An Examination of the Conservation Philosophy in Korea’s Wooden Cultural Heritage Using HBIM – A Case Study of Geungnakbojeon Hall of Muwisa Temple, Gangjin

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Abstract

This study explores the evolution of repair practices and conservation philosophy in Korean wooden heritage architecture through a detailed analysis of HBIM (Historic Building Information Modeling) data from Geungnakbojeon Hall at Muwisa Temple. As one of Korea’s representative timber structures, the hall underwent major repairs in 1956 and 1983, each reflecting differing approaches to material treatment and heritage values. HBIM was utilized to visualize replaced, restored, and reused components based on archival records and field investigations. This process revealed not only the technical aspects of past repairs but also the dissonance between conservation philosophy and practical decision-making.

A key finding is the contrast in conservation attitudes: while the 1956 repairs were conducted in the name of ‘original form restoration’, they involved modifications to some components, the 1983 intervention emphasized reinforcement and partial reuse using synthetic materials. However, decisions made on-site were often driven by practicality rather than preservation principles. These inconsistencies highlight the need for value-based frameworks in future repairs.

HBIM functions as a platform for comparative analysis, transparent decision-making, and simulation of multiple conservation scenarios. By integrating physical and historical data, it enables heritage professionals to assess the implications of repair choices before implementation. This approach helps ensure not only the efficiency of repair work but also the authenticity of traditional architecture. This study concludes that a systematic and reflective application of HBIM can play a central role in ensuring the sustainability and philosophical coherence of conservation efforts.

1. Introduction

Wooden architectural heritage in Korea has been preserved through continuous repair and restoration over centuries, shaped by diverse environmental and sociocultural factors. However, systematic documentation and management of such repair activities only began after the country’s liberation in 1956. Reports from this period are considered valuable historical records, reflecting the technological limitations and evolving conservation philosophies of the time. A representative first case of state-led restoration is the dismantling and repair work conducted on Geungnakbojeon Hall of Muwisa Temple, Gangjin during that year (Korea Heritage Service 2010).

In the 1980s, the introduction of synthetic resins and other modern materials enabled the reuse of wooden components (Kim, 1980), which had traditionally been replaced entirely. While these innovations allowed for broader reuse, they also altered the appearance and structural configurations of the materials. This shift became a turning point that brought to light a fundamental conflict in conservation philosophy—between strict historical fidelity on the one hand, and efficiency and practical maintenance in the repair process on the other.

More recently, efforts have been made to manage the repair and conservation of wooden heritage more systematically and scientifically. Among these, the adoption of Historic Building Information Modeling (HBIM) stands out as a leading approach. HBIM enables the creation of digital representations of traditional structures for the purposes of preservation, management, and planning. In Korea, HBIM implementation has been officially pursued by the National Heritage Administration since 2022 (Korea Heritage Service, 2022).

This study analyzes HBIM data containing past repair records of Geungnakbojeon Hall to propose a new methodology for interpreting and utilizing historical repair information. Furthermore, it explores the evolution of conservation practices in Korea and identifies key considerations for future repair strategies based on philosophical transitions evident in past interventions.

2. Materials and Methods

The subject of this study, Geungnakbojeon Hall at Muwisa Temple in Gangjin, is a representative example of wooden architectural heritage from the Joseon Dynasty, constructed in 1430 and currently designated as a national treasure by the Korean government. Major repair interventions were carried out in 1956 and 1983, each reflecting the conservation philosophy and technological developments of their respective periods.

This study utilized outcomes from the repair history database (DB) and the HBIM (Historic Building Information Modeling) project conducted by the Korea Foundation for Traditional Architecture and Technology. The HBIM dataset incorporates historical repair records of Geungnakbojeon Hall, which were visualized using the software Archicad. This visualization enabled the identification of the location and condition of replaced or reinforced components. To assess how these components were described in past records, a comparative review was conducted using corresponding repair reports and documentation.

In addition, field investigations were carried out to verify the completeness of the records and to validate the accuracy of the

HBIM dataset. Through this digitally grounded analytical approach, the study aims to overcome limitations of traditional repair documentation and to derive key discussion points for establishing consistent and sustainable conservation strategies in future interventions.

