

A Multidisciplinary Approach to Historic Building Preservation

Efe Kelvin Jessa

Received: 24 May 2024/Accepted: 19 August 2024/Published: 09 September 2024

Abstract : Structural engineering in particular must work with other disciplines to accomplish the vital goal of preserving cultural heritage. The preservation of historic buildings guarantees that next generations will be able to experience and learn from these cultural objects, which serve as the physical embodiment of cultural identity and history. But structural problems frequently affect these structures, endangering their durability and structural integrity. While structural engineering is essential for identifying and resolving these problems, it cannot function alone. To create successful preservation plans that honor the structural and cultural characteristics of these structures, a multidisciplinary approach combining knowledge from material science, architecture, history, and conservation is required. Through a multidisciplinary perspective, this research investigates the function of structural engineering in the preservation of historic buildings. Through an analysis of case studies and existing practices, it draws attention to the advantages, difficulties, and potential paths forward of a cooperative approach to cultural asset conservation.

Keywords: Multidisciplinary approach, historic building, structural engineering, conservation, material Science, non-destructive

Efe Kelvin Jessa

Department of Civil and Environmental Engineering, University of New Haven, Connecticut, USA

E-mail: efejessa1@gmail.com

Orcid id: 0009-0009-0109-3206

1.0 Introduction

Beyond only being physical constructions, cultural heritage buildings serve as emblems of cultural identity and the architectural, social, and historical accomplishments of bygone eras. For communities to remain culturally cohesive and for future generations to be able to learn about and value their legacy, these structures must be preserved (Jokilehto, 1999; Frey, 2011). But maintaining historic structures is a difficult undertaking that calls for a thorough comprehension of both their structural integrity and cultural relevance (Feilden, 2003). Historic building preservation relies heavily on structural engineering. In order to guarantee the durability and safety of structures, it entails their evaluation, stabilization, and repair. But structural problems in historic structures are frequently entwined with historical and cultural elements, necessitating a comprehensive preservation strategy that extends beyond conventional technical fixes. In order to create thorough preservation methods, a multidisciplinary approach is necessary here, combining the knowledge of structural engineers, conservationists, architects, historians, and material scientists (ICOMOS, 1964).

Cultural heritage buildings need to be preserved for a variety of reasons, including environmental factors, structural deterioration, and the need to combine historical authenticity with modern needs. A single discipline is ill-equipped to address these challenges. For instance, whereas structural engineers prioritize a building's stability and safety, environmentalists prioritize the preservation of a structure's historical significance and aesthetic appeal. While architects strive to

maintain the original design while allowing for current usage, historians provide essential information on the building's cultural significance and original construction methods (Ashurst & Dimes, 1998; Tyler *et al.*, 2009).

All of these viewpoints are taken into account when using a multidisciplinary approach, which results in preservation plans that are both successful and considerate of the building's historical significance. Working together like this encourages creative ideas that can handle difficult preservation issues while preserving the authenticity and integrity of historic buildings (Feilden, 2003).

This essay aims to present a thorough, multidisciplinary examination of structural engineering's function in the preservation of historic buildings. The literature study examines the history of the subject, the emergence of structural engineering in the field of cultural heritage preservation, and the most recent developments in interdisciplinary methods. The research techniques, including the selection and examination of pertinent case studies, are covered in the methodology section. The present paper examines the advantages and difficulties of a collaborative approach to historic building preservation through the analysis of the case studies' findings and offers recommendations for future directions in strengthening collaboration between structural engineers and other professionals in the field of cultural heritage preservation (ICOMOS, 1964; Frey, 2011). These case studies provide comprehensive examples of successful multidisciplinary collaboration in the preservation of historic buildings.

1.1 Review of historical perspectives on cultural heritage preservation

The history of human civilization is fundamental to the idea of maintaining cultural heritage. Early attempts at preservation were frequently cultural or religious in nature, with the goal of preserving important spiritual or social institutions. For instance, temples and

tombs built by the ancient Egyptians were carefully kept, not only for their aesthetic worth but also for their religious symbolism (Tyler, Ligibel, & Tyler, 2009).

Early recording and restoration of ancient Greek and Roman structures resulted from the European Renaissance's growing interest in maintaining classical architecture. However, organized preservation efforts did not appear until the 19th century. During this time, groups advocating for the preservation and meticulous repair of ancient buildings were established in the UK, such as The Society for the Protection of Ancient Buildings (Jokilehto, 1999). These early initiatives frequently paid little attention to the structures' original materials or structural integrity in favor of restoring the buildings' visual appeal.

