

Integration of Local Building Materials to Preserve the Architectural Identity in Siwa Oasis

Prof. Nader Gharib

Professor Faculty of Engineering and Technology at the Arab Academy for Science,
Technology and Maritime Transport

nader.gharib@aast.edu

Dr. Mo'men Abdelqader

Lecturer Aboukir high institute, Alexandria, Egypt

, momen2468@Alexu.edu.eg

Abstract

This paper addresses the architectural distortion in Siwa Oasis caused by tourist lodges using building materials and design elements inconsistent with the oasis's authentic character. The research focuses on documenting local building materials, particularly Karshef (salt-clay brick), and developing environmentally sustainable local materials to preserve the region's unique architectural identity. Through historical documentation, field testing, and stakeholder consultation, the study examines local experiences in traditional, transitional, and contemporary building approaches. The research proposes strategies for integrating modern techniques with local materials, including rammed earth technology, salt-based construction, and polymer-reinforced clay. The findings suggest that integrating local building materials is essential for preserving Siwa's architectural identity, with compacted soil technology offering a sustainable solution that respects the oasis's authentic character. The development of eco-lodges requires precise standards for locally sourced materials enhanced by modern technologies, making Siwa a model for sustainable tourism development that balances preservation with innovation.

Keywords:

Architectural identity, Local building materials, Karshef, Sustainable tourism development, Siwa Oasis

المخلص:

تمثل مواد البناء المحلية المستدامة عنصراً محورياً في تشكيل الطابع المعماري للنزل السياحية، حيث تساهم في خلق تجربة سياحية فريدة تتكامل فيها عناصر البيئة الطبيعية مع الإبداع الإنساني. تكمن مشكلة البحث في ظهور التشوه المعماري الذي تعاني منه واحة سيوة نتيجة انتشار النزل السياحية التي تستخدم مواد بناء متباينة ومفردات تشكيلية غير متجانسة مع طابع الواحة الأصيل. فقد أدى استلهم تصاميم من بيئات مختلفة إلى إضعاف الهوية المعمارية المميزة للمنطقة، رغم ادعاء هذه المنشآت استخدام مواد بيئية. لذا يهدف البحث إلى رصد واقع استخدام مواد البناء في النزل السياحية بواحة سيوة، وتطوير المواد المحلية بما يحقق الاستدامة البيئية ويحافظ على الطابع المعماري الأصيل للمنطقة. ولتحقيق هذه الأهداف، اعتمد البحث منهجية تعتمد على دراسة الحالة لنماذج النزل البيئية القائمة وتقييم مدى توافقها مع السياق العمراني للواحة، مع التركيز على دور مواد البناء المحلية في تحقيق التوافق البيئي. كما تضمنت المنهجية مراجعة تقنيات البناء المعاصرة التي يمكن توظيفها لتطوير المواد المحلية، مع دراسة خاصة لتجربة إحياء التراث العمراني في واحة سيوة منذ بداية القرن الحادي والعشرين. تم التركيز بشكل خاص على تقنية التربة المدمكة كأحد الحلول المستدامة التي تتناسب مع طبيعة واحة سيوة، التي تعتبر مادة بناء قوية ومستدامة تحافظ على الخصائص البيئية. ونتج أن دمج هذه التقنية مع المواد المحلية يحسن من أداء المباني بيئياً وإنشائياً، مع الحفاظ على الطابع البصري المميز للواحة. وأن محاولات البناء غير المستدامة فشلت في الحفاظ على الطابع

المعماري للواحة بسبب تجاهل الخصائص البيئية والثقافية المحلية، وأن نجاح التجربة العمرانية يتطلب تطوير مواد البناء المحلية وفقاً لمعايير الاستدامة البيئية. كما أظهرت النتائج إمكانية الاستفادة من التقنيات المعاصرة مثل الطباعة ثلاثية الأبعاد وتقنية التربة المدمكة في تحسين خصائص المواد المحلية وتحويل المواد غير المستدامة إلى مواد صديقة للبيئة. وأكدت النتائج أن تجربة واحة سيوة في الحفاظ على منظومتها التراثية المتكاملة تقدم نموذجاً يمكن الاستفادة من إيجابياته في مشروعات التنمية السياحية المستقبلية. يستوجب تطوير صناعة النزل البيئية تطبيق معايير دقيقة لمواد البناء، مع التركيز على استخدام المواد المحلية المحسنة بالتقنيات الحديثة، وخاصة تقنية التربة المدمكة كحل مثالي يوازن بين الاستدامة والطابع المعماري الأصيل. وتتطلب المحافظة على الواحة حماية تراثها المادي والمعنوي من خلال حلول عصرية تحترم هويتها التقليدية.

