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Editorial

Architectural Heritage Management in Earthquake-Prone Areas Heritage

Michele Betti [1,*], Giovanni Castellazzi [2] and Francesco Clementi [3]

[1] Department of Civil and Environmental Engineering (DICEA), University of Florence, Via di Santa Marta 3, 50139 Florence, Italy
[2] Department of Civil, Chemical, Environmental, and Engineering (DICAM), University of Bologna, Viale Risorgimento 2, 40136 Bologna, Italy; giovanni.castellazzi@unibo.it
[3] Department of Construction, Civil Engineering, and Architecture (DICEA), Polytechnic University of Marche, Via Brecce Bianche 12, 60131 Ancona, Italy; francesco.clementi@univpm.it
* Correspondence: michele.betti@unifi.it

1. Introduction

Historic masonry buildings represent one of the most valuable components of the world's architectural heritage. Many of them were designed and constructed in times when seismic engineering was unknown, relying on empirical rules and traditional techniques. As a result, they often display a high level of vulnerability to earthquakes, especially in regions where both geological conditions and human activities have evolved over time. Their exposure to seismic risk is not only a structural matter but also a cultural one, since modifications, changes of use, and a lack of maintenance frequently alter their original balance.

This Special Issue of *Heritage*, titled "*Architectural Heritage Management in Earthquake-Prone Areas*", was conceived to gather research contributions addressing these multifaceted challenges. The aim was to explore how technological innovation, methodological rigor, and multidisciplinary collaboration can enhance our understanding and management of historic constructions subjected to seismic risk. The published papers offer a wide and complementary perspective on these issues, ranging from digital documentation to seismic assessment and emergency management.

2. Overview of the Contributions

The first group of studies focuses on digital documentation and HBIM-based approaches, which have proven to be essential tools for the knowledge and management of heritage structures. Monchetti et al. (Contribution 1) illustrate this through the case of the *Galleria dell'Accademia di Firenze*, where an HBIM model was developed to integrate geometrical, material, and structural data in support of numerical analyses. Castellazzi et al. (Contribution 2) present a cloud-based system that combines BIM models with historical and diagnostic data, enabling an interactive platform for the management and visualisation of cultural heritage assets. Ciuffreda et al. (Contribution 3) and De Falco et al. (Contribution 4) further advance this theme with two studies on Florentine and Pisan monuments—*San Niccolò's Tower Gate* and the *Certosa di Pisa*—showing how HBIM environments can evolve into dynamic tools for structural diagnosis, maintenance planning, and seismic safety evaluation.

A second set of papers emphasises preventive conservation and vulnerability assessment. Chaves et al. (Contribution 5) propose a digital workflow for the *Church of Santa Ana* in Seville, integrating surveying, non-destructive testing, and FEM analysis within an HBIM

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framework, demonstrating how data-driven methodologies can support risk-informed decisions in seismic areas. Formisano and Longobardi's study (Contribution 6) on *Villa Vannucchi* in Naples moves from diagnosis to intervention design, combining analytical and numerical approaches to propose compatible restoration strategies that enhance resilience while respecting the architectural and historical authenticity of the building.

The Special Issue also includes two contributions addressing emergency management and post-earthquake strategies. Ferrari (Contribution 7) presents an integrated framework for emergency response developed after the 2012 Emilia earthquake, highlighting the need for coordinated procedures that reconcile safety, conservation, and cost-effectiveness in the aftermath of seismic events. In the same regional context, Zanazzi (Contribution 8) introduces a GIS-based geodatabase designed to map and analyse damage to historic castles, correlating structural typologies with seismic parameters to define fragility curves and prioritise interventions according to the principle of minimum intervention.

3. Concluding Remarks and Future Outlook

Altogether, these papers demonstrate how digital innovation, scientific analysis, and conservation ethics can be effectively combined in the management of built heritage exposed to seismic hazards. The integration of HBIM, GIS, and cloud-based systems provides a common platform for knowledge sharing and decision-making. At the same time, the case studies confirm the importance of interdisciplinary collaboration between engineers, architects, conservators, and data scientists in addressing the complexities of heritage preservation.

Several key themes emerge from this collection:

Integration of digital and structural workflows: The increasing use of HBIM, BIM–cloud infrastructures and GIS demonstrates that digital tools are becoming central to heritage-seismic workflows, not only for documentation but also as decision-making enablers.
From reactive to proactive and preventive conservation: Rather than simply responding to damage, the research emphasises continuous monitoring, data integration, and the use of digital twins as part of a comprehensive resilience strategy.
Context sensitivity and typology-specific solutions: While shared frameworks are helpful, the case studies underscore how structural typology, historic context and seismic hazard interplay require tailor-made workflows.
Linking assessment to action: Moving beyond modelling and diagnosis, several papers propose clear steps toward conservation or emergency response, showing how research connects to practice.

In addition, the contributions have highlighted the following challenges: how to standardise workflows across contexts, how to integrate real-time monitoring data, and how to embed economic and social dimensions (e.g., use, access, community value) into seismic heritage management tools.

The Guest Editors are confident that the studies collected in this Special Issue will serve as valuable references and inspiration for both researchers and practitioners involved in the protection of architectural heritage in earthquake-prone regions. A reliable understanding of the vulnerability of historic buildings exposed to seismic hazards is, in fact, the essential starting point for their preservation. Such knowledge not only enables the planning of effective preventive maintenance strategies, but also supports more informed decision-making after an earthquake, helping to prioritise interventions and to identify, more rapidly, the buildings where safety measures are most urgently required. In this regard, technological innovation and multidisciplinary collaboration, as demonstrated by the contributions gathered in this Special Issue, will play a key role in advancing the structural performance and safety of our Cultural and Architectural Heritage.

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