

# The Use of a Building Information Model to Support Seismic Analysis: Application to the National Palace of Sintra, Portugal

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## ABSTRACT

In this work, it is presented an application of a Building Information Model (BIM) to the National Palace of Sintra, Portugal, a large and complex building that is included in the Cultural Landscape of Sintra, classified under the UNESCO World Heritage list in 1995. The developed BIM model has the ability to provide the geometric information of the structure of the building, together with its descriptive attributes, such as the mechanical characterization of the building materials, as inputs to the seismic structural analysis. The results of such analyses are also stored as attributes in the BIM model, providing an integrated platform usable by the building management.

The geometry of the palace was acquired with a combination of terrestrial laser-scanning (TLS) and unmanned aerial vehicle (UAV) techniques, covering the 11 levels of the building, which correspond to 244 spaces (e.g. rooms, outdoor gardens, patios) and surrounding environment locations. The two point clouds datasets were combined into a single coherent model and modelled using the Revit software, enabling its conversion to individual surfaces and objects. The Palace is composed of several buildings connected between them that were built along the centuries. Due to the large scale of the monument, the BIM model is divided into the main bodies of the palace, thus keeping a reasonable model size. One of the challenges in such complex and culturally important structures is to define the equilibrium between the maximum quality level required versus the time spent and the data size. This problem can appear either while collecting scans or modelling the Revit model.

The acquisition of the material properties employed several *in-situ* experimental tests – ground-penetration radar (GPR), masonry samples collection, flat-jack tests, ambient vibration tests – as the palace was built using different materials along its construction from the 11th to early 20th centuries. The experimental results were used to evaluate the structural condition of the palace and to assess its structural safety level, allowing for a fine tuning of the strengthening and rehabilitation interventions.

The completed operational model constitutes a useful tool to spatially reference the various tests and essays that are being conducted in the palace, allowing to support the production of adequate structural models and to integrate the results of the structural analyses into the BIM database.

## REFERENCES

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