

**Investigating Traditional Architecture for Contemporary Use:
Analysis of Climatic Aspects through Perception Study of
Assam-Type Houses**

Thesis submitted by

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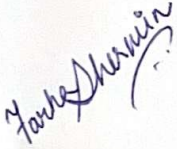
PROFORMA – 1

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I **Farha Shermin** registered on **May 8, 2018** do hereby declare that this thesis entitled **“Investigating Traditional Architecture for Contemporary Use: Analysis of Climatic Aspects through Perception Study of Assam-Type Houses”** contains literature survey and original research work done by the undersigned candidate as part of Doctoral studies.


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This is to certify that the thesis entitled “**Investigating Traditional Architecture for Contemporary Use: Analysis of Climatic Aspects through Perception Study of Assam-Type Houses**” submitted by Smt. **Farha Shermin**, who got her name registered on **May 8, 2018**, for the award of Ph.D. (Engg.) degree of Jadavpur University is absolutely based upon her own work under the supervision of **Dr. Mainak Ghosh** and that neither her thesis nor any part of the thesis has been submitted for any degree/diploma or any other academic award anywhere before.

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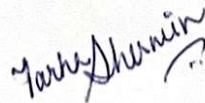
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ABSTRACT

Traditional built forms have long reflected human adaptation to climate, evolving over generations to offer functional and sustainable solutions tailored to regional environmental conditions. As concerns about energy efficiency, thermal comfort, and sustainability become increasingly central in architectural discourse, traditional practices have emerged as vital sources of knowledge for contemporary design. In the context of Northeast India, the Assam-type house stands as a prominent traditional typology, known for its adaptability to the region's humid subtropical climate through passive design strategies. However, with rapid urbanization, changing construction technologies, and evolving lifestyle preferences, the application of such traditional wisdom has been increasingly marginalized in contemporary architectural practices. This research investigates the potential for integrating traditional features of Assam-type houses into contemporary residential designs for climate responsiveness.

The study began by identifying context-specific traditional elements and corresponding attributes, through a combination of literature studies of traditional architecture and an expert opinion survey involving professionals familiar with traditional and climate responsive architecture in Northeast India. These features, recognized for their climatic performance, formed the basis of further inquiry, and were used to identify the features of traditional Assam-type houses which support climate responsiveness. These features were subsequently looked at through three lenses: user perception on comfort and efficiency and acceptability of the traditional features, expert recommendations on relevance of the traditional features and feasibility of adoption in contemporary designs, and building surveys which shows the extent of their use in current practices. This multi-source examination was structured through a triangulation-based analysis, enabling the cross-verification of findings and offering a comprehensive lens to assess the relevance, practicality, and acceptability of traditional design features in the contemporary context.

A significant contribution of the study is its emphasis on user perception, a perspective that is often underrepresented in architectural research. Since

homeowners and users are the ultimate decision-makers in the design and construction of residential spaces, their views on comfort, efficiency, and willingness to adopt traditional features are pivotal. Understanding their preferences not only sheds light on the cultural and functional appeal of traditional architecture but also helps identify features that have the highest likelihood of successful adaptation in present-day housing.

The research presents a structured framework for analysing and evaluating traditional architecture for contemporary use. It culminates in a ranked list of adoptable traditional Assam-type house features for climate responsiveness, providing clear and actionable guidance for homeowners, architects, builders, and others involved in the process of designing climate-responsive contemporary houses. By identifying the most contextually effective and user-accepted elements of traditional design, this study offers a practical guiding tool for integrating traditional wisdom into current practices. It not only shows the continued relevance of traditional architectural knowledge, but also bridges the gap between traditional wisdom and contemporary architectural requirements.

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List of Abbreviations

ATH	Assam-Type House
RCC.....	Reinforced Cement Concrete
ICOMOS	International Council on Monuments and Sites
ANV	Advanced Natural Ventilation
HVAC	Heating, Ventilation and Air Conditioning
VRF	Variable Refrigerant Flow
UGI.....	Urban Green Infrastructure
GI	Galvanised Iron
CGI.....	Corrugated Galvanised Iron
POP	Plaster of Paris
RIDIT	Relative to an Identified Distribution Integral Transformation

Chapter I: INTRODUCTION

1.1 Background

India showcases diverse examples of cultures, traditions, geography, and climates, with the architecture in each region, deeply rooted and shaped by its unique identity. The way locals adapt to the diverse contexts of the country and climates is a remarkable example of pure adaptation and sustainability. Traditional architecture in India, shaped by regional climates, utilizes locally sourced materials and design practices to enhance natural comfort and efficiency. Every region is a testimony that architecture thrived when it harmonized with the region's climate and geography.

In today's context, climate-responsive architecture is crucial due to the pressing challenges posed by climate change. The contemporary buildings today rely heavily on external heating and cooling systems to attain comfortable thermal conditions, resulting in high energy usage. Moreover, India's rapid urbanization is increasing the demand for constructing more buildings, which already contribute to over 30 percent of the country's total electricity consumption. Buildings significantly contribute to carbon emissions and energy consumption, indicating the need for designs that minimize environmental impact and enhance resilience against changing climates (Jain, 2022).

In response to these challenges, there is a renewed interest in studying traditional architectural practices that inherently embody climate-responsive design principles. By examining these indigenous architectural features, architects and designers can gain valuable insights into sustainable design strategies that enhance occupant comfort while reducing reliance on artificial energy sources. Traditional buildings offer valuable lessons in adapting to local environmental conditions sustainably. Renowned architect B.V. Doshi, a recipient of the Pritzker Prize in 2018, had emphasized that the built environment has always been shaped by various societal factors. On a physical level, it reflects an understanding of orientation, climate, building materials, and construction techniques whereas in a spiritual level it is interconnected with the lifestyle of the people (Doshi, 1985).

Learning from these time-tested practices can inform contemporary architecture, leading to more environmentally friendly and climate-responsive building designs. Embracing these

principles could not only reduce carbon footprints but also enhance the comfort and sustainability of built environments, offering a path towards a more resilient and environmentally conscious future.

The questions that arise now is, how can the knowledge embedded in traditional practices be adopted in contemporary designs to make the buildings climate responsive and yet cater to the everchanging needs of the contemporary world. Research into traditional architecture is not new but it has predominantly focused on design principles, local materials, and its responsiveness to regional climates and geographical contexts. Similarly, studies on climate responsive architecture in the Indian subcontinent have explored various facets such as climatic conditions, passive design strategies, and uniqueness of certain typology. While these investigations provide valuable insights, they often overlook an essential factor: user perception and experience. Understanding how users interact with and perceive these traditional inspired designs is crucial, as it influences their comfort, adaptability, and acceptance of climate-responsive solutions. The need to understand user perception is very important, which if ignored in contemporary designs, we may miss the opportunity to align traditional principles with modern expectations, resulting in spaces that are either inefficient or fail to resonate with present-day occupants.

Hence, bridging the gap between traditional architectural wisdom and contemporary user expectations is vital for creating sustainable, climate-responsive architecture that remains functional and relevant.

1.1.1 The Relevance of Traditional Architecture in Contemporary Designs

Traditional architecture refers to building styles and methods that have been passed down through generations, reflecting the cultural, historical, and environmental context of a specific region (Oliver, 2006). It is often characterized by the use of local materials, adaptation to climate, and incorporation of cultural symbols and practices (Rapoport, 1969). Traditional architecture often emphasizes functionality, sustainability, and a strong connection to the local community (Fathy, 1986). These buildings are typically constructed using time-tested techniques and embody the collective wisdom of a society, resulting in structures that are well-suited to their environment and deeply rooted in cultural identity (Rudofsky, 1964). The study of traditional architecture has gained importance in recent decades as architects and planners seek to learn from these sustainable and culturally appropriate building practices (Asquith and Vellinga, 2006).

Although the terms traditional and vernacular are often used interchangeably with respect to architecture, vernacular architecture has been distinguished from traditional architecture because of their certain essential differences. The most notable of which is that traditional architecture included formal buildings like places of worship and palaces whereas the vernacular did not typically include them (Khan as cited in Jain, 2012, p.17).

Contemporary architecture on the other hand is the architecture of the present. Contemporary architecture refers to the diverse range of architectural styles and approaches that have emerged in the 21st century, characterized by innovative design, advanced technology, and often, a focus on sustainability (Jencks, 2002). It usually features unconventional forms, mixed materials, and a blending of indoor and outdoor spaces (Ibelings, 2014). Unlike the more rigid styles of the past, contemporary architecture is fluid and adaptable, reflecting the rapidly changing needs and values of modern society (Jodidio, 2008).

The importance of traditional architectural knowledge in contemporary design lies in its proven ability to address environmental challenges through sustainable, climate-responsive strategies. Drawing from centuries-old practices, traditional architecture offers valuable insights into passive design techniques and resource-efficient solutions, which are increasingly relevant as modern societies seek to reduce energy consumption and mitigate climate impacts.

Even though the lessons from traditional architecture cannot directly address contemporary issues, they do suggest signs and clues that are applicable in contemporary contexts. It has been established through documented evidence that traditional architecture, especially the houses, are effectively responsive to the prevailing climatic conditions, which is missing in most contemporary architecture (Gulati 2017).

In this regard, Auliciems and Szokolay, both experts in bioclimatic and sustainable architecture, emphasized the need to revisit passive energy technologies. They pointed out that these methods, when combined with ways of living that suit the local climate, have long been effective in handling extreme weather and environmental challenges. Their research suggests that many of these passive strategies are still relevant today and deserve more attention. They also encouraged looking to traditional and vernacular architecture, which has successfully used passive design principles for generations to create comfortable and resilient spaces. This approach not only respects the wisdom embedded in these

longstanding practices but also offers practical solutions for building in harmony with the environment (Auliciems & Szokolay, 2007).

In India, where the population has already exceeded one billion and continues to grow at a rate of over 1.9%, there are unique pressures on resources and space. The country supports around 16% of the world's population while occupying only 2.3% of the Earth's land area (Gulati, 2017). This imbalance creates significant economic and environmental challenges, as resources are limited and must be managed carefully. One effective response to this situation is to explore and learn from India's rich traditions of energy-efficient and climate-responsive architecture. By studying these traditional methods, which were developed over centuries to work in harmony with the climate and available resources, modern design can adopt sustainable practices that reduce energy consumption and make the best use of limited resources.

Similarly, considering Assam in north eastern India, where energy supplies are both irregular and dwindling, (The Sentinel, 2024) it becomes increasingly important to look to the region's traditional architecture for guidance. Assam's local architectural practices have long incorporated passive energy techniques to maintain comfort in the region's humid and variable climate. By studying these time-tested strategies, architects and planners can create designs that naturally respond to local climates, reducing reliance on artificial climate control systems. This approach helps build more resilient and sustainable communities, ensuring comfort and adaptability in the face of changing environmental conditions.

1.2 Research Problem and Justification

In recent years, climate change has posed major challenges to the built environment, driving the need for climate-responsive architecture. This approach optimizes design through passive strategies like natural ventilation, insulation, and solar orientation to reduce energy use, enhance comfort, and minimize environmental impact. It is particularly crucial in regions with distinct climatic challenges, where traditional building practices have long provided effective solutions for adapting to the environment.

Assam, located in the northeastern region of India, presents such a unique climatic and environmental context that has historically shaped the local built environment. Assam experiences high humidity, heavy rainfall, and seasonal temperature variations that demand specific architectural responses. The traditional *Assam-type house (ATH)* is a prime

example of how local architecture has evolved to respond to these conditions. These houses illustrate an inherent climate responsiveness that has long been a hallmark of Assamese traditional architecture (Deka, 2018).

Research on traditional Assamese architecture has revealed its remarkable thermal performance and structural adaptations to the local climate. Studies indicate that the stilted house design promotes air circulation beneath the floor, effectively reducing humidity and mitigating flood damage, a common concern in Assam (Deka, 2018). The use of natural materials such as bamboo and thatch provide excellent insulation while allowing air permeability, crucial for the region's humid climate (Borah et al., 2016). The characteristic pitched roof with extended eaves serves a dual purpose: it prevents rainwater infiltration into walls and shields windows and walls from direct sunlight, thereby maintaining cooler interiors during summer months (Sarma, 2015). These investigations have underscored how traditional Assamese architectural practices align with climate-responsive design principles, demonstrating sustainable techniques well-suited to the local environmental conditions (Das and Das, 2019). The traditional architecture of Assam thus offers valuable insights into sustainable building practices that effectively address the region's unique climatic challenges.

Despite these understanding, the adoption of traditional architectural designs or climate-responsive features in contemporary Assamese construction remains limited. New residential buildings are increasingly opting for modern materials and designs, which lack the climate adaptability seen in traditional designs. This trend suggests that practical, economic, or cultural factors might influence residents' decisions to give up traditional architectural practices.

Existing research has largely focused on the technical merits of traditional architecture. However, a crucial aspect remains largely unexplored: the perspectives of the residents and users themselves. While technical evaluations of climate-responsive features are invaluable, the decision to adopt these elements ultimately rests with the people building and living in these spaces. Understanding what residents value or find challenging in traditional Assamese architecture is essential, as they are the final decision-makers in choosing their house designs. Understanding the user perspective is also crucial, as it will help in identifying potential adaptations that could make these features more relevant to contemporary needs.

This research builds on previous studies by seeking to understand not only the climate-responsive features of traditional ATHs but also the attitudes and preferences of the residents themselves. By exploring what users value, find challenging, or deem impractical in traditional design, this study aims to bridge the gap between the technical benefits of traditional architecture and the practical, everyday considerations of modern residents. This dual focus is essential for developing guidelines for climate-responsive architecture.

1.3 Research Gap

Contemporary housing in urban and semi-urban areas of Assam stands in stark contrast to the traditional built environment that has long defined the region. ATHs are designed with climate adaptability in mind, incorporating features such as stilted foundations, bamboo structures, and pitched roofs. In contrast, modern constructions tend to prioritize concrete and steel, focusing more on contemporary aesthetics than climate responsiveness.

However, with rising awareness about sustainability and the value of traditional construction methods, there has been a renewed focus that has led to numerous studies analysing these houses, with particular emphasis on their thermal performance, material efficiency, and architectural strategies for adapting to Assam's humid, subtropical climate (Das and Das, 2019). These studies have revealed that traditional Assamese architecture embodies principles of passive cooling and climate adaptation, offering valuable insights for contemporary sustainable building practices (Deka and Nath, 2020).

The reviewed studies, as elaborated in Chapter 2, Section 2.6, collectively highlight the continued relevance of ATHs in addressing modern challenges like seismic resilience, environmental sustainability, and cultural preservation. Traditionally constructed with locally sourced materials such as bamboo, timber, and ikra, these houses have proven to be earthquake-resistant, climate-adaptive, and resource-efficient. Research has examined various aspects of ATHs, including their seismic performance, material sustainability (e.g., bamboo and Bamcrete), environmental adaptability, and cultural significance. The incorporation of materials like Bamcrete, which combines bamboo with cement mortar, has emerged as a promising modern adaptation that enhances durability without compromising sustainability.

Despite these valuable insights, the studies do not provide clear guidance on which specific features of ATHs should be integrated into contemporary designs. While some advocate for the continued use of traditional elements, there is no consensus on which aspects would be most beneficial for modern construction. Additionally, none of these studies explore how these traditional features are perceived, valued or prioritised by the people who inhabit such houses, leaving a gap in understanding the human and experiential dimension of climate responsive design.

This lack of user feedback limits the practical application of the findings, as the adoption of climate-responsive features ultimately depends on the needs and preferences of the people who inhabit these houses. Furthermore, there is currently no comprehensive reference for architects and designers that outlines which features of ATHs are most effective for climate responsiveness and how these elements can be successfully integrated into contemporary designs. This gap in actionable guidance hinders the broader adoption of traditional, climate-resilient elements in modern construction.

Recognising this, it is important to note that user perception has been studied extensively in broader sustainability and housing research, for example, through post-occupancy evaluations and participatory studies such as ‘Post-occupancy and Participatory Design Evaluation of a Marginalized Low-Income Settlement in Ahmedabad, India (Sharmin & Khalid, 2021), and similar attempts have been made to relate human perception to vernacular design in recent works (e.g. Human Perception Analysis of Adapting Vernacular Architectural Solutions in Urban Single Residences by Jeyasingh & Banerjee, 2024). Nevertheless, these approaches are limited either to performance assessment or to perception in isolation, without combining multiple perspectives to translate traditional knowledge into adoptable design features.

1.3.1 Contribution Statement

Building on these existing efforts, this research consolidates and advances prior work on traditional and climate-responsive architecture by developing an operational, triangulated framework that integrates three complementary perspectives; user perception, expert validation and field-based building surveys to identify, validate and prioritize adoptable traditional features for climate-responsive contemporary designs. The contribution is therefore methodological and applied, offering a replicable model that transforms disparate insights

on traditional design into actionable decision-supporting tool for homeowners as well as professionals.

1.4 Aim and Objectives

Building on the identified research gap, the following aim and objectives have been established to guide the study -

1.4.1 Aim: This research aims to examine the climatic aspects of the Assam-type houses by identifying key architectural features that support climate-responsive design. It seeks to evaluate these features through a perception-based study and assess their potential for integration into contemporary architectural practices.

1.4.2 Objectives: The objectives are framed to provide a foundational methodological framework for identifying adoptable traditional features in contemporary designs. This systematic approach, demonstrated through Assam-type houses as a case study, can be adapted to other traditional architectural typologies and climatic contexts, guiding future research and design practice.

The objectives based on the mentioned aim are as follows:

- a. To examine existing studies on traditional architecture for understanding and identifying common framework of analysis.
- b. To identify the key features of traditional ATH that support climate-responsive design.
- c. To understand the user's perception of the key features of traditional ATHs that support climate responsive design and their willingness to adopt the features in their future houses.
- d. To validate the identified climate responsive key features with experts focusing on their feasibility and potential for adoption in contemporary designs.
- e. To develop a framework for investigating traditional architecture for contemporary use, based on user and expert perception, to guide the adoption of traditional features in modern designs.
- f. To propose a prioritized list of traditional ATH features based on their importance for adoption in contemporary designs, with a focus on enhancing climate responsiveness.

1.5 Methodology Overview

This research adopts a mixed-method approach combining expert insights, user perceptions, and building surveys to investigate climate-responsive features of traditional ATHs and their applicability in contemporary housing.

The study began by mapping traditional architectural practices against India's climatic zones, establishing a foundational understanding of their climate adaptability. Building on this a literature review was conducted to analyse how traditional architecture has been studied previously, which resulted in the identification of key building elements and their corresponding attributes important to study traditional architecture.

Using these building element–attribute combinations, an expert opinion survey was conducted to identify which of the building element and its corresponding attribute support climate responsive design and can be integrated into contemporary housing.

These identified combinations were then mapped specifically to traditional ATHs based on professional knowledge of experts, to identify their features which support climate responsive design and can be integrated into contemporary housing.

Using the identified features of traditional ATHs which support climate responsive design, user perceptions were gathered through structured engagements with residents of both traditional ATHs and contemporary RCC houses. This helped assess their experiences with thermal comfort, the efficiency of traditional features, and their willingness to adopt these features in future construction.

Expert evaluations further validated the findings of user perception, by providing recommendations on the relevance and practicality of incorporating traditional ATH features into contemporary housing.

Building surveys of both traditional and contemporary ATHs were conducted to observe how climate-responsive features function in real-world conditions. These practical observations provided insights into the effectiveness of traditional elements in regulating thermal comfort and their adaptability to modern construction.

By integrating findings from literature, experts, user feedback, and building surveys, the research developed a prioritized list of climate-responsive features from ATHs that are suitable for adoption in contemporary housing. This approach bridges traditional architectural

wisdom with modern construction practices, promoting sustainable and climate-adaptive design solutions.

1.6 Research Questions

The research questions are:

- a. How should traditional architecture be studied to gain a comprehensive understanding of its important characteristics and design logic?
- b. What are the defining architectural features of traditional Assam-type House that make it climate responsive?
- c. How do users perceive these traditional features of Assam-type houses in terms of comfort and efficiency, and what is their willingness to adopt them in their future houses?
- d. What is the feasibility and relevance of integrating tradition Assam-type house features into contemporary house design practices in Assam?
- e. What outcome can be developed from the analysis of traditional Assam-type Houses to facilitate the identification of priority features for contemporary climate responsive design?

1.7 Scope and Limitations

Scope: This research investigates the climate-responsive features of traditional Assam-type architecture and explores their potential integration into contemporary housing practices in Assam. The study focuses on ATHs, which are significant due to their cultural importance and climate adaptability. It emphasizes identifying its architectural features that enhance climate responsiveness, with the goal of applying these features to contemporary construction.

With respect to building surveys, the research covers diverse regions of Assam, including urban and rural areas, to capture a broad understanding of traditional housing practices. While the primary focus remains on existing self-built ATHs, the study also examines contemporary ATH to compare and assess the feasibility of adopting traditional design elements in contemporary contexts. This comparative analysis helps identify adaptable features that support climate responsive design.

The focus on self-built Assam-type houses is supported by National Sample Survey (76th Round, 2018) data, which indicates that the majority of independent houses across Assam use traditional or semi-pucca materials (mud, bamboo, unburnt brick, burnt brick/stone) and sloping metal-sheet roofs typical of Assam-type architecture. Financing is largely owner-driven, reflecting that construction is predominantly self-built, especially in rural areas. These findings are further corroborated by direct observations conducted during the study, which show that most existing independent houses follow self-built construction practices. While urban areas may have a higher proportion of professionally designed houses, the methodology and the prioritized checklist of climate-responsive features developed in this study are applicable to both self-builders and professional practitioners, providing a practical tool for contemporary housing design.

The research primarily focuses on the residents of Assam-type and RCC houses, along with architectural experts, to gather both experiential and professional insights. The findings contribute to the broader discourse on sustainable architecture by offering a prioritized list of climate-responsive features suitable for incorporation into contemporary housing, providing practical recommendations for enhancing climate adaptability in Assam and similar regions.

Although regionally specific, this study serves as a methodological foundation. The framework of combining user perception, expert opinion and building surveys is designed to be replicable across other traditional housing typologies and climatic zones, thereby extending its relevance beyond Assam.

Limitations: While this research offers valuable insights into the climate-responsive features of ATHs, there are a few limitations that should be considered. The study is focused on self-built ATHs, which reflect traditional knowledge and user-driven construction practices. Thus, specifically excluding professionally designed or contractor-built structures which may differ in design intent.

Secondly, with respect to fieldwork, due to the vast and varied geography of Assam, some regions were not accessible, which may slightly limit the representation of all regional variations of ATHs. However, care has been taken to include examples from the different climatic zones of Assam, considering it is a study to understand the climatic aspects of ATHs.

In terms of data sources, while a wealth of secondary studies exists on ATHs, gaps in available literature sometimes posed challenges, especially when trying to access detailed information on more recent developments or lesser-studied areas. Nevertheless, the study made every effort to fill these gaps through primary data collection and expert consultations, which helped validate the findings.

Although the methodological framework developed through this research is adaptable to other traditional architectural contexts, its practical application may require minor contextual adjustments, particularly in the design of survey instruments and field documentation with respect to region-specific materials, construction practices, and socio-cultural factors without altering the core methodology.

