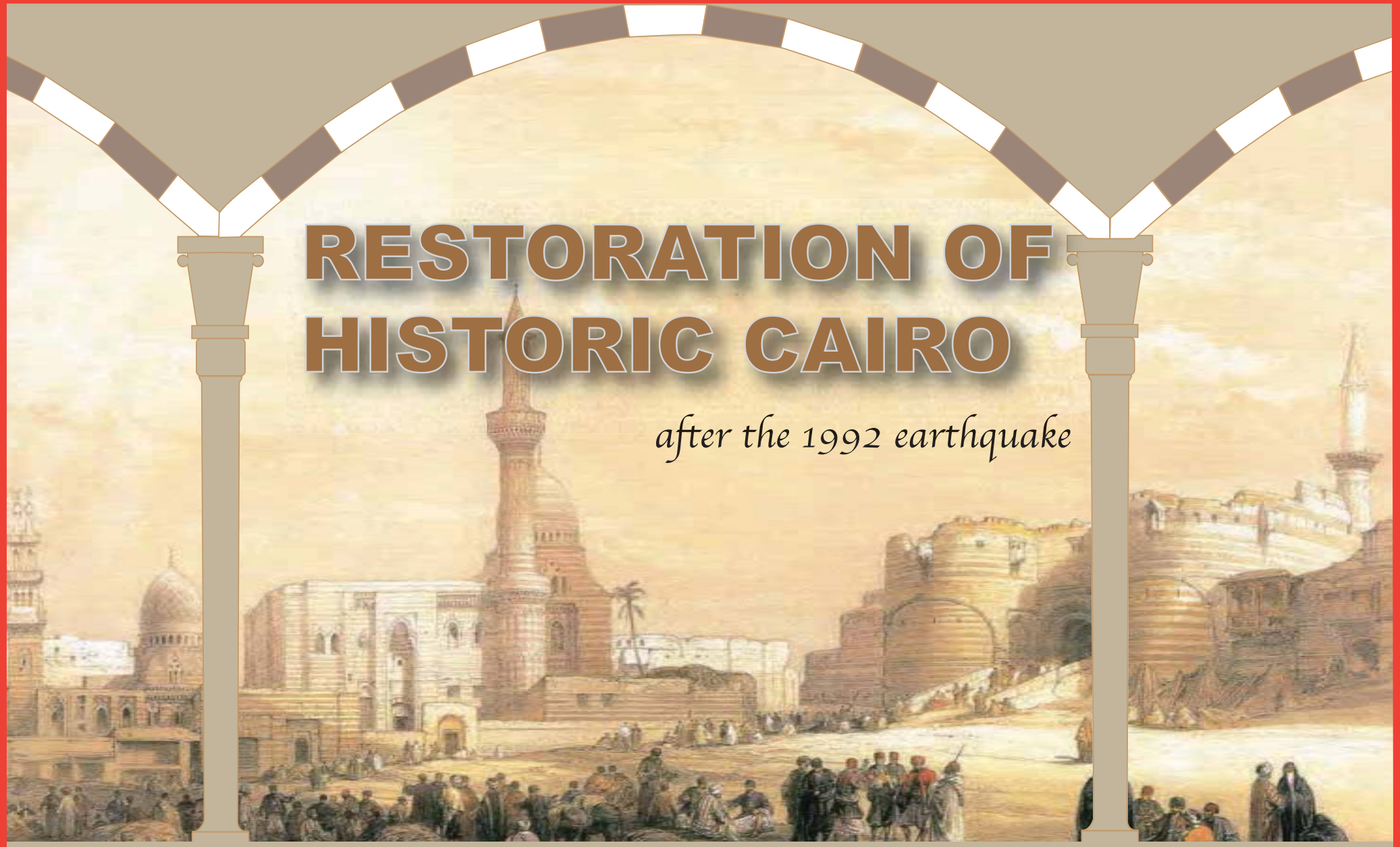


RESTORATION OF HISTORIC CAIRO

after the 1992 earthquake

preserving the past for the future

CINTEC

HISTORIC CAIRO

On the 12th October 1992, with an epicentre near Dahshur 35km south of Cairo, an earthquake measuring 5.8 on the Richter scale struck the Egyptian capital.
This seismic event albeit relatively small was unusually destructive causing 545 deaths, injuring 6512 and making 50,000 people homeless. It was the most damaging event to effect Cairo.