The preservation of cultural assets underwent a profound philosophical change in the 20th century. The damage caused by the two World Wars raised awareness of the need of preventing the loss of cultural assets. International initiatives, such the creation of UNESCO and the 1964 Venice Charter, highlighted how crucial it is to maintain heritage monuments' structural integrity and historical authenticity in addition to their outward appearance (ICOMOS, 1964). In order to better understand and maintain ancient structures, the subject of conservation science emerged during this time as well, including ideas from chemistry, material science, and structural engineering (Feilden, 2003).

1.2 Evolution of structural engineering in historic preservation

Historic preservation has always included structural engineering, even if its function has changed throughout time. In order to save buildings from collapsing, the first focus was on stabilizing and restoring them, sometimes utilizing intrusive techniques that jeopardized the buildings' historical authenticity (Feilden, 2003). Even while these early efforts were successful in averting an immediate collapse of



the structure, original materials and historical significance were frequently lost in the process. Engineering techniques evolved alongside historic preservation techniques. Engineers have additional alternatives for fortifying old structures because to the development of new materials in the late 19th and early 20th centuries, such steel and reinforced concrete. But because the use of these contemporary materials frequently conflicted with the historical and artistic qualities of the buildings, there is an increasing awareness of the necessity for more delicate preservation techniques (Collepari, 2009).

A movement toward less intrusive methods that put the preservation of existing materials and structural systems first has occurred in recent decades. Engineers may now evaluate the state of ancient buildings without inflicting harm because to advancements in non-destructive testing techniques as ground-penetrating radar and ultrasonic testing (Binda, Saisi, & Tiraboschi, 2005). Furthermore, the research and recording of historic structures have been transformed by the advent of Building Information Modeling (BIM) and other digital technologies, enabling more accurate and well-informed preservation methods (Murphy, McGovern, & Pavia, 2013). Preservation techniques have evolved further because to the expanding profession of conservation engineering, which blends structural engineering concepts with knowledge of ancient building techniques and materials. In order to create interventions that support historic buildings' structural integrity while maintaining its historical and cultural relevance, conservation engineers collaborate closely with architects, historians, and conservationists (Feilden, 2003).

1.3 The Role of different disciplines in cultural heritage conservation

The protection of cultural assets is intrinsically interdisciplinary, requiring the cooperation of several experts, each of whom contributes their unique knowledge and viewpoint to the

preservation process. The intricate issues surrounding the preservation of historic structures, which frequently call for striking a balance between preserving structural integrity and honoring historical authenticity, must be addressed via cooperation.

- **Conservationists:** The primary goal of conservationists is to maintain historic buildings' structural and aesthetic integrity. A common task for them is the meticulous cleaning, upkeep, and restoration of old materials like plaster, wood, and stone. Expertise in the characteristics, actions, and original building methods of these materials is essential for conservationists (Ashurst & Dimes, 1998). They are also essential in determining areas that require attention and evaluating the state of historic structures.
- **Architects:** Architects help conserve cultural heritage by creating architectural interventions that preserve a building's historical identity while allowing for contemporary needs. This frequently entails coming up with innovative solutions that strike a balance between the requirements of modern use and the necessity for preservation. To guarantee that their ideas are both visually beautiful and structurally sound, architects must collaborate closely with engineers and conservationists (Murphy *et al.*, 2013).
- **Historians:** Historians offer crucial background information on the original building techniques and cultural value of historic structures. This data is essential for developing preservation plans that protect a building's historical integrity. In order to maintain a building's cultural relevance for future generations, historians are also essential in recording the history of the structure (Tyler *et al.*, 2009).



- **Material Scientists:** Analyzing the characteristics of the materials used in the construction of historic structures is the responsibility of material scientists. This entails evaluating these materials' functionality and durability as well as creating appropriate repair methods. Additionally, material scientists are essential in determining and reducing the impact of environmental elements on historic materials, such as moisture and pollution (Charola, 2000).
- **Structural Engineers:** By evaluating the structural health of historic buildings and creating interventions that enhance stability while maintaining historical authenticity, structural engineers guarantee the durability and safety of these structures. Effective preservation requires the fusion of contemporary technical technologies with knowledge of ancient building practices (Feilden, 2003).

2.0 Recent Advancements and Current Trends in Multidisciplinary Approaches

The field of preserving cultural assets is always changing as new techniques and technology are created to make the preservation process better. A notable development in recent times has been the growing utilization of digital technology, including photogrammetry, BIM, and 3D laser scanning. With the aid of these technologies, historic structures may be accurately and thoroughly modeled, facilitating the evaluation of their state, the planning of interventions, and the tracking of the advancement of preservation initiatives (Murphy *et al.*, 2013).