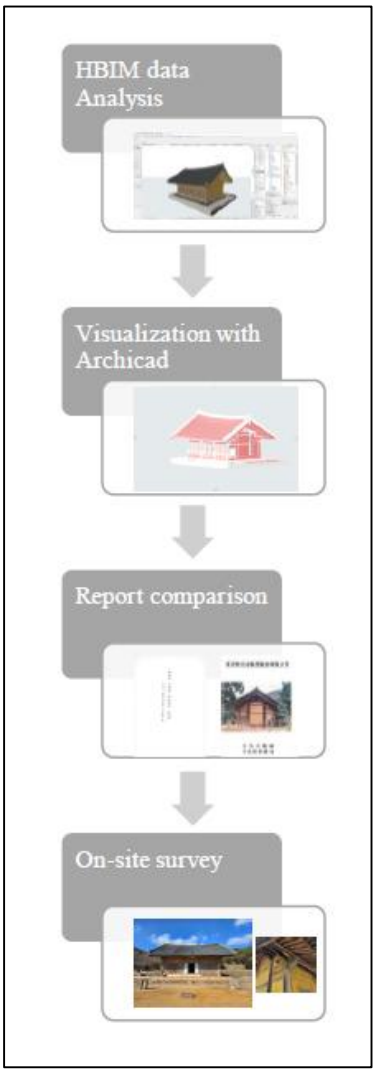


Figure 1. Research process.

3. Analysis

Figure 2. Highlighted components from the 1956 repair.

Figure 3. Highlighted components from the 1983 repair.

As a result of the visualization, components repaired in 1956 were marked in orange, with key highlighted elements shown in sky blue (1956 column of Table 1). For the 1983 repairs, the overall components were represented in light purple, while emphasized elements were shown in pink. (1983 column of Table 1) According to the 1983 repair report, the dismantling and restoration primarily focused on components above the bracket sets, indicating that the repair work largely centered on the roof structure. However, reinforcement of certain column members was also observed, although no components were explicitly recorded as having been "restored." The report does mention modifications to certain shapes, but these changes pertained to internal structural reinforcements, such as within the roof framing, that were not readily visible from the exterior.

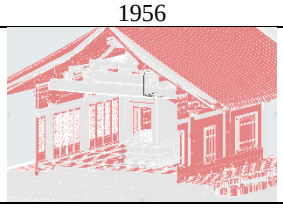
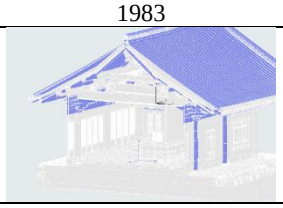
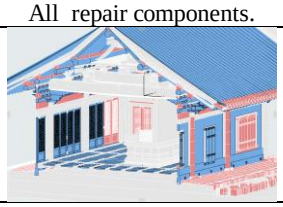
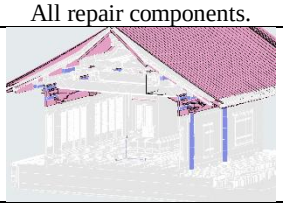
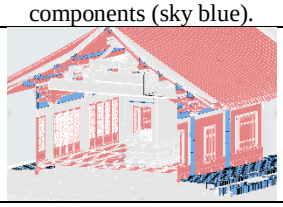
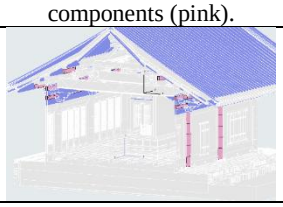
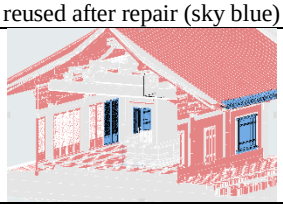
1956	1983
	
All repair components.	All repair components.
	
Highlighted replacement components (sky blue).	Highlighted replacement components (pink).
	
Highlighted components reused after repair (sky blue)	Highlighted components reused after repair (pink)
	-
Highlighted restored to their original form components (sky blue)	There are no restored components

Table 1. Visualization of repair components.

In anticipation of future repair interventions, attention was given to components that had undergone repairs in both periods. These commonly repaired elements were visualized separately for comparative analysis. In particular, while it was evident that some roof tiles were replaced during dismantling, the HBIM dataset and accompanying reports did not specify which tiles had been substituted. Aside from the structural elements located above the rafters(*Seokkarae*), the interior wooden framework could be examined in detail through the visualized drawings (Figure 5).

Figure 4. Repeatedly repaired components.

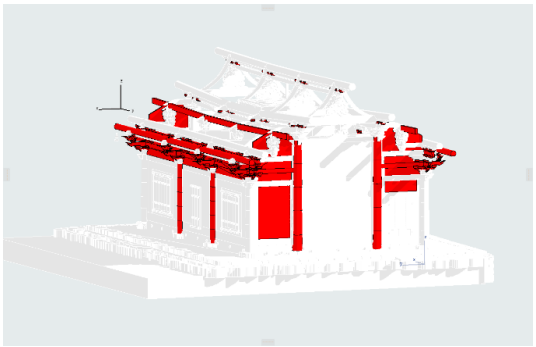


Figure 5. Repeatedly repaired components (interior).