الكلمات المفتاحية :

النزل البيئية، التربة المدمكة، الهوية المعمارية، التراث العمراني، واحة سيوة، السياحة البيئية

1. Introduction

Siwa Oasis represents one of Egypt's most distinctive regions with a unique architectural character developed through centuries of adaptation to local environmental, climatic, social, and cultural conditions. "Vernacular architecture represents a collective memory embedded in material and form." (Oliver,1997). The architectural identity of any region encompasses multiple elements, including "cultural, social, physical, climatic, economic factors, materials, air quality, renewable resources, and site conditions" (Ali, 2023). In recent decades, tourism development has introduced new construction practices to Siwa that often fail to harmonize with its traditional built environment. "Culture plays a fundamental role in shaping the built environment and its meaning for the community." (Rapoport,1969)



Figure 1: Key elements of architectural identity: Cultural, social, physical, climatic, economic factors, materials, air quality, renewable resources, and site conditions. (Ali, 2023)

1.1 Research Problem

The research problem centers on the architectural distortion occurring in Siwa Oasis due to tourist accommodation facilities employing building materials and design elements inconsistent with the region's authentic character. Despite claims of using environmental materials, many developments weaken the oasis's distinctive architectural identity through inappropriate material choices and construction techniques. This distortion threatens the cultural heritage that makes Siwa a unique destination for tourists seeking authentic experiences.

The impact of building materials on environmental sustainability cannot be overstated. The building sector accounts for approximately 30% of global energy consumption, with construction activities responsible for 60% of resource use, 50% of waste generation, and 35% of energy consumption and CO₂ emissions worldwide (Smith, 2023). This underscores the critical importance of rethinking building material selection and application, particularly in culturally significant regions like Siwa.

2.1. Research Aim and Objectives

The study aims to preserve Siwa Oasis's architectural identity by developing sustainable local materials integrated with modern construction techniques. This research objectives are to document the current building materials used in Siwa's tourist lodges and develop local alternatives that enhance environmental sustainability while preserving the region's authentic architectural character. It addresses the architectural distortion resulting from incompatible tourism development by integrating contemporary techniques—such as compressed earth technology and 3D printing—with local materials. Ultimately, the study seeks to establish guidelines for sustainable tourism architecture that align with Siwa's unique identity.

3.1 Research Methodology

To achieve the research objectives, the study adopted a structured methodology that integrates both deductive and inductive approaches, as illustrated in the accompanying diagram. While both reasoning methods were applied, the deductive method had a significantly stronger influence on shaping the research process and deriving outcomes. The methodology began with historical documentation, where deductive reasoning was employed to analyze urban heritage revival efforts in Siwa since 2000. This involved applying theoretical frameworks to interpret and assess various preservation practices, identifying both successes and shortcomings.

In the phase of field testing, the methodology combined deductive analysis with inductive insight. Laboratory and on-site examinations of enhanced local materials provided observational data, which were then evaluated against established construction standards to determine durability and compatibility. The stakeholder consultation phase relied more heavily on the inductive method. Insights drawn from local builders, architects, community members, and tourism operators helped uncover patterns and formulate an understanding of the challenges and perceptions surrounding architectural identity preservation. By blending these three components, the research methodology maintained a thoughtful balance between deductive structure and inductive exploration, with a clear emphasis on deductive reasoning throughout the study.

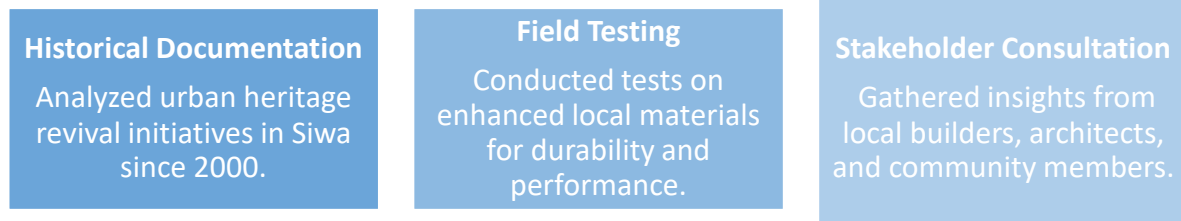


Figure2: Comprehensive approach to sustainable heritage restoration in Siwa: Combining historical analysis, material testing, and community engagement (Researcher2025).

