

## **SAFETY ANALYSIS OF THE BELL TOWER OF S. MARIA MAGGIORE CATHEDRAL IN GUARDIAGRELE (ITALY)**

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### **ABSTRACT**

The study of historical building goes beyond the modern principles of earthquake engineering and requires on one side a good knowledge of the building techniques at the time of construction and of the building transformations over the centuries, on the other an in depth survey of the building. While macroscopic analytical methods are key to a first assessment of the structure failure mechanisms, advanced modeling tools are very useful, though they require great care by the analyst as the building materials are highly heterogeneous and brittle in the case of historical masonry structures.

This paper presents the results of the static and seismic safety assessment analysis of an ancient 19-m high bell tower erected in the XIII century and located in Guardiagrele in the Chieti Province, Abruzzo, Italy.

An extensive in situ experimental campaign was conducted to identify the material properties and the exact geometry of the tower as well as the stratigraphy of the supporting soil. The tower natural frequencies and mode shapes are extracted from ambient vibration data using state-of-the-art system identification techniques.

The onsite investigation results was used to calibrate a 3D finite element model of the tower developed using the program ABAQUS, HKS inc. In this model, the foundation soil is modeled explicitly in order to study the superficial soil layer filtering of the ground motion input at the base rock and its effects on the structural response. Realistic nonlinear constitutive models for cyclic loading are used for the structural and soil materials. The results indicate that the response of the tower is greatly influenced by the supporting soil.

*KEYWORDS: seismic vulnerability assessment, nonlinear analysis, cultural heritage, masonry structures, soil structure interaction*