This study intentionally focuses on climate-responsive and user-perception dimensions of Assam-type houses. Detailed structural/seismic analysis and economic feasibility/cost modelling are outside the present scope, as each requires dedicated methods (e.g., structural modelling, bill-of-quantities, and LCC analyses). These domains are identified for future interdisciplinary work to complement the comfort and adoption focused findings reported here.

Despite these constraints, the research successfully presents a thorough understanding of ATHs and their relevance in contemporary housing, providing valuable recommendations for integrating climate-responsive features into modern design practices.

1.8 Structure of Thesis

Following the methodology adopted, the thesis is developed with the following structure, explained in the following sequence of 6 chapters.

Chapter 1: Introduction

This chapter provides an overview of the research, including the background information on traditional architecture and its relevance to contemporary design. It outlines the aim and objectives of the study, discusses the research methodology, and defines the scope and limitations of the project. The introduction sets the stage for the subsequent chapters by establishing the significance of the research topic.

Chapter 2: Literature Review

This chapter presents a comprehensive review of existing literature related to traditional architecture, climate responsiveness, the socio-cultural context of Assam with a focus on ATHs. It synthesizes previous studies and theoretical frameworks, highlighting gaps in the literature that the current research aims to address. This review informs the foundation for the research methodology and context.

Chapter 3: Materials and Methods

This chapter details the research design and methods employed to collect and analyse data. It describes the qualitative and quantitative approaches used, including surveys and field observations and documentation. The chapter also outlines the criteria for selecting study participants and the tools used for data collection and analysis.

Chapter 4: Survey and Analysis

This chapter presents the findings from the survey and analysis of Assam-type houses (ATH), incorporating data from user perception surveys, expert recommendation surveys, and building surveys of both traditional and modern ATHs. It provides a systematic evaluation of the collected data, including feedback from residents and experts, as well as observations from building surveys. The analysis also involves the application of the element-attribute matrix to assess climate-responsive features, comparing traditional and new ATHs. Key insights are drawn regarding the integration of these features into contemporary design practices, with a focus on enhancing climate adaptability.

Chapter 5: Discussion of Findings

The Discussion of Findings chapter interprets the results from the data analysis, drawing insights from user perception surveys, expert recommendation surveys, building surveys, and the expert opinion survey. It presents a comparative analysis of the findings from the previous chapter and highlights the most adoptable parameters of traditional Assam-type houses (ATH) for enhancing climate responsiveness. The chapter discusses the implications of integrating these features into contemporary designs and offers recommendations for their practical application.

Chapter 6: Conclusion

The Conclusion chapter summarizes key findings, answers the research questions, and presents a ranked list of recommended climate-responsive features for contemporary

adoption, as well as a comprehensive framework for investigating traditional architecture for contemporary use. It discusses the implications for contemporary housing design and highlights broader contributions to climate-responsive architecture.

This chapter outlined the significance of traditional architectural knowledge in contemporary climate-responsive design. It defined the research problem, identified gaps, and established the study's objectives and methodology.

A comprehensive review of existing literature is essential to contextualize this research. The next chapter examines traditional and contemporary architecture, climate-responsive strategies, and user perception etc, providing the theoretical foundation for this study.

Chapter II: LITERATURE STUDY

2.1 Chapter Overview

This chapter reviews the body of literature relevant to understanding the conceptual and contextual foundations of this study. The review is organised thematically to trace how knowledge about traditional architecture, contemporary practice, climate-responsive design, and user perception has evolved, and how these strands converge in the context of Assam-type houses (ATHs).

The discussion is divided into six broad thematic sections:

- a. Traditional architecture, outlining its definitions, characteristics, and analytical approaches used in earlier studies;
- b. Contemporary architecture, describing its conceptual and material contrast with traditional forms;
- c. Climatic aspects and climate-responsive design, explaining environmental determinants and passive-active strategies;
- d. Perception study, examining the role of user perception in evaluating and adapting design features;
- e. Regional context of North-East India and Assam, situating the study within its geographical and socio-cultural background; and
- f. Assam-type houses, reviewing their evolution, climatic logic, and previous scholarly analyses.

Within each thematic group, prior research is discussed in terms of its scope, analytical method, and outcomes. Each section concludes with observations that summarise key strengths and limitations, setting up the rationale for the present study.

The review therefore establishes a coherent understanding of how traditional climatic wisdom and user-centred insights intersect, providing the conceptual foundation for the triangulated methodological framework introduced in the next chapter. An accompanying addendum updates this review with recent international literature on traditional architecture and climate-adaptive design (2019–2025).

2.2 Traditional Architecture

Traditional architecture is a vast conceptual term and is connected to several aspects of the built environment. Ironically the term ‘architecture’ is used to describe these building where probably an architect or designer was not even involved. However, there has been a lot of questions in the coining of the term as there are differences in the way of explanation of term and the application (Oliver, 2006).

2.2.1 Definition and Characteristics

Since the early 1970s, the term *traditional* has come into use to describe buildings that were once labelled as *primitive*, *folk*, *indigenous*, or *vernacular*. Paul Oliver points out that *tradition* is defined in *The Concise Oxford Dictionary* (1954) as “opinion or belief or custom handed down from ancestors to posterity,” “doctrine supposed to have divine authority but not committed to writing,” and “artistic or literary principles based on accumulated experience or continuous usage.” However, he argues that such definitions fail to specify a particular architectural style, which makes applying the term to architecture problematic.

Another widely used term for *traditional* is *vernacular*. Various definitions emphasize the unique local or regional qualities of vernacular architecture, which set it apart from *modern* architecture, often seen as more national or international (Mercer, 1975; Brunskill, 1987; Carter and Cromley, 2005). Some definitions highlight the social aspects of construction, referring to vernacular architecture as *hand-built* (Steen et al., 2003; May, 2010), *architecture without architects* (Rudofsky, 1964, 1977), or *the architecture of the people* (Oliver, 1997, 2003, 2006), distinguishing it from more industrial, formalized, or elite forms of architecture. Other interpretations blend regional and social aspects, describing vernacular architecture as the *common*, everyday structures found in specific parts of the world (Upton and Vlach, 1986; Heath, 2009). Across these definitions, a shared characteristic is the emphasis on the methods of production, such as local materials, manual labour, or regionally adapted techniques, that identify vernacular architecture as a unified category distinct from other architectural forms (Vellinga, 2011).

Sociologist Edward Shils presents an inclusive theory of tradition, describing it as encompassing not only beliefs and customs but also objects and practices passed down from the past to the present. For Shils, tradition consists of “that which is handed down”, material objects, beliefs, representations of people and events, practices, and institutions. This

includes everything from buildings, monuments, and landscapes to sculptures, books, tools, and machinery. It represents all that a society inherits from previous generations, apart from elements purely shaped by natural or environmental factors (Shils, 1971).

In *The Invention of Tradition*, Eric Hobsbawm and Terence Ranger argue that traditions are not static but evolve over time, often starting as innovations. These innovations gain significance and are regarded as traditions after being passed down through multiple generations. By the third generation, the practice has typically distanced itself from its original context and is imbued with a sense of historical continuity and cultural value (Hobsbawm & Ranger, 1983).

This concept can be applied to traditional architecture, which is closely tied to the cultural context from which it emerges. The cultural influences that shape traditional architecture can be observed in several areas, including:

- Religious beliefs and superstitions
- Social values and lifestyles
- Family and kinship structures
- Artistic expressions
- The psychological needs of individuals and societies

The study of vernacular architecture gained considerable attention in the 20th century, particularly after Bernard Rudofsky's 1964 exhibition, *Architecture without Architects*, at the Metropolitan Museum of Art in New York. This exhibition sparked new interest in traditional building practices, leading to further studies on vernacular architecture. Notable milestones in this academic field include the publication of the *Encyclopaedia of Vernacular Architecture of the World* (1997) and the *ICOMOS Charter on Built Vernacular Heritage* (1999), which highlighted the value of these architectural forms. Since then, numerous researchers and architects have embraced vernacular design principles, integrating them into contemporary architecture.

Yet, even in 2018, as we observe the architecture of our cities and towns, it is clear that powerful forces such as globalization, modernization, and industrialization often overshadow the values of tradition, culture, sustainability, and ecological sensitivity.

The significance of traditional architecture is well documented, with the *ICOMOS Charter for Built Vernacular Heritage* (1999) emphasizing that vernacular buildings are essential expressions of the cultural identity of a community, reflecting its relationship to the land and contributing to the diversity of global heritage.

While understanding the importance of traditional architecture is crucial, it is equally important to explore how to protect and preserve it. Paul Oliver, in his work, suggests that the preservation of vernacular architecture is not about freezing these traditions in time but rather about understanding the evolving knowledge systems, construction techniques, and environmental adaptations that have defined these practices while maintaining their distinctive character (Oliver, 2003).

This thesis aims to explore the conflicts that arise within the built environment, particularly those related to traditional architecture. It seeks to understand the importance of traditional architectural knowledge and its relevance in the contemporary context. Moreover, it investigates how to strike a balance between traditional and contemporary approaches in design.

2.2.2 Traditional and Vernacular Architecture

Vernacular architecture, derived from the Latin word *vernaculus*, meaning "native" or "local," refers to the "native science of building" (Oliver, 2006). It encompasses structures that are shaped by and built in response to the specific environmental conditions, available materials, and cultural practices of a particular region. These buildings are typically constructed by local communities or individuals rather than professional architects, using traditional techniques and materials that have been passed down over generations. The defining characteristic of vernacular architecture is that it evolves over time, shaped by trial and error, and is deeply embedded in the local context, reflecting the needs, values, and skills of the people who create it (Oliver, 2006).

The *Encyclopaedia of Vernacular Architecture* defines it as buildings that are directly tied to their environmental context and available resources. These structures are customarily built by local people, using locally available or natural materials like wood, stone, earth, or bamboo. Vernacular architecture is regionally and socially specific, with each community developing solutions to its unique challenges. Over time, these solutions become refined and passed down, creating a cultural continuity that links past generations to the present (Oliver, 2006).

Amos Rapoport (1969) elaborates further by noting that vernacular architecture arises from a "complex interaction of materials, cultural skills, climatic conditions, and economic levels" within a specific locale. These structures are not simply individual responses to needs but rather collective, community-driven solutions that evolve through continuous adaptation to the local environment. The vernacular building process, driven by communal knowledge and trial-and-error experimentation, results in designs that are well-suited to their geographical, climatic, and social contexts.

Although vernacular architecture has been traditionally understood as focusing on local and natural materials, it is important to recognize that traditional architecture, while often associated with grand, formal structures like temples and palaces, can also include smaller, more commonplace buildings like houses, which may share similar building materials and techniques with vernacular forms. However, the key difference lies in the *practice* and *continuity* of these building forms. Traditional architecture, whether monumental or residential, is still considered traditional if it has been practiced over generations. For example, in certain cultures, even the construction of houses may be regarded as part of a broader traditional architectural practice, particularly if the design and construction methods have been handed down through many generations, regardless of the materials used (Asquith and Vellinga 2006).

While traditional architecture may incorporate modern materials such as steel, concrete, or glass, as long as these materials are used in ways that align with longstanding cultural practices and construction methods, the structure can still be considered "traditional" (Asquith and Vellinga 2006). In contrast, vernacular architecture places a stronger emphasis on the local availability of materials, often relying on natural or locally sourced materials that are shaped by the environment itself. The materials used in vernacular construction are typically chosen for their suitability to the local climate and their availability in the surrounding area. These materials may include stone, wood, mud, clay, and other natural resources that are indigenous to the region, further emphasizing the deep connection between vernacular architecture and the environment (Fathy 1986).

Vernacular architecture also evolves more organically and incrementally, with modifications being made over time in response to changing environmental conditions, cultural shifts, or new technological innovations. As Rapoport (1969) suggests, vernacular dwellings and settlements are the result of an ongoing "system of trial and error," reflecting a

collective wisdom that develops over generations. Each new generation adapts the existing knowledge to meet new needs or challenges, refining the architectural practices without necessarily abandoning the traditional forms.

In contrast, traditional architecture is often more formal and codified, with established rules and designs that may be dictated by religious, political, or cultural ideals. These structures, such as temples, palaces, and other monumental buildings, are designed to serve specific symbolic or ceremonial purposes, and while they may also respond to environmental needs (e.g., using natural light or ventilation), their primary function is often related to cultural expression, social status, or religious reverence. However, traditional architecture can include smaller structures like houses as well, which might blend elements of both vernacular and traditional practices, depending on the region and historical context.

In summary, while vernacular architecture is deeply rooted in the local availability of materials and responds directly to environmental conditions, traditional architecture can encompass a wider range of building types and may include the use of modern materials, as long as these practices have been followed over time. The primary distinction between the two lies in their origins and the way they evolve: vernacular architecture is more focused on local resource use and community-driven solutions, while traditional architecture may also reflect broader cultural or symbolic purposes, even if it adapts over time to incorporate new materials and techniques. Both, however, are essential to understanding the built environment of a particular region, representing the accumulated knowledge, cultural practices, and environmental adaptations of their communities.

2.2.3 Traditional Residential Architecture in India

Traditional architecture in India represents a rich fabric of diverse styles, techniques, and materials that have evolved over ages, reflecting the country's varied climate, geography, and cultural influences. This architectural heritage encompasses a wide range of structures, from humble dwellings to grand temples and palaces, each embodying unique regional characteristics and historical significance.

Traditional residential architecture in India is renowned for its ability to adapt to local conditions and its focus on creating a harmonious relationship with the natural environment. As Jain (2019, p. 78) observes, "The traditional Indian house was a microcosm of the larger

cosmic order, designed to create a balance between the built form and the natural environment." This approach resulted in sustainable building practices long before the concept became a global concern.

Traditional Indian residential architecture is characterized by a wide range of regional styles, each with its own distinctive features. For instance, the large, open verandas and sloping roofs of the houses in the hill regions of Himachal Pradesh differ significantly from the compact, mud-brick homes with thick walls and flat roofs found in the desert regions of Rajasthan. These architectural differences are influenced not only by the local climate but also by the cultural and historical contexts that have shaped each region's building traditions. (Tadgell, 1990). This regional variation is not only a reflection of climatic differences but also of cultural and historical influences.

Climate has played a pivotal role in shaping the traditional residential architecture of India, acting as a guiding force in the design, materials, and spatial organization of homes across its diverse regions. India's vast geographical expanse encompasses a variety of climatic zones, from the snow-clad Himalayas and the arid deserts of Rajasthan to the humid tropical coasts of Kerala and the flood-prone plains of Assam. Each of these regions has given rise to unique architectural solutions tailored to local environmental challenges. Traditional homes in India are more than mere shelters; they are sophisticated responses to climatic needs, designed to ensure comfort, sustainability, and harmony with nature.

For example, the hot and arid zones of Rajasthan saw the emergence of thick-walled havelis and compact settlements that minimized solar exposure, while the humid coastal areas of Kerala developed sloping roofs and open courtyards to tackle heavy rainfall and high humidity. In Assam, homes built on stilts protect against frequent floods and allow ventilation in a tropical environment. These architectural forms are not only functional but also deeply integrated with cultural practices, demonstrating a seamless blend of environmental adaptation and social life.

The interplay of climate and architecture in traditional Indian homes is marked by an emphasis on passive design strategies, such as orientation, ventilation, and shading, to regulate indoor temperatures and create comfortable living environments. This approach shows the ingenuity of traditional builders who used locally available materials like bamboo, stone, mud, and lime to craft structures perfectly suited to their surroundings. In a world facing

challenges of climate change and energy efficiency, the climate-responsive designs of India's traditional homes stand as timeless examples of sustainable living and resourceful adaptation.

2.2.4 Traditional Architecture in India with respect to Climatic Zones

Traditional architecture in India showcases a remarkable diversity of styles and techniques that have evolved over centuries in response to the country's varied bioclimatic zones. From the arid deserts of Rajasthan to the tropical coasts of Kerala, and from the cold Himalayan regions to the humid plains of Bengal, each area has developed unique architectural solutions that harmonize with local climate, available materials, and cultural practices (Vellinga et al., 2007).

Research has shown that traditional Indian architecture is highly adaptable to different climatic conditions, making it both sustainable and efficient. Step wells in arid regions, for example, were not just a source of water but also helped cool their surroundings, proving their effectiveness in managing extreme heat (Ford et al., 2010). Likewise, houses in Jaisalmer and Ladakh are designed to endure harsh temperatures, while Nalukettu houses in South India naturally enhance ventilation and keep interiors cool (Krishan, 1996; Vyas, 2005). In cities like Mumbai, Ahmedabad, and Old Delhi, traditional houses were built with thoughtful climate-responsive strategies, ensuring comfort without excessive reliance on artificial cooling (Kotharkar, 2008; Agrawal, 2009; Prasad, 1998). These architectural traditions not only showcase centuries of wisdom but also offer valuable lessons for creating sustainable and climate-responsive buildings today.

Mapping traditional architecture in India based on climatic zones is beneficial because it considers the local climate and environmental conditions, which have significantly influenced architectural styles.

1. Traditional architecture has evolved by adapting to the diverse climates in India. (Manzano-Agugliaro et al., 2015)
2. It thus incorporates features like natural ventilation, shading, suitable materials etc. (Kamal, 2021)
3. Mapping traditional architecture based on climatic zones helps in better understanding of the ecological context of traditional structures.

2.2.4.1 Examples of Traditional Architecture Across Various Climatic Zones of India

Examples of traditional houses across India illustrate how climate significantly influences their orientation, form, layout, and choice of materials. Climate thus serves as one of the most effective criteria for categorizing the diverse typologies of traditional Indian architecture. Climatic conditions also play a major role in thermal comfort. India has a wide range of bioclimatic (or climatic) zones. The National Building Code of India classifies India under the following climatic zones -

- a. Hot And Dry
- b. Warm and Humid
- c. Temperate
- d. Cold
- e. Composite

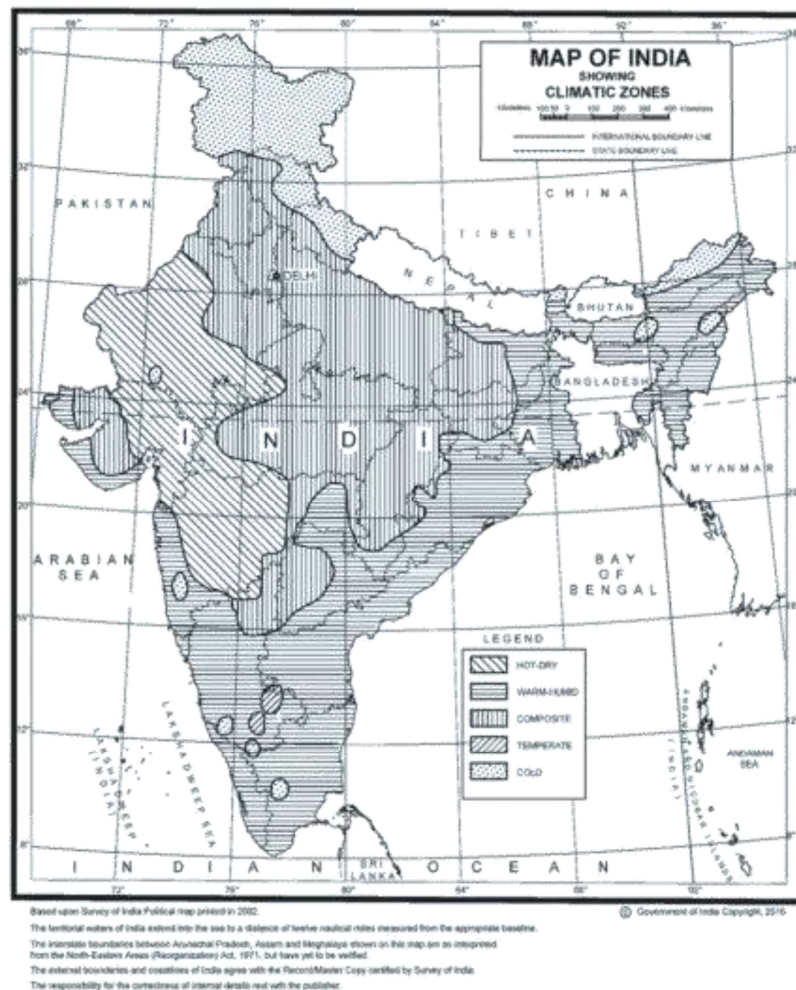


Figure 2.1: Climatic Zones of India (Source: Bureau of Indian Standards, 2016)

a. Hot and Dry Climatic Zone – Traditional Architecture – Jaisalmer, Rajasthan

This region, located in the northwestern part of India, includes areas like Jaisalmer, Jodhpur, and the Thar Desert, spanning across Rajasthan and parts of Gujarat. Characterized by flat, sandy, and rocky terrain, the landscape is dotted with cacti and thorny bushes, with little vegetation. The dry climate, due to low humidity, results in extremely hot summers accompanied by strong winds and frequent sandstorms.

A defining feature of traditional architecture in this region is the ‘haveli’, a style of residence typically built as two or three-story structures. These houses are centred around a courtyard, which serves as the heart of the house, providing natural light and ventilation. The rooms are arranged around this open space, creating a passive cooling effect. To minimize heat gain, the street-facing side of the building is kept narrow. Additionally, houses are closely packed together, allowing them to cast shadows on one another, which helps in keeping the streets and interiors cooler.

The design of these buildings incorporates natural ventilation techniques. Hot air rises from the courtyard through convection, while cooler air is drawn in from the narrow streets, ensuring continuous airflow. The ‘jharokhas,’ or overhanging enclosed balconies with intricate jaali (lattice) work, extend outward from the upper floors, enabling women to observe street activities while maintaining privacy. Elements like chajjas (overhanging eaves) and jharokhas also provide shade, reducing heat absorption on the façade.

Locally sourced materials such as stone and timber are used for construction, making these buildings cost-effective and well-suited for the harsh desert climate. Skilled local craftsmen build these structures, ensuring durability while preserving the architectural heritage of the region (Bera, 2019).

b. Warm and Humid Zone – Traditional Architecture - Kerala

This region encompasses India’s coastal areas, including major cities such as Mumbai, Chennai, and Kolkata. Due to the high humidity, the landscape here is lush with abundant vegetation. Kerala stands out for its distinct cultural and linguistic identity, shaped in part by its unique climatic conditions (Tipnis, 2012).

Traditional houses in Kerala are designed to adapt to the region's tropical climate. Typically, these houses are elevated on a high plinth, with spacious verandas on two sides. The layout revolves around a central courtyard, which, along with the deep verandas, facilitates cross-ventilation, keeping the interiors cool and comfortable. To withstand the region's heavy rainfall, houses feature sloping roofs that allow water to run off efficiently.