2. Ecotourism and Architectural Character

Ecotourism represents a sustainable approach to tourism focused on visiting natural areas while preserving the environment and supporting local communities. This approach aims to reduce negative environmental impacts while promoting environmental awareness and sustainable economic development for host communities. Within this framework, architecture plays a crucial role in either reinforcing or undermining a destination's authentic character.

Traditional architecture in regions like Siwa reflects cultural heritage through distinctive materials, construction techniques, and design elements. Smith (2023) notes that architectural character can be classified along a spectrum from traditional to contemporary, with transitional forms serving as bridges between historical practices and modern requirements.

Architectural characters in heritage contexts like Siwa Oasis encompasses three main categories:

1. Traditional: Employing historical construction methods, materials, and forms without significant modification.
2. Transitional: Adapting traditional elements to accommodate contemporary needs while maintaining visual and cultural connections to historical architecture.
3. Contemporary: Utilizing modern design approaches and materials while drawing inspiration from traditional forms, patterns, or spatial concepts.
4. The balance among these categories determines how effectively tourism development preserves and enhances local architectural identity.

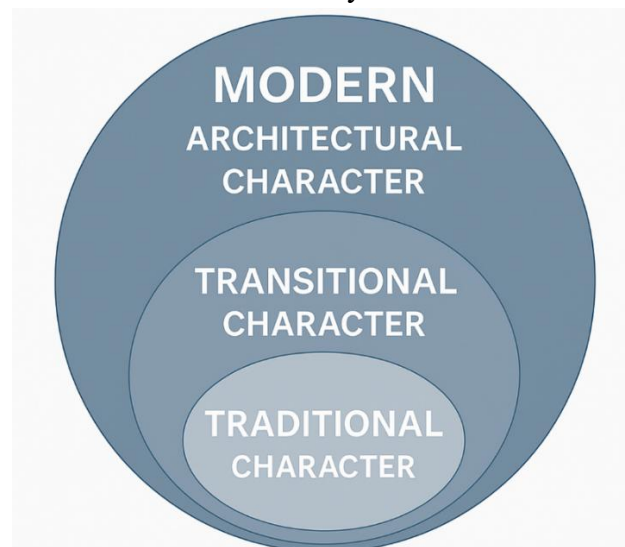


Figure 3: Visual hierarchy of architectural character levels—Traditional, Transitional, and Modern—within the broader architectural identity. (Researcher, 2024)

3. Main Local Building Material: Karshef

Karshef (or kirshef) represents the cornerstone of Siwa's traditional architecture. This unique building material consists of salt-rich clay extracted from the beds of Siwa's salt lakes, formed into blocks then sun-dried. The resulting material demonstrates remarkable thermal insulation properties ideally suited to the oasis's extreme desert climate.

The old town of Shali in Siwa Oasis stands as testimony to karshef's historical significance, with structures dating back centuries constructed entirely from this indigenous material (Hermann, 2016). However, contemporary challenges threaten both existing karshef structures and the continued use of this traditional material.

