 1267; six days later than that date given above by Maqrīzī.

Jarosław Dobrowolski
Polish Archaeological Center in Cairo

POLISH-EGYPTIAN RESTORATION PROJECT
AT THE EASTERN CEMETERY IN CAIRO

The funerary complexes of Sultan al Ashraf Inal and Amir Kebir Qurqumas, both outstanding examples of the architecture of Circassian Mamluk period, are located in the northern part of Cairo's medieval necropolis, known as the Eastern Cemetery or the Mamluks' Desert. The area has recently undergone a great deal of change from a deserted cemetery setting into an urban district.

Al Ashraf Inal's complex dates from 1451-1456, Amir Qurqumas' edifices adjoined in 1505-1509. Both complexes are large multifunctional religious-funerary foundations, comprising a domed mausoleum, a mosque-madrassa with a minaret, a founder's residential compound, khankas for sufis as well as subsidiary and service areas. Elaborate water supply and sewage disposal systems were in use. The buildings display both excellent craftsmanship and high artistic values. In spite of some historically interesting particularities their layout and design was typical for Cairene architecture of the period. Nowadays unlike most other examples that have been reduced to isolated tombs and mosques, they are preserved fairly complete, though much ruined and stripped of their originally lavish decoration.

The buildings were deserted probably soon after Ottoman conquest and later on were used as military barracks and depots. In 1883 they were returned to the Waqf authorities and some restorations were done by the Committee for Conservation of Islamic Architecture, but the site continued to be used by the military and police until quite recently.

Since 1972 Amir Kebir's and later also Sultan Inal's edifices have been restored by a Polish-Egyptian team, organized and financed on the Egyptian side by the E.A.O., and on the Polish side by PKZ, a Polish state-owned company for monuments' restoration and by the Polish Archaeological Center of the Warsaw University. The mission's activities involved historical research and on-site investigation and documentation, archaeological excavations in and around the objects, anthropological examination of bone remains, as well as actual restoration of the buildings.

The restoration works concentrated on ruined parts of Amir Qurqumas' mosque, tomb and palace, with an aim to re-create a complete, roofed building that could be practically and safely used. Ruined parts of walls were rebuilt, eroded stone blocks replaced, roofs repaired or rebuilt throughout the complex, window grills, shutters and doors installed. A thorough restoration of the minaret was performed, including reconstruction of the top part.

The site has been cleared of all previous users, declared an area under E.A.O. s authority and fenced.

Since 1992 the PKZ company has withdrawn from the project, and in the season that followed the Polish Archaeological Center took full responsibility, while the E.A.O. abandoned the system of contracting construction works and acted directly in the restoration.

At present the mission continues to protect the mosque of Amir Kebir Qurqumas by installing a new roof over the badly damaged original ceiling in the western liwan. Eroded stone blocks are being replaced in the walls of the madrasa and the qasr of Amir Kebir. Excavations were also continued.

The beginning of the season coincided with the earthquake of Oct. 12th, 1992. A study on damage caused to the 35-odd monuments in the whole area was done by the mission, and the state of the monuments was regularly monitored in following months. Endangered minarets were shored up with timber and possibilities of their definite restoration were studied.

The future course of action for Amir Kebir and Sultan Inal's complexes is envisaged as: /1/- completing the restoration of Amir's mosque-madrasa and attached compounds, /2/- protecting ruined parts of the complexes against further damage and render them safe for visitors, while keeping the intervention into the original structures down to the minimum necessitated by safety reasons.

STRUCTURAL BUILDING MATERIALS AND DEGRADATION
PHENOMENA WITH REFERENCE TO AMIR SHAIKHOU MAUSOLEUM

By

SALEH AHMED SALEH^{*1}, MOHAIED ABDEL HADI MOHAIED^{*2}
AND MOHAIED AHMED AWAD^{*3}

ABSTRACT :

The Amir Shaikhou Mausoleum and Khankah-southern Amir Shaikhou Mosque - were established since 1355 A.D., 756 H. and today represent an ideal case for the study of conservation of Islamic Monuments. Structural building materials used here, are those traditional ones : limestone for foundation and lower parts of walls to 3-meters height and frame of arches , red bricks for the rest of the walls , marbles for columns of different forms and diameters , base and crowns then wood essentially for ceilings and the two famous domes of that monument . Decorative materials such as gypsum, metal and wood for windows or wooden stalactite for wooden domes and lattern are marvillicus examples of Islamic Arts.