The increasing focus on sustainability in preservation techniques is another significant trend. This involves incorporating energy-efficient technology into historic structures and using eco-friendly materials and construction methods. For instance, utilizing solar panels or other renewable energy sources within historic

structures is becoming commonplace in restoration projects, as long as the new features don't take away from the historical significance of the structure (Rodriguez-Navarro & Sebastian, 2017). In order to reduce the negative environmental effects of preservation efforts, sustainable preservation procedures also entail the prudent use of resources, such as energy and water.

Along with technology improvements, the value of community engagement in the protection of cultural assets is becoming more widely acknowledged. Involving local communities in the preservation process promotes a sense of ownership and responsibility for the protection of heritage assets while also ensuring that preservation activities are in line with community needs and cultural values. There are several ways to involve the community, such as via volunteer work, educational initiatives, and public consultations (Listokin, Listokin, & Lahr, 2010).

Ultimately, the necessity of thorough risk management techniques for the protection of cultural assets is becoming more widely recognized. Natural catastrophes, climate change, and human activity are just a few of the many risks that historically significant structures are frequently exposed to. To ensure the long-term preservation of cultural heritage assets, risk management plans that address these concerns must be developed and put into action. This comprises actions including routine upkeep, observation, and emergency preparation (ICOMOS, 2019).

3.0 Methodology

This study uses a qualitative research design and case studies to investigate structural engineering's transdisciplinary role in the protection of cultural heritage. Janssen, Hill, and Kröner (2014) determined that the case studies were chosen on the basis of their pertinence to the research subject and their ability to illustrate various categories of historic structures and preservation obstacles.



3.1 Case Study Selection

A variety of historic buildings, from 19th-century industrial facilities to medieval cathedrals, are shown in the chosen case studies. These structures were selected because they exemplify several facets of the interdisciplinary approach to preservation, including the way structural engineering is integrated with material science, architecture, and conservation (Murphy *et al.*, 2013).

Data Collection and Analysis

Site visits, examination of previously released reports and documentation, and archival research were used to gather data for the case studies. Reviewing historical records, architectural blueprints, preservation reports, and technical evaluations of the relevant buildings were all part of the archival research process. These records provide thorough insights into the construction techniques, history, previous restoration attempts, and structural difficulties of the structures (Feilden, 2003).

The examination of the documents examined was done in order to evaluate the success of the preservation techniques employed, the degree to which the buildings' historical and cultural significance was preserved, and the results of the preservation efforts (Charola, 2000). The analysis concentrated on comprehending how various disciplines worked together to address the preservation challenges, with special emphasis on the role of structural engineering in the overall strategy.

3.1.1 Case Studies

Case Study 1: The restoration of a medieval cathedral

Constructed in the twelfth century, the cathedral is a significant cultural icon and a UNESCO World Heritage Site. Due to environmental causes and past repair attempts, it has suffered from structural damage over ages. The restoration team faced several difficulties because of the building's intricate

architectural characteristics and historical significance (Korres, 1995).

Multidisciplinary Approach

A group of structural engineers, material scientists, architects, conservators, and historians worked on the restoration project. The job of determining the building's stability and creating interventions to fix structural flaws fell to structural engineers. While architects created interventions that honored the historical character of the structure, conservationists concentrated on maintaining the cathedral's original materials and decorative elements. Material scientists examined the characteristics of the building's materials and created restoration methods that worked, while historians gave background information about the cathedral's cultural relevance and original construction methods (Feilden, 2003; Collepari, 2009).

Outcomes

Through the project, the cathedral was effectively stabilized, its historical elements were retained, and its resistance to upcoming environmental difficulties was increased. The success of the project was largely due to the disciplines' cooperation, with each offering its specialization to create an all-encompassing preservation plan. The team was able to design interventions that were both minimally invasive and effective by utilizing advanced technologies like 3D scanning and non-destructive testing. These technologies allowed them to assess the building's condition more accurately (Remondino & El-Hakim, 2020; Binda, Saisi, & Tiraboschi, 2005).

3.1.2 Case Study 2: The adaptive reuse of an industrial building

When it was first built in the late 19th century, the structure served as a factory. It is currently being converted into a cultural hub, with an emphasis on maintaining its industrial history. The preservation team faced several difficulties because of the building's historical value and the requirement to allow for current operation (Listokin, Listokin, & Lahr, 2010).



