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Resilience improvement of historical timber floors subjected to cyclic loading

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Abstract

Horizontal diaphragms play an important role in the seismic behaviour of old buildings, and their behaviour when loaded by in-plane shear has not yet been sufficiently described in literature. The distribution of horizontal forces among bearing walls is strongly dependent on the stiffness of horizontal components and their connections to the vertical structures. The paper focuses on horizontal diaphragms of historic buildings, such as traditional floor systems and feasible intervention technologies for the improvement of their resilience. Experimental behaviour of original and strengthened wooden floors is analysed in order to obtain information on the system performance and supply parameters for use in numerical modelling.

Keywords: horizontal structures; timber floors; masonry; planking with various orientations; wood diagonals or grids; in-plane cyclic test.

1 Introduction

Timber is the main material used in the construction of floors in historical buildings and traditional houses. The effect of various strengthening techniques on the in-plane stiffness of timber floors was tested, analysed and characterized. Strengthening solutions using both traditional (orthogonal and diagonal planking, tongue and groove planking, ceilings made with rammed earth) and up-to-date materials were executed. Ceilings were subjected to cyclic loading to obtain basic knowledge of the mechanical properties of different structural elements.

Horizontal structural elements such as floors and arches, in the case of seismic loads, play an important role in transferring horizontal forces to the foundations through vertical elements. Reinforcement or replacement of original horizontal structures requires a sensitive approach; otherwise, generalized intervention solutions on floors can have catastrophic consequences. Replacing or upgrading original wooden floors with rigid reinforced concrete slabs was carried out to force CH buildings into 'modern' box-type behaviour [1] but, as observed in recent post-earthquake analyses [2, 3], this has lead to premature and devastating failure. Some researchers began reconsidering the possibility of slight strengthening of horizontal elements in order to preserve the structure, and the consequences were less intrusive. In old buildings wooden floors are commonly made with simply supported beams covered by a nailed timber planking. The advantage of such horizontal elements is their good flexural and comfort performance, and ease of production and workmanship [4, 5, 6].

There is little reference in literature to the study of the impact of traditional wooden floors on seismic

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