These houses blend seamlessly into their natural surroundings, often nestled among dense tree plantations. Locally available materials are predominantly used for construction, ensuring sustainability and durability. Foundations are made of granite, while laterite is commonly used for walls. Timber is utilized for wall facings and roof frames, with Mangalore tiles serving as the primary roofing material. Other materials, such as mud, thatch, coconut leaves, and bamboo, are also integrated into the design.

c. Temperate Zone – Traditional Architecture – Pune, Maharashtra

This climatic zone prevails in comparatively smaller areas. A major city which falls in this zone is Bangalore (Karnataka). Areas having a temperate climate are generally located on hilly or high-plateau regions with abundant vegetation. The solar radiation in this region is more or less the same throughout the year. Being located at relatively higher elevations, these places experience lower temperatures than hot and dry regions. The temperatures are neither too hot nor too cold. In summers, the temperature reaches 30-34°C during the day and 17-24°C at night. In winter, the maximum temperature is between 27 to 33 °C during the day and 16 to 18 °C at night. The design criteria in the moderate zone are to reduce heat gain by providing shading, and to promote heat loss by ventilation.

The 'Thotti Mane', translating to "courtyard house" in Kannada, is a traditional architectural style prevalent in Bangalore, Karnataka. This design centres around a central courtyard, serving as the nucleus of the home, facilitating natural light, ventilation, and acting as a communal space for family activities. The courtyard is often surrounded by a semi-open passage, creating a seamless transition between indoor and outdoor environments. Materials such as exposed brick, compressed earth blocks, and Mangalore tiles are commonly utilized, not only for their aesthetic appeal but also for their thermal efficiency, maintaining comfortable indoor temperatures. The incorporation of sloped roofs aids in efficient rainwater drainage, essential during monsoon seasons. This architectural approach

harmoniously blends functionality with cultural heritage, fostering a sustainable and comfortable living environment (Srinivasan, 2015).

d. Cold Zone– Traditional Architecture - Ladakh

Ladakh, a union territory in northern India and part of the Kashmir region, is the country's highest plateau, with much of its land rising above 3,000 meters. Its extreme climate, with harsh winters dropping to -40°C and summers reaching 35°C , has shaped its traditional architecture over centuries. The region receives minimal rainfall, limiting tree growth and making timber scarce (Ferrari, 2018).

Traditional Ladakhi houses are built using locally available earth, stone, and wood. Sun-dried mud bricks and rammed earth are the primary construction methods, chosen for their insulating properties. Thick walls of mud and straw provide warmth, while timber lintels act as thermal barriers to prevent heat loss. Houses are designed to maximize sunlight, with main living spaces facing south. Even in freezing winters, these structures can maintain indoor temperatures over 40°C warmer than the outside (Nasir Kamal, 2021).

Larger houses are often built around a courtyard, while smaller ones follow a compact design. The ground floor typically shelters livestock and stores supplies, while the upper floor serves as the main living area, featuring a prayer room, kitchen, and bedrooms. Kitchens are placed near sleeping areas so that cooking heat contributes to indoor warmth. A central, ornately carved timber post is a distinctive architectural feature, adding both structural support and aesthetic value (Nasir Kamal, 2021). Ladakh's architecture is a testament to its people's resilience, blending functionality with sustainability to withstand one of the world's harshest climates.

e. Composite Zone- Traditional Architecture – Delhi

Most of the states in Central India have a mix of hot and dry, and warm and humid weather, with only a few months of each. The climate-responsive architecture found in such regions incorporates elements from both, focusing on withstanding heat as well as rain. Elements such as courtyards, big overhangs, water features, landscaping, neutral colours, etc are commonly used. Such traditional buildings are built from locally available materials & resources.

The Havelis of Delhi and the regions around are an example. There is a limited amount of land available for havelis, which are typically townhouses grouped together and defined by social ties to caste, family, and occupation.

In a limited space, a courtyard design offers the most usable outside space while also offering privacy, security, and ventilation. Havelis were created with a variety of areas, from exterior courts (chowks) and terraces to verandas to interior rooms, for use at various times of day and throughout the year in order to reduce the excesses of the hot environment. Through breezes were welcomed, and often the only doors were on the store rooms.

When more warmth was needed, curtains were hung over openings or bamboo blinds were used to offer shade while maintaining air flows. Some grander Mughal houses had cool underground rooms, but less extravagant cooling methods included screens of 'khas' grass soaked in water, hand held fans, and awnings (Guerrieri, 2018, Ali 2012).

2.2.5 Approaches to Study Traditional Architecture

To understand how traditional architecture has been studied, a review of several published research papers and books was conducted. The analysis revealed that most studies focused on traditional architecture through specific architectural elements, such as roofs, walls, and spatial organization. This approach appeared to be the most common and effective method for understanding the nuances of traditional building practices. By examining the recurring elements mentioned across various studies, it became clear that certain architectural features were frequently identified as key to the study of traditional architecture. Based on this review, a list of these common elements was compiled, reflecting the most suggested aspects of traditional architecture as outlined in the literature. Among the wide range of literature reviewed, the following 20 selected books, research papers, reports etc on traditional architecture, emerged as the most relevant due to their comprehensive approach and methodological clarity. This list serves as the foundation for the study of traditional architecture in this research.

Table 2.1: Review of Literature Showcasing Building Elements Used in the Study of Traditional Architecture (Source: Author)

Sl.No	Book/ Research Paper/Report/Thesis	Author	Year of Publication	Building Elements
1	World Housing Encyclopedia – Housing Report Assam-Type House	Hemant B. Kaushik, K.S Ravindra Babu	2009	a. Structural system – Masonry, structural concrete, steel, timber b. Floor and roof system c. Foundation
2	Assessment Of The Climate Responsive Architecture Of Traditional Houses Of Warm Humid Climate Zone - A Case Study Of Chettinadu Dwellings Of Tamilnadu	Radhakrishnan S (Anna University)	2011	a. Building orientation b. Various spatial arrangements (living room, bed room, courtyard etc) c. The building envelope (walls, floor, openings, roof) d. Materials and methods of construction
3	A Study On Climate Responsive Vernacular Architecture Of Bikaner	Tanaya Verma (Sushant University)	2021	a. Urban fabric b. Street composition and orientation c. Spatial composition d. Building Envelope (Walls, openings, roof, ground) e. Material and construction technique f. Thermal behaviour
4	Earthen Dwellings and Structures – Current Status in Their Adoption Chapter 36 – Exploring The Attributes of Vernacular Assam Type House Design Techniques In Contemporary Setting	Shiva Ji and Ravi Mokashi Punekar	2019	a. Dimension and size b. Structure c. Planning and Costing d. Foundations e. Flooring f. Walls g. Roofing h. Materials
5	Analysis Of Traditional Building Techniques and Damage Assessment of Traditional Turkish House: The Study of Timber-Framed Kula Houses International Journal of	Mine Tanac Zeren, Ozgul Yilmaz Karaman	2015	a. Spatial Organisation b. Structural system and its components c. Floor d. Roof e. Projections

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	Architectural Research Archnet-IJAR			f. Architectural building components - Doors, windows, fireplace, ceiling, Facade, Stairs, Ornaments, Eaves
6	Living the Common Styles- Kerala and South Kanara Traditional Architecture	Dr. Lekha S Hegde	2020	a. Planning and layout b. Material and methods of construction c. Roof form d. Elevation treatment
7	Learned Lessons from Traditional Architecture in Yemen -Towards Sustainable Architecture	Ahmed S Attia	2022	a. Spatial organisation b. Construction system and building material c. Openings and ornaments
8	A Review on Vernacular Architecture of Chhattisgarh	Shanta Dash and Mahendra Joshi	2022	a. Orientation b. Raised platform c. Planning type Floor d. Walls e. Plaster/finish f. Doors g. Windows h. Openings i. Roof j. Structure k. Materials l. Compound wall
9	Study on Architectural Characteristic and Natural Environment Control System of Japanese Traditional House: Case Study Traditional Houses in Kitakyushu City, Japan	Dian Sekartaji, Bart Dewancker	2013	a. Basic form b. Structure- Main structure, roof , wall, floor, foundation c. Materials- Envelope, Roof, Wall, Ceiling, Floor d. Spatial Organisation e. Details
10	People's Acceptance of Vernacular Houses - Transformed Dwellings of Ghantasala, Andhra Pradesh	Venkata Krishna Kumar Sadhu*, Srikonda Ramesh	2019	a. Plan b. Openings c. Roofing d. Flooring e. Structural support f. Mouldings g. Walls h. Outside seating

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				i. Open space
11	Design of Building Elements in Traditional Houses (A Case Study in Kırklareli/Turkey)	Izzet YÜKSEK	2013	a. Basement b. Walls c. Flooring d. Ceiling e. Roof f. Chimney g. Wall coating
12	Analysis of Interior Elements on the Atmosphere of Interior Space in Cikondang Traditional House	Mutiara Silmi Muzaki, Tiara Isfiaty	2023	a. Wall b. Roof c. Floor d. Interior Elements
13	Socio-cultural transformations in modernity and household patterns: a study on local traditions housing and the impact and evolution of vernacular architecture in Yazd, Iran	Aimal Formolly, M H Saraei	2024	a. Wall b. Roof c. Floor d. Foundation e. Courtyard f. Doors and Windows
14	Assessment of multi-dimensional sustainability of vernacular architecture from global perspective: A critical review over the period (2000-2023)	Aritra Majumder, Anupam Debsarkar	2024	a. Wall b. Roof c. Floor d. Foundation
15	Vernacular Residential Architecture in the Context of Sustainability – Case Study of Svrzo's House Complex	Sanja P. Martinić, Nurin Zecevic, Amira Salihbegovic	2023	a. Walls b. Roof c. Floor d. Foundation e. Natural Elements
16	Employing Vernacular Urbanism and Traditional Practices in Enhancing Contemporary Cities: Insights from India	Spoorthi Chikkaveerappa, Sruti Rashmit, Joyce Sequeira		a. Walls b. Roof c. Floor d. Foundation e. Opening f. Open Space g. Layout h. Structure

17	Vernacular Architecture: Exploring the Architectural Characteristics and Changes in Traditional Settlements of Rana Tharu from Far Western Nepal	Kishan Datta Bhatta, Madhab Raj Neupane, and Sudeep Sharma Paudyal.	2023	<ul style="list-style-type: none"> a. Walls b. Roof c. Floor d. Foundation e. Opening f. Open Space - courtyard g. Layout h. Structure
18	Analysis of Passive Strategies in Traditional Vernacular Architecture	Pedro Moscoso-García and Felipe Quesada-Molina	2023	<ul style="list-style-type: none"> a. Walls b. Roof c. Floor d. Structure e. Opening f. Patio/ Open Space g. Layout
19	Study on Vietnamese Design Methods of Traditional Vernacular Architecture and Discussion on Their Technical Origins	Vinh An Le, Dinh Son Cao	2023	<ul style="list-style-type: none"> a. Walls b. Roof c. Floor d. Structure e. Opening f. Open Space - courtyard g. Layout
20	The Study of Traditional Architectural Elements on Modern Building Design	Zeja Zhang	2024	<ul style="list-style-type: none"> a. Structural elements b. Decorative features d. Spatial features

In the study of traditional architecture, understanding the building elements and their respective attributes is crucial for analysing the design, function, and cultural significance of a building. These elements, such as the roof, walls, floors, openings, courtyards, and spatial arrangements, are integral to the overall form and function of the building. The attributes associated with these elements, including form or shape, primary material, size or dimension, colour or finish, passive design features, location or site, and unique regional features, provide a deeper understanding of how traditional buildings respond to both environmental conditions and cultural needs. While previous studies may not always combine all these attributes explicitly, they are frequently explored across various studies through different elements. The selection of these attributes is based on the recurring themes observed in the

reviewed literature, which consistently highlight the role of these factors in defining traditional architectural elements. Form or shape, primary material, and size or dimension are essential for understanding the physical composition and structural integrity of elements like the roof, walls, or floor. Colour or finish plays a key role in the aesthetic and cultural expression of building elements. Passive design features, such as natural ventilation, thermal insulation, and sun shading, are vital for the environmental performance of elements like the roof or walls, enhancing their climate responsiveness. Location or site influences how the building elements interact with the surrounding environment, while unique regional features, such as locally sourced materials or specific design patterns, give the architecture its distinct regional identity. Collectively, these attributes provide a comprehensive framework for analysing the building elements of traditional architecture, aligning with the predominant approaches identified in the reviewed literature.

From this section of the research the following list of traditional building elements and their attributes have been derived.

a. Building elements:

- Structural System
- Roof System
- Orientation
- Spatial Arrangement
- Building envelope – Wall, Roof, Floor, Openings
- Foundation
- Open Space
- Compound Wall
- Basement / Attic
- Other elements – Ceiling, Stairs, Façade, Ornaments, Fireplace

b. Attributes of the building elements:

- Form or Shape – The geometry or physical configuration of the element.

- Primary Material – The dominant material used in the construction of the element.
- Size and Dimension – The scale and proportions of the element.
- Colour or Finish – The surface treatment, colour, and texture of the element.
- Passive Design Features – The features which help in improving thermal comfort, ventilation, and light distribution naturally.
- Location or Site – The positioning of the element within the building or its relationship to the surrounding environment.
- Unique Regional Features – Distinctive characteristics influenced by local climate conditions, culture, or traditional building techniques.

From the identified building elements and their corresponding attributes, it becomes evident that these elements and attributes together form a framework that defines the core aspects of traditional architecture. Just as in various technical fields, where the combination of elements and their attributes is used to define specific parameters or configurations, we can similarly consider these elements and attributes as parameters for understanding traditional architecture.

In various technical contexts, the term ‘parameter’ is used to describe a specific configuration or input value, often represented by an element and its associated attributes. For instance, in the field of Information Technology (IT), XML-based frameworks, such as XML Schema Definitions (XSD), attributes define additional information about an element, modifying or specifying its characteristics, thereby acting as parameters that shape the element’s function or behaviour (W3Schools, n.d). Similarly in systems like IBM’s AIX operating system, a parameter is represented by an element that includes attributes like name, value, and apply type to specify its properties (IBM, n.d).

- c. Parameters of Traditional Architecture:** Drawing from this conceptual framework, we can extend the definition of parameters to the study of traditional architecture. Here, the building elements, such as the roof, walls, and courtyards, serve as the ‘elements,’ while their corresponding attributes, including form, material, and size, represent the defining ‘attributes.’ Just as in technical fields, where elements and attributes combine to form parameters, in traditional architecture, the

combination of these building elements and attributes forms the parameters that define and guide the study of traditional architecture.

2.2.6 Critical Understanding – Traditional Architecture

The literature on traditional and vernacular architecture provides valuable insights into how culture, local materials, and climate together influence the design of buildings. These studies reveal the wisdom behind region-specific construction techniques and their ability to create comfort using natural means.

Across these works, researchers have used different ways of studying traditional architecture, depending on their regional or disciplinary focus. While this diversity enriches understanding, it also means that findings are not always directly comparable. In addition, fewer studies have explored how people themselves perceive or value traditional spaces and elements in everyday life an aspect that is important for linking cultural knowledge with present-day needs.

Recognizing these observations, the present study adopts and consolidates the commonly identified aspects of traditional architecture into a systematic framework, which forms the foundation of the methodological approach later used in this thesis to study Assam-type houses and their climate-responsive potential.

2.3 Contemporary Architecture

Unlike traditional architecture, which is deeply rooted in cultural and regional practices, contemporary architecture focuses on innovation, functionality, and the use of cutting-edge technology. It embraces bold, diverse designs and materials to create spaces that respond to modern needs and aesthetics.

2.3.1 Definition and Characteristics

The Oxford Dictionary defines "contemporary" as "belonging to the present time," highlighting the challenge of defining contemporary architecture through fixed features or characteristics. Unlike modern architecture, which emerged in the early to mid-20th century and emphasized clean lines and functional design (Galal, 2013), contemporary architecture is more fluid, reflecting the present moment.

Norwegian architect Johan Fredrik Ellefsen captured the spirit of this transition during his influential 1927 lecture at the Oslo Architectural Society, often referred to as "the manifestation of modernism." He argued that a new architectural style should find its expression in technology, which, at the time, symbolized societal progress and artistic achievement. Engineering was celebrated as a pure and functional art form, ideally suited to the needs of a modernizing world (Rustad, 2009).

Building on this perspective, Holmes (2006) noted that the 19th and 20th centuries marked a turning point in technological advancement, ushering in changes of an unprecedented scale. These developments not only transformed society but were also embraced as rational, inevitable, and progressive by architects who sought to align their designs with the technological momentum of the era.

This shift from tradition to innovation and technology laid the groundwork for the architectural experimentation we associate with contemporary design today. It is a reflection of societal values, challenges, and aspirations, continuously evolving to respond to the needs of the present.

2.3.2 Contemporary and Modern Architecture

The terms "modern architecture" and "contemporary architecture" are often used interchangeably, but they refer to distinct periods and approaches in the architectural field. While both represent shifts from traditional styles and emphasize innovation, they differ in their historical context, principles, and design philosophies. Understanding these differences helps clarify their roles in shaping the built environment.

Modern architecture, which emerged in the early 20th century, was part of a broader movement known as modernism. It was characterized by a rejection of ornate, historical styles in favour of clean lines, functional design, and the use of new materials and technologies like steel, glass, and reinforced concrete. Modernism was driven by the belief that architecture could reflect the progress and ideals of the modern industrial world. The focus was on creating functional, efficient, and "timeless" designs that embodied the technological advancements of the time. Architects such as Le Corbusier, Ludwig Mies van der Rohe, and Frank Lloyd Wright became icons of modern architecture, with their works promoting minimalist aesthetics and an emphasis on form following function. Modernism sought a

universal, rational approach to design that aimed to improve society (Dean Larkin Design, 2024) (Ralston Architects, 2024).

Contemporary architecture, on the other hand, refers to the architecture of today, starting in the late 20th century and continuing into the present. Unlike modern architecture, contemporary design is not bound by a specific style or set of principles. Instead, it is fluid and ever-evolving, responding to current cultural, technological, and environmental trends. One of the defining characteristics of contemporary architecture is its diversity; it is a melting pot of different styles, techniques, and influences, making it hard to pin down to one uniform aesthetic. Sustainability is a major focus of contemporary design, with architects incorporating energy-efficient materials, renewable energy sources, and environmentally friendly construction methods. There is also a strong emphasis on technology, with the use of smart building systems, automated features, and advanced materials like composites and nanomaterials. Notable contemporary architects like Zaha Hadid, Bjarke Ingels, and Norman Foster have pioneered works that reflect the evolving needs of society, integrating form, function, and environmental consciousness (Ralston Architects, 2024) (Sen, 2022).

Despite the distinct characteristics of modern and contemporary architecture, there are overlaps, especially in their emphasis on innovation and breaking away from traditional architectural forms. Modern architecture laid the foundation for many of the principles found in contemporary design, particularly the use of industrial materials and the idea of function over ornamentation. However, contemporary architecture goes beyond modernism's functionalism to incorporate a wider range of expressive, cultural, and sustainable considerations. While modern architecture was about creating a new, universal language for the modern world, contemporary architecture is more diverse, adaptable, and responsive to the challenges of today's world.

2.3.3 Globalisation and Architectural Identity

Architectural character plays a pivotal role in defining the identity of a place, serving as a cornerstone in shaping the quality of the built environment. In an increasingly interconnected world, urban areas and neighbourhoods are facing profound challenges brought about by globalization. Although the term "globalization" was coined in the mid-20th century, it was not until the 1980s that its influence began to significantly impact public consciousness and shape discourse in multiple sectors, including architecture (Galal, 2013; Holmes, 2006). This global transformation has dramatically reshaped urban planning,

architectural design, and the overall evolution of cities, resulting in cities that are more interconnected and globally influenced than ever before. Globalization has allowed diverse regions of the world to influence each other, thus fostering a reciprocal flow of ideas, trends, and cultural expressions (Galal, 2013; Oncu and Weyland, 1997).

One of the most visible effects of globalization on architecture is the growing uniformity in design, which has blurred the lines between urban and rural areas. The accessibility of modern materials such as glass, steel, and concrete, fuelled by advancements in transportation, has contributed to a more standardized architectural language that spans continents. As a result, the same materials and designs are now available globally, providing a universal sense of comfort and modernity. However, this widespread availability also raises concerns. Galal (2013) observes that there has long been a tension between the forces of local and global architecture. On one hand, there is a push to preserve and celebrate indigenous architectural traditions, forms, and technologies, emphasizing cultural continuity, diversity, and the protection of local identity. On the other hand, global architectural trends often embrace technological innovation, driving the creation of new forms and structures that meet evolving functional needs and reflect contemporary sensibilities (Lewis, 2002).

The ongoing debate between traditional and contemporary architectural ideologies invites deeper examination. Is there an inherent conflict between these two forces, and if so, what causes this tension? Nadia M. Alhasani, in her research paper *Tradition vs. Modernity* (1996), suggests that the two opposing forces need not be in direct conflict. Instead, they can coexist harmoniously through the thoughtful integration of traditional and modern elements. Alhasani argues that architecture's symbolism plays a critical role in preserving cultural identity. The more symbolic an architectural form is, the more it reflects the culture it belongs to. However, as abstraction increases in modern architecture, the connection between the building and its cultural origin may diminish, leading to a loss of contextual significance.

Alhasani further elaborates on the relationship between culture and technology, which underpins both tradition and modernity. She categorizes the interplay of these two forces into four frameworks:

- traditional technologies applied to traditional forms,
- traditional technologies applied to modern forms,

- modern technologies applied to traditional forms, and
- modern technologies applied to modern forms.

These frameworks illustrate different ways of integrating technology into architectural forms, balancing the global trend of "universalization" with the need for "contextualization." Universalization seeks standardization and global applicability through modern materials and methods, whereas contextualization emphasizes tailoring designs to local cultural and environmental factors.

The tension between these two forces, universalization and contextualization remains central to the architectural discourse. While global techniques and materials push for a homogenized world of architecture, local traditions continue to call for designs that are specifically rooted in their cultural and environmental context. Alhasani's work emphasizes the necessity of recognizing and accommodating both perspectives. Michael Sorkin's reflection, cited in her paper, further illuminates this challenge. Sorkin notes that while traditional societies may lack established solutions for modern building types like airports or office towers, modernism similarly struggles to address traditional building types such as mosques or neighbourhoods. This brings forward the fundamental challenge of maintaining cultural identity within the pressures of modern architectural demands (Alhasani, 1996).

2.3.4 Critical Understanding – Contemporary Architecture

The reviewed literature on contemporary architecture highlights a clear transition from traditional, locally grounded design philosophies to an era defined by innovation, technology, and global interconnectedness. Contemporary architecture is not limited to a single aesthetic or doctrine; rather, it reflects a constantly evolving response to the cultural, social, and environmental needs of modern society.

Modernism focused on rational design and material efficiency, whereas contemporary architecture extends these ideas by emphasizing diversity, inclusivity, and sustainability. This evolution represents a move from the pursuit of universal design principles toward more adaptive, context-sensitive approaches that acknowledge cultural and ecological diversity.

The reviewed literature highlights that contemporary design reflects the evolving priorities of a globalized world, technological innovation, sustainability, and cultural pluralism. Yet, much of this discourse remains conceptual, often celebrating innovation without critically examining its contextual implications. This limits a deeper understanding of how

contemporary architecture can meaningfully engage with local identity and environmental responsiveness.

The literature suggests that the future of architecture depends on finding balance between innovation and identity, universalization, and contextualization. For this thesis, this understanding establishes the foundation for exploring how traditional wisdom, embodied in the design of Assam-type houses, can inform sustainable, climate-responsive, and culturally rooted approaches to contemporary architecture.