The lateral columns and rear columns also showed repeated reinforcement and repair, indicating the possibility of structural issues, such as ground subsidence, in those areas. In addition, other wooden components were also observed to be in a condition requiring ongoing maintenance and repair.

Figure 6. Bracket sets fully replaced in 1956.

Figure 7. Bracket sets partially reinforced in 1983.

The bracket set components underwent structural interventions in both repair periods, and a clear difference in repair methodology was observed. In the 1956 repair, most of the bracket sets were fully replaced (Figure 6), whereas the 1983 intervention marked the beginning of a shift toward reusing original components through reinforcement with epoxy resin (Figure 7).

This analysis indicates that the bracket sets have been subject to recurrent structural issues, likely due to the load-bearing stress of the roof. In particular, components reinforced with epoxy require close monitoring in future repairs. Detailed documentation of their current condition, along with long-term tracking of the physical properties of the reinforcing materials and their impact on structural integrity, will be essential.

4. Discussion

Through the analysis of HBIM data, it was possible to identify the specific repair methods and procedures applied to individual components. This new analytical approach also allowed for the interpretation of the underlying conservation philosophies emphasized in each intervention. Based on this evaluation, it became evident that neither the 1956 nor the 1983 repairs incorporated a systematic consideration of conservation philosophy. In particular, the 1956 intervention, as one of the earliest repair cases, was carried out under the label of “original form restoration,” yet in practice, it permitted relatively liberal alterations in form. This approach appears to have been influenced more by the judgment of on-site practitioners and considerations of management efficiency than by any clear academic or historical rationale. Such characteristics are most clearly exemplified in the installation of the ridge-end tiles (*Maksae giwa*).

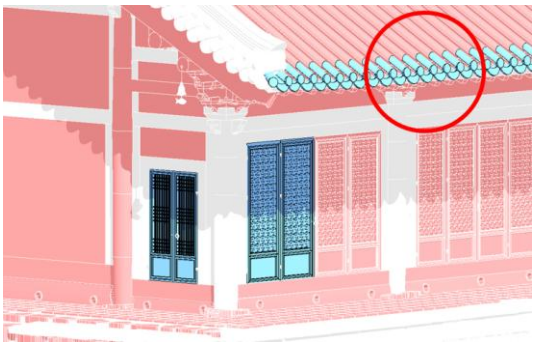


Figure 8. Restored ridge-end tiles *(Maksae giwa)* from the 1956 repair.

The table below presents the documentation related to the ridge-end tiles as recorded in the repair report.

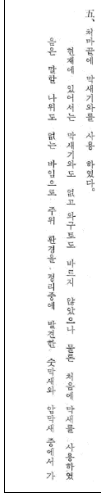
Report record	Description
	"Although neither ridge-end tiles *(Maksae giwa)* nor lime plaster *(Waguto)* are present today, it goes without saying that ridge-end tiles were originally used. Accordingly, among the male and female ridge tiles discovered during site cleaning, the most intact specimens were selected and used as models for newly fired replacements."

Table 2. References to the restoration of ridge-end tiles in the 1956 repair report.

The phrase “it goes without saying”, as recorded in the 1956 repair report, presumes the legitimacy of the restoration as self-evident. However, this also implies that the intervention may have been carried out without critical verification. While the ridge-end tiles discovered during site maintenance may have previously been used, there is insufficient evidence to confirm their original placement at the current location. The possibility of later alterations cannot be excluded. Therefore, this intervention may be more accurately interpreted not as a restoration of the original form, but rather as a repair motivated by managerial convenience.

By contrast, the 1983 intervention reflects a different conservation approach. In Korea, techniques for reinforcing and reusing wooden components using synthetic resins began to emerge in the late 1970s (Kim, 1980). The 1983 repair includes instances in which such materials were applied, indicating a shift in conservation philosophy from an emphasis on efficiency and managerial convenience in the repair process to a more component-specific methodology. While the repair report documents certain modifications in form, there were no records of overt alterations to visible exterior elements; most interventions focused on structural reinforcement in areas not readily observable.