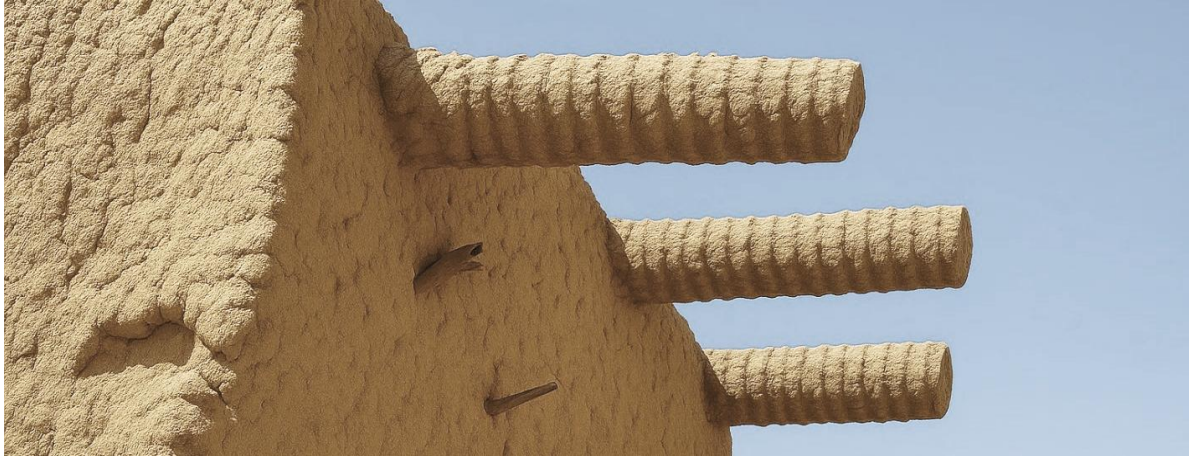


Figure 4: Siwa Oasis, Egypt, Shali (Old Town), famous for its karshef (Mud brick) architecture. (Michael Hermann, 2016)

3.1 Properties and Challenges

"Architectural responses to hot arid climates must prioritize thermal mass and passive cooling strategies." (Hassan ,2010), Kashif's thermal insulation capabilities make it particularly valuable in Siwa's harsh climate. Research indicates that buildings constructed with karshef require significantly less energy for cooling due to the material's high thermal resistance. However, the material faces serious durability challenges: A study published in the Journal of Cultural Heritage (Mohammed et al., 2023) analyzed the deterioration of traditional materials due to humidity and high soil salinity in Siwa. The researchers identified critical vulnerability to moisture, which weakens the salt-clay matrix and leads to structural degradation over time. This vulnerability has accelerated in recent decades due to rising groundwater levels and changing precipitation patterns attributed to climate change. UNESCO (2023) has warned specifically about the threats posed by climate change and rising levels of saline groundwater to archaeological buildings in regions like Siwa, calling for urgent development of protection strategies.



Figure 5: Traditional construction method (the Researcher, 2003)

Recent research has focused on improving karshef's durability while maintaining its environmental benefits and aesthetic qualities. Adding natural materials such as straw or plant fibers to the traditional karshef mixture has shown promise in enhancing structural strength while preserving thermal performance. These natural additives create a fibrous matrix that reduces cracking and improves resistance to moisture damage.

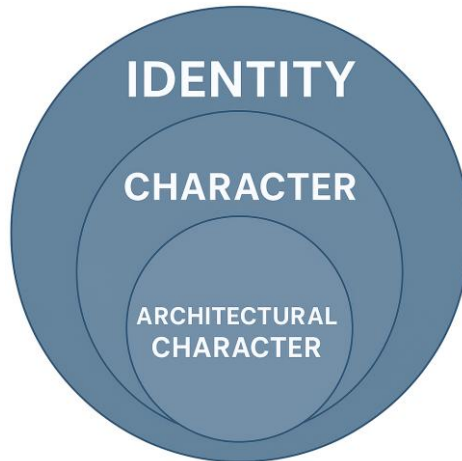


Figure 11: Classification of architectural character into Traditional, Transitional, and Modern levels, showing its gradual evolution. (Researcher, 2024)

4. Local Experiences

Field research documented various approaches to building in Siwa Oasis, classified according to the architectural character spectrum, several tourism facilities have committed to authentic traditional construction methods:

- Hostel Bungalow (2023): Employs pure karshef material using traditional construction techniques with minimal modern interventions.

- Traditional Construction Method (2003): Features wooden and linen ceilings following historical precedents.

"Courtyard-based designs inherently regulate temperature fluctuations in desert environments." (Bahammam ,2002). These projects demonstrate the feasibility of maintaining traditional building practices while meeting contemporary functional requirements, though they typically require more intensive maintenance regimes.



Figure 6: Rishis material – traditional construction method (the Researcher,2023)

4.2 Transitional Approaches

Transitional architecture represents the most common approach in recent Siwa developments:

Tyrant Inn – Bungalow Style (2023): Incorporates karshef in main structural elements while integrating modern conveniences through contemporary interior finishes and building systems. This approach balances preservation of visual character with practical concerns about durability and guest comfort. Transitional buildings typically feature traditional exteriors with varying degrees of modern intervention in interiors and structural systems.