2.4 Climatic Aspects in Architecture: Climate Responsive Design

Architecture is inherently shaped by the climate in which it is built. Climatic aspects in architecture refer to the environmental factors such as temperature, humidity, solar radiation, wind patterns, and precipitation that influence building design (Xu *et al.* 2023). Throughout history, architectural forms, materials, and construction techniques have evolved as direct responses to these climatic conditions, ensuring comfort, durability, and efficiency.

The consideration of climatic aspects in architecture has led to the development of design strategies that passively interact with the environment. With advancements in scientific understanding and building technology, these passive strategies have been further analysed, optimized, and integrated into a broader framework known as climate-responsive architecture.

Climate-responsive architecture refers to the design and construction of buildings that actively respond to local climate conditions. This approach emphasizes the need to minimize energy consumption, reduce environmental impact, and enhance occupant comfort by aligning architectural practices with the natural environment (Ravindra, n.d.). It involves integrating strategies that harness the local climate to regulate temperature, humidity, ventilation, and daylight, ultimately creating sustainable and resilient built environments. By employing techniques such as passive design, renewable energy use, and climate-responsive materials, climate-responsive architecture aims to reduce dependency on mechanical systems, lower carbon footprints, and promote ecological balance.

In climate-responsive design, the building acts as a mediator between natural climate resources and low-energy comfort. This means the building uses elements like walls,

windows, and roofs that are designed to work with the local climate. These features help capture and use resources like sunlight, wind, and cool air to naturally regulate the temperature and airflow inside the building. This reduces the need for energy-consuming systems, making the building more energy-efficient and environmentally friendly (Looman, 2017).

The growing need to address climate change has made climate-responsive design an essential aspect of contemporary architecture. As global temperatures rise and extreme weather patterns become more frequent, architects and urban planners are increasingly tasked with creating buildings that not only adapt to these conditions but also contribute to mitigating their impacts.

The three approaches outlined by Hastings (1989) highlight the varying degrees of interaction between a building and its environment, which are important to the concept of climate-responsive architecture. Hastings (1989) identifies three different ways a building can engage with its surrounding environment (cited in Looman, 2017):

- **Climate-insensitive design:** In this approach, the building has no interaction with the outdoor climate. It functions independently of its environmental context, with most interior spaces having no direct connection to the outside, and all building services are provided mechanically.
- **Climate-combative design:** Here, the building "resists" the outdoor climate, primarily through the use of extensive insulation. While this design considers the local climate, it focuses on counteracting it by providing the necessary insulation to maintain comfort inside.
- **Climate-responsive design:** In this approach, the building serves as an environmental filter, carefully balancing the exclusion of harmful external forces while allowing beneficial ones to enter. This creates a more harmonious interaction between the building and its surroundings.

Thus climate-responsive design as a concept that shows the role of buildings as a bridge between indoor and outdoor environments. The natural environment and local climate are closely linked to low-energy design. Depending on the circumstances, the local climate can either be utilized as a resource when beneficial or mitigated when unfavourable (Looman, 2017). Climate-responsive design encompasses the integration of three key principles:

a. Energy Exchange with the Environment for Comfort Provision: The primary focus of climate-responsive design is ensuring occupant comfort. This can often be achieved by harnessing natural energy flows for climate control, minimizing the need for complex systems. Recognizing the outdoor environment as a potential energy source or sink, the design seeks to collect and utilize resources to meet energy demands effectively. The building's shape and structure act as a bridge, allowing the indoor environment to adapt to changing outdoor conditions. Since outdoor conditions don't always match comfort needs, buildings must use additional strategies like conserving, distributing, storing, or reusing energy. By combining various methods, the overall design creates a comfortable space that primarily relies on natural energy for balance and efficiency.

b. The Building as a Responsive System: Responsiveness refers to a system's ability to react to stimuli in this case, the climate. In climate-responsive design, building spaces and materials act as intermediaries, facilitating energy exchange between indoor and outdoor environments while filtering environmental impacts. The overall building design including its form, layout, materials, and systems, is developed with an openness that allows it to serve as a mediator between internal and external conditions. A climate-responsive building adapts to both environmental changes and occupant behaviours.

c. Comprehensive Architectural or Structural Integration: Climate-responsive design emphasizes the interaction between indoor and outdoor environments. Decisions regarding spatial organization and building massing play a crucial role in enabling an integrated energy system. This approach ensures that architectural and structural elements work cohesively to enhance energy efficiency and responsiveness (Looman, 2017).

2.4.1 Passive Design Strategies

Passive design strategies are at the heart of climate-responsive architecture. They help create comfortable indoor environments while using less energy and minimizing environmental impact. By tapping into natural resources like sunlight, wind, and thermal energy, these strategies offer a way to make buildings more efficient and sustainable. When tailored to the local climate, passive design greatly reduces the need for mechanical systems, making it a practical and eco-friendly choice for modern architecture.

Foundational studies in climatic design theory have long explained how buildings interact with their surrounding environment to achieve comfort without mechanical systems. Olgay (2015), Givoni (1998), and Szokolay (2014) outlined how orientation, shading, ventilation, and material properties influence indoor thermal balance in different climatic zones. Their frameworks, later consolidated in the ASHRAE Handbook (2021), remain central to understanding passive design principles, particularly for warm-humid regions like Assam. These principles explain why traditional strategies such as deep verandas, roof overhangs, and cross-ventilation continue to perform effectively in moderating heat and humidity. Below, we'll explore the key approaches to passive heating and cooling in more detail.

2.4.1.1 Passive Heating Strategies

- a. **Using Solar Energy:** Harnessing the sun's energy is one of the simplest and most effective ways to heat buildings. Techniques like direct solar gain, Trombe walls, and sunspaces are designed to capture and store heat naturally. For instance, direct gain involves placing windows and openings in a way that allows sunlight to enter and warm the interiors. Trombe walls, which are specially designed thermal storage walls, absorb heat during the day and release it slowly at night, keeping rooms cozy without additional heating. Similarly, sunspaces, enclosed glass areas attached to buildings can gather solar heat and help maintain a comfortable indoor climate (Patel, 2024).
- b. **Storing Heat with Thermal Mass:** Materials like stone, brick, or concrete have a high thermal mass, meaning they can absorb and store heat during the day and release it gradually as temperatures drop at night. This simple yet powerful technique helps stabilize indoor temperatures, reducing the need for mechanical heating. In regions with significant temperature swings between day and night, thermal mass can make a noticeable difference in maintaining comfort (Patel, 2024).
- c. **Optimizing Orientation and Design:** The way a building is positioned plays a huge role in how much natural heat it can capture. Orienting buildings to maximize sun exposure, like ensuring windows face the sun during colder months, can significantly improve passive heating. Thoughtful design, such as arranging spaces to allow sunlight to spread evenly, makes the most of solar energy and reduces heating demands (Manuel et al., 2024).

2.4.1.2 Passive Cooling Strategies

- a. **Making Use of Natural Ventilation:** Natural ventilation is an effective way to cool buildings without relying on air conditioning. By designing spaces that align with local wind patterns and placing openings like windows and vents strategically, air can flow freely through the structure, removing heat and refreshing the space. This method works particularly well in areas with consistent breezes and can drastically cut energy costs (Asyraf & Andrea, 2024).
- b. **Shading the Building:** Keeping sunlight out during hot months is key to passive cooling. Shading devices like overhangs, awnings, and louvers block direct sunlight, preventing heat from building up indoors. Planting trees or adding green facades also provides shade and naturally cools the environment through evaporation. These techniques are especially important in hotter climates, where too much sun exposure can make buildings uncomfortably warm (Toroxel & Silva, 2024).
- c. **Designing an Efficient Building Envelope:** The building's outer shell, or envelope, is its first defence against heat. Insulating walls, using reflective materials, and installing features like double-glazed windows can help keep the heat out and maintain a cool interior. Reflective roof coatings, for example, bounce sunlight away, while proper insulation minimizes heat transfer. An efficient envelope ensures that a building stays comfortable even in extreme temperatures (Manuel et al., 2024).

2.4.1.3 Daylighting

Daylighting is an essential strategy in sustainable design, focusing on the effective use of natural light to brighten indoor spaces. It not only reduces the dependence on artificial lighting but also has significant benefits for occupant well-being. By bringing sunlight into the interior, daylighting creates more visually appealing and comfortable environments while lowering energy consumption. This dual benefit of energy efficiency and improved quality of life makes daylighting a key component of climate-responsive architecture.

- a. **Natural Light:** One of the primary goals of daylighting is to maximize the amount of natural light entering a building. Thoughtful placement of windows, skylights, and other openings allows sunlight to illuminate indoor spaces effectively. This strategy minimizes the need for artificial lighting during the day, leading to

substantial energy savings. Additionally, exposure to natural light has been shown to improve mood, productivity, and overall well-being, making it especially beneficial in workplaces, schools, and homes (Gil-Ozoudeh et al., 2022). However, designing for maximum natural light is not just about increasing brightness. It requires careful consideration of factors like glare and heat gain. The placement, size, and orientation of openings must be optimized to ensure that spaces receive sufficient light without causing discomfort or excessive energy use for cooling.

- b. Shading Devices:** To balance the benefits of daylighting with the challenges of solar heat gain, shading devices play a crucial role. Features like overhangs, louvers, and vertical fins are designed to block excessive sunlight during summer, preventing indoor spaces from overheating. These devices are particularly effective when tailored to the building's location and orientation. For instance, horizontal overhangs can shield windows from high-angle summer sun while still allowing low-angle winter sunlight to penetrate, providing warmth and light when needed most (Gil-Ozoudeh et al., 2022). In addition to regulating heat gain, shading devices help diffuse incoming light, reducing glare and creating a softer, more even illumination. This improves visual comfort and enhances the overall experience of the space. When integrated with other daylighting strategies, shading devices contribute to a dynamic system that adapts to seasonal and daily variations in sunlight, ensuring a comfortable and energy-efficient indoor environment. By thoughtfully combining strategies to maximize natural light with the use of shading devices, daylighting becomes a powerful tool for energy savings and enhancing indoor quality.

2.4.2 Active Design Strategies

Active design strategies form an integral part of climate-responsive architecture, focusing on the use of advanced systems and technologies to improve energy efficiency and comfort. These strategies combine mechanical systems such as ventilation, heating, air conditioning, lighting, energy management, and renewable energy to create buildings that are both sustainable and adaptable. By integrating these systems with the overall building design, architects can significantly reduce energy consumption while enhancing occupant well-being. The following sections explore these components in detail.

- a. Mechanical Ventilation:** Mechanical ventilation systems play a crucial role in regulating indoor air quality and temperature while reducing energy use. Advanced techniques

like natural ventilation and cross ventilation allow fresh air to circulate through the building, reducing reliance on mechanical cooling systems. Studies have shown that advanced natural ventilation (ANV) techniques can cut cooling energy loads by up to 65.3% in specific climates, making them highly effective in reducing overall energy consumption (Pešić & Alcojor, 2022).

Additionally, mechanical ventilation systems can be designed to work seamlessly with the building structure. For instance, climate-active building enclosures adapt to changing environmental conditions, optimizing airflow and improving thermal comfort. These enclosures are engineered to reduce energy usage by enhancing natural ventilation, creating a balance between mechanical systems and passive design elements (Lucarelli et al., 2023).

b. Air Conditioning and Heating: Air conditioning and heating systems are essential for maintaining comfortable indoor environments in diverse climates. However, their energy consumption can be significantly reduced through integrated energy management systems. These systems coordinate HVAC operations with passive strategies such as shading, natural ventilation, and thermal mass storage to minimize energy use. By syncing mechanical systems with passive design features, energy efficiency can be greatly improved (Sun et al., 2013).

In addition, solar passive heating systems offer a sustainable alternative to conventional heating. Design features like Trombe walls capture and store solar energy, reducing the need for mechanical heating. This integration of passive heating elements into the building design not only saves energy but also promotes a seamless connection between the built environment and natural forces (Patel, 2024).

c. Lighting Systems: Lighting systems in active design strategies often focus on maximizing the use of daylight to reduce dependence on artificial lighting. Properly designed spaces that allow natural light to illuminate interiors can significantly lower energy consumption. Techniques such as strategic placement of windows, skylights, and light shelves enhance daylight utilization, creating bright and comfortable spaces during the day. This approach not only cuts down on electricity costs but also improves the well-being of occupants by providing natural light, which has been linked to better mood and productivity (Sun et al., 2013).

d. Energy Management Systems: Energy management systems are critical to optimizing the performance of climate-responsive buildings. These systems use dynamic control technologies to adjust building operations in real time based on occupancy patterns, weather conditions, and energy demand. For example, they can modulate lighting, heating, and cooling systems automatically to ensure maximum efficiency. By responding to environmental changes and occupant needs, advanced energy management systems can significantly enhance overall energy performance and sustainability (Sun et al., 2013).

e. Renewable Energy Integration

The integration of renewable energy sources is a vital aspect of active design strategies, supporting energy independence and reducing the environmental impact of buildings. Bioclimatic approaches, such as incorporating solar panels, wind turbines, or geothermal systems, enable buildings to generate clean energy on-site. These systems not only meet a significant portion of a building's energy needs but also promote long-term sustainability by reducing reliance on fossil fuels (Pešić & Alcojor, 2022).

2.4.3 Energy Efficiency

Energy efficiency is a cornerstone of climate-responsive design, offering a pathway to reduce environmental impact while enhancing building performance and occupant comfort. By thoughtfully integrating components such as a well-designed building envelope, energy-efficient windows and glazing, high-performance HVAC systems, effective lighting, and energy monitoring, buildings can achieve significant energy savings. These strategies not only lower operational costs but also contribute to creating sustainable and resilient built environments. The sections below elaborate on these critical aspects.

a. Building Envelope Design: The building envelope is the first line of defence against external climatic conditions, acting as a barrier that influences both indoor comfort and energy use. A well-designed envelope can reduce energy consumption by 20% to 50%, depending on the materials, orientation, and shading strategies employed (Kaur & Singh, 2022). Insulation plays a pivotal role in minimizing heat transfer, ensuring that indoor temperatures remain stable regardless of outdoor conditions. This reduces the load on heating, ventilation, and air conditioning (HVAC) systems, leading to significant energy savings and improved thermal comfort (Cobîrzan, 2010).

Additionally, shading devices integrated into the envelope design can reduce unwanted heat gain during the summer while allowing beneficial sunlight during the winter. The strategic placement of openings and the use of advanced materials can further optimize the envelope's performance, making it a cornerstone of energy-efficient building design.

b. Energy-Efficient Windows and Glazing: Windows and glazing are critical elements in determining a building's energy efficiency. High-performance glazing materials, such as low-emissivity (low-E) glass, can significantly reduce heating and cooling demands by controlling solar heat gain and minimizing heat loss. These materials allow natural light to enter while filtering out excessive heat, creating a balance between daylighting and thermal control (Tuluca, 1997).

Shading devices like blinds, overhangs, and reflective films can further enhance the energy performance of windows. These features mitigate glare and reduce cooling loads, especially in regions with high solar exposure. By addressing both thermal and visual comfort, energy-efficient windows and glazing contribute to a well-balanced indoor environment.

c. High-Efficiency HVAC Systems: HVAC systems are among the largest energy consumers in buildings, making their efficiency a priority in climate-responsive design. High-performance HVAC technologies, such as heat recovery ventilators, variable refrigerant flow (VRF) systems, and geothermal heat pumps, optimize energy use while maintaining indoor air quality and thermal comfort (Tuluca, 1997).

These systems work more efficiently when integrated with passive design elements, such as natural ventilation and thermal mass. For example, heat recovery systems can capture and reuse energy from exhaust air, reducing the overall energy demand. Proper zoning and smart control systems further enhance the efficiency of HVAC operations, tailoring energy use to specific areas and occupancy levels.

d. Lighting Efficiency: Lighting is another significant contributor to energy consumption in buildings, but it offers substantial opportunities for savings. Modern lighting designs incorporate energy-efficient fixtures, such as LEDs, which consume significantly less energy than traditional bulbs. Beyond artificial lighting, daylighting strategies such as the use of skylights, light shelves, and reflective surfaces can maximize natural light, reducing reliance on electric lighting (Mitterer et al., 2012).

Integrating natural light into building design not only lowers energy costs but also enhances occupant well-being. Studies have shown that exposure to daylight improves mood, productivity, and overall satisfaction, making it a critical aspect of occupant-focused design.

e. Energy Monitoring and Control: Energy monitoring systems are essential for real-time tracking and optimization of energy consumption. These systems provide valuable data on energy use patterns, enabling building managers to identify inefficiencies and adjust operations accordingly. Advanced control systems can automate these adjustments, ensuring optimal performance without manual intervention (Mitterer et al., 2012).

Proactive energy management not only reduces energy waste but also improves occupant comfort. For instance, systems can automatically adjust lighting and HVAC settings based on occupancy or changes in weather, maintaining a comfortable indoor environment while minimizing energy use.

f. Balancing Efficiency with Occupant Comfort: While energy efficiency is a key goal, it is equally important to prioritize occupant satisfaction and comfort. Overemphasis on energy savings without considering user needs can lead to dissatisfaction and unintended energy use. For example, poorly designed systems may prompt occupants to use portable heaters or fans, negating the intended energy savings (Mitterer et al., 2012).

Achieving the right balance between efficiency and comfort requires a holistic approach to design. By aligning energy-saving measures with occupant preferences, climate-responsive buildings can deliver optimal performance while fostering positive user experiences.

Through the thoughtful integration of these strategies, energy efficiency in climate-responsive design becomes a tool not only for sustainability but also for enhancing the quality of life within built environments.

2.4.4 Critical Understanding – Climate Responsive Design

The reviewed studies explain how buildings respond to their climate through design strategies that use local energy flows, materials, and passive or active systems. They show that comfort and efficiency can often be achieved by aligning design choices with environmental conditions rather than depending only on mechanical systems.

However, much of the literature remains descriptive and technical, focusing on listing strategies instead of comparing how well they work in real situations. Many studies also treat these methods as universal, giving less attention to regional differences or to how people experience comfort in such buildings.

For this thesis, these studies provide the basic understanding of climatic logic needed to analyse Assam-type houses. This helps identify which of their features function as climate-responsive elements and how they might be prioritized for inclusion in contemporary, energy-efficient housing.

2.5 Perception Study

Perception studies are important for understanding how people experience and respond to technologies, services, or products. These studies focus on user attitudes, preferences, and expectations, helping to identify what works well and what needs improvement. By analysing user feedback, researchers and designers can create better solutions that meet user needs, improve satisfaction, and make interactions more effective.

2.5.1 Definition of Perception Study

Perception studies involve the systematic examination of how individuals perceive and evaluate products, services, or technologies. These studies focus on aspects such as emotional responses, usability, and overall satisfaction. For example, research on mobile payment platforms utilized big data to analyse user sentiments, revealing varying emotional scores across different platforms (Park, 2023).

In architecture, perception encompasses both intuitive and analytical interpretations of spatial environments by users and experts alike. It is influenced by sensory experiences, cognitive processes, and contextual factors, including the physical characteristics of a space, its intended function, and its broader environmental and cultural context. Research highlights that cultural backgrounds and spatial settings significantly shape how users perceive and interpret their environments. For instance, Auliyah and Loebis (2019) emphasize that cultural norms, social practices, and environmental conditions play a pivotal role in influencing how individuals experience and relate to architectural spaces. This insight underscores the importance of integrating cultural and spatial considerations into design

processes to create environments that resonate with users on both practical and emotional levels.

Furthermore, studies indicate that built environments have a substantial impact on human cognition and emotional well-being, showcasing the need for architects to incorporate diverse design parameters to optimize user experiences (Shynu & Suseelan, 2023). A systematic review of perception-based research also emphasizes the need for more comprehensive studies focusing on visual features and contextual factors in urban environments (Shynu & Suseelan, 2023).

2.5.2 Significance of Perception Study in Architecture

Perception studies in architecture are essential for understanding how individuals interact with and experience built environments. These studies reveal the complex interplay between user needs, socio-cultural contexts, and architectural design, providing insights that inform better design practices. By examining how people perceive and respond to spaces, architects can create environments that are functional, inclusive, and emotionally resonant.

A key aspect of perception studies is their emphasis on user-centered design. Incorporating user feedback into the design process enables the creation of spaces that align more closely with the needs and preferences of occupants (Maheshika, 2024). For example, research on healthcare architecture demonstrates how virtual reality tools can be used to capture user preferences, leading to tailored environments that enhance patient outcomes (Yang et al., 2024). This approach ensures that design solutions are not only practical but also improve the overall user experience.

Socio-cultural influences also play a critical role in shaping architectural perception. Studies have shown that socio-economic factors, such as financial status, significantly affect how individuals perceive architectural quality (Herath et al., 2023). Recognizing these influences allows architects to design spaces that are more inclusive and culturally sensitive, ensuring they resonate with diverse user groups. Addressing these factors helps bridge gaps between design intent and user experience, fostering a deeper connection between people and their environments.

The relationship between perception and sustainable architecture is another emerging area of interest. Research indicates that user cognition significantly impacts behaviours related to environmental sustainability, suggesting that well-designed spaces can encourage sustainable practices (Ye et al., 2023). This underscores the need for architectural designs that go beyond aesthetics and functionality to actively promote environmental responsibility. By integrating sustainability into the design process, architects can create spaces that support both user well-being and ecological balance.

In sum, perception studies provide valuable insights that enable architects to design spaces that are responsive, inclusive, and sustainable. These studies underscore the importance of understanding human experiences and socio-cultural dynamics to create environments that truly meet the needs of their users.

2.5.3 Parameters of Perception in Architecture

Perception in architecture is shaped by multiple parameters that influence how individuals experience and evaluate built environments. These parameters include socio-cultural influences, emotional responses, and functional aspects such as lighting, thermal comfort, and ergonomics. Understanding these factors is essential for architects aiming to create user-centered designs that meet diverse needs and enhance overall satisfaction.

a. Socio-Cultural Influences: Socio-cultural factors play a pivotal role in shaping perception. Research shows that socio-economic conditions, such as financial status, strongly correlate with architectural preferences, impacting how users perceive quality and aesthetics (Herath et al., 2023). Additionally, cultural backgrounds and gender significantly influence how users evaluate the functionality and appeal of spaces (Herath et al., 2023). For architects, incorporating socio-cultural sensitivity into design ensures that spaces resonate with users from diverse backgrounds, fostering inclusivity and relevance.

b. Emotional Responses: Emotional reactions to architectural spaces are complex and vary across individuals. The design of a space and its environmental context can evoke a wide range of feelings, from comfort and relaxation to anxiety or awe (Bhambri & Saha, 2018). Emotional responses are critical for creating environments that positively resonate with users. For instance, spaces with harmonious proportions, natural elements, and thoughtful

layouts tend to foster positive emotional experiences, underscoring the importance of integrating emotional considerations into design (Bhambri & Saha, 2018).

c. Functional and Ergonomic Considerations: Functional aspects, including lighting, ventilation, and thermal comfort, have a direct impact on user satisfaction. Studies highlight that poorly designed environments can lead to discomfort and reduced usability, whereas spaces optimized for thermal comfort and natural lighting enhance the user experience (Michieletto & Adedayo, 2021). Ergonomic design, particularly in specialized facilities such as healthcare or educational institutions, is equally important. Poor ergonomics can negatively affect mental health and overall well-being, further emphasizing the need for designs that align with user needs and daily activities (Pinto, 2018).

