

Restoration of Egyptian Monuments

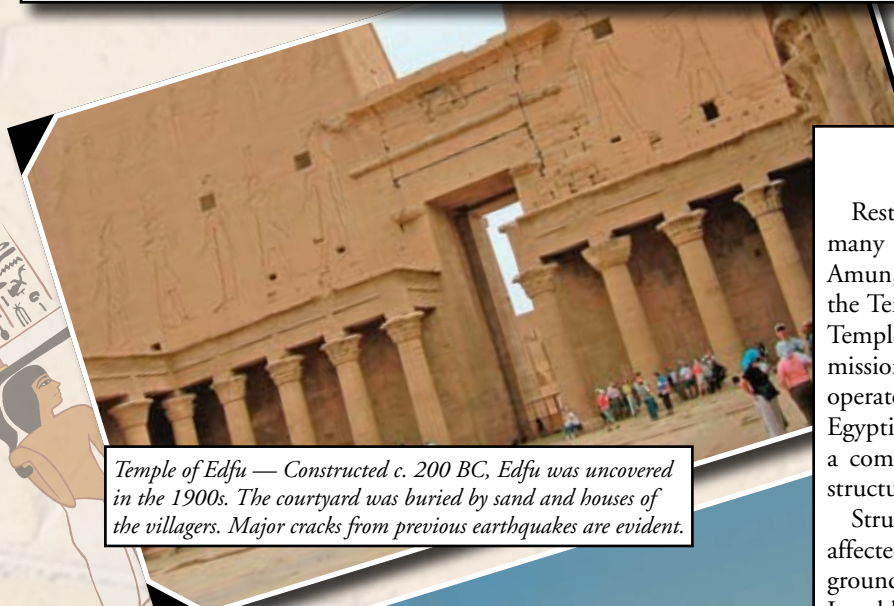
By David T. Biggs, P.E., Hon. M. ASCE



Egypt is the richest country in built heritage and, in 1979, Cairo was one of the first cities added to the World Heritage List of the United Nations Educational, Scientific and Cultural Organization (UNESCO). It's no surprise that the task of preserving, conserving and restoring Egypt's antiquities is an amazing challenge. Egyptian antiquities date as far back as 5,000 years. The most famous is the Great Pyramid, which is the sole surviving member of the Seven Wonders of the Ancient World. However, the number of temples, palaces, monuments and tombs is incalculable.

The concept of developing guidelines for conserving and restoring antiquities began with a group of Egyptians and foreigners in 1881. They gathered to create the "Comité," with their aim to record and preserve more than 600 structures in historic Cairo. Throughout the 20th century, that task was completed, but conservation efforts were sometimes misguided and harmful to the structures.

There has been a government body in charge of cultural heritage in Egypt since 1859. That tremendous task is currently delegated to the Supreme Council of Antiquities (SCA) and Dr. Sahi Hawass, who is Secretary General. Dr. Hawass estimates that 70 percent of the Egyptian monuments remain buried, waiting to be discovered. Thus, improving restoration techniques in Egypt is of paramount importance.



Temple of Edfu — Constructed c. 200 BC, Edfu was uncovered in the 1900s. The courtyard was buried by sand and houses of the villagers. Major cracks from previous earthquakes are evident.

Egyptian Restoration

Restoration is performed by Egyptians, as well as many foreign missions. For example, The Temple of Amun, located in Luxor, has an American mission; the Temple of Karnak has a French mission; and the Temple of Hatshepsut at Deir el-Bahari has a Polish mission. There are many more throughout Egypt. All operate under the guidelines of the SCA and have an Egyptian inspector associated with them. Most have a component in the restoration program to restore structural integrity.

Structural integrity of the monuments has been affected by the earthquakes of 1304 and 1992, and groundwater seepage created by sewage in the soil. In addition, the poor condition of various Egyptian monuments has resulted from poor maintenance, environmental pollution, a high population density, and general neglect and misuse. Under Dr. Hawass, new initiatives are taking place to develop standards for the conservation and restoration of Egyptian antiquities.



