

# Numerical Simulation of Traditional Timber-Masonry Buildings Subjected to Lateral Loads

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## ABSTRACT

Hybrid timber-masonry buildings are part of urban historical centres in many cities around the world. Timber frame constructions are widely spread in seismically hazardous zones due to their well-known good seismic behaviour. Some remarkable examples are the *Pombalino* buildings in Portugal [1], the *casa baraccata* in southern Italy, the *quincha* buildings in Peru [2], and the *adobillo* houses in Chile [3,4]. Most of these traditional typologies are vernacular constructions, built without compliance with existing seismic codes. In spite of that, the use of anti-seismic techniques is commonly associated with the design and construction practice growing in the territories with high seismic hazard, and most of these typologies have demonstrated their good response after major earthquakes.

This paper studies the nonlinear behavior of hybrid timber-masonry structures subjected to lateral loads by applying nonlinear static (pushover) analysis. Simplified numerical models are developed by considering lumped plasticity frame models for timber structure, and continuum finite element macro-models for masonry walls. Lumped plasticity models consider nonlinearities embedded in the connections among the linear frame elements, represented by nonlinear hinges. Nonlinear constitutive laws controlling the hinges' responses are calibrated based on experimental data and analytical approaches. The infill within the frames is modelled by using the simplified equivalent strut method. The masonry material behavior is modelled by using proper constitutive laws to describe the nonlinear response under tensile, compressive and shear loading.

After the calibration and validation of the hybrid timber-masonry model, the research analyses the nonlinear seismic response of a multi-story timber-masonry building existing in the historical center of the city of Valparaíso (Chile). This example is considered as an excellent case study as it combines external unreinforced masonry walls with timber frames infilled with *adobillo*. All the models have been developed by using the engineering software SAP2000 (v20).

## REFERENCES

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