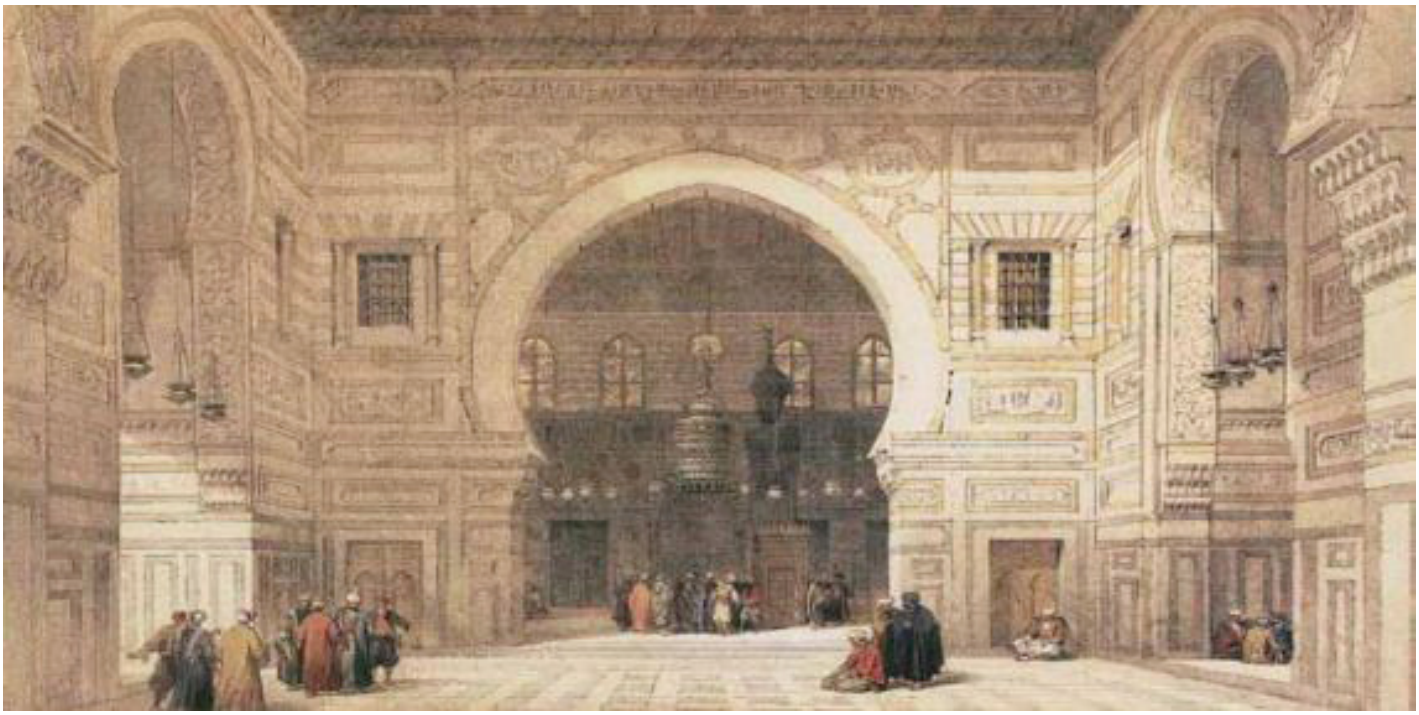
Case History

CINTEC™
REINFORCEMENT SYSTEMS

The Madrasa & Kanqah Of Sultan Al-Ghuri, Cairo Egypt



19th Century illustration of Mosque

The Madrasa and Khanqah of Sultan al-Ghouri is one of the Mohammedan monuments under the care of Egyptian Antiquities Organization. It dates back to 909-10 Ah 1503-4 AD.

The Madrasa Mosque with its strong features, bold design, marble panels and intricate geometric design carved into the surface of the arches and ceiling represents the last great flowering of Mamaluk Art.

A massive earthquake in 1992 almost saw the end of the 500 year old treasure. The CINTEC proprietary anchoring system saved this historic gem from being torn down.

The Al-Ghuri Mosque

The Damage

An inspection of the Madrasa reveal some very severe longstanding problems. The floor of the mosque undultated dramatically, providing evidence of very significant foundation problems of the masonry vaults supporting the florr. Attempts had been made in the past to underpin the sleeper walls supporting the vaults, these had failed. All the walls of the Mosque exhibited very severe fractures. The problems were brought about by earthquake damage in October 1992 and by the rising contaminated ground water. Further problems in the external walls had been caused by the activites of the shopkeepers trying to enlarge the space available for selling their wares.

Seismic damage to decorative arches

As a consequence, sections of masonry have been demolished at ground floor level to create this additional space. The net result of the above was the mosque of al-Ghori was in a very delicate state of equilibrium. Despite having survived for nearly 500 years, the toll of a rising water table, earthquakes and neglect had brought this structure to the point of collapse. Urgent measures were required to reintroduce some structural strength and stiffness into the building. It was understood that the Madrasa was underpinned by using a system of micropiling. The requirements therefore remained to tie the elements of superstructure together.

Temporary support of the Dikka arches

The very high walls were laterally unrestrained and very vulnerable to lateral forces such as may be produced by the next earthquake.