Restoration of the Sphinx of Giza — Buried several times since its construction (c. 2550 B.C.), the Sphinx was last cleared in 1905. It suffers from deterioration due to erosion. In addition, the nose was damaged during the Turkish occupation when it was used for target practice. Current restoration has Egyptian masons replacing the eroded stone exterior. Most of the paws have been completed. The figure shows work continuing on the lower body.

The Ayyubid Wall, Cairo

Historic Cairo was fortified in 1176. Over the centuries, the city expanded and the fortified walls became obsolete. The wall shown to the left represents approximately 1500 meters of the eastern side of Cairo. City expansion did not occur because a massive dump was created that ultimately buried the outside of the wall. The green in the right of the figure is where the dump was converted to a park, the wall was uncovered and is now undergoing restoration. Exterior stone damage occurred due to the chemicals and salts in the soil that covered the walls as well as water damage from the buildings that were built adjacent to and over the wall.

Current Efforts

In April 2006, the SCA convened the First International Conference on the Restoration of Heritage Masonry Structures. It was co-sponsored by Ain Shams University in Cairo, The Masonry Society in the USA, and Drexel University in Philadelphia. The conference was dedicated to the evaluation, assessment and retrofit/restoration of all types of historic and heritage masonry structures. The conference was co-chaired by Dr. Ahmad Hamid, P.E. (SEI Member) of Drexel University. Dr. Hamid is the co-author of *Masonry Structures: Behavior and Design* which is used throughout North America.

In addition to holding the conference, the SCA assembled an international team to develop guidelines for the structural restoration of Egyptian monuments. Dr. Hawass indicated that guidelines are essential for the future restoration of antiquities in Egypt. The team reviewed existing techniques and presented the SCA with a draft outline. The draft is currently under review, and the SCA is determining whether to fund the continuing efforts of the team. Besides Dr. Hamid, the team included:

Dr. Samir Chidiac, Engineer, Dept. of Civil Engineering, McMaster University, Canada

Dr. Luiga Binda, Architect, Dept. of Structural Engineering, Politecnico of Milan, Italy

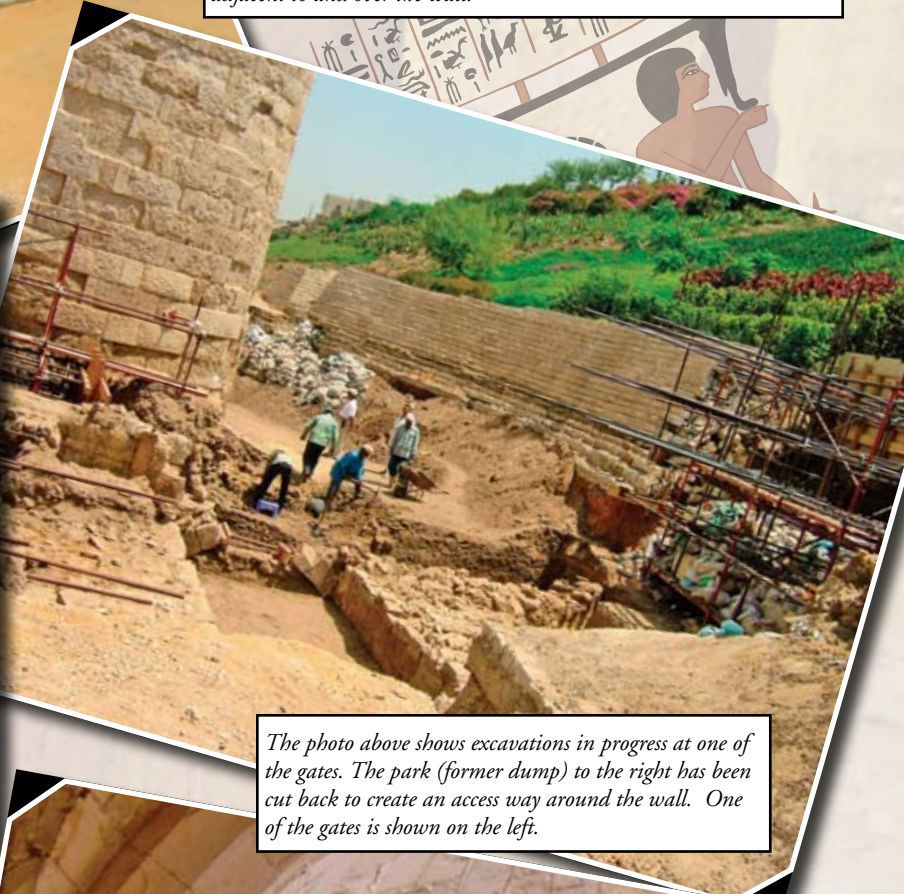
Frank Matero, Architect, Chairman of the Department of Historic Preservation, University of Pennsylvania