The areas of greatest damage were in the Old Cairo, Bulaq and southwards along the Nile as far as Gera, on the West Bank 350 Buildings were completely destroyed and 9000 others severely damaged. Some 216 Mosques and Maqaads were badly damaged particularly the older masonry and abobe structures. This was made worst with liquefraction reported in the epicenter and in the old historic quarter of the city.

Typical damaged facade

Behind the facade

Structures with temporary suppports

SCOPE OF WORK

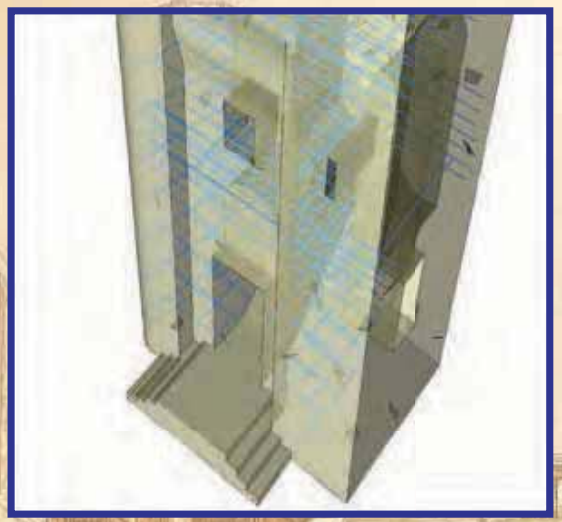
A tender to reconstruct the greater part of old Cairo was prepared. A number of large general contractors were awarded contracts to undertake the demolition of damaged structures and rebuild the structures and monuments where needed. Cintec International Ltd was asked to tender for the specialist anchoring and reinforcing to the damaged structure to save as much of the historic buildings as possible.
The work concentrated on historic mosques and Maqaad's. Each building was carefully surveyed and detailed work schedules were prepared together with structural analysis of the buildings including discrete element mathematical modeling.
The contract was undertaken over a three year period.

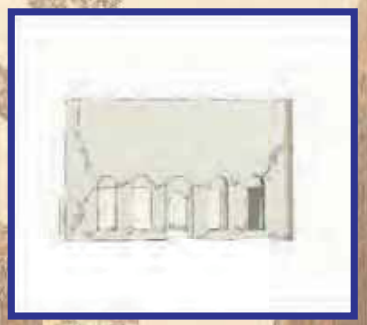
Some of the structures included;

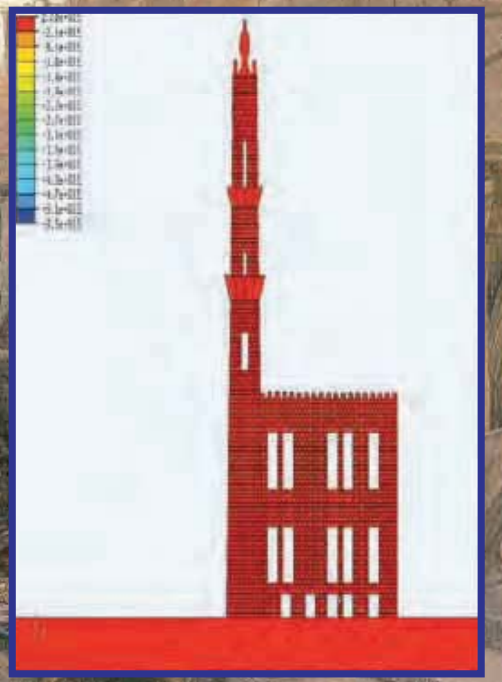
Al Ghory Mosque and minaret
As Silahdar Mosque
Mahmoud Moharam Mosque
Beshtaq Mosque
Sarghitmish Mosque
Pabers Mosque
Maqaad Mamy As Saifi
Maqaad Waqf A L Mulla House
Maqaad Palace of Emir Tas
Maqaad ash Shabshiri House
Maqaad Qayt Bay House.

In total over 15,000 metres of Cintec remedial reinforcement and anchoring

The discrete element analysis was undertaken by Rockfield Software Company using the unique program Elfren. This program was able to provide a three dimensional view of the the existing structure and the resultant damage. It was able to position the reinforcement in the most effective position and confirm its suitablity for future seismic events







Access was provided by the main contractors at each site

Internal cross walls stitched and secured to the external walls.

