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EVALUATING KELARAI ASLI IN HERITAGE CONSERVATION AS A CULTURAL ASSET OR CONSTRAINT

**Wan Faida Wan Mohd Azmi¹, Syed Abdul Haris Syed Mustapa², Lilawati
Ab Wahab³, Mohd Nurfaizal Baharuddin⁴, Muhammad Suhaimi Musa⁵**

*Department of Built Environment Studies and Technology,
College of Built Environment,
UNIVERSITI TEKNOLOGI MARA, PERAK BRANCH, MALAYSIA*

Abstract

The objective of this study is to examine the relationship between heritage conservation and restoration constraints. The heritage building in question is the Ihsaniah Iskandariah Mosque in Perak that is earmarked for repair. The exterior walls of the mosque are adorned with Kelarai Asli woven bamboo weaves panels that have deteriorated over time. Four laboratory experiments are conducted to determine their existing conditions. The tensile test results reveal moderate strength (2.1–2.4 kN), indicating structural viability. Adhesion tests (ASTM D4541) discover 100% failure in adhesion of the coating, while water absorption tests (ASTM D570) expose high rates of saturation (55%–65%), raising concerns over moisture resistance. SEM analysis however, confirms a dense fiber structure, giving it sustained mechanical durability. This study concludes that Kelarai Asli is indeed a cultural asset worthy of preservation based on the fortified nature of the bamboo weaves and overall structural integrity and durability. The problematic paint work and coating, adhesion and moisture retention issues could be addressed using modern treatment solutions and technical expertise. Such a prominent heritage site should be preserved that show the creativity and craftsmanship of an era before the advent of modern technology. This study provides some useful guidelines, discussion and rationale for future investigations concerning preservation of vernacular elements in Malaysian heritage sites and their restoration practices.

Keywords: Kelarai Asli, Heritage Conservation, Mosque, Bamboo Panel

¹ Corresponding author. Email: wfaida@uitm.edu.my

INTRODUCTION

Heritage buildings, acknowledged as vital assets for local development, particularly in the realm of tourism and cultural enrichment, require conservation efforts aligned with urban regeneration initiatives (Nik Hashim et al., 2024). The incorporation of traditional skills into heritage conservation has been a growing topic of research interest. In this regard, *kelarai asli*, traditional Malay bamboo weaving art, provides a unique bridge between vernacular design, local identity and cultural sustainability. Cultural representations such as traditional weaving methods are much more than ornamental, they have symbolic meanings that are tied to community identity

Kelarai is defined as checkered weave patterns, a craft work that has been passed down from generation to generation in Malay culture and people in Southeast Asia. *Kelarai Asli* in this study is well known for its complex geometric motifs in bamboo weaving. Mat weaves are used in traditional buildings not only for its practical function but also reflects local skills as well as cultural identity. On the one hand, *kelarai* supports intangible heritage, strengthening local identity and community participation (Ahmad, 2006). On the other hand, its practical limitations in terms of vulnerability to environmental degradation, lack of skilled craftsmen, and high maintenance costs pose major challenges to long-term conservation initiatives (Ismail, 2018).

A prominent example of its usage is found in the Masjid Ihsaniah Iskandariah in Perak, Malaysia, where the walls are decorated with colourful *kelarai* designs. Applying this to Masjid Ihsaniah Iskandariah's conservation and usage of *kelarai*, one could claim that the materials and design choices contribute to the preservation of its "sense of place". If *kelarai* is removed or replaced with alternative modern materials, the mosque risks becoming placeless or timeless. Despite being culturally important and more cost-effective, *kelarai* panels might require more frequent repairs and maintenance, particularly in termite-prone and humid climates such as Malaysia. Cost-effectiveness balanced with long performance on a project such as rehabilitating the Old Mosque Kuala Dal is absolutely paramount. (Syed Abdul Haris Syed Mustapa et al., 2024)

Although *kelarai* is savored for its environmental and cultural value, it is also susceptible to environmental elements like unpredictable rain and temperature fluctuations, which also cause the material to degrade over time (Wan Faida Wan Mohd Azmi et al., 2025). Since parts of the Masjid Ihsaniah Iskandarariah were found to be defective in 2008 some restoration efforts have been made, yet more deterioration persisted. Presently, the mosque is only used for occasional religious events, leading to reduced community involvement. Its underutilization limits its potential as a heritage and educational hub, and without consistent programming, the site risks further disconnection from the community. Revitalizing its use would stand to recapture its relevance and importance to

culture and tradition. Hence, this research challenge lies in the dualistic nature of Kelarai Asli in heritage conservation, both as a cultural asset appeal as well as a form of restoration constraint.