Vertical shear crack

Lintel Stones

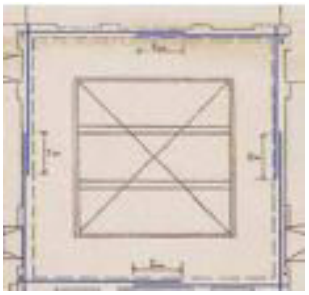
The Repair

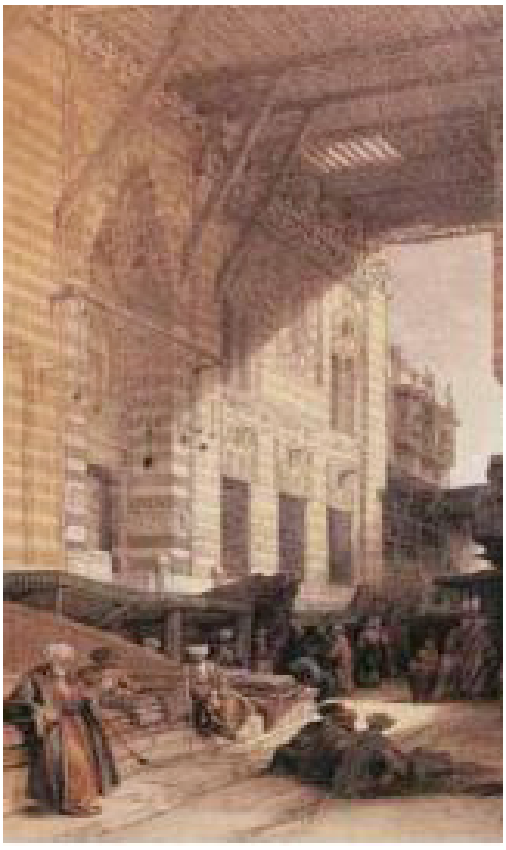
The CINTEC stitches would also be used to tie the roof structure to the perimeter walls and create a diaphragm action. Again this is an internationally recognized system of introducing greater stiffness and earthquake resistance into a structure. The beauty of the Cintec anchor is that it contains the grout to be used within a sleeve and control of grout flow, and its impact upon the existing structure is therefore very good.

The anchors to be used would be invisible in the repaired structure, eventually over 1200 meters of anchors were installed at al-ghouri. The installation team needed to keep a fine balance between the archeological project and the Egyptian Authority whilst encountering natural hazards like dust, confined working spaces, insects and high temperatures.

The success in refurbishing this ancient mosque was as a result of combined association of Cintec, Arab Contractors, Intro Trading and the advice and co-operation of the Egyptian Antiquities Organizations thus ensuring the stability of the 500 year old important heritage building.

Roof section above central courtyard





Market place outside Mosque 19th century illustration

Roof consolidation anchors

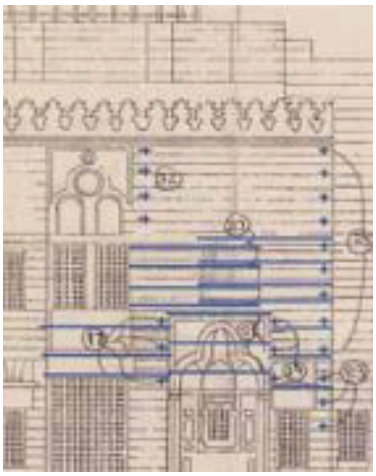
Installed roof anchor

Typical consolidation anchor prior to grout injection

5 meter long vertical anchors at roof level

The Cintec stitching system was extensively used at Al-Ghouri. These reinforcement anchors, up to 12 meters long, serve to stiffen each individual wall immensely. The walls of Al-Ghouri are generally of two facing skins in-filled with a core of rubble. The large arched openings in the mosque are particular points of weakness in the structure.

Longitudinal ties in each of the stone facings of the wall above the arch would serve to resist the thrusts naturally produced by the arch aa a well as serving to assist the walls to resist the next earthquake. In addition to longitudinal ties, transverse ties of length equal to the thickness of the wal were introduced to increase the strength of the wall.



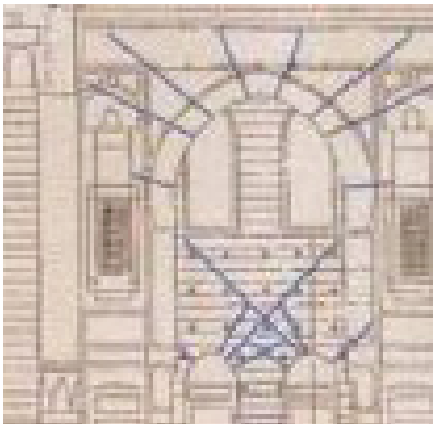
Dikka arch in the main courtyard

Drilling the vaults.

Typical repair detail for the arched vaults at ground level.

One of the four arches of the court being scaffolded prior to drilling and anchoring.

Decorative panels being drilled ready for installation of consolidation anchors.

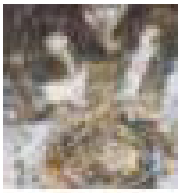


Typical anchor placement details for the arches and sidela walls.

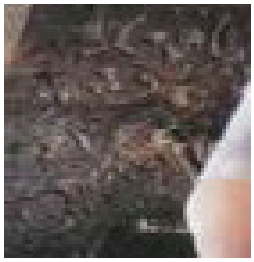
Diamond drilling the arch stone.

The Diamond drilling rig.

Anchor installed & inflated ready for front core to be replaced.



Front core replaced, after anchor installation and made good.



Drilling the stonework after removal of front core.

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