2.5.4 Challenges in Studying Perception in Architecture

Studying perception in architecture is challenging because it involves understanding the personal and diverse ways people experience and interact with buildings and spaces. These experiences are influenced by various factors, such as personal preferences, cultural background, and economic conditions, which can make each individual's perception unique (Herath et al., 2023). This subjectivity means that people can interpret the same space in very different ways, making it difficult for architects to create universal design principles that work for everyone (Nguyen-Tran et al., 2022).

Another challenge is the limitations of traditional research methods. These methods often rely on fixed categories to evaluate user experiences, which may not capture the full range of how people feel or respond to a space (Nguyen-Tran et al., 2022). Additionally, there is no widely accepted standard for measuring perceptions, making it hard to compare how people experience different buildings or environments (Dykes, 2012).

Technological and practical constraints also add to the difficulty. Advanced tools, such as neuroimaging, can offer valuable insights into how people perceive spaces, but these tools are expensive and not always accessible (Khaleghimoghaddam, 2022). Similarly, generative design tools, which use data to create user-centred designs, require large amounts of detailed information to truly reflect the needs of all users, especially those from underrepresented groups (Ballegaard et al., 2021).

Despite these challenges, understanding perception is essential for creating buildings and spaces that improve people's well-being and functionality. By developing better research

methods, using innovative tools, and prioritizing inclusivity in design, architects can create environments that meet the needs of a wide range of users and provide more meaningful and satisfying experiences.

2.5.5 Perception in Climate Responsive Design

Perception plays a vital role in climate-responsive architectural design, as it helps create environments that enhance both comfort and sustainability. Understanding how users interact with their surroundings can significantly influence design decisions, leading to improved thermal comfort and energy efficiency. Key aspects of perception in this context include the role of user control, the impact of urban green infrastructure (UGI), and the importance of context-specific design guidelines.

User control over environmental conditions is a critical factor in satisfaction. For instance, proximity to windows allows users to regulate thermal conditions and ventilation, which significantly enhances their comfort (Steiger, 1999). Similarly, individual offices, where occupants have greater control over the environment, tend to result in higher satisfaction levels compared to shared spaces (Steiger, 1999). This highlights the importance of designing spaces that provide users with control over their immediate surroundings.

Urban green infrastructure (UGI), such as parks and street trees, also plays a crucial role in shaping perceptions of thermal comfort. UGI mitigates urban heat, improves microclimates, and positively influences residents' subjective thermal experiences (Klemm, 2018). Evidence-based design guidelines for UGI, which incorporate microclimate analysis and user behaviour, can further enhance urban liveability and climate responsiveness (Klemm, 2018). Incorporating greenery into urban areas not only supports sustainability goals but also addresses user comfort and well-being.

Context-specific design guidelines are essential for effective climate-responsive architecture. These guidelines must consider local climatic conditions and user needs to ensure designs are both functional and comfortable (Chang, 2024; Liu et al., 2023). Flexibility in adapting these guidelines to various climates and user expectations is also critical, as this ensures that designs can meet the diverse requirements of different regions and populations (Chang, 2024).

While focusing on perception in climate-responsive design is essential, several challenges must be addressed. These include the complexity of integrating user feedback into

architectural practices and the need for ongoing education among designers to effectively implement climate-responsive principles. By overcoming these challenges, architects can create spaces that not only meet sustainability goals but also provide meaningful and comfortable experiences for users.

2.5.6 Relevance of Perception in Residential Architecture

Perception plays a crucial role in residential architecture, significantly influencing design, functionality, and community integration. The interplay between user-led design and socio-cultural values helps shape the built environment, reflecting both individual needs and collective identities. This discussion explores the importance of perception in residential architectural design through various dimensions.

a. User-Led Design and Creativity: Informal user-led architectural production allows individuals to express their creativity through the design of their houses, resulting in unique spatial experiences that cater to both personal and community needs (Maheshika, 2024). In such contexts, users often perceive design, construction, and inhabitation as interconnected and repetitive processes. This dynamic approach leads to living spaces that continuously evolve to better reflect the lifestyles and preferences of their inhabitants (Maheshika, 2024).

b. Socio-Cultural Influences: Residential architecture frequently incorporates socio-cultural values, creating designs that resonate with local traditions and communal practices (Ngo et al., 2018). The influence of cultural norms and daily activities often drives residence transformations, fostering a sense of belonging and reinforcing community identity (Ngo et al., 2018). This alignment of design with cultural and social expectations ensures that residential environments serve not just as physical shelters but as meaningful spaces that integrate seamlessly into the broader social fabric.

c. User Satisfaction and Quality Assessment: Understanding perceptions of residential quality is essential for enhancing satisfaction and ensuring alignment with residents' internal value systems (Parincu, 2020). Involving users in the design process fosters a better connection between the physical attributes of housing and their underlying motivational needs, as described by Maslow's theory of hierarchy (Zavei & Jusan, 2017). This participatory approach can significantly improve the relevance and functionality of self-built houses, contributing to their long-term success.

While perception is undeniably important in residential architecture, challenges also emerge. The absence of professional architectural standards in some projects may lead to issues with structural integrity and long-term sustainability. Striking a balance between user creativity and expert input is critical to achieving both individual satisfaction and broader community resilience.

2.5.7 Critical Understanding - Perception Study

The reviewed literature shows that perception studies help explain how people actually experience and interpret architectural spaces, shaped by cultural background, emotional response, and everyday comfort needs. These studies emphasize that architecture should be understood not only as a physical or technical system but also as something that affects how people feel, behave, and connect with their environment.

However, most of the existing studies look at perception from separate angles, such as comfort, aesthetics, or cultural meaning, without combining these aspects into a single, structured framework. This makes it difficult to compare results or apply them directly to design practice. There is also limited research showing how insights from perception can be applied to make design decisions that are truly context-specific and user-centred.

For this thesis, the reviewed works clarify the importance of integrating human experience with climate responsive architectural design. These insights guide the development of surveys that link user comfort, perception, and willingness to adopt traditional features, helping to interpret the value of Assam-type houses from both human and environmental perspectives.

2.6 Northeast India: An Overview

The Northeast region of India comprises eight states: Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim, and Tripura. This region is distinguished by its diverse topography, encompassing mountainous terrains, expansive plains, and fertile river valleys, which significantly influence the architectural practices of its inhabitants. Renowned for its unique environmental and geographical characteristics, Northeast India offers an invaluable context for examining traditional and contemporary residential architecture, particularly through the lens of climate-responsive design.

Strategically positioned, the region shares international borders with China, Bangladesh, Myanmar, Bhutan, and Nepal, further enriching its cultural and architectural heritage. It is connected to mainland India through the narrow Siliguri Corridor, which spans approximately 22 kilometres in width. This region, usually addressed as the Northeast, is also distinguished for its remarkable ecological diversity, with nearly 60% of its area under forest cover. Its complex topography ranges from the Himalayan foothills to dense forests and fertile river basins, giving rise to a variety of microclimates. This altitudinal variation results in a spectrum of climatic conditions, from subtropical to temperate and alpine, which further shapes the region's architectural responses to its environment (North Eastern Zonal Cultural Centre, n.d.).

2.6.1 Geographic Location and Climate Characteristics

The Northeast region of India is characterized by its unique geographic and climatic features, shaped by its position as the easternmost extension of the Himalayan range. This region encompasses diverse landscapes, including towering mountains, undulating plateaus, and fertile plains (Dikshit & Dikshit, 2014; Dimri et al., 2018). It lies at the confluence of the Indo-Malayan, Indo-Chinese, and Indian biogeographical zones, contributing to its rich biodiversity and distinct environmental conditions.

The climate of this region is predominantly influenced by the southwest monsoon, which spans from June to September and serves as the primary source of precipitation. Areas like Cherrapunji in Meghalaya exemplify the region's extraordinary rainfall patterns, receiving over 11,000 mm of rainfall annually, making it one of the wettest places on Earth (Dikshit & Dikshit, 2014). This intense rainfall has significant implications for agriculture, hydrology, and local livelihoods.

Temperature variations in the Northeast are considerable, reflecting its topographical diversity. In the summer, valley regions experience average temperatures ranging from 30 to 33 °C, while the mountainous areas remain cooler, with average temperatures around 20 °C (Dikshit & Dikshit, 2014; Kumar & Dimri, 2018). Such thermal differences contribute to varied microclimatic zones within the region, further supporting its ecological variety.

The region's terrain, comprising the eastern Himalayan hills and valleys, plays a critical role in shaping its climatic patterns. The mountains act as a barrier, influencing wind and precipitation dynamics, while the plains facilitate the movement of weather systems. This

geographic interplay creates a highly complex and sensitive climatic framework, with significant seasonal and spatial variability (Dikshit & Dikshit, 2014; Dimri et al., 2018).

2.6.2 Rationale for selecting North-East India for the Study

a. Ecologically Sensitive: The northeastern region of India, nestled within the Himalayan Mountains, is an ecologically sensitive area long inhabited by tribal communities deeply connected to their natural surroundings. These societies have traditionally relied on local resources for sustenance, with nature woven into their ancestral knowledge, folklore, festivals, beliefs, and daily life. However, the relentless push for industrialization and urbanization is eroding the once harmonious relationship between these communities and their environment, leading to overexploitation and degradation. Additionally, the rise of consumer culture is shifting these environmentally conscious communities toward modern consumerism, gradually eroding indigenous traditions and values. (Sankyan and Sigroha, 2017).

b. Vulnerable to Climate Change: The northeastern states of India are experiencing heightened vulnerability to climate change, marked by substantial forest cover loss across various hill districts. The 2018 Climate Vulnerability Assessment identified Assam and Mizoram as the northeastern states most susceptible to climate change impacts. Especially, the region has also seen a significant reduction in forest cover, as detailed in a recent comparison with 2019 data. Arunachal Pradesh, which comprises 16 hill districts, recorded a forest cover loss of 257 sq km, followed by Assam's three hill districts with a 107 sq. km decrease. Manipur's nine hill districts lost 249 sq km, Mizoram's eight hill districts saw a 186 sq. km reduction, Meghalaya's seven hill districts lost 73 sq. km, Nagaland's 11 districts showed a 235 sq. km decline, while Sikkim and Tripura's four districts experienced smaller losses of 1 sq. km and 4 sq. km, respectively. (IANS, 2022).

c. Rapid Urbanization: Urban growth is a relatively recent but rapidly emerging trend in Northeast India. According to the 2011 Census of India, there are nine cities in this region with populations over 100,000. Among these, Guwahati in Assam has the largest population, making it the most urbanized city in the Northeast, followed by Agartala, Aizawl, and Imphal, the capitals of Tripura, Mizoram, and Manipur, respectively.

Although development in the Northeast has traditionally followed a more conservative path, Guwahati's urbanization now resembles the patterns seen in other major urban

agglomerations (UAs) across India. Consequently, Guwahati is experiencing similar issues, including environmental degradation and a decline in quality of life, that have affected other urban centres in the country. Given the Northeast's more fragile and ecologically sensitive landscape, it is crucial to avoid replicating the urbanization missteps made elsewhere, as this could have severe consequences for the region's people, cultural heritage, and biodiversity. (Meitei and Das, 2024).

2.6.3 Traditional Residential Architecture of North East India

Based on similarities in terms of materials used the traditional architecture of the North-East region, it can be categorised in two broad sections: '*kutcha*' structures and '*pukka*' or semi *pukka* structures (Nag and Gondane, 2013), *Kutcha construction*: *Kutcha*, meaning raw or uncooked; is an adjective used for structures made of natural and locally available materials such as mud, bamboo, and thatch.

On the other hand, the *pukka* or semi-*pukka* structures are made with a combination of organic and inorganic materials. These are a result of the influence of the British colonial architecture to the local architecture. The roof is pitched with a high gable to cater to the heavy rainfall in the region over many months (Alhasani 1996).

In Northeast India, *kutcha* houses come in diverse forms, shaped by both local microclimates and cultural traditions. Generally, the foundation and plinth of these houses are made from compacted earth with timber or bamboo columns for structural support. The walls are often built with bamboo mats, split bamboo frames, and natural materials like grass, earth, and cane leaves. Thatch roofs, typically made from rice, wheat, or maize straw with bamboo framing, are common in these constructions. Some *kutcha* houses combine bamboo and wood, with the foundation made from compacted earth and reinforced by timber or bamboo columns. The walls consist of bamboo mats supported by split bamboo framing, while the plinth is strengthened with rammed earth and finished with a mix of mud and cow dung plaster. In many cases, the walls are also plastered with a mud and cow dung mixture. These natural materials require frequent upkeep as the mud plaster tends to crack from drying and shrinkage, and heavy rains can cause it to wash away. In colder regions like Arunachal Pradesh, thicker walls are made from wood or stone masonry, helping to retain heat within the home (Kaushik and Babu, 2009).

Stilt houses represent another interesting type of *kutch*a structure. Commonly seen in regions with heavy rainfall and high soil moisture, such as parts of Arunachal Pradesh and Assam, these houses are elevated on bamboo or wooden stilts. This helps keep the living space dry and well-ventilated, and the roof is typically thatched.

In contrast, *pukka* houses are built with more durable materials like wood, a local reed called *ikra*, bricks, and galvanized iron (GI) sheets for roofing. This style emerged in Assam and nearby states during British rule. These houses are known for their earthquake resilience, as their lightweight construction, flexible joints, and sturdy framing have proven effective in seismic events. However, due to the untreated wood used in many *pukka* houses, they are vulnerable to fire. These houses can be found in both rural and urban settings, serving as residential, commercial, or multipurpose buildings. They are generally single-story structures with raised plinths to protect against floodwaters and keep out animals, though two-story buildings are constructed when necessary (Kaushik and Babu, 2009).

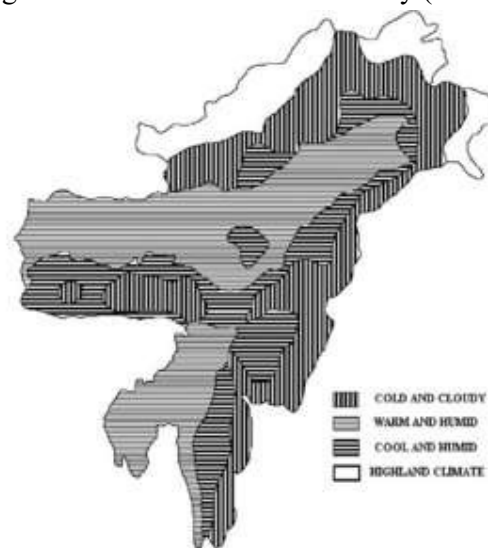


Figure 2.2: Bioclimatic Zones of the North East region of India (Source: Singh et al., 2009)

Another important categorization of traditional architecture in the North East could be based on bioclimatic zone. According to a study by Manoj Kumar Singh, Sadhan Mahapatra, and S.K. Atreya (Singh et al., 2009), the northeastern region of India can be divided into three main bioclimatic zones: warm and humid, cool, and humid, and cold and cloudy. This classification considers factors like temperature, humidity, rainfall, wind speed, altitude, solar radiation, and the landscape of each area.

In the warm and humid lowlands, houses are often built on stilts to stay above floodwaters and to allow for better air circulation. These structures typically use lightweight bamboo

and thatch materials, which encourage ventilation, and have steeply sloped roofs to help shed heavy monsoon rains. In the cool and humid mid-elevations, found in parts of Meghalaya and Nagaland, houses are made with thicker materials like wood or mud for better insulation. The houses also have steep roofs and raised floors to protect against rain and improve airflow. At higher altitudes, in the cold and cloudy zones of Arunachal Pradesh and Sikkim, houses are constructed with thick stone or rammed earth to retain heat. These houses often feature flat roofs, designed to handle snow accumulation, moderate size windows to reduce heat loss, and central fireplaces to provide warmth (Singh et al., 2009).

Each of these architectural adaptations is tailored to local climatic conditions, allowing houses to harmonize with their environment.

a. Warm and Humid Zone: This zone primarily includes the plains of Assam and parts of Tripura. The traditional architecture in this region is characterized by structures that promote natural ventilation and protection from heavy rainfall. A prime example is the ATH, locally known as "Ikra house." As described by Das (2015, p. 78), "These houses feature raised platforms, sloping roofs with large overhangs, and walls made of bamboo or reed (ikra) plastered with mud." The raised platform protects against floods and dampness, while the sloping roof efficiently drains rainwater. Large verandas and numerous windows facilitate cross-ventilation, crucial in this humid climate.

b. Cool and Humid Zone: This zone encompasses parts of Meghalaya, Manipur, and Mizoram, and certain areas in Assam, characterized by moderate temperatures and high humidity. In Meghalaya, the Khasi and Garo tribes have developed unique architectural styles. Tiwari (2017, p. 123) notes, "The traditional Khasi house, or 'iing,' is typically constructed with timber and thatch, featuring a distinctive hood-like roof structure that extends almost to the ground." This design provides excellent insulation and protection from the frequent rains. In Manipur, the traditional Meitei house, or "Yumjao," is another example. According to Devi (2019, p. 56), "The Yumjao is characterized by its rectangular shape, raised plinth, and thatched roof with extended eaves, all designed to cope with the region's high rainfall and moderate temperatures.

c. Cold and Cloudy Zone: This zone primarily includes parts of Arunachal Pradesh and parts of Sikkim, featuring lower temperatures and frequent cloud cover. In Arunachal Pradesh, the Adi tribe's traditional houses, known as "Mishmi houses," are well-adapted to the cold climate. Ghosh (2018, p. 201) describes them as "long, rectangular structures built on

stilts, with thick thatched roofs and walls made of bamboo and wood. The houses often feature a central fireplace, crucial for warmth in the cold climate". In Sikkim, traditional Lepcha houses demonstrate another adaptation to the cold and cloudy environment. As noted by Bhutia (2016, p. 89), "These houses are typically built with stone and wood, featuring moderate windows to retain heat and sloping roofs to shed snow. The interior often includes a traditional stove, serving both for cooking and heating."

d. Highland Climate

The highland climate in Northeast India is primarily found in the higher altitudes of Arunachal Pradesh, particularly in districts such as Tawang, West Kameng etc. These regions experience extremely cold temperatures, snowfall during winters, and a short growing season due to their elevation above 3,500 meters. In response to these harsh climatic conditions, the traditional architecture of these areas is designed for thermal comfort and resilience. Houses are typically built using locally available materials like timber and stone, featuring raised floors for insulation, sloped roofs to prevent snow accumulation, and central hearths for heating (Barua et al., 2020).

In each of these bioclimatic zones, the traditional architecture of Northeast India demonstrates remarkable creativity in adapting to diverse climates. From the raised and ventilated structures of the warm and humid plains to the insulated and compact designs of the cold mountainous regions, these houses reveal a deep connection between people and place. The prevalent use of local materials like bamboo, wood, stone and thatch not only makes these structures sustainable but also reinforces a strong cultural identity, with each community's architecture embodying unique aspects of their way of life.

This seamless integration of climate-responsive design and cultural expression is especially evident in Assam, where traditional houses like the *Ikra* house have evolved to address the specific challenges of flooding, humidity, and rainfall. In the following section, we will examine the traditional houses in Assam in greater detail to understand how they exemplify both practical and climate resilience.

2.6.4 Critical Understanding - Northeast India

The literature presents Northeast India as a region of remarkable ecological diversity and cultural richness, where architecture closely reflects climatic and geographic variation. The traditional houses of the region demonstrate how local materials such as bamboo, timber,

and thatch have been effectively used to create climate-responsive structures suited to both the humid plains and the cooler uplands. Classifying these traditions according to bioclimatic zones reveals clear regional patterns, particularly in the warm and humid plains, where stilted and ventilated forms like the Ikra or Assam-type houses have evolved to withstand high rainfall, humidity, and flooding while maintaining indoor comfort.

Although this literature provides valuable documentation of regional typologies, it primarily remains descriptive. Comparative or interpretive analyses that connect these architectural forms to issues of modernization, urban expansion, or long-term adaptability are relatively limited. As urbanization accelerates in the plains of Assam, where population density and development pressures are highest, the continuity of these traditional building forms faces increasing strain. The need to understand and selectively adapt their principles for present-day design contexts becomes more urgent.

For this thesis, this background clarifies why Assam, located within the warm and humid zone, serves as an appropriate focus area. The Assam-type (Ikra) house, widely recognized and still in use, represents one of the most refined regional responses to the climatic and cultural realities of the Northeast. Studying this typology allows a focused yet contextually rich exploration of how traditional wisdom can inform contemporary housing in regions facing similar environmental and social transformations.

2.7 Assam in North East India

Assam is one of the most important states of the North-East. The central location of this state makes it the gateway to the rest of the North-Eastern states and thus Assam experiences the most of urbanization and economic activities.

Assam, spanning approximately 78,523 square kilometres, is defined by its diverse landscape of plains, hills, and river valleys. The Barak and Brahmaputra Valleys form its most significant landmasses, with the mighty Brahmaputra River playing a crucial role in shaping the region's geography. This river not only makes the land highly fertile but also ensures an abundance of natural resources, supporting agriculture and providing essential materials like bamboo and wood for sustainable construction. The state experiences a tropical monsoon rainforest climate for most of the year, marked by high humidity and heavy rainfall. While the plains have a warm and humid environment, the hilly regions enjoy a cooler, sub-alpine climate, offering a contrast in weather conditions across different terrains (Das

et al., 2014). With respect to the climatic zones (Figure 2.2), Assam falls mostly under the warm and humid zone with some areas under the cool and humid zone.

Assam has a long history of natural disasters, facing frequent floods, landslides, and earthquakes. Being situated in one of the world's six most seismically active regions, the state is highly vulnerable to seismic activity. It has witnessed two of the most powerful earthquakes in Indian history, the Assam Earthquake of 1897, which had a magnitude of 8.7, and the Assam-Tibet Earthquake of 1950, measuring 8.4 in magnitude (Das et al., 2014).

Assam shares international boundaries with Bhutan to the north and Bangladesh to the south. Domestically, it is bordered by Arunachal Pradesh to the north, Nagaland and Manipur to the east, Meghalaya, Tripura, and Mizoram to the south, and West Bengal to the west via the Siliguri Corridor - a narrow stretch connecting Assam to the rest of India. The states of Arunachal Pradesh, Nagaland, Mizoram, and Meghalaya were originally part of Assam before being separated into distinct entities. Shillong, which previously served as Assam's capital, became the capital of Meghalaya, leading to the relocation of Assam's administrative centre to Dispur, a locality within Guwahati, in 1972. The state spans an area of 78,438 square kilometres (30,285 square miles) and had a population of 31,169,272 as per the 2011 census (Lodrick & Das, 2025).

Historically, the region was known as Pragjyotisha in epics like the Mahabharata and Ramayana, which later evolved into Kamarupa. The name Assam emerged later, reflecting the region's rich historical and cultural heritage. The earliest mention of Kamarupa is found in the 4th-century Allahabad inscription of Samudragupta, which lists it among frontier kingdoms. The name "Kamarupa" persisted for centuries, with the Ahom people later referring to the region as "Assam," a term that eventually supplanted Kamarupa as the accepted name (Borah, 2022).