Figure 7 Tyrant Inn – Bungalow Style (Researcher,2023)

4.3 Contemporary Approaches

Fully contemporary approaches emphasize modern construction methods while drawing inspiration from traditional forms, Dheiba Inn – Swedish Wood Bottom (2023): Utilizes

imported wood construction systems with aesthetic elements inspired by traditional Siwan architecture. Though less authentic in terms of materials and construction techniques, well-designed contemporary buildings can still contribute positively to the regional character through thoughtful form, proportion, and integration with the landscape.



Figure 8: Dheiba Inn – Swedish Wood Bottom (Researcher,2023) Innovative sustainable building material in Siwa

The research explored sustainable development strategies for Karshef compatible with Siwa's architectural identity, as "traditional architecture often provides naturally sustainable solutions superior to contemporary practices" (El-Shorbagy, 2010). Recent approaches focus on enhancing Karshef through natural foam additives to reduce density while maintaining thermal performance, and small cement additions to improve moisture resistance with minimal impact on environmental performance.

5. Salt as a Complementary Building Material

Salt extracted from Siwa's lakes offers intriguing possibilities as a supplementary building material like: Jaafar Village (2004), utilized salt blocks for interior cladding and as translucent window openings replacing glass. Siwa Museum (2023): Employed salt blocks as an alternative to glass bricks, creating distinctive light effects while maintaining thermal performance as shown in figure 8. It should be noted that in figure 9, salt was added and incorporated as a complementary material rather than a primary structural component, to impart special properties to the concrete.



Figure 9: Jaafar Village - Salt Breaking in the Interior Cladding (Researcher, 2004)



Figure 10: Siwa Museum - Salt Block Opening as an Alternative to Glass Bricks (Researcher, 2023)



Figure 11: Salt concrete finishing surface (rocksolidseal.com,2025)

Recent research offers promising directions for next-generation local materials:

Clay Reinforcement with Polymers: The Desert Research Center in Egypt (Abdel Rahman et al., 2022) found that adding biopolymers to clay significantly improves its mechanical properties, making it harder and more resistant to cracking in dry climates. **Salt Concrete:** A joint research project between Egypt and Italy (2023) utilizes salt extracted from Siwa lakes to produce specialized concrete formulations tailored for desert areas while preserving the visual characteristics of traditional architecture.

6. Rammed Earth Technology

Rammed earth represents a promising alternative that maintains the aesthetic and environmental benefits of earth-based construction while improving durability: "Integrating vernacular techniques into modern construction enhances both cultural value and environmental performance." (Gado, 2011).

This technique constructs foundations, floors, and walls using compacted natural raw materials such as earth, chalk, lime, or gravel. Modern rammed earth typically incorporates small percentages of cement or lime as stabilizers, significantly improving durability compared to

traditional karshef while maintaining a similar visual character. "Traditional techniques like earth architecture inherently achieve thermal comfort without mechanical intervention." (Fathy .1986)

The N-Abu Galoum Project (2023) demonstrated successful application of rammed earth technology in the regional context, with completed structures showing excellent performance in the local climate while maintaining visual compatibility with traditional architecture.

6.1 Environmental Impact Assessment

The environmental benefits of local materials extend beyond energy efficiency in building operation. Life cycle analysis indicates that locally sourced earth-based materials like enhanced karshef and rammed earth significantly reduce embodied carbon compared to conventional construction materials: Minimal transportation energy, Low processing energy requirements, Natural temperature regulation reducing operational energy, End-of-life recyclability. These factors position appropriate local materials as integral to achieving sustainable tourism development in environmentally sensitive regions like Siwa.