Dr. Wolfram Jager, Engineer, Dresden University of Technology, Dresden, Germany

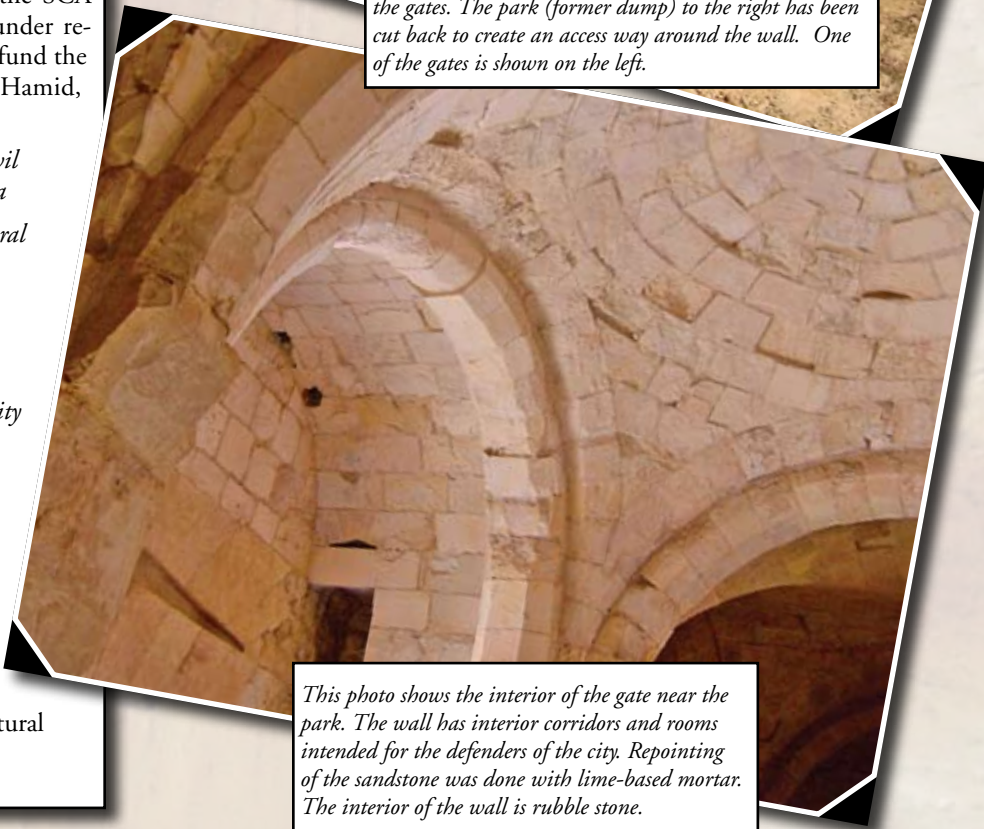
David Biggs P.E., Engineer (SEI Member), Ryan-Biggs, Troy, New York

Dr. Paulo Lourenco, Engineer, Chairman of the Dept. of Civil Engineering, Minho University, Portugal

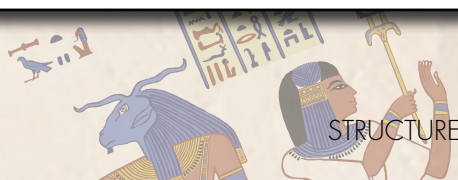
Since the restoration efforts are primarily structural, the team includes architects and engineers with expertise in materials and structural behavior of historic structures.



