

Dangerous synergies causing failures of historical structures

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Abstract

The safety and reliability of historical structures or structures generally are typically assessed under “ideal” load or environmental service conditions. However, natural events and human activity or intervention during the life of historical structures may generate synergic effects which decrease their safety and even cause serious defects or failures. This paper presents selected situations involving combined time dependent degradation and sudden impacts of natural or artificial loads or human activity, identifies problems involved in coupling incompatible materials with weather or climate effects and incompatible remedial or strengthening work on historical structures. It further deals with a common problem: inadequate design, harmful interventions, and inadequate protection or preservation treatments. Lessons learned in practice and basic recommendations for preventing catastrophic results are presented.

Keywords: historical structures; safety assessment; climate action; temperature and moisture; material degradation; windstorm; flood; earthquake; environmental fatigue; maintenance.

1 Introduction

1.1 Reliability of historical structures

According to the general criteria set by the ICOMOS ISCARSAH recommendations [1] the study of the reliability of historical structures is based on a multidisciplinary approach and a scientific methodology which encompasses anamnesis, diagnosis, therapy and monitoring. An essential element is the understanding of the short- and long-term effects of any action to which structure is subjected, as well as its synergy with inherent material degradation.

The safety evaluation, which follows the diagnosis, is where the decision regarding intervention is made, and it needs to reconcile qualitative and quantitative analyses. Often the application of the same safety levels used in the design of new

buildings requires excessive, if not impossible, measures. In such cases other methods may allow different approaches to safety when justified. For example, on the basis of qualitative and quantitative evaluations we can improve safety levels (according to the principle of safety improvement) without having to respect entirely the prescriptions for new buildings based on analytic controls.

1.2 Assessment methods

There exist a wide range of approaches to assess the reliability of historical structures, namely: a historical approach (gathering data based on the history of the structure); a qualitative approach (comparing and extrapolating from other buildings); the analytical approach (a deductive procedure – e.g. structural analysis) and an experimental approach (experimenting on