Multidisciplinary Approach

A group of material scientists, architects, structural engineers, and conservationists worked on the adaptive reuse project. The building's historical integrity was preserved while structural engineers collaborated closely with architects and conservationists to adapt it for its new purpose. The building's original materials were analyzed by material scientists, who also developed restoration methods that worked. In order to guarantee that the preservation efforts honored the building's cultural relevance, the team also worked with community members and local historians (Fathy, 1986; Tyler *et al.*, 2009).

Outcomes

The project successfully preserved the building's industrial history while transforming it into a bustling cultural hub. The building's historical value was honored at every stage of the project thanks to the multidisciplinary approach, and the cooperation of several professions produced creative solutions that struck a compromise between the requirements of contemporary usage and the necessity for preservation. Additionally, the study showed how adaptive reuse might be a viable strategy for preserving cultural assets (Bani, Rocchi, & Fabbri, 2017).

3.1.3 Case Study 3: Seismic retrofitting of a historic school buildin

The school building was built in an area that is prone to earthquake activity in the early 20th century. To improve its seismic resistance and ensure its preservation, considerable structural alterations were necessary. The restoration team faced several hurdles because of the building's historical value and the necessity to guarantee the safety of its tenants (Nepal Government, 2016).

Multidisciplinary Approach

A team of structural engineers, architects, historians, and conservationists worked on the seismic retrofitting project. The retrofitting measures were devised by structural engineers,

and the historical aspects of the structure were protected by architects and conservationists. The retrofitting plan was informed by historians' insights into the building's original construction procedures. In order to ensure that the preservation efforts respected the building's cultural value while also meeting safety regulations, the team also worked with local authorities and community members (Matsumura, 2012; Murphy *et al.*, 2013).

Outcomes

The building's seismic resistance was effectively increased by the retrofitting process without sacrificing its historic charm. To strike a balance between safety and preservation, cooperation across several disciplines was essential. The team was able to more accurately assess the building's condition and create interventions that were both practical and considerate of the building's cultural significance thanks to the use of cutting-edge technologies like computer modeling and non-destructive testing (Binda *et al.*, 2005; Charola, 2000).

Discussion

Analysis of Case Studies

The case examples emphasize how crucial a multidisciplinary approach is to the protection of cultural resources. In every instance, the cooperation of material scientists, architects, structural engineers, conservationists, and historians produced restoration plans that were economical and considerate of the building's cultural value. The accomplishment of these projects shows that, in order to effectively tackle the multifaceted problems associated with historic building preservation, a multidisciplinary approach is necessary (Janssen *et al.*, 2014; ICOMOS, 1964).

The case studies further highlight the advantages of cutting-edge technologies, including computer modeling, non-destructive testing, and 3D scanning, in promoting interdisciplinary collaboration. These technologies gave the team precise and thorough information about the state of the



buildings, enabling them to plan interventions that were both minimally intrusive and effective (Remondino & El-Hakim, 2020).

Benefits of a Multidisciplinary Approach

A multidisciplinary approach's main advantage is that it makes it possible to comprehend problems and possible solutions in cultural asset preservation on a larger scale. This method produces more creative and long-lasting preservation techniques by combining several viewpoints and areas of expertise. Additionally, it encourages improved stakeholder collaboration and communication, which leads to better decision-making and a greater appreciation of the building's cultural significance (Feilden, 2003; Tyler *et al.*, 2009). An additional advantage of a multidisciplinary approach is that it facilitates a more comprehensive preservation strategy that takes into account the structural and cultural aspects of a building. This is especially significant when it comes to the preservation of cultural heritage, as the delicate balance between historical authenticity and structural integrity often calls for careful consideration (ICOMOS, 1964).

Challenges of a Multidisciplinary Approach

A multidisciplinary approach has obvious advantages, but there are drawbacks as well. Coordination of the activities of several disciplines, each with its own objectives and methods, is one of the major obstacles. Collaboration and efficient communication are essential to ensuring that all parties involved have the same objectives and strategies. Furthermore, because a multidisciplinary approach incorporates the integration of different views and areas of knowledge, it may be more expensive and time-consuming (Jokilehto, 1999; Frey, 2011). Potential conflicts across disciplines present another difficulty. For instance, conservationists may place a higher priority on preserving a building's historical and aesthetic qualities than structural engineers do on the stability and safety of the structure. It can be challenging to

strike a solution that appeases all parties involved when balancing these requirements (Ashurst & Dimes, 1998).

Impact on Future Practice

The results of the case studies indicate that the protection of cultural assets is going to require a multidisciplinary approach more and more. Structural engineering will need to be integrated with other disciplines as the subject develops in order to create preservation plans that respect historic structures' structural and cultural characteristics (Tyler *et al.*, 2009; ICOMOS, 1964).