Throughout its history, Assam was ruled by various dynasties like, the Pala, Koch, Kachari, and Chutiya. There was constant warfare among the princes until the arrival of the Ahom people in the 13th century. The Ahom crossed the Patkai Range from Myanmar (Burma) and conquered the local chieftains of the upper Assam plain. In the 15th century, the Ahom became the dominant power in upper Assam. Ahom power and prosperity reached their height during the reign of King Rudra Singh (1696–1714). However, internal conflicts and external threats gradually weakened the kingdom, and by the late 18th century, warriors from Myanmar seized control.

The weakening of central authority was largely due to disputes among Ahom princes. In 1786, King Gaurinath Singh, struggling to maintain order, sought assistance from the British in Calcutta (now Kolkata), which had become the capital of British India. A British army officer was sent to restore peace, successfully stabilizing the region. However, despite the Ahom king's protests, the British soon withdrew their forces, leaving Assam vulnerable to further strife. Without strong leadership, Assam fell into repeated crises. In 1817, a rebellious governor invited Myanmar's forces into the region, leading to widespread destruction and chaos. The British, seeing their interests threatened, eventually intervened, and drove out the invaders. Following the Treaty of Yandabo in 1826, Assam officially became part of British India, marking the end of Ahom rule (Lodrick & Das, 2025).

The architectural heritage of Assam reflects this diverse history. Religious structures, such as temples and monasteries, were often constructed using durable materials like stone and brick, showcasing intricate carvings and designs. The Ahom Kingdom utilized advanced construction methods, including building forts, ramparts, and extensive roads (Kakoty, 2022).

In contrast, vernacular architecture primarily utilized locally available natural materials, including bamboo, timber, and mud plaster. These materials were not only sustainable but also suited to the region's climatic conditions, demonstrating an early understanding of climate-responsive design. The use of elevated structures, slanted thatched roofs, and stilted houses are notable features that addressed issues like heavy rainfall and flooding. This architectural approach ensured durability and comfort, reflecting the ingenuity of Assam's traditional builders (Das et al., 2012).

2.7.1 Geography of Assam

Assam is predominantly a land of plains and river valleys, divided into three major geographical regions. The Brahmaputra River valley lies in the north, while the Barak River valley, also known as the upper Surma River valley, is located in the south. Separating these two lowland areas is a hilly region that extends between Meghalaya to the west and Nagaland and Manipur to the east in the south-central part of the state. Among these regions, the Brahmaputra River valley is the largest (Lodrick & Das, 2025).

The state extends approximately 800 kilometres along the Brahmaputra River. This geographical layout comprises a combination of low-lying alluvial plains and hilly terrains, resulting in notable elevation variations that affect drainage patterns and flood distribution.

The Brahmaputra River, one of the major rivers of the world, traverses the length of Assam, playing a pivotal role in shaping the state's topography and hydrology. Originating from the Angsi Glacier in Tibet, the river enters Assam after cutting through the eastern Himalayas, bringing with it a substantial volume of water and sediment. The river's braided channels and numerous tributaries contribute to the formation of the fertile alluvial plains that dominate the region. However, this also makes Assam particularly susceptible to annual flooding, especially during the monsoon season, when heavy rainfall leads to the rivers overflowing their banks, inundating vast areas and affecting agriculture, infrastructure, and settlements (Ahmad & Lodrick, 2025).

Assam's location at the convergence of the Indian and Eurasian tectonic plates renders it prone to significant seismic activity. The state lies within a seismically active zone, having experienced major earthquakes in the past, notably in 1897 and 1950. The tectonic movements associated with these plates have not only shaped the region's mountainous and hilly terrains but also contribute to ongoing geological transformations. The combination of active tectonics and the dynamic fluvial processes of the Brahmaputra and Barak river systems continues to influence Assam's landscape, making it a region of interest for studies in geomorphology and environmental science (Gupta et al., 2022).

2.7.2 Climate of Assam and its Impact on Built Forms

Assam falls under two climatic zones, Warm and Humid and Cool and Humid. Assam experiences a tropical monsoon climate characterized by high humidity and significant rainfall. Average temperatures range from highs of about 36 °C (upper 90s °F) in August to lows of approximately 7 °C (mid-40s °F) in January. The cool season, lasting from October to February, is marked by fogs and brief showers, while the state generally escapes the hot, dry season typical of much of India. The heaviest precipitation occurs with the southwest monsoon, arriving in June and persisting through September, often leading to widespread and destructive flooding. Annual rainfall varies from about 1,800 mm (70 inches) in the west to more than 3,000 mm (120 inches) in the east, ranking among the highest in the world (Lodrick & Das, 2025).

These climatic conditions have profoundly influenced the region's architectural practices. Traditional Assamese architecture has evolved to address the challenges posed by heavy rainfall and humidity. Structures are typically built on raised platforms or stilts, known locally as "chang ghar," to protect against flooding and to promote air circulation beneath the living spaces, reducing dampness and pest intrusion. High-pitched roofs with extended eaves are common, designed to facilitate rapid water runoff and to shield the walls from direct exposure to rain. Materials such as bamboo and timber are extensively used, owing to their availability and suitability in the humid climate; these materials allow for flexibility and resilience, essential qualities in a region prone to seismic activity. The orientation and layout of traditional houses also reflect climatic considerations. Verandas and open spaces are incorporated to enhance natural ventilation, mitigating the effects of high temperatures and humidity. Thick thatched roofs and walls provide insulation, keeping interiors cool during the hot season and warm during cooler months. The use of locally sourced materials not only ensures harmony with the environment but also contributes to the sustainability and adaptability of the built forms (Ji & Punekar, 2019).

2.7.3 Traditional Residential Architecture of Assam

Traditional residential architecture in Assam can be categorized under two local terms: 'kutcha' or 'kesa' and 'pukka' or 'poka'. The term 'pukka' generally refers to buildings constructed using cement mortar or reinforced cement concrete (RCC), while traditional houses typically fall under the 'kutcha/kesa' or 'semi-pukka/poka' category. Kutcha structures are built using raw, natural, and locally available materials such as mud, bamboo, and thatch, whereas semi-pukka structures incorporate both organic and inorganic materials (Das et al., 2014). The main typologies of traditional residential architecture in Assam are as follows.

a. Bamboo Houses: As the name suggests, bamboo is the primary material used in the construction of these houses, which are most found in rural areas. The construction process is relatively simple, where bamboo culms are anchored into the ground, and a structural frame is erected. The plinth is typically made of rammed earth with mud plaster, while the floors are finished with a mixture of mud and cow dung in a 1:1 ratio. The walls are woven from bamboo and, in some cases, plastered with mud. Traditionally, the sloping roof is covered with thatch or ikra, although modern constructions have started incorporating corrugated galvanized iron (CGI) sheets.

These houses generally have three or four rooms arranged in a linear fashion, with rooms opening into one another. The size and layout vary according to family requirements. The drawing room, known as the Sora Ghar, serves as a communal space for gatherings and hosting guests. Bedrooms, or Huwa Ghar, may be divided with partition walls depending on the number of family members (Nag and Gondane, 2013). The Randhoni Ghar, or kitchen space, is usually separated from the main living areas for safety and hygiene purposes. The bathing area and toilets are commonly located away from the main house, preferably near a water source.

b. Stilted Houses (Chang Ghar): Stilted kutcha houses, or 'chang ghar,' are traditionally built in areas with high precipitation and moisture content in both the air and soil. This typology is particularly prevalent among communities residing in flood-prone regions. These houses are primarily constructed using bamboo or wood, with thatch used for roofing.

Structurally, chang ghars are rectangular and follow a linear planning pattern similar to bamboo houses. They are elevated on bamboo pillars, with diagonal bamboo bracings fastened to create the stilt. Horizontal members are secured above using dowel and tenon joints, with additional stability provided by jute ropes tied across the posts. The height of the stilts generally ranges between 1.50 and 2.00 meters above ground level, ensuring protection from floodwaters. A canoe is often stored beneath the house for emergency use during floods.

These houses are designed to withstand the monsoon season. The walls and floors, made primarily of bamboo, allow rainwater to pass through instead of accumulating. Roofs are constructed using a local variety of hay or rice straw, spread over bamboo trusses fixed atop the supporting posts. The roof height is typically around 3.50 meters above the floor level. A bamboo loft is commonly added just below the roof to store essential goods safely during floods. Bamboo's low thermal conductivity helps maintain a cool indoor environment, while adequate ventilation through permeable walls and floors helps regulate moisture levels inside the house (Kaushik and Babu, 2009).

In some cases, chang ghar construction incorporates the ikra method, where houses are built on wooden stilts with walls made of ikra and wood. In colder regions, the space

beneath the stilts is sometimes used to shelter cattle, which, in turn, helps maintain warmth inside the house.

c. Ikra Houses or Assam-type Houses: Ikra houses, commonly known as ATHs, are among the most prominent and widely recognized traditional residential structures in the region. The name 'ikra' is derived from a local reed that grows in the marshy lands and loamy soils of Assam's River plains and lakes. This material is extensively used in the walls and, in some cases, the roofing of ATHs. These structures have stood the test of time due to their adaptability, durability, and ability to withstand Assam's challenging climatic conditions.

Among the different types of traditional residential architecture in Assam, the most prominent and widely recognized is the ATH. This typology has gained popularity due to its resilience to the region's climatic challenges, including heavy rainfall, humidity, and seismic activity. ATHs have evolved over time, integrating traditional knowledge with modern construction practices while maintaining their distinctive characteristics. These houses will be discussed in greater detail in the following section.

2.7.4 Critical Understanding - Assam in Northeast India

The reviewed literature identifies Assam as one of the most influential states in the North-east, both geographically and culturally. Its central position within the region and its exposure to a warm-humid climate, recurrent flooding, and seismic activity have collectively shaped a distinctive architectural identity. These environmental and socio-economic conditions make Assam an essential context for examining how traditional architecture evolves in response to both natural and human pressures.

Traditional Assamese architecture demonstrates a pragmatic adaptation to its environment through raised plinths, stilted bases, bamboo-timber frameworks, and sloping roofs that address rainfall, flooding, humidity, and ventilation challenges. These design strategies show an intuitive understanding of climate-responsive principles and reflect how communities have refined construction techniques through experience and local knowledge.

Among Assam's various house types, the Assam-type (Ikra) house represents the most refined and enduring example of this evolution. Unlike purely vernacular bamboo or stilt

houses limited to specific localities, the Assam-type house embodies a transitional typology, traditional and yet responsive to technological and material change. Developed during the colonial period and continuously adapted since, it integrates local materials like ikra and bamboo with newer elements such as bricks and metal roofing. This blend of tradition and innovation has made it resilient to climatic extremes while retaining its regional identity.

For this thesis, the Assam-type house is therefore not just representative of Assam's architecture but also demonstrates how traditional knowledge can evolve to remain relevant in contemporary contexts. Its hybrid nature and adaptability make it an ideal case for exploring how traditional architectural principles can inform contemporary, climate-responsive, and context-specific housing design.

2.8 Assam-Type House: A Traditional Residential Typology

Traditional ATHs are commonly known as Ikra houses. This reed is widely used in the construction of walls and, occasionally, in roofing due to its excellent thermal insulation properties. One of the unique characteristics of Ikra is its natural protective sheath, a thick, siliceous layer that covers the body of the shoot between internodes. The diameter of Ikra shoots typically ranges from 6 to 16 mm, with an average usable height of 2.5 to 3.65 meters, although the plant can grow as tall as 4.5 meters. The durability of Ikra makes it particularly suitable for building, as it is less prone to insect attacks compared to bamboo. Its hollow inner core plays a crucial role in providing good thermal insulation, which helps regulate indoor temperatures effectively. Additionally, Ikra has excellent adhesion properties with various binding materials, including cement, lime, and mud mortar, making it a reliable choice for constructing walls (Nag and Gondane, 2013).

When constructed as residential dwellings, ATHs are typically designed as independent, single-unit structures. These houses are built on a raised plinth, which serves multiple purposes, such as protecting them from stray animals, including reptiles, and preventing waterlogging caused by heavy rainfall. In some cases, these houses are elevated further by constructing them on stilts, with wooden planks used for flooring. Double-story ATHs are also quite common. Given the region's high rainfall, the entrances of these houses are recessed to prevent water from entering. The lower portion of the walls is generally made of backed brick masonry, while the upper portion is constructed using wooden materials.

The roofs of these traditional houses are designed to withstand heavy rain and are typically sloping, either in two or four directions and sometimes can be multi-tiered'. These sloping roofs extend beyond the walls to create overhangs, which serve as protective features against rainwater. Additionally, the orientation of these houses is carefully considered to take advantage of prevailing wind patterns, enhancing natural ventilation. One of the passive design elements sometimes incorporated into ATHs is an air gap in the lower part of the ceiling, which plays a crucial role in improving indoor comfort. This air gap is created by constructing the ceiling with two layers, one made of bamboo and the other of wood. The presence of this gap aids in thermal insulation by facilitating airflow and reducing heat buildup within the house (Singh et al., 2009).

Windows and doors in these houses are entirely made of wood and are designed to be partially opened according to the residents' needs, providing flexibility in ventilation control. Additionally, window overhangs are used to block direct sunlight, helping to maintain a cooler indoor environment. Most houses of this typology have rooms with ceiling heights ranging from 4.57 meters to 5.49 meters, while the walls have a thickness of approximately 0.46 meters to 0.51 meters. The increased ceiling height plays a significant role in generating a natural draft, which enhances ventilation within the indoor spaces (Singh et al., 2009). This unique construction style has been practiced for more than two centuries, demonstrating its resilience and adaptability to the region's climatic conditions.

Traditionally, Sal wood is extensively used for constructing key structural elements such as the elevated flooring, roof trusses, and vertical posts. The superstructure of ATHs follows a framework-based design, where wooden frameworks are infilled with wall panels. These panels are made by inserting Ikra reeds into vertically arranged bamboo frames. Once assembled, the walls are plastered on both sides using a mixture of mud and dung, employing the Wattle and Daub technique. The roofing material typically consists of thick layers of Ikra reeds or thatch, which provide excellent insulation and protection from the elements (Nag and Gondane, 2013).



Figure 2.3: A Traditional Assam-type House (Source: Author)

The spatial organization of ATHs is typically symmetrical, with a central court away from the main house and close to the source of water which could be a well or tube well; the kitchen is also built separately, usually separated by an open courtyard to avoid fire hazards since most of the materials used were organic and prone to catch fire easily (Das et al., 2014).

Figure 2.3 illustrates a traditional self-built ATH, highlighting its characteristic architectural features and construction techniques. ATHs remain the most prominent and widely adopted form of traditional residential architecture in the region. Their continued relevance is attributed to their ability to adapt to Assam's climate, offering a balance of resilience, affordability, and thermal comfort. In the following section, a more detailed discussion on ATHs will be presented, covering their structural variations, material adaptations, and contemporary relevance.

2.8.1 Key Architectural Characteristics of Traditional Assam-type Houses

ATHs possess a set of distinctive architectural characteristics that have been studied and analysed by experts in the field. These features include the careful selection of construction materials, specialized building techniques, spatial organization, aesthetic elements, and a strong focus on sustainability. Together, these aspects define the unique identity of Assam-type dwellings and their adaptability to the local climate and seismic conditions.

2.8.1.1 Materials



Figure 2.4: Visible Materials in a Partially Exposed Section of a Traditional Assam-Type House
(Source: Author)

The construction of ATHs primarily relies on traditional materials such as timber, bamboo, reeds, and natural binding agents like mud and dung. These materials are lightweight, making them ideal for the seismic-prone region. During the British colonial period, certain modern materials were also introduced into Assam-type construction. Glass was used for partial glazing in windows and doors, while cement plaster was applied to strengthen walls. Bricks were incorporated in the lower portion of the ground floor walls up to sill height, and galvanized iron (GI) sheets became a common choice for roofing. Additionally, steel sections were sometimes used at the corners of houses as vertical support members. Cement concrete was primarily limited to the plinth construction. Despite the inclusion of modern materials, their use remained minimal, ensuring that the overall weight of the building structure remained low (Chand et al., 2020). Figure 2.4 shows the use of bamboo, wood, CGI sheets, glass, and mud mortar in the construction of a traditional ATH.

2.8.1.2 Construction Method

The construction methodology of Assam-type buildings is simple, flexible, and highly adaptable to the local environmental and seismic conditions. The design follows a fundamental principle: a strong base, a flexible midsection, and a lightweight top. Consequently, bricks or stones are primarily used in the plinth or for constructing a short ground-floor wall, while the upper structure remains lightweight. This technique has evolved over generations, prioritizing earthquake resistance and climate responsiveness (Ji and Punekar, 2019).



Figure 2.5: Side View of an Assam-Type House Illustrating the Core Principle of Assam-Type Construction: Strong Base, Flexible Midsection, and Lightweight Top (Source: Author)

A crucial aspect of Assam-type construction is the connection between wooden frames, lightweight walls, and the roof. These elements are joined using flexible connections, allowing the structure to absorb seismic shocks effectively. This flexible system enhances earthquake resistance, reducing structural damage during tremors.

The most common roofing material is corrugated galvanized iron (CGI) sheets supported by timber trusses. This roofing system is well-suited to the region's heavy rainfall, as its sloping design facilitates efficient water drainage. Flooring in ATHs varies based on the building type. Single-story homes often feature cement flooring over a base of sand and brick soling or rammed earth floors finished with a mud-dung mixture. In stilted houses

and double-story structures, the upper floors are typically constructed using wooden planks laid over wooden beams and runners (Das et al., 2012).

2.8.1.3 Seismic Resilience Features

ATHs have a long-standing reputation for withstanding earthquakes effectively. Several key characteristics contribute to their seismic resilience:

- a. **Use of Wood, Bamboo, and Ikra:** These materials are highly flexible and lightweight, allowing them to absorb seismic energy and sway with ground movements rather than resisting them rigidly. Bamboo is particularly valued for its natural flexibility, while wood offers high strength relative to its weight.
- b. **Lightweight Construction:** The low mass of Assam-type buildings reduces the overall force exerted on the foundation during an earthquake, thereby lowering the risk of collapse.
- c. **Flexible Connections:** The joints between structural elements are designed to allow movement, reducing the likelihood of structural failure under seismic stress.
- d. **Moderate Size Openings:** Unlike modern buildings, ATHs have relatively Moderate window and door openings, which help maintain the strength of walls against lateral forces during earthquakes.



Figure 2.6: Moderate Sized Openings, Symmetrical Design, Simple Roof Structure etc in a Traditional Assam-Type House (Source: Author)

- e. **Symmetrical Design:** The symmetrical layout of these houses ensures even distribution of seismic forces, minimizing torsional effects that could lead to structural damage.
- f. **Roof Structure:** The lightweight, simple design of the roof minimizes the risk of serious damage in the event of structural failure (Ji and Punekar, 2019) (Kaushik and Babu,2009).

2.8.1.4 Spatial Configuration

ATHs typically follow standardized layouts, with a spatial arrangement that balances functionality, ventilation, and climate adaptability. One of the most common design elements is the presence of a **semi-covered veranda or porch**, which either encircles the building entirely or extends along its longer sides. This veranda serves multiple functions: it provides shading, protects mud-plastered walls from being eroded by rain, and offers an informal, multipurpose space for household activities.

Medium to large ATHs often adopt **H or U-shaped layouts**, which naturally create a central courtyard. This courtyard serves as a buffer zone separating the main house from utility spaces such as the kitchen and bathrooms. A distinctive feature of these houses is the intentional separation of kitchens and toilets from the main living areas. This was primarily done to improve fire safety and moisture control. Traditionally, kitchens and toilets were constructed as separate annexes or detached structures within a courtyard, minimizing the risk of fire spreading, particularly in homes built with flammable materials such as bamboo, thatch, and timber. The courtyard and veranda provide a private outdoor area for activities such as drying clothes, processing grains, or hosting informal family gatherings (Ji and Punekar, 2019) (Ravishankar & Ji, 2021).

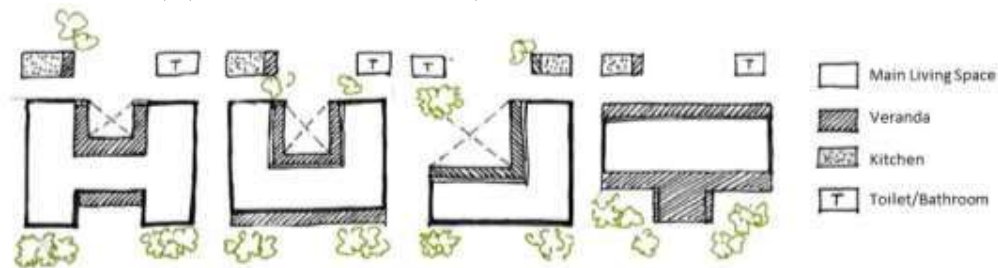


Figure 2.7: Sketch showing the common layouts of Traditional Assam-Type Houses. (Source: Sketch developed by author based on figures from Housing Report- Assam Type House, Kaushik and Babu, 2009)

Another notable aspect of ATHs is their modular design, facilitated by the framed structure and symmetrical layout. This inherent modularity allows for straightforward expansion if additional space is required.

2.8.1.5. Aesthetic Characteristics

The architectural style of ATHs is deeply rooted in the cultural and environmental context of Assam and the broader northeastern region of India. Their distinct visual identity is characterized by the following elements:



Figure 2.8: Aesthetic characteristics in a Traditional Assam-Type House (Source: Author)

- a. Multi-Gable Roofs:** The pitched, sloping roof is a key aesthetic feature that adds visual interest. Larger buildings often have intricate roof designs with multiple slopes of varying sizes, sometimes incorporating a central roof lantern.
- b. Decorative Bargeboards:** These ornamental wooden elements are commonly found along the roof edges, enhancing the building's aesthetic appeal.
- c. Neutral Colour Palette:** Traditional ATHs are typically finished with lime wash, while exposed wooden structural elements are coated with black bitumen paint. This combination not only provides weather protection but also creates a striking contrast between the white lime finish and the dark timber framework.
- d. Proportional Symmetry:** The design of ATHs emphasizes balance, symmetry, and well-proportioned spaces, creating a harmonious architectural expression.

- e. **Minimalist Design:** Despite their intricate craftsmanship, ATHs maintain a simple, understated elegance. Their clean lines and organic material palette allow them to blend seamlessly with the natural surroundings, creating an unobtrusive and visually pleasing architectural form (Ji and Puneekar, 2019) (Ravishankar & Ji, 2021) (Dash and Gupta, 2022)

2.8.1.6 Passive Design Features in Traditional Assam-type Houses

The ATH stands as a remarkable example of climate-responsive architecture, specifically designed to address the environmental challenges posed by Assam's tropical monsoon climate. A closer examination of these features highlights how this architectural style successfully integrates functionality with environmental sensitivity, making it a model for climate-adaptive housing.

