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SEISMIC BEHAVIOUR OF PORTUGUESE RAMMED EARTH BUILDINGS

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ABSTRACT

Rammed earth is one of the oldest building materials in the world and is present in the Portugal with a particular focus in the South of the country. The mechanical properties and the structural behaviour of rammed earth constructions have been the subject of study of many researchers in the recent years. This study is part of a broader research on vernacular seismic culture in Portugal. Numerical analyses were carried out on a rammed earth masonry construction representative of the vernacular heritage of Alentejo region. Variations in the geometry, constructive characteristics and material properties were implemented and the main conclusions of the non-linear static and modal analysis are presented. Analysing the damage framework allowed interpreting the weaknesses of this type of constructions and consider the most appropriate reinforcement methodologies.

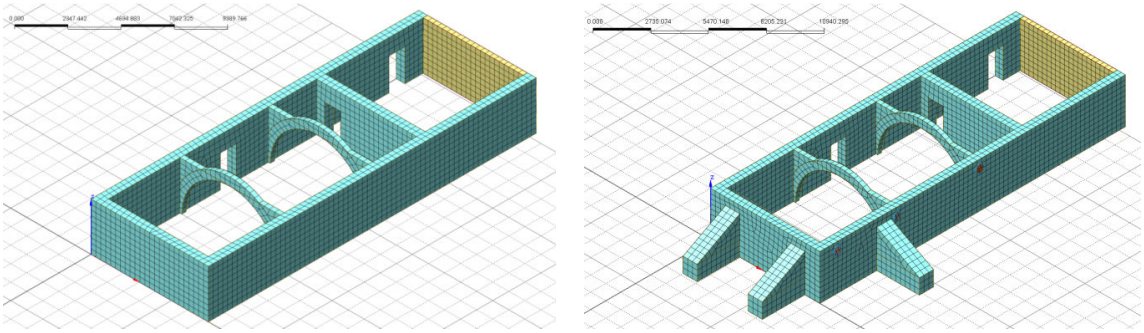
Keywords: Rammed earth, vernacular heritage, seismic behaviour.

INTRODUCTION

Earth has been used as a construction material along the years due to its reduced cost, available almost everywhere, recyclable, and provides good thermal and acoustic insulation. Rammed earth is one of the popular building materials in the South of Portugal. The present study is part of a broader research on vernacular seismic culture in Portugal. Numerical analyses were carried out on a rammed earth masonry construction representative of the vernacular heritage of Alentejo region (Figure 1).

Fig. 1 - Representative rammed earth construction (Correia, 2007).

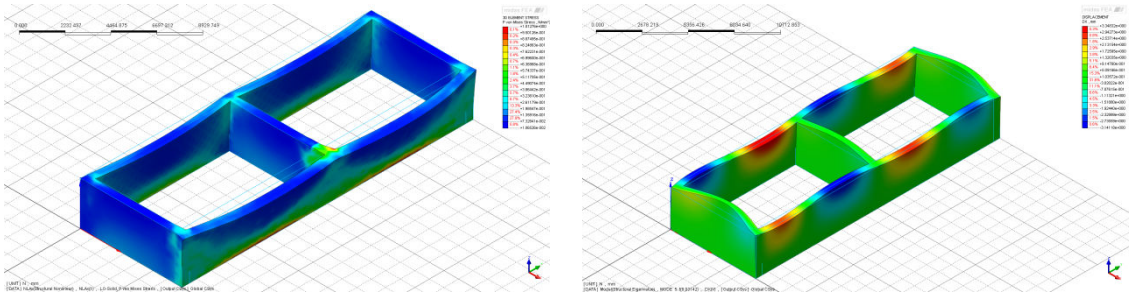
Two models were developed. The reference model, considering only the walls, without any reinforcement measures. Then different models were developed, considering the foothills (Figure 2b) and another with tie-rods. Variations in the geometry, constructive characteristics and material properties were also implemented and the non-linear models. The numerical model was developed with solid elements (Figure 2). On this study were considered two materials on the walls, rammed earth and brick. The roof load was considered as dead load applied on the tops of the walls.



a) b)

Fig. 2 - Numerical model; a) Base model; b) Model with foothills and ties reinforcement.

To assess the seismic behaviour of the buildings, pushover analyses were performed by incrementally applying a load distributed to the mass on both horizontal directions. The analysis of the damage framework allowed interpreting the weaknesses of this type of constructions and considering the most appropriate reinforcement methodologies (Figure 3).



a) b)

Fig. 3 - Obtained results; a) Non linear static analysis, b) Eigenvalue analysis.

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