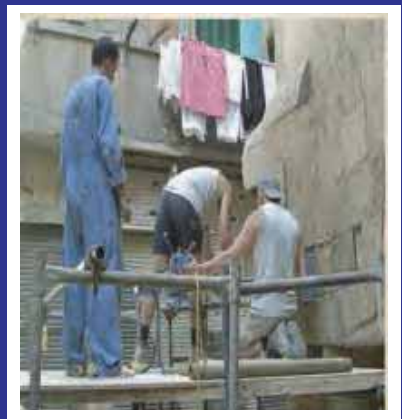
Positioning anchors in confined areas

Injecting the grout from the rear to the front

The work was carried out under the supervision of the Egyptian Antiquities throughout the project.
All the work was undertaken whilst the normal every day activities by the local population was in residence in and around the historic structures.

Anchor placement

Typical consolidation tie



Installation of the Cintec system

Over 15,000 metres of the unique Cintec sock system was installed both to internal and external walls of the buildings. These comprised in the main of M20 stainless steel anchor bodies, M16 anchor bodies and M12 anchor bodies all in 65mm drilled holes. Smaller consolidation anchors comprising of a 10mm circular hollow section in a 32mm drilled hole. The main grout was a special Presstec White lime grout to match the existing parent material.
The anchors varied in length to match each condition and were from 20mm to 15 metres in length.

Each anchor assembly is filled with grout under pressure from the rear to the front so that the entire anchor body is inflated like a balloon.

Internal and external walls are drilled with diamond core hollow tubes to the desired diameter.

Typical damage caused to exterior walls

Buckling and movement of columns

Drilling at roof level adjacent to previous timber intervention

Corner stitching using diamond drilling rig

Design Concepts

Cintec almost exclusively use stainless steel for any reinforcing intervention.
The designer calculates the size and profile of the reinforcing member depending on type and anticipated loads needed.

THE REINFORCING MEMBER

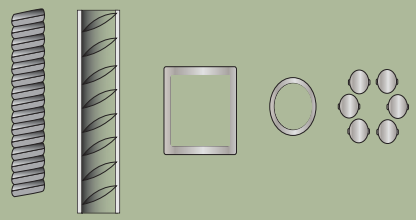
The designer is able to choose from all commercially available sizes and profiles such as solid threaded bar rebar and grip bar. Also from circular, square and rectangular hollow sections and even rolled steel joists.

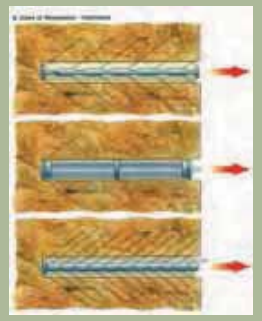
The grade of stainless steel varies according to its use from grade 303, 304 to 316 the relevant standard.

Metal plates can be attached to the ends of the reinforcement and circular and square hollow section can be cripped to increase the cone of compression when loaded.

THE PARENT MATERIAL

The strength of the parent material and /or mortar can govern the anchor capacity. Design checks on the parent material capacity can be based on the resistance strength of the in situ construction to the anchor force according to national standards. When the parent material or mortar strength is indeterminate, the capacity of the material can be determined from in situ tests.





THE DRILLED HOLE

The drilled hole is calculated on the bond strength between the grouted sock and the parent material. A conservative figure used as a standard would be 0.2 newtons per square millimeters. However, the material can be tested in situ where the strength is indeterminable.
It is also necessary to increase the hole diameter proportional to the length of the drilled hole to allow for extra sock and increased size of the injection tubes.

M20

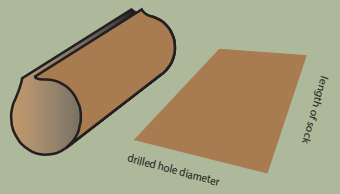
THE GROUT

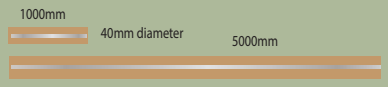
M20

Presstec is a cementitious grout, a factory produced mix with graded aggregates and other constituents which, when mixed with water, produce a pump able grout that exhibits a good strength with no shrinkage.
Presstec is made in accordance with German Din Standards.
The grout has been accelerated age tested for fourty years without any reduction in quality. Also extensive freeze thaw testing has successfully undertaken with good results. It has also achieved a 2 hour fire rating.
Presstec can also be varied to match the parent material and conditions.
A rapid setting grout, a sulphate resisting grout and a lime added grout are available if required.