KELARAI ASLI DEFECTS AND CONSERVATION

Challenges to building conservation projects pose significant risk and uncertainty, especially if the building has undergone several interventions such as building extensions or physical alterations (Harun, 2020). According to Nik Hashim et al. (2024), conservation involves physical actions directed at safeguarding the fabric and materials of heritage buildings. It includes prevention of degradation and extending the life of the buildings in terms of maintaining their original structural, architectural and aesthetic values. Preserving original materials or structures is one of the main goals of the conservation. Thus, time-honored materials such as Kelarai asli that were once widely used in traditional Malay houses are worthy of preservation.

However, Kelarai asli knowledge and practice are on the decline, as are the numbers of traditional Malay houses in Malaysian culture today. Rural-urban migration, modernisation, and lifestyle changes have led to the progressive abandonment and disappearance of these traditional dwellings. This loss has resulted in the deterioration of traditional construction expertise and material technology, such as kelarai, which was historically utilised as a distinguishing feature in aristocratic and royal buildings (Taufik Shahidi et al., 2022; Yunus et al., 2010). It is essential to properly manage and maintain these heritage buildings; if not done so, we risk losing the historic townscape of the country one after another (Abdul Latip et al., 2018).

Zolkafli et al. (2019) have analyzed thirty-six (36) heritage buildings in peninsular Malaysia including religious buildings. They added that among the value enhancement and prevention of decay of heritage good maintenance work is the most important. Indeed, prevention is of course better than cure. Long periods of exposure to sunlight, as well as a lack of continuous restoration attempts, have caused substantial deterioration in many of the remaining panels in this Perak Mosque that are architectural specimens featuring Kelarai asli. As has been found, paint deterioration and physical degradation are common, especially in older buildings with infrequent maintenance (Taufik Shahidi et al., 2022). Weather has a considerable impact on such flaws. High precipitation, rainfall, and sun radiation in Malaysia's tropical environment encourage weathering activities, especially when no protection such as waterproofing or UV protection is given (Syed Mustapa et al., 2024; Nor Atiah et al., 2011). The problem is also made worse where more than a single coat of paint has been used without stripping away the old coating (Ahzahar et al., 2012; Hashim et al., 2019). Choice of proper materials is important. Choosing materials that are unsuitable

for local climates can lead to durability issues and structural problems (Khalid et al., 2024). Therefore, it is crucial to understand the characteristics of Kelarai Asli before proceeding with conservation and maintenance methods. Failure in specifying suitable materials whether it is the original materials or substitution are the main design flaws (Khalid et al., 2024). The question here lies in whether native Kelarai is considered to be an important cultural asset and should continue to be integrated into contemporary conservation to preserve as symbolic artifacts. or is it a major constraint, due to its high maintenance cost and extent of deterioration effects.

MASJID IHSANIAH ISKANDARIAH

In essence, heritage mosques should all be preserved because they show the creativity and craftsmanship of the locals during an era before modern technology. A heritage masjid is one that has been passed down to the current generation and will continue to be transmitted down to the following generations (Abd Rahim et al., 2022). Hence, a heritage mosque like Masjid Ihsaniah Iskandariah is one example of a valuable building that is worth preserving in terms of cultural identity and that fosters community pride.

Masjid Ihsaniah Iskandariah is identified by the Department of National Heritage for conservation due to its unique architectural characteristics, deep cultural roots, and historical significance to the Malay-Muslim community in Perak. The history of this particular Mosque goes way back in 1936, as commissioned by Sultan Idris Murshidul'adzam Shah (Harun et al., 2008). This mosque is not only a religious structure but also a symbol of traditional Malay craftsmanship and royal patronage, making it an important representation of both tangible and intangible heritage. Although the mosque has not been used since 1976, it is still attracting the eager attention of both local and foreign visitors.

One of the defining features that has caught public attention is the mosque's distinctive usage of Kelarai asli that is a traditional bamboo weaving technique on its external walls. This decorative element is now rare and visually striking, reflecting local artisanal knowledge, vernacular building practices, and Malay aesthetic values. Such craftsmanship is increasingly endangered, and its preservation aligns with the department's mission to safeguard indigenous heritage expressions. Unfortunately, the current condition of its Kelarai asli (as shown in Figure 1.0) has drastically deteriorated.



