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Seismic behaviour of the historical structural system of the island of Lefkada, Greece

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Abstract

The detailed survey of damages observed in numerous historical houses of the city of Lefkada, Greece, after the strong August 2003 earthquake, as well as the parameter analysis carried out within the present work allowed for the structural characteristics of this historical system (conceived to resist earthquake) to be identified and evaluated. The pathology of the structural system was analytically verified, and indicative intervention schemes were analytically examined.
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Keywords: Lefkada island; Historical structural system; Earthquake; Vulnerability; Stone masonry; Timber framed masonry; Pathology; Parameter analyses

1. Introduction

The island of Lefkada (Fig. 1), one of the Ionian Islands, is situated in the most earthquake prone region of Greece. A local structural system was developed before the 19th century in Lefkada. The strong earthquake which occurred in 1821, proved the adequacy of the system to sustain seismic actions. Thus, the British Authorities (ruling the Ionian Islands at that time) imposed rules for the construction of new houses following the main characteristics of this local structural system. These rules, further developed and completed, constituted the Code for Construction, issued in 1827. That Code provided guidance on the selection of building materials, on the thickness of stone masonry in the ground floor, as well as on the maximum storey height. In addition, a minimum distance is required between adjacent buildings to allow for better protection against fire and earthquake pounding. A considerable number of houses built according to this structural system are still in use in the city of Lefkada.

In August 14th, 2003, a strong earthquake (Mw of 6.2) occurred in the Lefkada segment of the Cephalonia Transform Fault running in a N–S direction along the Western coast of Greece. The peak ground acceleration recorded within the town was 0.35 g [1]. Extensive ground failures were observed, as well as severe damages in harbours, retaining walls and roads. Damages of varying severity were observed in modern RC structures (with one house collapsed), as well as in structures built according to the historical structural system of interest herein. With the aim to preserve the structural system surviving uniquely in Lefkada, a research project was carried out at the Laboratory of Reinforced Concrete, National Technical University of Athens. The scope of the project was (a) to check and complete the analysis of the local structural system, previously studied by Touliatos and Gante [2], (b) to study the pathology of the system, (c) to provide qualitative interpretation of typical damages observed and (d) to draft guidelines

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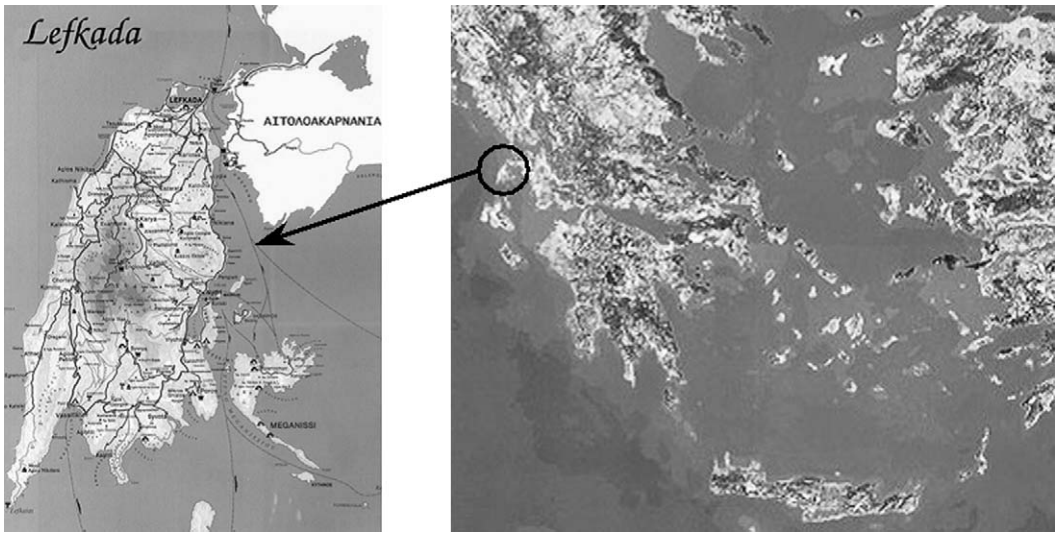

Fig. 1. Map of Lefkada.

for structural rehabilitation and strengthening of this type of buildings. The main steps taken to this purpose, as well as the main findings of this research (see also [3]) are briefly presented in this paper.

2. Short description of the structural system

The historical part of the city of Lefkada (Fig. 2) situated by the sea is developed both sides of a central street that separates the city into two parts of approximately equal areas. Lateral narrow streets start from the central street and are directed towards the sea (N–S or S–N direction). This arrangement allows for easy drainage of rainwater towards the sea. In addition, the-most frequent-north, northwest winds offer favourable conditions for reduction of humidity in the timber parts of these houses.

In what follows, the structural system of typical buildings is described, on the basis of the information provided by Touliatos and Gante [2], and completed by Vintzileou et al. [3], after extensive in situ work on a larger inventory of these buildings.

Fig. 2. The old part of the city of Lefkada.

2.1. Morphology

Typical buildings (one- to maximum three-storey buildings) consist of a stone masonry ground floor plus one or two timber framed brick masonry storeys. Intermediate floors and roof are made of timber. The roof is covered with tiles. Openings are practically symmetrically arranged in plan. To protect the timber framed masonry from humidity, the upper storeys used to be covered along the exterior façade by timber planks (Fig. 3(a)). The high cost of replacement of this cover (decayed with time) led to its replacement by plane or corrugated metal sheets (Fig. 3(b)). Covered walkways (Fig. 4) constitute a typical morphological and functional element in this city having frequent rainfalls.

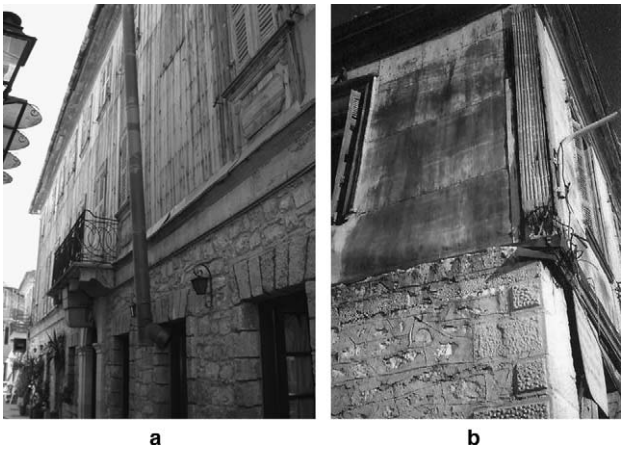

Fig. 3. Protection of timber elements: (a) by timber planks; (b) by metal sheets.

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