National Technical University of Athens (NTUA)
Faculty of civil engineering

DAMAGE ASSESSEMENT AND REHABILITATION OF HISTORIC TRADITIONAL MASONRY

Doctoral thesis

By

Mohamed Mostafa Mohamed Abdelmegeed

Assistant Lecturer, conservation and restoration department, Faculty of Archaeology

Under the supervisor of

Dr. Michael D., Kotsovos

Former Professor, School of Civil Engineering, Department of structural Engineering,
Reinforced Concrete Laboratory

Dr. Vougioukas E.

Lecturer, School of Civil Engineering,
Department of structural Engineering,
Reinforced Concrete Laboratory

Dr. Badogiannis E.

Lecturer, School of Civil Engineering,
Department of structural Engineering,
Reinforced Concrete Laboratory

Athens 2015

Historical traditional masonry is a form of architecture built by using local resources. It includes materials, techniques and skills of its constructors, and it is the fundamental expression of the culture of the different communities and their relation with nature and the landscape. Historic traditional masonry structures are the cultural reflections of a society; they create a strong link between the past and the present by presenting the economic, social and technical situation of the ancestors of a society.

Historic traditional masonry structures are also works of art and no matter whether they are famous monuments or so called minor or even vernacular architectures represent an important part of our cultural heritage. This patrimony which is the living memory of a country's history and development deemed to be a historic document of our past.

Traditional buildings present several structural deficiencies, such as fragility of the main walls and foundations under tensile forces, in addition to the total absence of seismic design, besides its poor capacity. It is also important to point out the contribution of the almost lake of maintenance and some poor interventions that lead to reduce building structural resistance.

From the structural risk point of view, the structural safety of historic traditional masonry seems to be very low and they may collapse under slight earthquakes without any apparent warning sign. Therefore, an appropriate use of the structural analysis could be employed in defining the eventual state of danger and in forecasting the future behavior of the structure.

The work that forms the subject (damage assessment and rehabilitation of historic traditional structures) lies on many scientific fields (civil engineering, architecture engineering, restoration and conservation science and materials science) cooperate to identify damage cases and damage assessment to historic traditional buildings and proposed adequate intervention methods to strengthening and rehabilitation of traditional buildings to re-use it in cultural job .

The research tried to employment previous experiences and works in building restoration and conservation of historic buildings in addition to in situ survey to historic traditional masonry buildings in Athens and Cairo used all of these studies to

damage assessment of historic traditional masonry houses in Athens-Greece and Cairo-Egypt which date back to 18th and 19th century. The methodology of the research has been discussed in five chapters, as follows:

1st chapter: Historic traditional masonry structures; history, development and structural elements. In this chapter we study the historical and architectural development of historic traditional masonry buildings and the development of traditional masonry residential buildings in Athens-Greece and Cairo-Egypt; attention is focused on a comparative study of the architectural components which governed the design concept of Athens and Cairo traditional house and highlighted its distinctive characteristics, building materials used for structural elements, and deterioration phenomena. Moreover, the study included the comparison of structural element joints and connection techniques.

2nd Chapter: Factors and aspects damage of historic traditional masonry. This chapter is concerned with a study of the deterioration factors and phenomena which may affect the integrity of historic traditional buildings. Such factors include earthquakes, change in uses and past conversion(s), structural (construction) defects, cracking, wall delamination, and the absence of conservation and restoration. On the other hand the chapter discussed the deterioration mechanism to historic traditional buildings.

3rd Chapter: Structural appraisal; Registration, Documentation, and Testing methods. As for the structural appraisal of historic traditional masonry, the chapter discusses and explains the procedures adopted for structural appraisal. These procedures include registration and documentation, monitoring, testing methods and laboratory work.

4th Chapter: Rehabilitation Methods for Historic Traditional Masonry Building. In this part the work focused on studying the methods which used to improve structural behaviour of the historic traditional masonry buildings. These methods involve the strengthening of masonry walls, the improvement of the connections between walls and floors, the repair of floors, and removal of existing features from those of other historic periods. The study is concluded with a discussion on how to re-use historic traditional buildings

5th Chapter: Case study. The building that forms the subject of the case study presented herein is located at the intersection of Aktaiou and Lykomidon streets and will be referred to as 'Aktaiou' building, thereafter. It was built in the early 19th century and it is considered to represent the structural and architectural trends prevailing in Athens this period, also it represented the structural and architectural characteristics of historic building in Egypt these buildings which located in the heart of historic Cairo (El-Kahera El-Khedeoia) and many building in Alexandria which date back to 18th, 19th and 20th century.

Aktaiou building has suffered significant deterioration phenomena. The work was divided as follows: General description of the building, history of the building, archaeological studies, presents appraisal, deterioration phenomena and factors, present condition, damage assessment and identification of damage phenomena. The work was based on mechanical and chemical tests such as XRD, XRF, optical microscope, compression tests, strain gage measurements, study of the mechanical and physical properties and linking these properties with deterioration phenomena.

Structural analysis of the building in both its initial state and after the implementation of the proposed interventions, identification of the causes of damage based on visual observation and mapping of the deterioration phenomena., identification of the causes of damage based on numerical analysis. The identification of the causes of damage is based on the results obtained by finite element stress analysis of the building**,** proposed intervention methods for Aktaiou building rehabilitating, and verification of proposed intervention of Aktaiou building to resist different deterioration factors in the future