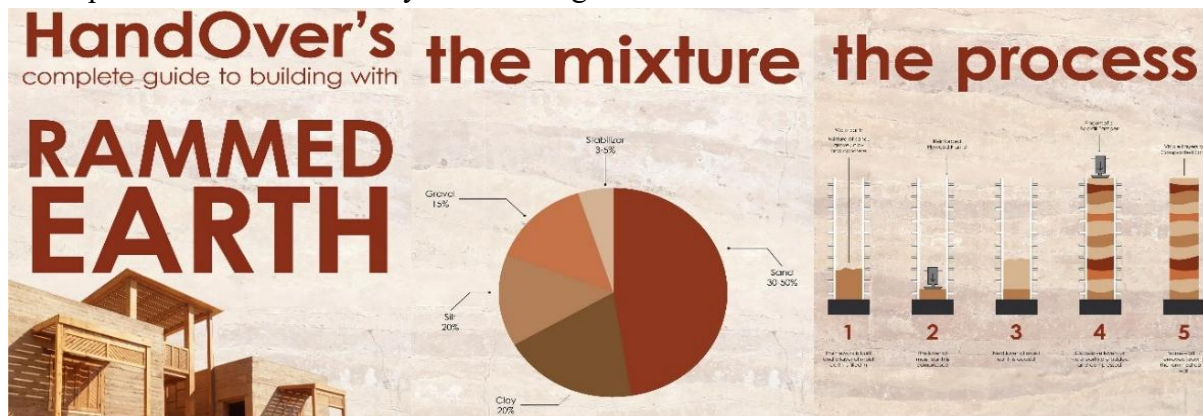


Figure 12: Technical diagram showing rammed earth composition percentages, test samples, and a finished building - demonstrating sustainable construction materials and methods.

6.2 Cultural Preservation Considerations

Material choices profoundly impact the preservation of Siwa's cultural heritage. The research indicates that architectural distortion occurs not only through inappropriate material selection but also through misapplication of traditional materials or superficial imitation of traditional forms using incompatible modern materials. "In the era of globalization, preserving vernacular identity becomes a conscious act of resistance." (AlSayyad ,2006)). Among contemporary experiments, the Siwa Workshop stands out as a significant initiative where all modern techniques applicable to the research objectives were simulated and tested extensively, as demonstrated in figure 13 in the following page. This workshop provided valuable insights into how traditional building methods can be adapted using contemporary knowledge while maintaining cultural authenticity.

Stakeholder consultation revealed strong community support for maintaining authentic building traditions, with concerns about the loss of traditional building knowledge as older craftspeople retire without transmitting their expertise to younger generations. "Open spaces are vital not only for climate control but also for maintaining social cohesion in traditional settlements." (Al-Hagla ,2008).

This generational gap poses a critical challenge to the continuity of Siwa's architectural identity and underscores the urgency of documenting and revitalizing these practices through initiatives like the workshop. Retry Claude can make mistakes. Please double-check responses.

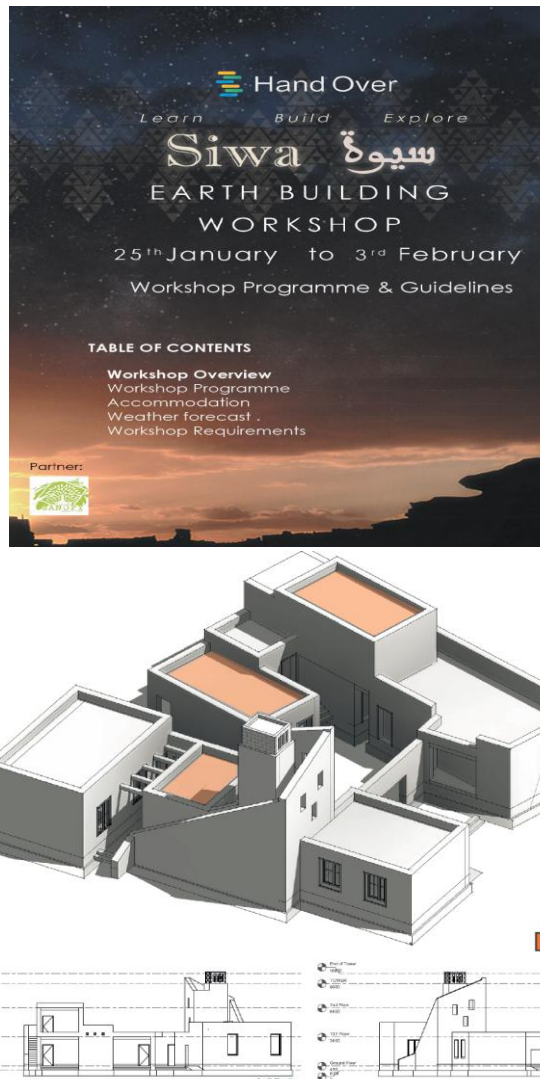


Figure 13: Siwa Earth Building Workshop poster and contemporary Siwan house design using rammed earth technique, showing Canopy Community Center plans. Retry Claude can make mistakes. Please double-check responses.