- a. **Construction Materials and Methods:** As already discussed, the construction of ATHs primarily employs the wattle and daub technique, where woven bamboo is coated with a processed mud layer. This method effectively reduces indoor heat gain, ensuring thermal comfort in the region's warm and humid climate. As both materials and labour are sourced locally, these houses have a low embodied energy, minimizing the environmental impact associated with material processing, transportation, and assembly (Choudhury and Chetry, 2023) (Deka, 2018).



Figure 2.9: Wattle and Daub Technique Used in the Walls of a Traditional Assam-Type House (Source: Author)

The lightweight structure of these houses is reinforced with horizontal and vertical wooden battens, enhancing their flexibility and making them highly resistant to earthquakes, a critical necessity in Assam's seismically active region. Walls are often plastered with a mixture of red soil and lime, which improves durability while adding a natural aesthetic. In older houses, some of which are over a century old, Sal wood columns were used in their natural cylindrical form rather than being shaped into rectangular sections, demonstrating resource efficiency and traditional craftsmanship (Choudhury and Chetry, 2023).

- b. Spatial Arrangement:** Traditional ATHs are characterized by well-planned spatial layouts that reflect both functional and environmental considerations. As discussed, the typical layouts followed are rectangular, L-shaped, or C-shaped floor plans, with rooms arranged along verandas to enhance natural ventilation. This open design fosters airflow and light penetration, which are essential for comfort in Assam's humid tropical climate (Choudhury and Chetry, 2023).



Figure 2.10: Lower Brick Wall and Upper Wood-Bamboo-Ikra Section Using Wattle and Daub in an Assam-Type House (Source: Shermin 2017)

- c. Walls:** The walls of ATHs are built with a combination of materials to enhance durability and moisture control. The lower portion, extending up to approximately 80–90 cm from the plinth, is made of bricks about 15 cm thick. This brick

foundation provides stability and protection against rising ground moisture. Above this level, the walls are constructed using the wattle and daub technique, where woven bamboo and Ikra is coated with mud plaster. These bamboo walls, around 5 cm thick, offer additional insulation and protection (Choudhury and Chettry, 2023). This method prevents bamboo from direct contact with moisture, thereby increasing the structure's longevity and ensuring better moisture control, which is essential in Assam's humid environment.

- d. Open Spaces and Vegetation:** Open spaces and vegetation play a significant role in enhancing the climate adaptability of ATHs. Courtyards and verandas are integral to the design, providing shaded areas that facilitate cross-ventilation and regulate indoor temperatures by promoting airflow. These spaces help dissipate heat buildup, ensuring comfortable living conditions in the humid tropical climate. Additionally, trees and plants are strategically placed around the house to provide shade, further cooling the surroundings, and acting as a natural buffer against direct sunlight. This combination of open spaces and vegetation supports passive cooling while fostering a harmonious relationship with nature, enhancing both comfort and sustainability (Choudhury and Chettry, 2023).



Figure 2.11: View of a Courtyard in a Traditional Assam-Type House (Source: Author)

- e. Openings and Ventilation:** The openings in ATHs, including doors, windows, and ventilators, are designed to maximize airflow while minimizing heat and

moisture intrusion. The windows are usually moderate in size and rectangular, strategically positioned to capture breezes and facilitate cross-ventilation. Additionally, small ventilators placed high near the ceiling allow hot air to escape, creating a natural airflow that keeps the interior cooler without relying on mechanical ventilation (Choudhury and Chettry, 2023). This system enhances indoor comfort while reducing energy consumption, making it an effective solution for the region's climate.

- f. Plinth Height:** A defining feature of ATHs is their elevated plinth, designed to mitigate the effects of heavy rainfall and flooding. By raising the structure several feet above ground level, the plinth prevents waterlogging and protects the house from floodwaters during the monsoon season. This elevation helps keep living spaces dry, reducing the risk of moisture-related damage and ensuring better indoor air quality in Assam's humid climate (Choudhury and Chettry, 2023).

- g. Roofing and Shading:** The steeply pitched roofs of ATHs are engineered to handle the region's high rainfall effectively. These roofs ensure rapid water runoff, preventing accumulation and potential damage. Traditional roofing materials include corrugated metal sheets, thatch, or tiles, all of which are lightweight yet durable. Large roof overhangs extend beyond the walls, providing essential shading for windows and walls while reducing direct exposure to sunlight. These overhangs also act as barriers against rain, preventing water from seeping into the house (Choudhury and Chettry, 2023). Additional overhangs or chajjas above windows enhance shading, further improving thermal comfort indoors.

- h. Ceiling and Ventilation:** Ceilings in ATHs are typically high, allowing warm air to rise and collect near the top, thus keeping the living areas cooler. This passive cooling strategy effectively minimizes heat buildup during the day. Materials such as bamboo and wood, which are lightweight and naturally insulating, are commonly used. In some houses, ceilings feature an additional layer of bamboo or wood for extra insulation, enhancing both summer cooling and winter warmth (Singh et al., 2009; Choudhury and Chettry, 2023).



Figure 2.12: High Ceiling and Ventilator in Traditional Assam-Type Houses (Source: Author)

- i. Special Features:** Several distinctive features in ATHs contribute to their climate adaptability:
- **Attic Space:** The steeply pitched roofs often house attics, which act as thermal buffers, reducing heat transfer to the lower living spaces. Attics also serve as storage areas for food and household items, protecting them from high humidity (Choudhury and Chetty, 2023).
 - **Open-Tread Wooden Staircases:** Staircases leading to the attic are often designed with open treads, allowing air circulation around the stairs and preventing heat and moisture buildup.
 - **Cement or Mud Plastered Floors:** Floors are finished with either cement or mud plaster. Mud floors naturally regulate temperature, keeping interiors cool in summer, while cement floors offer durability and moisture resistance, crucial in a flood-prone region (Kaushik and Babu, 2009).
 - **Bamboo Screens:** In traditional ATHs, bamboo screens enhance climate responsiveness by promoting cross-ventilation, providing shade, and diffusing light, crucial for cooling in the region's humid climate. Their porous structure allows airflow while protecting from direct sunlight and rain, making them a sustainable and effective solution for thermal comfort.

- Low height boundary walls built with wood or woven bamboo.



Figure 2.13: Example of a Bamboo Screen and Attic Storage Space in Traditional Assam-Type Houses (Source: Author)

2.8.2 History and Evolution of Assam-type House

Before the advent of British rule, Assam was governed by the Ahom kingdom for six centuries. During this period, the structures built by the Ahoms were often elaborate, costly, and complex to construct. In contrast, the common populace constructed homes featuring thatched roofs and bamboo walls, which were coated with a mixture of mud and cow dung. This construction style was well-suited to the region's tropical and humid climate (Baishya, 2003).

The advent of colonial rule and the subsequent architectural initiatives introduced substantial transformations to the region's built-environment, leading to the emergence of what is now known as the ATH. This architectural evolution marked a significant shift towards modernization and urbanization, particularly within the domain of residential structures. The transformation was particularly noticeable in areas where the British initially established their administrative and commercial activities, especially in Guwahati. Guwahati's journey toward modernity commenced after the British took control of the city on March 28, 1824, reclaiming it from Burmese occupation. While British administrative authority had been present in the Goalpara region since August 12, 1765, the annexation of Guwahati represented a crucial moment in Assam's history. It signalled Assam's integration into the British Empire, with Guwahati designated as an administrative headquarters. Over time,

the sparsely populated settlement underwent a gradual transformation, evolving into a town and later a municipal area by 1853. At that time, most residential structures in Guwahati were composed of bamboo and thatch. However, a significant fire during this period led to the destruction of nearly all dwellings, prompting residents to petition the government for permission to construct homes with terracotta tiles. To support this transition, skilled artisans from Bengal were brought in to manufacture bricks and terracotta tiles, marking a critical milestone in the architectural development of the city (Hazarika, 2013). During the early phase of British colonial rule in Assam (1826-1947), buildings were primarily constructed using timber walls and thatch, though some masonry structures were also introduced.

A major turning point occurred on June 12, 1897, when a powerful earthquake struck the northern ridge of the Shillong plateau. The seismic event caused widespread destruction, reducing most British-constructed buildings, made of limestone, bricks, and lath-and-plaster to rubble. This disaster highlighted the resilience of traditional construction techniques and prompted efforts to enhance them. A revised architectural model was subsequently developed in collaboration with Japanese seismologists, incorporating features to improve earthquake resistance (Kaushik and Babu, 2009).

Over the following decades, the Assam-type construction style evolved, becoming more refined and standardized through the introduction of detailed specifications, intricate joinery techniques, and selective modern materials. The British introduced materials such as baked brick, glass for window glazing, roofing sheets, and steel sections to reinforce traditional construction methods. Inspired by Japanese architectural principles, the structural improvements focused on increasing the durability of walls and enhancing overall stability. This was achieved using wall braces, metal reinforcements for joints, and the strategic placement of multiple layers of bamboo and reed mesh within a wooden framework. The entire structure was then plastered with mud, providing both insulation and flexibility (Sharma, 2021).

Following India's independence, successive governments recognized the benefits of the ATH's lightweight and sustainable construction. As a result, this architectural style was widely adopted for government buildings, including offices, institutions, and residences many of which remain functional today (Sharma, 2021).

Drawing inspiration from both Calcutta and Tudor architectural styles, these buildings featured steeply pitched gable roofs and incorporated a range of construction materials. Chinese carpenters played a crucial role in the development of Assam-style homes due to their exceptional craftsmanship and innovative techniques. These skilled professionals, highly regarded by both European and Indian elites, were part of the Chinese community in colonial Calcutta. Frequently employed in the construction of tea garden bungalows, their work introduced several enhancements, including L or U-shaped layouts, high false ceilings, spacious covered porches, ornate staircases, detailed barge boards, tall walls made from ikora and bamboo, wooden posts coated with cement, ventilators, bay windows, and red oxide flooring. The aristocracy often imported high-quality materials, particularly Portland cement and Burmese teakwood, to elevate the aesthetic and structural quality of these houses (Kalita, 2024). Notably, variations in design emerged based on the function of the buildings. For instance, office buildings were typically two-story structures with larger windows to maximize natural light and ventilation, whereas Assam-type churches featured distinct door, window, and roof shapes. A common feature in these buildings was a rear exit, designed to facilitate emergency evacuations (Kaushik and Babu, 2009). Additionally, the use of locally available materials contributed to their cost-effectiveness. It has been estimated that the construction cost of a traditional ATH is nearly half that of a comparable reinforced concrete (RCC) building (Das et al., 2014).

However, in the latter half of the twentieth century, a shift occurred as nuclear families opted for smaller houses. The Assam-Tibet earthquake of 1950, with a magnitude of 8.4, reinforced the durability of Assam-type constructions, prompting further innovations such as the use of iron railway tracks as foundation pillars and CGI sheets for roofing, as straw became less accessible. ATHs became widespread across the region, built by individuals from various social backgrounds, including government employees, businessmen, and communities such as Assamese and Bengalis. The Great Earthquake of 1897 and the Assam Earthquake of 1950 not only reshaped the physical landscape but also influenced societal structures and building practices (Kalita, 2024).

Unfortunately, the prominence of ATH began to wane with the growing adoption of reinforced cement concrete (RCC) structures in the latter part of the twentieth century, particularly after Guwahati was declared the capital in 1972. The rising cost and limited availability of traditional construction materials contributed to this decline. Additionally, rapid

urbanization and population growth made it increasingly difficult for low-rise ATHs to meet expanding housing demands (Kalita, 2024). These factors led to the gradual transformation in ATH designs as homeowners began adopting modern construction materials, and thus giving rise to a contemporary variation of ATH, commonly known as the ‘New ATH’.

2.8.3 Contemporary Adaptations: The Contemporary Assam-Type House

The contemporary ATH, locally called the ‘New ATH’, represents a contemporary evolution of the traditional ATH, retaining some key traditional features while adopting an RCC structure. This transition has occurred gradually over time. Based on examples studied, houses built a few decades ago, despite being constructed with RCC, still incorporated traditional elements, such as bamboo ceilings, bamboo screens on verandas, and complete traditional roof forms. Additionally, courtyards and vegetation were included wherever possible. However, more recent constructions have become increasingly compact, with bamboo ceilings being replaced by gypsum or POP, and bamboo screens on verandas being substituted with steel grills. This shift reflects changing material preferences, urban constraints, and evolving design sensibilities.

Current practices show that the construction of the contemporary ATH typically follows an RCC framework, characterized by reinforced concrete beams and columns, with brick masonry walls finished with cement plaster. Roof structures generally feature wooden rafters and purlins supported by the beams, covered with CGI sheets. Although this design is reminiscent of the traditional style, the use of steel trusses is becoming more common. Sal wood remains the preferred material for doors, windows, and ventilators. However, due to its high cost and limited availability, more economical alternatives, such as other timber varieties or engineered wood, are frequently used as substitutes (Kaushik and Babu, 2009).

The house layouts are typically simple and functional, generally consisting of four to six rooms. The integration of modern materials has minimized the risk of fire, allowing for the attachment of kitchens, toilets, and bathrooms to the main structure, usually at the rear for convenience and practicality. Figure 3 illustrates a newly constructed, contemporary self-built ATH, showcasing an RCC-based construction technique.



Figure 2.14: A Contemporary Assam-Type House (Source: Author)

2.8.4 Critical Understanding - Assam-Type House

The literature identifies the Assam-Type House (ATH) as one of the most distinctive and enduring residential forms in Northeast India, including Assam. Over time, it has evolved from vernacular bamboo and thatch houses into a hybrid model combining traditional wisdom with selective modern materials. Its raised base, sloping roofs, and well-ventilated spaces demonstrate a strong understanding of Assam’s hot, humid, and flood-prone conditions, while its light structure makes it resilient to frequent earthquakes. Together, these qualities show that the ATH is not only a response to the local climate but also an adaptable and sustainable building system.

In recent decades, however, this balance between tradition and performance has begun to decline. Many of the newer or “contemporary” Assam-type houses copy only the outward form, such as the sloping roof or veranda, while replacing features like effective cross ventilation, breathable wall materials and deep roof overhangs with sealed surfaces, compact layouts and limited openings, reducing the buildings ability to respond naturally to heat, humidity and rainfall and resulting in houses that visually resemble the traditional type but no longer function as effectively in the local environment.

This change makes the Assam-type house a crucial example for study. It clearly demonstrates how a once well-adapted and sustainable housing model can lose its environmental logic when adapted without understanding its core principles. Analysing this typology helps identify which traditional features truly contribute to comfort, resilience, and sustainability, offering valuable lessons for integrating climate-responsive thinking into contemporary residential design.

2.9 Review of Previous Studies on Assam-type House

Several studies have explored the architectural and climatic aspects of ATHs. This review summarizes the key findings of these studies.

a. Climate-responsive Building Design in North-East India by Manoj Kumar Singh, Sadhan Mahapatra, Atreya Kumar Sudhir, (Singh et al., 2009)

This paper provides an in-depth analysis of the thermal comfort and energy efficiency of vernacular architecture in Northeast India, with a specific focus on ATHs. It shows how these houses are meticulously designed to adapt to the warm and humid climate of the region. By utilizing locally available materials and traditional construction methods, ATHs exemplify a profound understanding of bioclimatism, promoting natural ventilation and reducing heat gain effectively.

The study incorporates a field survey involving 220 occupants across 75 vernacular buildings, including ATHs, to assess thermal comfort through data on temperature, humidity, and occupant perceptions. The findings reveal that while these houses perform admirably during the pre-summer months, they face challenges in maintaining comfort during the colder winter season. This underscores the need for improved insulation and ventilation to enhance year-round comfort.

One of the paper's key observations is the integration of solar passive design elements, such as high ceilings and strategically placed windows, which facilitate natural airflow and reduce dependence on artificial cooling systems. The research also emphasizes the importance of adaptive strategies, such as adjusting window openings and utilizing ceiling fans, to enhance thermal comfort across seasons.

Additionally, the paper underscores the cultural and environmental significance of ATHs. Their architecture not only provides thermal comfort but also reflects the socio-cultural identity of the region. The use of locally sourced materials and traditional construction methods contributes to sustainability and environmental harmony, positioning these houses as a model for climate-responsive and sustainable design.

In its recommendations, the paper advocates for the incorporation of improved insulation techniques and additional solar passive features to further optimize energy efficiency and thermal performance. Overall, the paper effectively positions ATHs as an exemplary case of vernacular architecture, blending energy efficiency, cultural heritage, and sustainability while offering avenues for modern enhancements to meet contemporary demands.

b. Experimental Study on Traditional Assam-type Wooden House for Seismic Assessment, by Biswajit Chand, Hemant B. Kaushik, Sandip Das, (Chand, Kaushik and Das, 2017)

This paper provides an in-depth examination of the construction methodology, material properties, and seismic performance of ATHs, focusing on their lateral load behaviour. It begins by situating ATHs within the global context of traditional half-timbered structures, noting their similarities to systems like Baghdadi and Himis in Turkey, renowned for their seismic resilience. ATHs, characterized by lightweight Ikra or bamboo mesh walls and local construction techniques, demonstrate excellent seismic performance. However, the paper notes a significant gap in research regarding their structural behaviour under lateral loads, which this study aims to address.

The paper outlines the construction methodology of ATHs, emphasizing their lightweight materials, such as Ikra and bamboo, combined with structural features like flexible joints, strong connections, and regular architectural plans. These design elements contribute to their seismic resilience. The study also describes two 2-D frame specimens constructed for testing, highlighting differences in material use and structural detailing. The testing procedure employed incremental displacement to evaluate the frames' behaviour under lateral loads. The results revealed distinct performance differences: The frame with Ikra infill, exhibited greater stability, higher lateral load capacity, and enhanced energy dissipation compared to the other frame without ikra. It also maintained its integrity, with minimal

damage to the Ikra infill panels. This underscores the critical role of infill materials in improving the seismic performance of ATHs.

The paper concludes by highlighting the superior lateral load behaviour of ATHs with Ikra infill, attributing their performance to the flexibility and energy dissipation properties of the materials and construction techniques. By addressing the lack of research on the seismic behaviour of ATHs, this study provides valuable insights into their structural resilience and emphasizes their potential as a model for earthquake-resistant design in regions with similar conditions.

c. Housing Report – Assam Type House, by Hemant B. Kaushik, K. S. Ravindra Babu. (Kaushik and Babu, 2009)

This report provides a comprehensive assessment of the seismic vulnerability of *Ikra*-type houses, focusing on their performance during earthquakes in regions prone to high seismic activity. By analysing historical data and structural behaviour, the report emphasizes the exceptional resilience of these houses compared to modern reinforced concrete structures. During significant seismic events, such as the 2011 Sikkim earthquake, *Ikra*-type houses demonstrated remarkable resistance to damage, while concrete structures often sustained severe and irreparable failures. This superior performance can be attributed to the light-weight materials, such as *Ikra* reed and Sal wood, and the flexible timber connections that enhance the structures' ability to absorb and dissipate seismic forces.

A significant portion of the report is dedicated to documenting the unique construction methodologies of *Ikra*-type houses, which have evolved over centuries to suit local environmental and seismic conditions. These traditional houses are single-storey, raised above ground to mitigate moisture and animal intrusion, and utilize locally available materials like timber frames and mud-dung plastered *Ikra* walls. Such practices ensure cost efficiency while enabling earthquake resistance. However, as the report notes, modern construction modifications, such as the use of heavy masonry infills, can increase seismic vulnerability, particularly in upper-storey extensions.

The report also explores the cultural and economic dimensions of *Ikra*-type houses. These structures hold cultural significance, reflecting the adaptation of communities to their environment over generations. Despite their strengths, the declining trend in their

construction is concerning. Factors such as the scarcity of affordable wood, fire hazards, and high insurance premiums have contributed to their reduced prevalence, particularly in urban areas. This decline further underscores the importance of preserving the traditional knowledge associated with *Ikra*-type houses.

In comparing *Ikra*-type houses with reinforced concrete structures, the report underscores the former's advantages in seismic-prone regions. While concrete buildings are rigid and prone to failure under seismic forces, *Ikra* houses remain flexible and lightweight, minimizing the risk of structural collapse. However, the report acknowledges certain vulnerabilities, such as fire risks and challenges on sloped terrains, where uneven foundation posts may cause asymmetrical shaking.

To ensure the continued viability of *Ikra*-type houses, the report provides key recommendations. It suggests integrating modern materials and construction techniques to enhance fire resistance and structural integrity while maintaining the traditional design principles that contribute to their seismic resilience. Additionally, the inclusion of *Ikra*-type construction in national building codes and standards is proposed to legitimize and support their use in both rural and urban settings.

Overall, the report serves as a valuable resource for understanding the seismic performance, construction practices, and cultural significance of *Ikra*-type houses. By offering insights into their strengths, vulnerabilities, and economic implications, it provides a roadmap for preserving and improving these structures in the face of evolving environmental and economic challenges.

d. Architecture of North East India: Vernacular Typologies, by Shubhankar Nag and Amol Gondane , (Nag and Gondane, 2013)

The paper titled "*Architecture of North East India: Vernacular Typologies*" provides an analysis of the traditional housing forms in North East India, emphasizing their architectural features, material use, and climatic responsiveness. It begins by acknowledging the region's rich tradition of vernacular architecture, which has evolved to meet environmental challenges using locally available materials. These buildings, rooted in sustainable construction principles, are inherently sensitive to the region's diverse climatic conditions. However, the study brings to light the adverse impacts of rapid urbanization, which has led

to the gradual replacement of these traditional structures with concrete buildings. The authors advocate for the formulation of specific byelaws to promote traditional architectural forms and ensure their relevance in contemporary contexts.

The research classifies traditional houses based on construction types and materials, offering a detailed examination of their design and functionality. *Kutchas*, constructed primarily with earth, bamboo, and thatch, reflect local microclimatic and cultural influences. Bamboo and wooden kutchas, for instance, feature walls plastered with mud and cow dung for insulation, providing thermal comfort but requiring frequent maintenance.

Stilted kutchas, common in flood-prone areas like Assam and Arunachal Pradesh, are elevated to prevent water damage, demonstrating a practical response to the region's heavy monsoons. Similarly, *high-pitched roof kutchas* feature bamboo or timber frames with thatched roofs, designed to shed rainwater effectively. These houses often incorporate continuous hearths, serving both thermal and functional purposes during colder months. The study also notes the emergence of *modified kutchas*, which retain traditional layouts but integrate modern materials such as concrete to address durability and maintenance concerns.

A significant focus of the report is on *ATHs*, which originated during British rule and remain an essential typology in the region. These houses, typically single-storey with elevated plinths, are constructed using materials like Sal wood, bamboo, and Ikra reeds. Their design, characterized by pitched roofs and continuous verandas, reflects a harmonious blend of climate responsiveness and aesthetic appeal. While modern adaptations incorporate concrete columns and brick walls for structural stability, they often maintain the traditional architectural language, ensuring cultural continuity.