In the present work , samples of the essential building materials were investigated using the most sophisticated equipment and techniques such as : optical microscopy , electron scanning microscopy, emission spectroscopy , I.R. spectrophotometry , atomic absorption spectrophotometryect. beside those used for evaluating of mechanical and physical properties of the examined materials .

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Session 6
Abdel El Hady

THE EFFECT OF GROUNDWATER ON THE
DETERIORATION OF ISLAMIC BUILDINGS IN EGYPT

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Abstract

The present research is a scientific study which deals with studying the dangerous role of the saline groundwater in the deterioration of the building materials used in the Islamic buildings, locating in different regions in Egypt.

The various recent researches written by the author in this field showed that the saline groundwater is considered one of the principle physio-chemical factors attacking the historical buildings in Egypt and cause serious damage to the mineral constituents and the physical structure of the building materials (stones, mortars, plasters) used in the buildings previously mentioned.

On the other hand, the present research shows that the water table is considerably high in the walls of different historical buildings in Cairo because the porosity of the sedimentary stones used in these buildings (Limestone) is commonly high.

The Environmental Deterioration of Islamic Monuments
With reference to El-Azhar Mosque and El-Ghuri Complex

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ABSTRACT : Cairo city is full of different Islamic monuments which belong to early Islamic period until the end of Othman period.

The Islamic monuments were established on stable soil and environmental conditions but when the human activities increased, buildings greatly extended together with other factors which caused changes in the environments and affected at the same time soil under the foundation. Such soil became saturated with waste and sewage water. The subsoil water caused changes in the soil properties and affected the stability of the Archaeological buildings. This created vertical and oblique micro and macro cracks in the main walls and architectural elements leading to severe damage of the Islamic monuments.

Ground water migrated by capillarity through the porous building materials, carrying different kinds of salts and organic matter causing great deterioration at different places of the buildings .

Industrial sites, around Cairo City at Helwan (30 km. South of Cairo) and at North of Cairo at Shobra El-Khima, Mostorod, Abu-Zaabal and electrical power stations represent heavy pollutive plants iron and steel, coock, cement, pottery, ceramic, glass, textiles and chemical industries.

All of these sites produced different pollutants, which are carried by dominant wind to the Cairo City, which caused severe deterioration to monuments.

Heavy traffic in El-Azhar street represents anoter source of deterioration.

The previous factors lead to severe deterioration of Islamic monuments.

X-ray diffraction analysis of samples collected from El-Azhar mosque and El-Ghori complex revealed the presence of salts such as : $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$, NaCl , $\text{K}_2(\text{NO}_3)_2$ and NaNO_3 . These salts are most important factors of deterioration of stones at lower parts of walls and other structural elements of such monuments.

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THE MONUMENTS OF CAIRO - READY FOR THE NEXT EARTHQUAKE?

BY RICHARD SWIFT - GIFFORD AND PARTNERS - UNITED KINGDOM

There are fifteen identified tectonic plates on the earth's surface.

The release of energy which occurred on 12 October 1992 occurred between the Arabic and African plates.

It is instructive to consider how buildings may react to seismic forces.

In Japan in 1964 many modern reinforced concrete buildings maintained their structural integrity. When the earthquake occurred the founding structure liquified and buildings simply rotated.

One of the patterns of movement that has been observed in earthquakes is the increased risk of damage which occurs when a tall building is located immediately adjacent to and abuts a shorter building. 'Pounding' occurs as the two buildings move at different natural frequencies and strike each other giving rise to increased localised damage. This may be observed from the earthquake in Mexico in 1985.

In the San Francisco earthquake of 1971 several buildings simply swayed in the lower ground floor storey. These had been designed on the basis of a 'Soft storey'. In basic terms this consists of the lowest storey being designed with an open plan and few shear walls or cross bracing. The principle is that the sidesway of the structure occurs in the lowest storey and little or no damage occurs in the upper storeys. In order to resist the forces generated, the columns at ground floor level have to be designed to act in a ductile manner to sway but to continue to support the load. If the forces generated exceed the ductile capacity of the columns, failure may be catastrophic.

The design of buildings subject to earthquakes is a matter of hazard assessment and the evaluation of the risk of loss of life.

Current thinking for public buildings is that the essential requirement is that loss of life should be minimised. Thus a building may be extensively damaged throughout its height but remain standing to enable occupants to escape.

The effect of an earthquake is governed to a large degree by the nature of the founding structure upon which the buildings are constructed.

In Mexico City for instance where alluvial deposits are up to 1000 metres deep, shock waves have long wavelength and low frequency. That is the local soil is soft and deep enough to filter out much of the high frequency ground motion. The buildings which are vulnerable in Mexico City are those which have a low natural frequency themselves and will resonate with the exciting force. These are the taller buildings.