7. Results

The research findings highlight several key considerations for preserving Siwa's architectural identity while accommodating tourism development, Karshef material analysis reveals a complex balance of advantages and disadvantages:

- Advantages: Excellent thermal insulation properties, Low embodied energy, Locally sourced materials, Cultural and historical significance, Distinctive aesthetic qualities.
- Disadvantages: Limited durability, especially in changing climate conditions, Difficulty meeting modern building codes.

KARSHIF MATERIAL

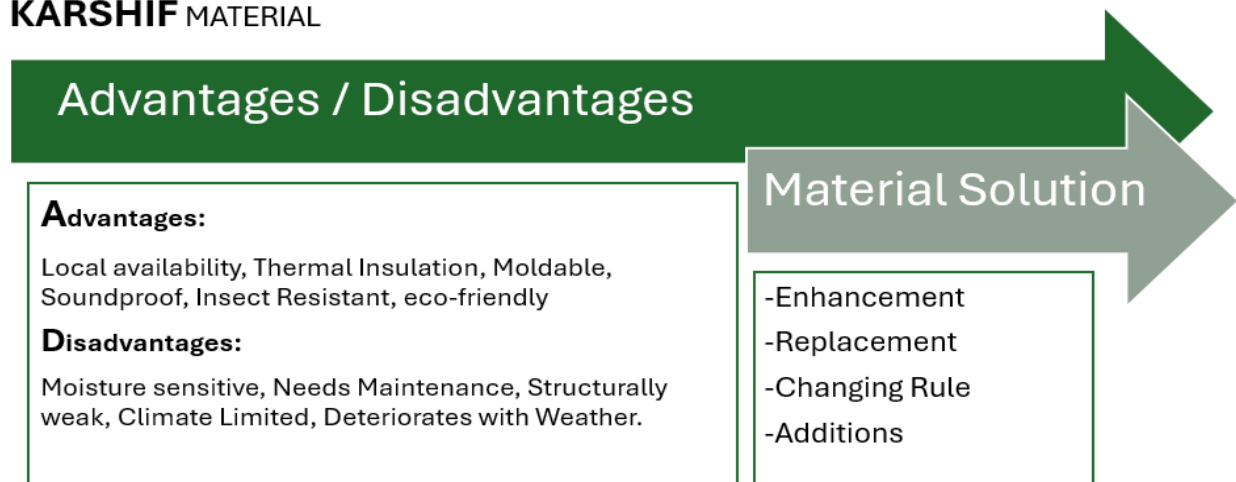


Figure 14: KARSHIF material analysis: Advantages, disadvantages, and potential solution strategies for improved implementation) the Researcher,2025)

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Labor-intensive construction process: Requires specialized knowledge increasingly rare among younger builders, Vulnerability to moisture damage, enhanced local materials developed through the research demonstrate potential to address these disadvantages while maintaining the material's core benefits. Rammed earth technology offers a promising balance of traditional character and modern performance.

8. Conclusion and Recommendations

While the study is theoretical in nature, it contributes original insight by synthesizing local materials research into an integrated sustainability framework tailored for Siwa. It also outlines practical applications for future experimental work.

1. Develop Material Standards: Establish clear performance and aesthetic standards for enhanced local materials, ensuring compatibility with both traditional character and contemporary requirements.
2. Knowledge Transfer Programs: Implement training initiatives to preserve traditional building knowledge and techniques among local builders and architects.
3. Regulatory Framework: Develop planning regulations specific to Siwa that require new tourism facilities to employ appropriate local materials and respect regional architectural character.
4. Material Innovation Center: Establish a research and development center focused on continuing innovation in local building materials, particularly enhancement of karshef and related earth-based construction systems.
5. Demonstration Projects: Support pilot projects showcasing successful integration of enhanced local materials in contemporary contexts.

"Sustainability in design must marry tradition with innovation to ensure long-term resilience." (Edwards ,2010). With appropriate implementation of these recommendations, Siwa's experience can become a model for sustainable tourism development that successfully balances preservation of architectural heritage with innovation and adaptation to contemporary needs.

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