Nevertheless, a philosophical conflict in the conservation approach became evident during the 1983 repair—most notably in the case of the trimming of the *Podongjaju* (a child-pillar in bracket-set form) components. During the review of HBIM data, several components were found to have been irregularly or incompletely cut, yet none of these modifications were recorded in the official documentation (Figure 9). This trimming suggests that, despite the reported emphasis on a component-specific repair methodology, the primary conservation approach in practice was driven more by procedural efficiency than by a strict adherence to individualized treatment of architectural elements.

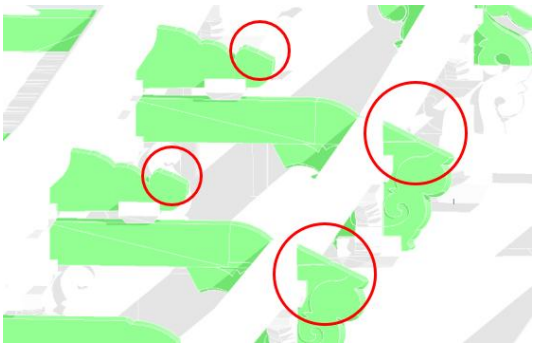


Figure 9. Cut ends of *Podongjaju* components in the HBIM dat

a.

These components were visibly present between the rafters*(Seokkarae)* in photographs taken during the 1956 repair (Figure 10), and their presence in the same location is also confirmed in a 1932 photograph (Figure 11). However, the 1983 repair report contains no mention of their removal or modification. Nevertheless, both construction photographs from that period (Figure 12) and recent field investigations (Figure 13) confirm that these components are currently cut in the same manner as represented in the HBIM dataset. Notably, the angle of the cuts matches the pitch of the rafters, suggesting that the ends of the components were uniformly trimmed during the roofing process to avoid interference with the rafter installation.

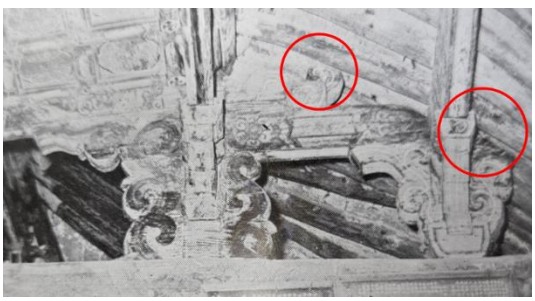


Figure 10. 1956 report photo of the *Podongjaju* location.

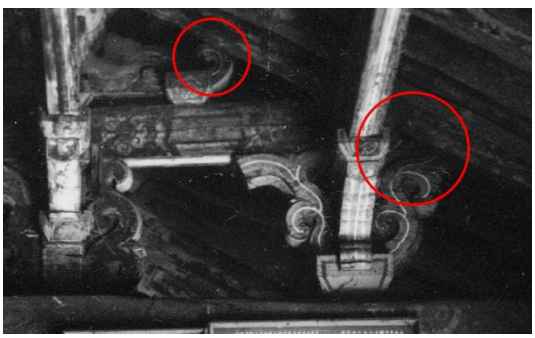


Figure 11. Archival photograph from 1932 confirming the same location.

Figure 12. 1983 report photo of the same location.

Figure 13. Current photo of the same location.

Moreover, the fact that identical cuts were made even in areas where no direct interference with the rafters (Figure 14) would have occurred strongly suggests that this was a preemptive measure taken for construction convenience.

Figure 14. Current photograph of a different location.

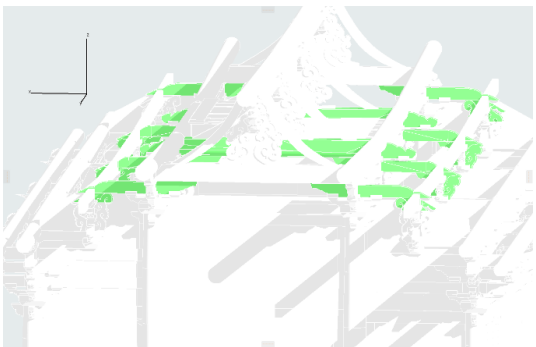


Figure 15. All *Podongjaju* components identified as trimmed in the HBIM data.

This case clearly demonstrates the dissonance between the conservation philosophy that emphasizes the reuse of original materials—as seen in the 1983 repair—and the pragmatic execution of repairs that prioritize efficiency and on-site workability. In particular, the trimming of the *Podongjaju* components to accommodate the installation of *Seokkarae* exemplifies this dissonance. The *Seokkarae* are regarded as a symbolic element in traditional Korean wooden architecture, as they typically preserve the natural curvature of the timber, thereby embodying the core values of traditional conservation philosophy.