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In contrast, where the site is a rock site, the seismic shock waves are transmitted directly to a structure founded upon the rock, the buildings at risk are the shorter buildings with a high natural frequency. It is these buildings which will resonate with the exciting force.

At any site then, the buildings at risk are those which will resonate with the natural frequency of the seismic waves experienced.

In Cairo, the depth of alluvial deposits overlying rock is perhaps 300m with thick sand and gravel layers interspersed. It is fortunate indeed that the natural frequency of the shock waves experienced by the building structures appears to be of short wavelength, high frequency. As a result the majority of minarets have survived. It is the mosque building itself which has suffered.

Some of the monuments of Cairo have endured and survived seven earthquakes exceeding 5 on the Richter scale.

The problems which confront the monuments of Cairo today are really five fold:

- i) The loss of interlocking bond or structural integrity as a result of the earthquake.
- ii) A recently generated contaminated perched water table leading to salt damage and foundation failure.
- iii) Abuse by users.
- iv) Inappropriate repairs.
- v) The absence of a training forum for those who repair the buildings.

This paper will seek to consider each of the five problems in turn with examples from monuments visited.

The effects of 'pounding' which is evident between mosque and minaret will be shown. The loss of integrity of the structure resulting in many high free standing walls will also be considered and the means by which this may be remedied. This will include the description of a recent innovation in 'stitching' techniques currently being used in the United Kingdom.

The mechanism of masonry decay due to salt crystallization will be described. This may be considered in parallel with the 'soft' storey design described earlier but without the capacity for ductile behaviour. Appropriate repairs for masonry affected by salt crystallization will be suggested. It is however essential that the problem of the perched water table should be solved. This should be achieved with the installation of the new drainage system currently being installed as part of the £2,500 million Greater Cairo waste water project. Inevitably when the ground water table is lowered some further damage to the structures may occur. Underpinning or injection grouting may then be necessary. Various systems for remedial underpinning will be described.

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practice of permitting shopkeepers to sell their wares around the base of some mosques has resulted in damage to the fabric of the building. Some unscrupulous vendors have formed openings in the base of walls to increase their storage space. This has reduced the ability of the building to resist horizontal ground shears.

Inappropriate repairs may lead to acceleration of degradation. This mainly concerns the practice of using hard cement renders for repairs to eroded masonry.

Consideration of the establishment of a training scheme should be high on the list of priorities of the Egyptian Antiquities Organisation. Foreign assistance will be essential to the success of this initiative but it will have to be co-ordinated to achieve success.

Investigation of Damage to Islamic Monuments Caused by the Egyptian Earthquake of October 12, 1992

James K. Wight

Abstract

On October 12, 1992, at 3:10 p.m. local time, a magnitude 5.9 earthquake occurred approximately 30 km south of Cairo, Egypt. In response to a call for assistance from the Egyptian Antiquities Organization, three University of Michigan professors from the Department of Civil and Environmental Engineering traveled to Egypt to evaluate damage caused by the earthquake to ancient Islamic Monuments in Cairo. During their four day period in Cairo the team developed a good understanding of the important issues regarding the repair and restoration of the Islamic monuments.

The earthquake of October 12, 1992 did cause damage to some of the Islamic monuments, such as cracking in the walls, arches and domes; leaning of minaret towers and corresponding failure of the interface between the minaret towers and the rest of the mosque structure; and partial or total collapse of the tops of the minarets. However, except for the collapse of the tops of the minarets, the damage caused by the earthquake seems to have only added to a long and ongoing process of deterioration that predates the earthquake. The primary reason for such damage is high groundwater. The water is having a deleterious effect on the foundations of many of the monuments, leading to uneven settlements of the foundation and structure. These differential settlements have resulted in sizeable cracking in the walls of several mosques and leaning of minarets.

The foundations for most of the visited structures consisted of placed stone with a silt and mud binder. The foundations are generally greater than 1 meter thick. At several of the visited locations, excavated pits allowed for direct observation of groundwater levels. The water was typically in contact with the stone foundation and no more than 1.5 meters below the ground surface. The binder material is highly erodible in the presence of seepage. Furthermore, the predominantly fine-grained silt causes capillary suction of water up from the phreatic surface. The water rises up into the porous limestone walls of the structures. Dissolution of both the foundation stone and the limestone blocks of the structures is evidently occurring. As the water reaches the surface of the limestone blocks, it evaporates, leaving a powdery precipitate. This yellowish powder was clearly visible in the lower sections of many walls and sometimes reached heights up to 1.5 meters above grade.