The photo above shows excavations in progress at one of the gates. The park (former dump) to the right has been cut back to create an access way around the wall. One of the gates is shown on the left.



This photo shows the interior of the gate near the park. The wall has interior corridors and rooms intended for the defenders of the city. Repointing of the sandstone was done with lime-based mortar. The interior of the wall is rubble stone.



Proposed Guidelines

The draft guidelines address the significant structural issues associated with monuments in Egypt. The outline includes:

1. Introduction
2. Historical Documentation, Recording and Classification
3. Site Investigation, Evaluation and Assessment
4. Intervention
5. Monitoring
6. Maintenance

The structural intervention aspects primarily include issues related to foundations and structures. Most are related to damage from groundwater, earthquakes, and material deterioration. Some issues include:

Foundation Techniques

- Dewatering
- Soil stabilization
 - Compaction confinement
 - Grout injection
- Structural modifications
 - Underpinning
 - Micro-piles
 - Base isolation



Structure Techniques

- Anchors and ties
- Grouting
- Joint reinforcement
- Reinforcement
- Jacketing
- Partial replacement
 - Partial unit replacement
 - Repointing
 - Unit stitching and repair
 - Composite repair
- Surface Techniques
 - Cleaning
 - Chemical treatment
 - Salt extraction

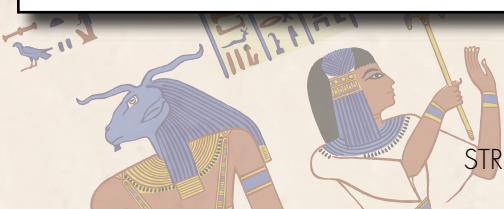
Expanded guidelines will review methods and techniques, determine the benefits and limitations of each, and rank each according to the degree to which they are intrusive. The emphasis on material restoration will address the primary Egyptian building materials used in the monuments: granite, limestone, sandstone and mud brick.


The desire is that these guidelines will help Egyptian heritage professionals execute proper planning and implementation of an agreed upon approach to restoration projects in Egypt. It will assist authorities to control the conservation work in Egypt using the minimum interventions that will ensure longevity of the monuments. ■

The Temple Complex of Karnak in Thebes (below) — There are three temples on 247 acres in modern Luxor; the largest temple complex in Egypt. Built over 1700 years, the site is now a French mission for restoration. 1700 years ago the two unfinished columns on the right of the figure (c.1300 BC) are part of the Great Hypostyle Hall; the builders erected sandstone slabs of stone and then ground them smooth as seen to the left.




Karnak Temple, Luxor — The photo above shows the restored sandstone column. The smooth section is intended to strengthen the column without giving the illusion of replicating the original. In the distance is a 97 foot tall granite obelisk (c.1470 BC). Other obelisks have fallen victim to earthquakes.