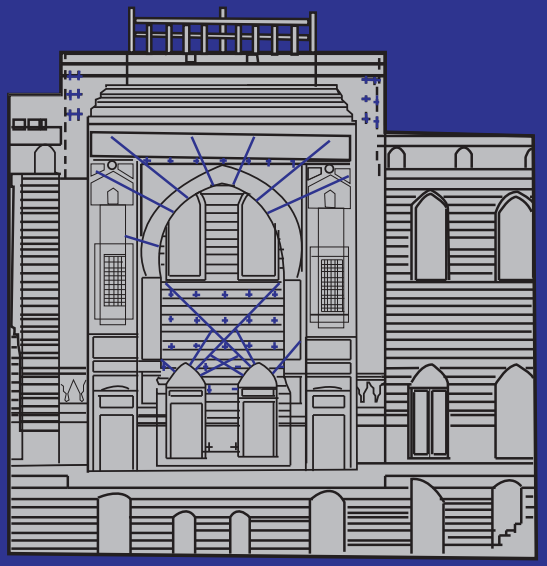
THE SOCK

The fabric sleeve is specially woven polyester based tubular sock with expansion properties to match the diameter of the drilled hole and substrate. The mesh sock is designed to contain the aggregates of the mixed grout while still allowing the cement enriched water (milk) to pass through the sock both sizing and bonding to the substrate. The sock is manufactured in sizes from 20mm to 300mm in diameter and is adjusted to suit each individual application.

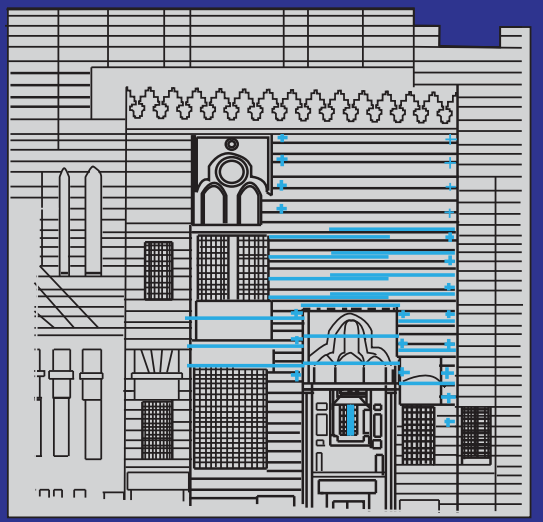




Typical anchor and stitching detail

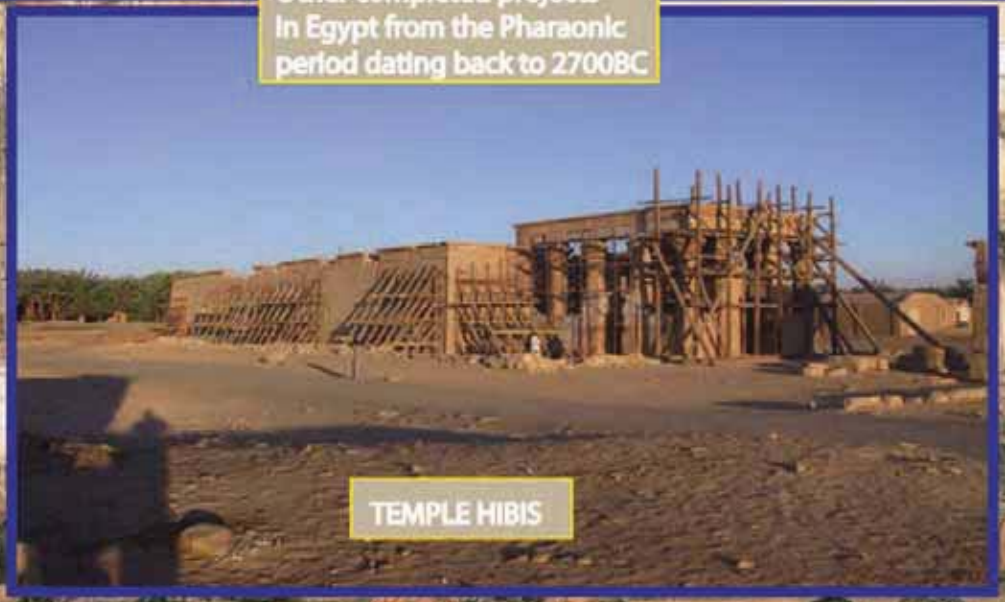


radial and consolidation anchors



Silidar and El Saifi mosques after handover to the Egyptian Antiquities High Committe

Other completed projects
In Egypt from the Pharaonic
period dating back to 2700BC



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