While it was clear that the earthquake caused some damage to the cracked walls and the leaning minaret towers, the degree of damage attributed to the earthquake could not be accurately assessed. In most cases the earthquake induced damage was less than twenty-five percent of the total damage observed. The only exception would be the partial or total collapse of the tops of some of the minarets. The ornate tops were generally supported by thin unreinforced columns or posts. Lateral shaking during the earthquake caused several of these supporting elements to fail and the tops crashed to the ground.

LOOK, DAVID W., National Park Service Western Region: "The Preservation and Seismic Retrofit of Damaged Islamic Historic Monuments in Cairo Following the Earthquake on October 12, 1992"

Any historic resource located in an active earthquake area is subject to the slow deterioration associated with the normal weathering of materials and the sudden damage from seismic jots and other disasters such as fire. In addition to these causes of destruction, the monuments of Cairo have been subjected to years of deferred maintenance, severe air pollution and rising damp. Taken together, the cumulative adverse effect from all of these causes of deterioration and damage is staggering.

To restore individual monuments without looking at the larger picture may not be wise. If the water problem is not solved and/or the seismic retrofit of the structure is not integrated into the restoration, much time, effort, and money may be wasted doing cosmetic work. The problems need to be studied and massive efforts initiated to provide permanent solutions. However, if we wait until the problem are solved, many monuments will undoubtedly be lost. Monuments on the verge of collapse cannot wait until for several years while major problems are studied and solutions initiated. Emergency stabilization and protect are treatments that will buy the time to study the problems, arrest or lessen the causes of deterioration, and allow the environment to stabilize. Many of these resources have withstood one or more earthquakes. What are the inherent strengths and weaknesses of these resources? In their current condition, what are they capable of withstanding?

To determine if the solutions are producing the desired results the resources need to be systematically monitored and documented. This does not automatically imply high technology or low technology, but the appropriate technology. The use of new high technology materials that have a very short track record may lead to even far worse catastrophes in the near future when applied to monuments originally built of low tech materials. On the other hand, the use of computer programs to compile and analyze much data from monitoring and studying various problems may be very cost effective. Equipment used to study, to test, and to monitor may vary from low tech to high tech depending on the situation and cost. If the low tech, inexpensive methods work in most cases, it is cost effective to use them and save high tech, more expensive methods for those situations where low tech methods are not existent or ineffective.

There is usually more than one way to solve a problem. In order to preserve as much of the historic fabric and character of these resources, it is wise to develop various alternatives and evaluate them as to their effect upon the resource and their cost effectiveness. What can be done with the least amount of money that will save lives and reduce future damage?

The purpose of this presentation is to look at the major problems facing these irreplaceable cultural monuments and to explore how to approach the solutions necessary to secure the future survival of these resources.

Session 8
APR 12 1993

**SOIL STABILIZATION TO MITIGATE DAMAGE TO HISTORIC MONUMENTS
IN CAIRO FROM EARTHQUAKES AND GROUNDWATER**

by David W. Sykora¹

ABSTRACT

Two of the greatest hazards to Islamic monuments in Cairo are groundwater and earthquakes—both geotechnical engineering issues. Groundwater is a continuous hazard that impacts the monuments by seeping into the pores of building materials (wood, brick, plaster, masonry block, and grout), altering chemical compositions and bonds, accelerating the degradation of these materials. Fluctuations in groundwater can also cause shifting of foundations leading to cracks and other damage. Damaging earthquakes occur infrequently in Cairo, but the few large earthquakes that have occurred over the past millennia have devastated the rich Islamic history and culture in Cairo and Egypt. These two hazards are also inter-related because the groundwater continually weakens the structural resistance to earthquakes.

Efforts to protect, preserve, rehabilitate, restore, and reconstruct monuments and conserve ancient building materials should evolve around a standard plan to carefully evaluate all natural and societal hazards. The engineering study of groundwater and earthquakes involves adequate scientific definition of the hazard, analysis of potential modes and extent of damage, and consequent consideration and study of alternative methods of mitigation.

Geotechnical conditions at the sites of most Islamic monuments in Cairo include deep alluvial deposits of the Nile River, substantial amounts of surficial fill, and a shallow water table. Cairo has been subjected to earthquakes in the past and earthquakes must be expected to occur in the future. The predominant soil conditions will tend to produce an amplification of ground motions at higher site periods (lower frequencies). Damage to monuments by earthquakes can be mitigated using ground remediation, seismic retrofit, and/or base isolation, all of which are being used in the U.S. The expected duration of high groundwater conditions is uncertain and immediate action is warranted. Local mitigation of groundwater effects can be accomplished through different passive and active techniques including a new U.S. technology for shallow, horizontal wells.

