Seismic assessment of a vernacular rammed earth building

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Abstract

Rammed earth constructions represent a valuable cultural heritage of vernacular architecture, whose significance has acquired even more importance in the last years with the renovated interest for this sustainable building technique. The aim of this work is to develop a FEM model typologically representative of a Portuguese vernacular rammed earth construction in order to characterize numerically its seismic performance and raise awareness about the level of improvement introduced by two compatible strengthening techniques: textile reinforced mortar (TRM) and a ring beam applied at the top of the walls.

Keywords: rammed earth; seismic assessment; pushover analysis; retrofitting; TRM

1 Introduction

Raw earth is used as building material since ancient times. The oldest permanent earthen houses known were found in Çatal Huyuk (Turkey) and Jericho (Israel), around 6000 BC, but archaeological evidences related to the use of earth as building material were also found in Egypt, Iraq, Pakistan, Ancient China and Peru [1].

The earth construction concept includes several building techniques, presenting different constructive features and depending on aspects mainly related to the properties of the local soil [2]. Rammed earth is a vernacular construction technique that consists in compacting moist earth by layers inside a temporary formwork in order to build solid monolithic walls. The use of a formwork differentiates this technique from others earth construction techniques [3].

Rammed earth constructions represent a valuable part of the world vernacular heritage, considering their cultural value and environmental compatibility. The conservation of this built heritage assumes an urgent need due to its weak structural properties, mainly against seismic actions, whose effects can severely affect the existing structures leading to partial or total collapse of earthen buildings [4].

In general, as long as the mechanical behaviour is concerned, the material shows a relatively acceptable response in compression, but really poor performance in tension and shear. Earthen materials show a compressive strength normally in between 1 and 4 MPa, depending on several factors such as particle size distribution and the construction technique. It is important to highlight the nonlinear behaviour of the material, starting from low values of stress, and its typical brittle of failure [5].

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