Figure 1.0: Current condition of the Kelarai walls of Ihsaniah Iskandariah Mosque, Padang Rengas
(Source: Syed Mustapa et al., 2024)

The rehabilitation of the Ihsaniah Iskandariah Mosque is thus a unique opportunity in preserving a valuable cultural landmark while fostering economic growth and social cohesion. From an economic standpoint, rehabilitation can play a crucial role in boosting local tourism and entrepreneurship opportunities. According to Wan Faida Wan Mohd Azmi et al. (2024), by transforming the mosque into an educational and cultural center, the project has the potential to draw visitors and create opportunities for local businesses and entrepreneurs to explore and thrive.

METHODOLOGY

Masjid Ihsaniah Iskandariah is one of the many buildings chosen for conservation by the Department of Heritage. The mosque is selected for this case study based on the uniqueness of the design characteristics that relate to the origin, and traditional custom and culture of the Malay people. The mode adopted is a qualitative method that studies and evaluates the current conditions and generates results for implementation and guidelines for future studies.

This study adopts a laboratory-based approach to evaluate whether Kelarai asli which is a potential cultural asset is problematic for heritage conservation. Figure 2.0 shows the four different scientific tests that are conducted on selected kelarai asli panels to assess their physical, mechanical, and structural performances in accordance with standard testing procedures.

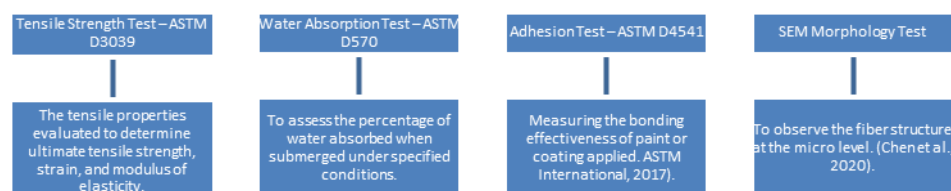


Figure 2.0: List of Scientific tests conducted on selected kelarai asli panels

The tests are conducted in a controlled environment, and each test involved two panel samples. Results are compared descriptively and interpreted against performance criteria typical for outdoor tropical applications. Admittedly there are some limitations in this study, namely only a small sample size of panels are collected and no long-term exposure trials are conducted. These constraints may limit the generalizability of the results. It is recommended that future studies should incorporate extensive field tests and including protective treatment evaluation.

DATA ANALYSIS

The data collected from each test are recorded and analyzed descriptively to compare the performance of the samples. The analysis evaluates optimal strength, moisture resistance, and surface adaptability.

Test 1: ASTM D3039 – Tensile Test

The tensile test, conducted in accordance with ASTM D3039, is designed to assess the tensile properties of materials, particularly their ability to resist axial loading until the point of failure. This test is essential in evaluating the mechanical performance of materials used in heritage conservation, especially those subject to environmental stressors. The material is tested under controlled load until failure to simulate its durability and structural reliability when used in architectural applications (ASTM International, 2017). For this study, natural kelarai asli panels are subjected to tensile loading to simulate real-life conditions where such materials would experience stress in structural applications. The results demonstrated notable tensile strength values, with Sample 1 recording a maximum load of 2.1 kN and Sample 2 recording 1.6 kN. These findings suggest that natural kelarai possesses considerable resistance to stretching forces before rupture.



Figure 3.0: Before and After ASTM D3039 Testing

Shown in Figure 3.0, before testing, the Kelarai asli strips appeared relatively undistorted and intact. After the tensile test, the specimens displayed visible elongation and tearing patterns along the fibers, confirming that axial tensile force had been applied. While the bamboo strips remained largely intact, some fraying at the ends and surface cracking are observed—consistent with expected tensile failure in natural materials. The fiber alignment remained clearly visible, illustrating the direction of stress application and showcasing the woven structure's capacity to distribute tensile forces.

Test 2: ASTM D570 – Standard Water Absorption Test

Results from the ASTM D570 water absorption test show that Kelarai asli, while culturally significant, is not naturally moisture-resistant. Effective conservation will require innovative material treatments or protective interventions to mitigate the effects of high water absorption, especially in tropical climates like Malaysia. Both samples have absorbed over 50% of their original weight, with Sample 2 reaching 62.5%. This indicates that Kelarai asli is highly hygroscopic, absorbing significant moisture when exposed to water. Such high water absorption suggests that the Kelarai is vulnerable to dimensional changes, warping, and degradation, especially when used in outdoor structures or environments with high humidity or rainfall. In heritage conservation, this highlights a major maintenance challenge, that is if untreated or uncoated, Kelarai panels may swell, soften, or decay due to prolonged exposure to moisture. This makes the material less suitable for structural or long-term external applications unless properly sealed or protected.

