Chapter 17
Selected Assessment and Retrofitting Application Techniques for Historical Unreinforced Masonry Buildings

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ABSTRACT

This chapter includes application of recent research on the repair and strengthening of historical structures and provides a structural assessment of five historical mosques in Albania. Apart from visual inspection, terrestrial laser scanner (TLS) data are used to analyze the historical structures. The FEM analysis conducted in SAP2000 aims to investigate the structural behavior of the undamaged model under static and dynamic loads. Stress concentration and mode period results have a considerable difference, which highlights earthquake vulnerability and changes the strategy of possible retrofitting. As a result, possible practical solutions for the structural problems based on previous research and enhancement of the existing structural resistance are suggested.

INTRODUCTION

Conservation or rehabilitation of a historic building is a multidisciplinary job that requires the expertise of different professionals and the latest technology for acquiring the geometrical and physical data on the oldest building methods and technologies. Despite the significant development of technology and intervention strategies, this process still requires a wide literature survey and deep knowledge of: the building’s history and evolution, geometry, structural details, crack patterns and material damage maps, construction techniques and of the material properties (Antonelli et al., 2008; Bartoli et al., 2006; Guarnieri et al., 2005).

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Every project is unique in its kind, and thus it has to be treated individually. Usually, dealing with an existing structure is more complicated than building a new one. Uncertainties related to construction material properties and the unpredictable behavior of masonry which is anisotropic and non-homogeneous, geometry, age, uncertainties regarding other repairs done during the lifespan of the building, etc., encumber such an endeavor.

The complexity of the restoration and rehabilitation process arises from natural and manmade factors. Decay of materials, degradation of structural elements from environmental conditions, mechanical shocks due to earthquakes, time-dependent mechanical behavior related to self-weight and geological phenomena such as erosion are some of the natural factors. The man-made factors which have a considerable influence on the lifespan of the structure include the sporadic modifications of the structure according to their specific needs, improper maintenance, usual lack of concern and improper strengthening and restoration. Due to the special characteristics of these buildings (cultural monuments of the first category and protected by law), restrictions on extracting samples for testing material properties, or removing any non-structural element make the process even more challenging, as does the limited research in this field.

As a result, these types of buildings are difficult to reduce to any modern standard structural scheme because of the uncertainties related to structural behavior ad material properties. Knowledge of the missing data for a historical construction may be achieved by combining in-situ and laboratory experiments together with an appropriate numerical model.

When assessing a historical structure, one of the basic procedures before modelling is obtaining the accurate measurement of the current geometrical shape of a structure, which eventually would provide insights into structural vulnerabilities and degradation, such as changes in the layout and existing crack propagations and settlements. Therefore, accurate geometrical measurements of historic structures with its imperfections have to be considered to model the present state and the effects of many interventions. However, it should be stated that in order to get a better understanding of the cracks and other structural problems, we need to remove excessive elements.

The main philosophy behind the repair of a historical structure is to extend the service life of the structure by mitigating the hazards coming from natural disasters and the deterioration of structural elements over time, as well as by improving its load resisting capacity.

This study includes application of some recent research on the repair and strengthening of historical structures and structural assessment of five historical mosques in Albania. Apart from visual inspection, precise geometrical data obtained by means of digital photogrammetry and terrestrial laser scanner (TLS) is used to identify the cracking pattern, and propose a diagnosis of the origin of the actual damage state based on a finite element model (FEM) structural analysis.

LITERATURE REVIEW

Protection of cultural heritage has become an emerging problem in recent years. It rises as a necessity for elimination of structural problems or distresses that result from unusual loading and exposure conditions, inadequate design or construction practices. These distresses may be caused from overloading, natural disasters, foundation settlement, deterioration of materials, etc. Some other reasons for strengthening are: correcting design or construction errors, resisting exceptional or accidental loading conditions, increasing tensile, shear, and flexural capacity of structural elements (Islam, 2009).
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