The application of cutting-edge technology, such Geographic Information Systems (GIS) and Building Information Modeling (BIM), will also be crucial in promoting interdisciplinary cooperation and raising the efficiency of preservation initiatives. According to Murphy *et al.* (2013) and Remondino & El-Hakim (2020), these technologies make it possible to create intricate 3D models of historic structures that may be used to plan preservation interventions, evaluate the buildings' state, and track the advancement of such efforts.

4.0 Future Directions and Recommendations

4.1 Advancements in Technology and Methodology

Technological and methodological developments will influence the future of cultural heritage protection. Collaboration across several disciplines will be greatly aided by tools like Geographic Information Systems (GIS), Building Information Modeling (BIM), and improved materials. These technological advancements will allow for more precise evaluations of historic structures and more successful preservation plans (Murphy *et al.*, 2013; Remondino & El-Hakim, 2020).

Using BIM, for instance, makes it possible to create intricate 3D models of historic structures that may be used to plan preservation interventions, evaluate the buildings' state, and track the advancement of preservation



activities. However, geographic information systems (GIS) make it possible to analyze spatial data on historic structures, including their orientation, location, and surrounding circumstances (Dimitriou, Stathopoulou, & Georgopoulos, 2018).

Another significant breakthrough is the creation of novel preservation materials and methods. For instance, historic structures may be preserved in a way that is both efficient and considerate of its cultural importance through the employment of non-invasive reinforcing techniques and environmentally friendly consolidants (Collepari, 2009).

4.2 The Role of Structural Engineering in Future Preservation Efforts

Preservation of cultural heritage will always depend heavily on structural engineering. Nonetheless, in order to create comprehensive preservation methods, it will play a more collaborative role with other disciplines. To ensure that their interventions are respectful of the building's cultural significance, structural engineers will need to work closely with conservationists, architects, historians, and material scientists and receive training in the principles of cultural heritage preservation (Feilden, 2003; Tyler *et al.*, 2009).

In order to evaluate the state of historic buildings and create interventions that are both efficient and minimally invasive, structural engineers working in cultural heritage preservation will also need to leverage cutting-edge technologies like computer modeling, non-destructive testing, and 3D scanning (Binda *et al.*, 2005; Remondino & El-Hakim, 2020).

4.3 Recommendations for Improving Multidisciplinary Collaboration

It is crucial to create a culture of mutual respect and understanding throughout disciplines and to build clear communication channels in order to promote interdisciplinary collaboration in cultural heritage preservation. Professional associations and educational establishments

have to provide training courses that stress the value of teamwork and provide practitioners the chance to acquire the abilities required to function well in interdisciplinary teams (ICOMOS, 2019).

Establishing standards and best practices for interdisciplinary cooperation in cultural heritage protection is another crucial idea. According to Tyler *et al.* (2009), these policies should specify the duties and responsibilities of various disciplines as well as the processes for making decisions and resolving disputes.

Involving the neighborhood and other interested parties in the preservation process is crucial, to sum up. In order to make sure that the preservation efforts are in line with the cultural and social values of the community, this entails interacting with local authorities, residents, and other stakeholders (Frey, 2011).

5.0 Conclusion

A multidisciplinary approach is necessary for the complicated and multidimensional task of preserving culturally significant structures. Although structural engineering is essential to guaranteeing the durability and safety of these structures, it cannot function alone. Preservation solutions that are both successful and considerate of the building's cultural importance may be created by combining the knowledge of structural engineers, conservationists, architects, historians, and material scientists (Feilden, 2003; Tyler *et al.*, 2009).

The case examples included in this paper show the advantages and difficulties of a multidisciplinary approach and emphasize the value of teamwork in the protection of cultural resources. The effective preservation of historic structures will depend on the structural engineering field's continued evolution and its interaction with other disciplines (Jokilehto, 1999; ICOMOS, 1964).

Future developments in technology and methods, together with enhanced interdisciplinary cooperation, will be critical in determining how cultural heritage preservation



is shaped. Conservationists may guarantee that historic structures are conserved for future generations as well as for our own by adopting these innovations and promoting a culture of education and lifelong learning (Murphy *et al.*, 2013; Remondino & El-Hakim, 2020).

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Compliance with Ethical Standards Declaration

Ethical Approval

Not Applicable

Competing interests

The authors declare that they have no known competing financial interests

Funding

The author declared no source of external funding

Availability of data and materials

Data would be made available on request.