Table 1.0: Standard Water Absorption Test Results

Specimen		Weight Before (g)	Weight After (g)	Water Absorption Percentage (%)
Kelarai Asli	Sample 1	2.1	3.3	57.14
	Sample 2	1.6	2.6	62.5

Test 3: ASTM D4541 – Adhesion Test

The ASTM D4541 test is then employed to assess the adhesion strength of paint applied to the material surface. This test measures the pull-off strength required to detach a coating (e.g., paint) from its substrate (e.g., kelarai) shown in Figure 4.0. It helps to assess the durability and bonding quality of coatings under stress and is critical in predicting paint performance in real environmental conditions.



Figure 4.0: Adhesion Test Images

Table 2.0 displays the pull-off test results that show both Sample 1 and Sample 2 experienced 100% adhesive failure, indicating that the failure occurred entirely at the interface between the adhesive and the Kelarai Asli surface. No cohesive failure within the substrate or adhesive layer is detected. Sample 2 exhibits a significantly higher pull-off force (48.43 N) compared to Sample 1 (14.06 N), suggesting better adhesive strength. However, the consistent occurrence of adhesive failure across both samples highlights a potential weakness in the bonding interface, possibly due to inadequate surface preparation or incompatibility between the adhesive and the Kelarai Asli material.

Table 2.0: Adhesion Test Results

Speciment	Pull-Off Force (N)	Failure		
		Adhesion (%)	Cohesive (%)	Adhesive Failure (Glue)
Sample 1	14.06	100	0	0
Sample 2	48.43	100	0	0

Test 4: Scanning Electron Microscopy (SEM) – Morphology Analysis

Furthermore, a Scanning Electron Microscopy (SEM) test is performed to analyze the microstructural properties of the material. The SEM images shown in Figure 5.0 reveals a **compact and continuous fiber network**, contributing to the overall mechanical strength and surface cohesion of the material. The presence of well-distributed microfibrils and minimal voids within the structure have enhanced both its tensile performance and durability. These microstructural characteristics further support the material's effectiveness in conservation applications, where strength and endurance are critical over time. Additionally, the detailed morphology analysis confirms the material's natural composition and texture, which are vital in preserving the authenticity of cultural heritage components.

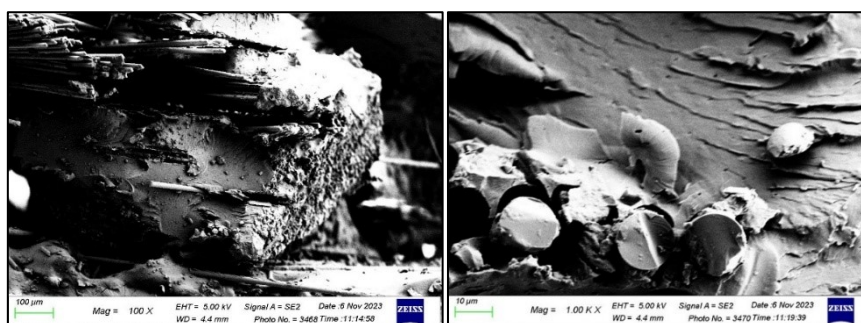


Figure 5.0: Scanning Electron Microscopy (SEM) Test Results

DISCUSSION

The results obtained from the various tests on Kelarai Asli provide insightful implications for its application in heritage conservation. These findings not only reflect the material's mechanical and physical properties but also emphasize its suitability and limitations when integrated into conservation practices.

The findings indicate that Kelarai Asli possesses significant structural integrity and is a promising candidate for use in heritage restoration projects where strength and durability are critical. Its ability to withstand considerable mechanical stress suggests that it can be efficiently applied in structural components that must endure environmental loads or other external factors commonly affecting cultural monuments. Its strength ensures that it can maintain its functional integrity over time, provided it is properly preserved. The fibrous texture of the kelarai, combined with the traditional weaving technique, contributes to a mechanically robust material capable of withstanding considerable stress.

In terms of water absorption, the high capacity of Kelarai Asli ranging from 40% to 80% of its weight reveals its susceptibility to moisture. While this

trait can be advantageous for materials used in environments where moisture retention is desirable, it can pose a risk in areas subjected to high humidity or exposure to direct water contact.