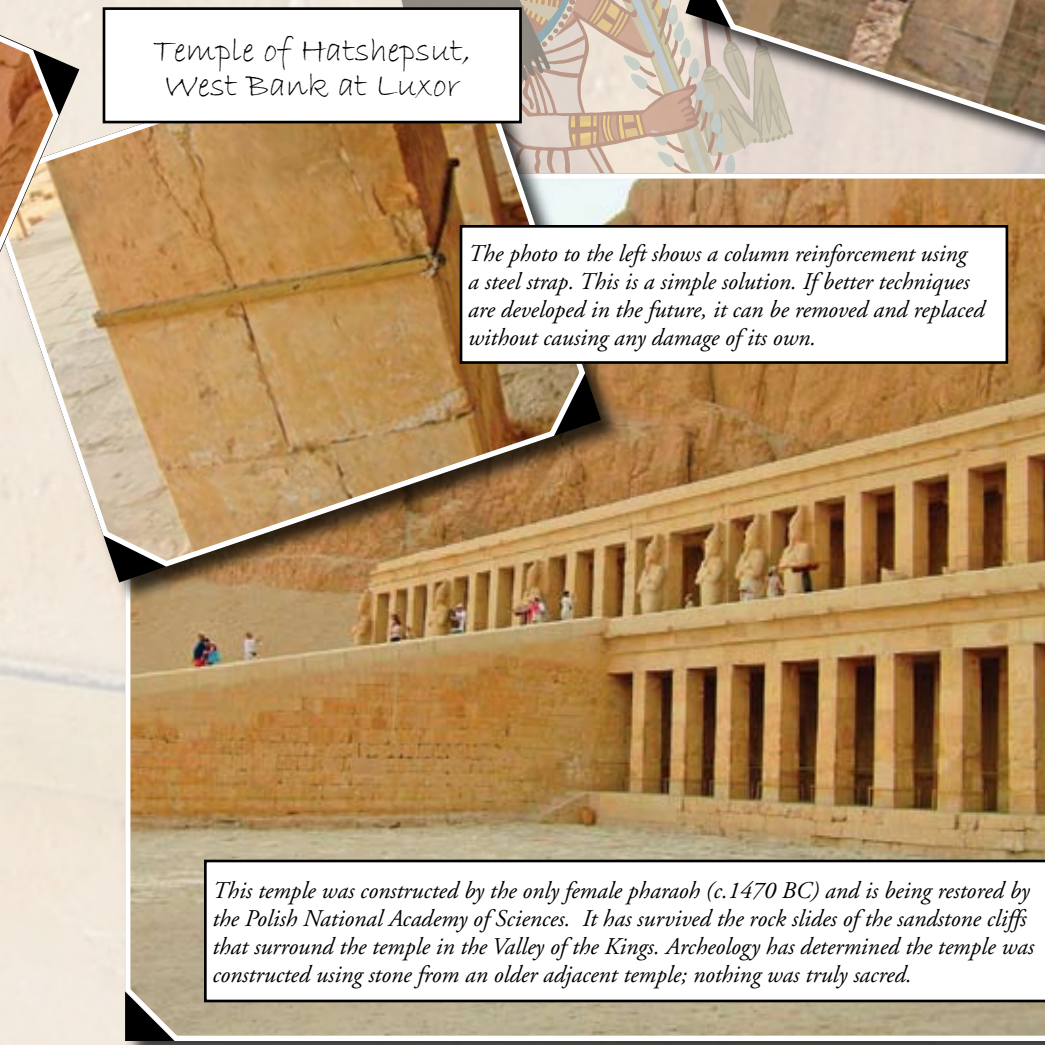


Temple of Isis at Philae




The rebuilt colonnade still shows signs where the columns were submerged (dark areas). The temple was rebuilt stone by stone.

The temple and other structures were constructed during the Roman Period (30 BC to 616 AD). Reportedly, this was the last temple built in Egypt. Prior to construction of the first Aswan Dam (1896), the temple was partially submerged two months out of the year; after the dam, it was totally submerged. A cofferdam was built and the island was pumped dry to allow the temple to be deconstructed stone by stone. The temple was completely rebuilt at its current location; access is by boat.



Temple of Hatshepsut,
West Bank at Luxor



The photo to the left shows a column reinforcement using a steel strap. This is a simple solution. If better techniques are developed in the future, it can be removed and replaced without causing any damage of its own.

David Biggs is with Ryan-Biggs Associates, a structural engineering firm in New York and Pennsylvania. He specializes in the design, evaluation, and restoration of masonry structures, forensic engineering, and the development of new masonry products. Mr. Biggs chairs the Prestressed Subcommittee for the MSJC 530 code and was a member of the ASCE-FEMA Building Performance Study team for the World Trade Center Disaster. David is also a member of the STRUCTURE® Editorial Board.

This temple was constructed by the only female pharaoh (c.1470 BC) and is being restored by the Polish National Academy of Sciences. It has survived the rock slides of the sandstone cliffs that surround the temple in the Valley of the Kings. Archeology has determined the temple was constructed using stone from an older adjacent temple; nothing was truly sacred.