The purpose of this presentation is to summarize basic facts about the geotechnical setting in Cairo and hazards to Islamic monuments, and present potential alternatives for hazard mitigation and post-earthquake stabilization. Some recent observations following the October 12, 1992 earthquake are used to show how and why damage is occurring and how this damage can be mitigated in the future.

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DARB-QIRMIZ: AN EGYPTIAN-GERMAN RESTORATION PROJECT IN CAIRO

Philipp Speiser

In 1973 the German Institute of Archaeology (DAI) and the Egyptian Antiquities Administration (EAO) started a joint venture project in the historic district of Cairo. The project centered around the Darb Qirmiz, a narrow lane branching off the main thoroughfare, Sharia Muizz li Din-Allah. From the beginning the project emphasized the aspect of area conservation rather than the single monument approach. As a suitable site the Darb Qirmiz was chosen, because it is bordered by a line of five 13-15th century monuments, which are under care of the EAO and therefore available for restoration.

At the same time, however, a minor portion of the Darb Qirmiz' built fabric, especially the wall, had been lost. In terms of architectural heritage along the street, the restoration and revitalization would spread to the neighborhood of a more recent date. This hope was fulfilled partially.

Restored buildings:

1. Madrasa of Sultan al-Nasir (14th cent.) restored 1973-76;
2. Madrasa of Sultan al-Nasir (16th cent.) restored 1977-78;
3. Madrasa of Sultan al-Nasir (14th cent.) restored 1980-82;
4. Madrasa of Sultan al-Nasir (18th cent.) restored 1980-84;
5. Madrasa of Sultan al-Nasir (14th cent.) restored 1982-84.

After the successful completion of those monuments the project moved to the nearby neighborhood of the Sharia Muizz li-Din, where three additional monuments were restored. The first of these is currently on the minaret of the madrasa of Sultan al-Nasir.

Project management:

The project was based on a very close cooperation between the EAO and the DAI. Both institutions delegated a project leader, who elaborated jointly the working program and supervised its implementation. The strong linkage of the two institutions was the result of saving costs and administrative red tape.

Funding:

The major part of the cash funds was provided by various German governmental institutions. The cultural funds of the Ministry of Foreign Affairs, as well as the cities of Hamburg and Stuttgart.

Egypt participated through the EAO in certain cases with substantial cash funds and put equipment, local specialists and building materials at disposal.

The two institutions contributed roughly an equal amount. The accessibility of the funds, administered by the DAI, was a key element for a steady progress of the work.

Skilled craftsmen:

The sheer amount of restoration work in Egypt to be done, leads automatically to a dramatic shortage of skilled workers or even more of restorers. Therefore this lack was countered by training over the years a group of gifted craftsmen in the field of conservation. Only for the most delicate work foreign experts with a good knowledge of the country were asked for assistance.

Restoration techniques and materials:

The limited funds and the scarceness of sophisticated restoration products on the local market, forced the restorers to use only traditional building materials as well as traditional techniques. As the development of conservation shows lately this approach is much less harmful to historic buildings, than the use of highly artificial materials.

REGISTRATION AND PRESERVATION OF ISLAMIC AND COPTIC MONUMENTS IN UPPER EGYPT

BY DR. MOHAMMED ABD ASSTAR OSMAN.

ABSTRACT

The paper deals with the registration and preservation of Islamic and Coptic monuments which had been built in Islamic period in Upper Egypt. These monuments can be classified into two groups. The first one contains the architectural works which had been carried out in the Fatimid period [5 -6 .H. / 11 -12 .A.D.] The second group consists of the list of buildings which had been built in the Ottoman period. Most of these Ottoman monuments can be dated in the 18 th century .

The paper covers the following points :-

The writer explains the importance of making an archeological survey - I . Depending on his modest bests and methods , the writer through his rambles in Upper Egypt shows many examples of Islamic and Coptic monuments must be registered . The registration of these monuments is the first step in the way of its preservation . There about [12] Islamic religious buildings and also about [37] Coptic ones unregistered . There are also many civil buildings which were built in the Ottoman period , especially in 19 th century and reflect clearly the architectural styles which were used in that period .

According to the law of Antiquities these buildings must be under the supervision of the Egyptian Organization of Antiquities . Preparing a scientific description, decorative and architectural drawings [plans - elevations - sections] and photos is very important for its registration . The historical and documental studies complete our knowledge about these monuments , and help us make in future , its appropriate restoration projects .