With regards Paint Adhesion Kelarai Asli passes the test of maintaining a robust bond with surface coatings, suggesting that it is compatible with modern restoration practices. Despite a minor failure rate (10%), this result confirms the material's utility for aesthetic and protective finishes in heritage conservation. The adhesion strength is especially important for retaining the visual appeal and protecting the material from environmental damage, such as weathering or UV.

Lastly, the SEM analysis reveals a highly compact and fibrous internal structure, which contributes to the material's overall strength and durability. This structural feature is crucial for ensuring the long-term stability of Kelarai Asli, particularly when exposed to environmental stresses or physical wear. The dense arrangement of fibers within the material not only contributes to its mechanical performance but also adds to its resistance to cracking or structural degradation over time. Furthermore, the SEM findings confirm the authenticity of traditional craftsmanship, as the material's internal structure reflects the practices and techniques used in its original creation, contributing to its cultural value.

The results from this study provide a comprehensive understanding of Kelarai Asli's potential and limitations within heritage conservation. The mechanical reliability demonstrated by the high tensile strength affirms that Kelarai Asli can be repurposed for structural restoration projects, particularly where durability is required. However, its water absorption properties necessitate careful handling and treatment, especially for projects exposed to environmental conditions that may lead to moisture accumulation. The material's good paint adhesion further enhances its suitability for conservation works, as it supports the application of protective coatings without significantly affecting the material's integrity.

Ultimately, the SEM findings offer valuable insight into the material's structure, underscoring the authenticity and quality of traditional materials used in heritage sites. This combination of strength, moisture sensitivity, adhesion properties, and structural integrity positions Kelarai Asli as a material that balances both functional and cultural significance, making it an essential element in the preservation of Malaysia's heritage.

CONCLUSION

This study underscores the importance of preserving Kelarai Asli as a cultural asset. Beyond its physical performance, it represents traditional craftsmanship, indigenous knowledge, and aesthetic values. It would be a major loss to the country if Kelarai Asli is not preserved. Scientifically, based on evaluating its properties, Kelarai Asli can be sustainably integrated into future heritage

restoration efforts. The presence of fibers and fibres in natural kelarai provides exceptional density and contributes significantly to the overall strength of the material and gives the kelarai a strong and durable structure.

Additionally, Kelarai Asli contributes to both material conservation science and the promotion of cultural identity in architectural heritage. However, a few suggestions or methods of maintenance is in need in order to preserve this traditionally structures. One of the suggestions is the need for better surface preparation of the Kelarai Asli weaving. Methods such as cleaning, sanding, or priming before painting may prolong the conservation efforts. Additionally, results showed 100% adhesive failure for both samples however, the strength of adhesion varied significantly, suggesting that surface preparation and bonding methods are critical for successful conservation work. Future conservation techniques may focus on improving surface treatment and testing different adhesives to achieve stronger and more consistent bonding. Additionally, the potential for swelling, mold growth, or degradation for Kelarai Asli surfaces can be resolved with application of water-resistant coatings or the integration of protective membranes to preserve the material's integrity in outdoor or humid environments especially in Malaysia.

This study acknowledges that future research should focus on conducting comparative testing between untreated and treated Kelarai materials to gauge the effectiveness of various conservation treatments, such as waterproof coatings or anti-fungal applications, in enhancing durability and longevity. Additionally, researchers are encouraged to explore alternative or substitute materials that replicate its visual and cultural aesthetics but offer improved resistance to environmental factors, especially for use in outdoor or high-moisture settings. It is also recommended that future studies investigate user and community perceptions of restored Kelarai weave elements to assess public acceptance, cultural relevance, and the social value of conservation efforts. Understanding community perspectives can guide more inclusive and meaningful heritage preservation strategies.

As claimed in Zolkafli et al., (2019), in order to protect these heritage buildings, maintenance works need to be properly and regularly carried out without affecting their original value. In conclusion, this paper supports the notion that Kelarai Asli antiquity holds significant cultural value and can enrich heritage conservation efforts when approached thoughtfully. However, unresolved tensions between symbolism and practicality imply that its role and contribution must be carefully evaluated to ensure that it contributes to meaningful cultural preservation rather than superficial restoration.

In conclusion, this study contributes to the discourse on vernacular conservation by integrating scientific evaluation of Kelarai Asli's physical

performance with its cultural significance, offering a holistic framework for material-based heritage preservation in Malaysia.

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