Photographs taken prior to 1950 (Figure 16) show that the *Seokkarae* were installed with irregular spacing and varied shapes, reflecting a reliance on the unaltered form of each timber. In contrast, the current condition (Figure 17) of the rafters, as confirmed by both field surveys and the HBIM dataset (Figure 18), reveals uniform spacing and standardized shapes, suggesting that this change was introduced during the repair process.

Figure 16. Archival photograph taken before 1950.

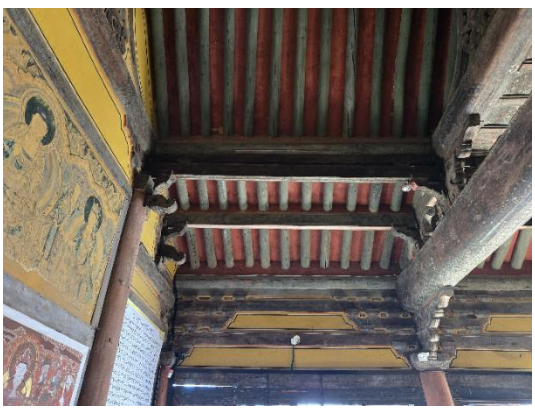


Figure 17. Current photograph.

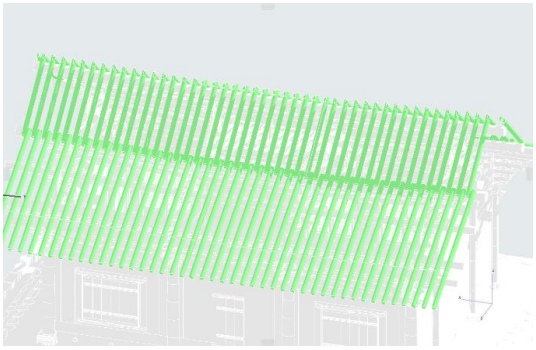


Figure 18. *Seokkarae* as visualized in the HBIM model

This trend is not unique to Geungnakbojeon Hall at Muwisa Temple; similar patterns are observed in many contemporary repair projects, where naturally curved components are often replaced with straight, easily processed materials. While the reuse of original components remains a stated principle in the repair of wooden heritage structures today, its application is frequently inconsistent, selectively implemented depending on site-specific conditions.

This underscores the need for a systematic approach to bridge the gap between the philosophical framework of conservation and its practical execution, ensuring greater consistency and integrity in heritage preservation practices.

5. Conclusion

This study analyzed the repair cases of Geungnakbojeon Hall at Muwisa Temple, conducted in 1956 and 1983, using HBIM data to investigate changes in repair practices over time and to identify key considerations for future interventions. During the analysis, certain damaged components—not documented in official repair records—were discovered. This finding demonstrates that HBIM analysis prior to construction can serve not only as a means of identifying physical targets for repair but also as a catalyst for deeper discussions on conservation philosophy before intervention begins.

In particular, the structural modifications observed in the *Podongjaju* and rafters *Seokkarae* should not be viewed merely as technical issues. Rather, they reflect fundamental value judgments directly tied to the authenticity of heritage conservation. Traditionally, rafters were crafted to respect the natural form of timber, allowing for harmonious structural integration. In modern repairs, however, the use of standardized linear components has led to conflicts with bracket bases, prompting the angled cutting of certain members to accommodate rafter installation. Although not clearly documented, such decisions were likely made in response to site-specific technical constraints.

In future repairs, a critical choice must be made: whether to preserve previous modifications as part of the building’s repair history, or to attempt a restoration of the original form. If the latter is chosen, strategies to resolve interference between rafters and bracket components must also be discussed—whether through adjusting spacing using straight members or by sourcing and shaping curved timbers in accordance with traditional practices. These decisions are not simply technical in nature; they involve philosophical interpretations of consistency and identity in cultural heritage conservation.

HBIM provides a robust platform for such deliberation by enabling structural review of past repairs and allowing for quantitative analysis of the placement, machining, and deterioration of existing components. This enhances both transparency and rationality in pre-repair decision-making.

In conclusion, this study demonstrates that HBIM can play a substantive role in guiding repair strategies for traditional wooden heritage—not merely as a record-keeping tool, but as an integrated decision-support system. However, current HBIM practices in Korea remain largely focused on documenting repair histories. Moving forward, HBIM must evolve to support the simulation of alternative repair scenarios and facilitate value-based planning, thereby deepening discussions on conservation philosophy even before physical work begins. In doing so, HBIM will become a key instrument for ensuring the consistency and sustainability of traditional timber architecture conservation.

Acknowledgements

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