The paper concludes by emphasizing that traditional housing typologies offer valuable lessons in sustainable and climate-responsive design. However, it also acknowledges the drawbacks, such as fire risks, dampness, and the need for regular maintenance, which have contributed to their decline. The authors argue that raising awareness about these vernacular forms and integrating advanced construction techniques can create modern yet sustainable solutions. Importantly, they highlight the absence of supportive local byelaws for traditional housing, particularly in hilly regions, and call on governments to enact policies that

promote the use of local materials while preserving the architectural heritage of North East India. The research underscores the importance of documenting and analysing vernacular architecture to inform future design practices. By advocating for the preservation and adaptation of traditional housing forms, it contributes to the ongoing discourse on sustainable architecture, cultural identity, and the socio-economic relevance of indigenous building methods in North East India.

e. Assam Type Architecture; Problems and Prospects, by Prerona Kaushik¹, Nagaraju Kaja, (Kaushik and Kaja, 2016)

The paper "*Assam Type Architecture: Problems and Prospects*" explores the enduring relevance of Assam type architecture, also known as the "Ikora Style," emphasizing its cultural, environmental, and practical significance in contemporary society. The research shows the unique features of these houses, particularly their stilted structures, which provide protection against floods and wild animals, making them highly suitable for the flood-prone and ecologically sensitive environment of Assam. By focusing on the natural materials used in construction, bamboo, cane, and palm leaves, the paper underscores their ecological value, as these materials are renewable, lightweight, and locally available. Bamboo, in particular, is praised for its strength, sustainability, and rapid growth, making it an essential component of the structural framework in Assam type houses.

The study positions Assam type architecture as a sustainable alternative to modern concrete structures, which rely heavily on non-renewable resources and contribute to significant environmental degradation. The paper criticizes the shift towards industrialized construction methods, which, while appearing modern, often disregard the ecological and cultural wisdom embedded in traditional practices. As a result, the decline of Assam type architecture reflects both the loss of environmentally friendly practices and a disconnection from local heritage. The paper highlights how rapid urbanization and globalization have led to an increasing preference for concrete and steel buildings, pushing traditional architecture to the margins.

To address this decline, the research advocates for the revival and adaptation of Assam type houses by integrating modern construction technologies. Such an approach, the paper argues, can combine the strengths of traditional methods, such as climate responsiveness and seismic resistance, with innovations that enhance durability and efficiency. Given Assam's

seismic vulnerability and hot, humid climate, these houses, with their lightweight materials and flexible structures, offer superior performance compared to modern, rigid buildings during earthquakes and extreme weather conditions.

The paper's methodology involves a focused study on the Kamrup district, where field data is collected to analyse the functional, material, and environmental advantages of Assam type houses. The findings emphasize the long-term sustainability of these traditional structures and highlight the environmental and cultural consequences of neglecting such practices. By positioning Assam type architecture as a solution to contemporary challenges, the paper demonstrates how these homes can address issues of flooding, seismic safety, and carbon footprint reduction while preserving cultural identity.

In conclusion, the paper calls for a balanced approach that revives and modernizes Assam type architecture, ensuring its relevance in contemporary society. It advocates for recognizing the ecological and cultural value of these homes and integrating modern techniques to create sustainable, climate-responsive, and eco-friendly living spaces. By doing so, Assam type architecture can serve as a model for sustainable development, addressing both environmental concerns and the need to preserve traditional practices.

f. Investigation of bioclimatic design features in vernacular architecture of Northeast India: Case studies of Assam-type houses and stilt houses (Chang Ghar) in Assam, India, by Ankita Sen Deka Choudhury and Vishal Chetty, (Choudhury and Chetty, 2023)

The paper provides a thorough investigation into the bioclimatic design features of vernacular architecture in Northeast India, with a particular focus on ATHs and stilt houses (Chang Ghar). These traditional typologies are analysed in the context of their response to the region's unique climatic challenges, including high rainfall, humidity, and seismic vulnerability. The study emphasizes how local materials and design strategies are utilized to create structures that are both functional and sustainable.

The research is situated in Assam, a state heavily influenced by the southwest tropical monsoon, with average annual rainfall ranging from 1600 mm to 4300 mm and temperatures fluctuating between 4°C–19°C in winter and 26°C–37°C in summer. The region's warm, humid climate and frequent flooding have shaped the architectural practices over

generations. The authors conducted a qualitative analysis, incorporating site surveys of ATHs over 40 years old and stilt houses over 35 years old. The research methodology assessed ten parameters, including construction materials, spatial arrangements, ventilation, plinth heights, and roofing systems, to document how these design features contribute to bioclimatic efficiency.

The study reveals that ATHs primarily use wattle and daub walls, wooden battens, and red soil plaster mixed with lime. Sal wood columns provide structural stability, while light construction materials enhance flexibility and earthquake resistance. Stilt houses, on the other hand, rely heavily on bamboo for their structure, which is both sustainable and resilient in flood-prone areas. Spatial layouts in both typologies are designed for effective airflow and ventilation, with L-shaped or rectangular layouts incorporating courtyards that promote heat loss and natural circulation. Openings, such as windows and ventilators, are strategically placed to align with prevailing winds, enabling cross-ventilation and reducing indoor heat buildup.

Roofing systems also play a crucial role in the bioclimatic efficiency of these structures. ATHs feature sloping roofs made of timber or galvanized iron (GI) sheets, which provide resistance to wind and water. In addition, sunshades and perforated bamboo or wooden screens enhance shading and allow diffused natural light to enter the interiors. Plinth heights, averaging around 45 cm, are elevated further in flood-prone areas to protect against water damage. Stilt houses extend this strategy by raising the entire structure, creating shared open spaces underneath that facilitate cooling and provide communal gathering areas.

The paper brings forward the adaptability of these typologies to the region's environmental conditions and their socio-cultural significance. The integration of open spaces, adjacent water bodies, and vegetation reflects a holistic design approach that prioritizes thermal comfort, resilience to humidity, and flood mitigation. However, the authors note that the increasing preference for modern construction materials such as concrete and steel is threatening the survival of these vernacular practices. While modern buildings may appear cost-effective, they often lack the climate responsiveness and sustainability inherent in traditional architecture.

The study concludes by emphasizing the importance of preserving and integrating vernacular design principles into contemporary construction practices. Recommendations include lowering roof heights to improve insulation and exploring hybrid designs that combine traditional techniques with modern materials. The paper underscores that the knowledge embedded in ATHs and stilt houses offers valuable lessons for sustainable design, particularly in regions facing similar climatic challenges. By bridging traditional wisdom with modern innovations, the findings advocate for environmentally responsive architecture that aligns with sustainable development goals.

g. Vernacular Architecture as Cultural Heritage: An Interpretation of Urban Vernacular ‘Bangla Baton’ Houses of Sylhet City, Bangladesh, by Kawshik Saha, Rezwan Sobhan, Mohammad Nahyan, Sadiya Afrin Mazumder, (Saha et al., 2021)

The paper titled “*Vernacular Architecture as Cultural Heritage: An Interpretation of Urban Vernacular ‘Bangla Baton’ Houses of Sylhet City, Bangladesh*” provides a detailed exploration of the architectural, cultural, and environmental significance of the ‘Bangla Baton’ houses in Sylhet. Although the study is based in Bangladesh, it acknowledges that the ‘Bangla Baton’ houses are a subcategory of the ATHs due to the shared historical background before the partition of India and Bangladesh. Sylhet was once part of the larger Assam region, and this historical connection influences the architectural practices in both areas, particularly in the design and construction of these traditional houses.

The paper displays how ‘Bangla Baton’ houses emerged during British colonial rule, combining local vernacular architectural practices with colonial construction techniques. These houses, made from locally available materials such as bamboo, reed, and timber, were developed in response to Sylhet’s subtropical monsoon climate. The study traces the evolution of these houses, noting their shift from traditional mud-bamboo homes to more durable, earthquake-resistant structures, particularly after the 1897 Assam earthquake. The ‘Bangla Baton’ houses were designed with lightweight materials and earthquake-responsive features, drawing from the lessons learned during the seismic events that impacted the region.

Architecturally, the paper provides a comprehensive analysis of the design and layout of ‘Bangla Baton’ houses, emphasizing their functional and aesthetic qualities. The houses typically feature rectangular plans for single-family units, and U, L, or C-shaped layouts for multi-family dwellings. The design incorporates elements that prioritize ventilation,

thermal comfort, and privacy, such as verandas, courtyards, and buffer zones. These spatial features reflect the socio-cultural norms of the region, providing spaces for family interaction while maintaining privacy. Aesthetic features, including gabled roofs, ornamental timber, and floral designs, contribute to the houses' unique visual identity and cultural significance.

Sustainability is another key focus of the study, with the paper examining how 'Bangla Baton' houses are designed to address environmental challenges. The houses feature large roof overhangs for shading, pitched roofs for effective rainwater drainage, and ample windows for ventilation, all of which enhance thermal comfort and contribute to the houses' resilience in Sylhet's climate. The lightweight construction and modular design of these houses also make them adaptable and easy to repair, ensuring their longevity. The study shows how these design principles align with modern sustainable building practices, especially in urban areas where land is limited and affordable housing is crucial.

In terms of socio-cultural significance, the paper explores how 'Bangla Baton' houses represent the cultural identity and social values of the Sylheti people. The houses are designed to reflect traditional norms, such as gender privacy and communal living, with features like private courts and semi-outdoor spaces that facilitate social interaction and family rituals. The houses are also symbols of social unity, with their symmetrical designs fostering a sense of order and community. However, the paper raises concerns about the ongoing threats to these houses, including rapid urbanization, rising land prices, and a lack of formal conservation policies. Many of these houses are being altered or demolished, leading to a gradual erosion of the region's cultural heritage.

The methodology of the study includes an ethnographic approach, involving physical surveys, interviews with inhabitants, and participant observation to document the architectural and cultural aspects of 'Bangla Baton' houses. The study identifies nearly 45 such houses in old Sylhet, with several selected for detailed analysis based on heritage assessment criteria. The paper evaluates these houses' historical, architectural, aesthetic, scientific, and socio-cultural significance, offering a comprehensive understanding of their value as cultural heritage.

In conclusion, the paper advocates for the conservation of 'Bangla Baton' houses and highlights their potential role in modern sustainable design. By recognizing these houses as

cultural heritage, the study not only raises awareness of their historical and architectural significance but also emphasizes their relevance to contemporary sustainability practices.

h. Exploring Attributes of Vernacular Assam Type House Design Techniques in Contemporary Setting, by Shiva Ji, Ravi Mokashi Punekar, (Ji and Punekar, 2019)

The paper, "*Exploring Attributes of Vernacular Assam Type House Design Techniques in Contemporary Setting*," provides a detailed investigation into the architectural, structural, and sustainable attributes of traditional ATHs. The study focuses on understanding the design techniques of these vernacular structures and their historical significance, particularly their adaptability to local environmental conditions and resilience against seismic forces in earthquake-prone zones.

Through an extensive field study, the research examines the planning, design, materials, and construction methods of ATH. It demonstrates key features, such as the strategic use of wooden materials and the segmentation of walling, which contribute to their structural integrity and aesthetic appeal. The study also identifies sustainable practices embedded in the construction of ATH, emphasizing their reliance on local resources and techniques that align with environmental considerations.

The paper provides insights into the role of lightweight materials like bamboo and Ikra in maintaining structural flexibility and enhancing seismic performance. It also documents how these traditional houses are designed with regular plans, minimal projections, and strong connections, making them functionally efficient and well-suited to the region's climate and seismic activity.

In conclusion, the paper offers a thorough analysis of the attributes of ATHs, shedding light on their architectural and functional significance. By decoding their traditional design elements, the study contributes valuable knowledge about the sustainability and resilience inherent in vernacular architecture, specifically in the context of Northeast India.

i. Seismic Evaluation of Assam-Type Building Using ABAQUS, by D. P. Shevchenko (Shevchenko, 2023)

The paper titled "*Seismic Evaluation of Assam-Type Building Using ABAQUS®*" by D. P. Shevchenko offers an insightful exploration of Assam-type housing, focusing on its

seismic performance, cost-effectiveness, and environmental sustainability. Grounded in the historical context of the 1897 Assam Earthquake, the study delves into the structural and material characteristics that make ATH a resilient and sustainable building style. By utilizing locally available materials such as timber, bamboo, and ikra for the superstructure, along with reinforced concrete (RCC) confined masonry up to the sill level, ATH is positioned as an innovative yet traditional solution for housing in seismically active regions.

A key concern addressed in the paper is the declining prevalence of ATH in favour of RCC frame structures, which are more resource-intensive and environmentally detrimental. The research critiques this shift, drawing attention to the sustainability challenges posed by modern construction trends. In response, the study advocates for the continued relevance of ATH by highlighting its advantages in terms of both cost and environmental impact.

The methodological rigor of the study stands out, as it employs advanced finite element modelling using ABAQUS® to evaluate the seismic performance of Assam-type buildings. Through dynamic modal analysis and the application of the response spectrum method, aligned with IS 1893 (Part 1): 2016, the study assesses the structural response of ATH to seismic activities. The findings are compelling, indicating that ATH provides adequate safety against seismic excitation in the studied region, further reinforcing its potential as a viable alternative to contemporary construction practices.

The paper effectively underscores the structural resilience of ATH, emphasizing its ability to withstand seismic forces while remaining environmentally sustainable and economically viable. The conclusions drawn from the research advocate for a revival of Assam-type housing, not only as a means of preserving vernacular architecture but also as a practical response to the challenges of modern construction in seismically active and resource-sensitive areas.

j. Exploring Two Housing Typologies in the Vernacular Architecture of Assam, by Srinidhi Ravishankar, Shiva Ji, (Ravishankar and Ji, 2021)

The paper "*Exploring Two Housing Typologies in the Vernacular Architecture of Assam*" by Srinidhi Ravishankar and Shiva Ji offers a detailed examination of the ATH and the Chang Ghar, two iconic vernacular housing typologies in Assam. The study underscores the unique characteristics of these architectural forms, focusing on their resilience to

seismic activity and adaptability to local weather conditions, which are central to the spatial variations in the region's traditional architecture.

The research explores the evolutionary trajectory of these housing types, presenting the ATH as a more advanced and evolved version of the Chang Ghar. This evolution is attributed to improvements in building structure, integration of materials, and enhanced resilience to environmental challenges. The comparative approach taken by the authors is particularly insightful, as it highlights the architectural distinctions and shared principles of these two typologies. By examining their construction techniques, spatial organization, and cultural significance, the paper provides a nuanced understanding of how these housing types address the challenges of the local environment.

Case studies included in the paper enrich the analysis, offering tangible examples of the design principles and architectural features of both typologies. These examples effectively illustrate how vernacular practices have been adapted over time to meet practical needs while maintaining cultural relevance.

The findings reveal both the commonalities and differences between the ATH and Chang Ghar, reflecting their distinct historical and cultural contexts. While both typologies are grounded in the vernacular tradition, the ATH stands out for its more sophisticated design and material integration, which enhance its structural resilience and functional performance.

In conclusion, the paper emphasizes the relevance of understanding and preserving these vernacular architectural forms, not only for their aesthetic and cultural value but also for their practical lessons in contemporary architecture. The authors make a compelling case for drawing inspiration from these traditional practices, particularly in the context of sustainable and disaster-resilient design. This study contributes significantly to the discourse on vernacular architecture and its applications in modern contexts, especially in regions prone to natural disasters.

k. Study of Bamcrete wall panel in the Traditional Assam Type house, by A. K. Dash, Supratic Gupta, (Dash and Gupta, 2022)

The paper titled “*Study of Bamcrete Wall Panel in the Traditional Assam Type House*” by A. K. Dash and Supratic Gupta investigates Bamcrete, a modern adaptation of the traditional Ikra wall, widely used in Assam Type houses. The research highlights Bamcrete as an innovative walling system that combines bamboo mesh with cement mortar, replacing the conventional mud plaster seen in vernacular Assamese architecture. The study situates Bamcrete as a sustainable construction method that addresses growing concerns regarding modern materials' reliance on non-renewable resources, particularly in the context of increasing urbanization and the shift toward multi-storied buildings.

A central focus of the study is the examination of strength and durability in Bamcrete wall panels, specifically analysing a 40-year-old Bamcrete panel from an existing Assam Type house. The authors conducted a hard-body horizontal impact test to evaluate the energy absorption behaviour of these walls compared to traditional mason mortar plaster. Additionally, lab-cast Bamcrete panels, created using a design mix mortar, were tested to compare their performance with the older in-situ samples. The findings of this assessment reveal significant improvements in impact resistance for Bamcrete panels, demonstrating their robustness and ability to endure external forces far better than traditional materials.

One of the most noteworthy conclusions of the study is the durability of the bamboo mesh within the mortar plaster. Despite being exposed to environmental conditions for over four decades, the bamboo shows no signs of deterioration, underscoring the long-term structural integrity of Bamcrete. These findings challenge preconceived notions about bamboo's vulnerability to decay and highlights its potential as a renewable and reliable construction material, particularly when combined with cement mortar.

The paper also emphasizes the sustainability of Bamcrete, positioning it as an eco-friendly alternative to conventional construction materials. By utilizing bamboo, a fast-growing and renewable resource, Bamcrete aligns with sustainable development goals while preserving local building traditions. The integration of this method into modern construction not only promotes resource efficiency but also addresses the need for durable and cost-effective building materials in regions vulnerable to seismic activity, such as Assam.

In conclusion, the study advocates for the adoption of Bamcrete wall panels in contemporary construction practices. The demonstrated durability, strength, and sustainability of Bamcrete make it a compelling alternative to modern materials, with the potential to

revitalize interest in traditional Assamese building techniques. The authors call for further scientific research to explore and promote the use of Bamcrete, highlighting its relevance in balancing cultural heritage preservation and the demands of modern infrastructure. This research reinforces Bamcrete's capacity to serve as both a durable and eco-conscious solution for sustainable architecture in Assam and beyond.

I. Material Characterization of Traditional Assam-Type Wooden Houses in North-eastern India, by Biswajit Chand, Hemant B. Kaushik, Sandip Das, (Chand, Kaushik and Das, 2020)

The study “*Material Characterization of Traditional Assam-Type Wooden Houses*” sheds light on the unique architectural legacy of ATHs, emphasizing their material attributes, structural resilience, and cultural importance. These houses, deeply rooted in the northeastern Himalayan region, serve as an outstanding example of traditional construction practices that have evolved to address the local environment, particularly the challenges posed by seismic activity.

A central focus of the paper is the seismic performance of these structures, which have demonstrated exceptional resilience during earthquakes. This durability is attributed to their flexible wooden frameworks, an ingenious feature that allows the structures to absorb and dissipate seismic energy effectively. Unlike modern rigid materials, the locally sourced timber provides a balance of strength and flexibility, ensuring the safety and longevity of the houses in this earthquake-prone region.

The study further explores the material properties of the wood used in ATHs, drawing attention to its density, strength, and durability. These characteristics make the wood particularly suited to the region’s climatic demands while contributing significantly to the structural stability of the houses. The reliance on local species highlights the sustainable use of resources, a practice that aligns with the environmental ethos of vernacular architecture.

Equally significant are the traditional construction techniques passed down through generations. These methods not only showcase skilled craftsmanship but also ensure that the houses remain durable, adaptable, and aesthetically appealing. By combining locally available materials with time-tested building practices, ATHs exemplify sustainable and resource-efficient design solutions.

The cultural relevance of these houses is another critical aspect discussed in the study. They stand as living symbols of the local community's heritage, reflecting their traditions, values, and lifestyle. Beyond their functional role as dwellings, these houses embody the identity of the people and serve as a reminder of the region's rich architectural history.

In summary, the paper highlights the Assam-type wooden houses as a model of resilience, sustainability, and cultural continuity. By analysing their material characteristics and construction techniques, the study demonstrates the potential of vernacular architecture to inspire modern sustainable practices, particularly in disaster-prone areas. It underscores the value of integrating traditional knowledge with contemporary architectural solutions to create buildings that are both environmentally responsive and structurally robust.

m. Seismic Performance of Traditional Bamboo-Stilted House of Flood Plains in Assam, Abhishek Kumar Laskar, Nayan Jyoti Dutta, Rahul Datta, Lalnghatlien Darn-gawn, Aktar Hussain, Anjan Dutta, (Laskar et al., 2022)

The study on the *seismic performance of traditional bamboo-stilted houses in the flood plains of Assam, India* sheds light on the structural resilience and environmental adaptability of this vernacular housing form. By focusing on a representative bamboo-stilted house in the Nimatighat area of Jorhat, the research underscores the relevance of these structures in regions vulnerable to both flooding and seismic events, emphasizing their dual role as sustainable and disaster-resistant housing solutions.

The strength of the study lies in its systematic approach, combining field-based observations and advanced structural modelling. Detailed data were gathered on the building's configuration, material properties, structural details, and foundation systems, ensuring that the study reflects real-world conditions. The use of *SAP 2000*® for structural analysis is a significant methodological choice, enabling a precise simulation of the building's behaviour during seismic events. Notably, the incorporation of spring elements to account for soil-structure interaction enhances the model's accuracy, as soil conditions are critical in determining the seismic response of stilted structures in floodplains.

An important aspect of the study is its focus on *Bambusa balcooa*, the bamboo species commonly used in these houses. By adhering to the IS 15912:2012 standards for bamboo's physical and mechanical properties, the authors ensure that the material is accurately

represented in the structural model. Additionally, the geometrical properties derived from the field survey and calculated spring stiffness values tailored to the local soil type further strengthen the reliability of the analysis.

The seismic evaluation was conducted using the *response spectrum method* as per IS 1893(Part 1):2016, which provides critical insights into how the structure responds to seismic forces. This standardized approach highlights the bamboo-stilted house's ability to absorb and dissipate seismic energy, contributing to its structural stability and safety. The study effectively demonstrates that these traditional houses, despite their simplicity, exhibit notable resilience during earthquakes.

In conclusion, the research highlights the importance of traditional bamboo-stilted houses as sustainable, adaptive, and earthquake-resistant structures in flood-prone regions. By combining local materials, indigenous construction techniques, and modern structural analysis, the study makes a compelling case for the continued relevance of such housing forms in disaster-prone areas. It also contributes to the broader field of earthquake engineering by showcasing how vernacular architecture can inform contemporary design practices, particularly in regions where resilience and sustainability are paramount.

n. The Ethno-Cultural Influences on “Assam Type” Building Typology - A Case of Barduwa, Assam, by Shiva Ji, Ravi Mokashi Punekar, (Ji and Punekar, 2019)

The paper "*The Ethno-Cultural Influences on 'Assam Type' Building Typology - A Case of Barduwa, Assam*" by Shiva Ji and Ravi Mokashi Punekar explores how cultural traditions and environmental factors shape the design of ATHs, particularly in Barduwa village. These houses have evolved over time to adapt to challenges like earthquakes and heavy rainfall while reflecting the community's cultural identity.

The study highlights the use of local materials such as bamboo and timber, combined with traditional construction techniques, which make ATHs sustainable and resilient. These methods not only suit the region's climate but also promote self-reliance and a connection to the local environment. The authors conducted fieldwork, including interviews and observations, to understand the daily lives of the villagers and the relationship between architecture and culture.

A key focus of the paper is on the role of architecture in fostering community values. The ATH is portrayed as more than just a shelter; it reflects the identity and practices of the people. Additionally, the temple complex in Barduwa serves as a central hub for social activities, strengthening cultural ties and promoting equality among residents. This communal space highlights how architecture supports social cohesion and cultural continuity.

The authors conclude that understanding the interplay between culture and architecture offers valuable lessons for contemporary design practices. By integrating local traditions, materials, and sustainable methods, architects can create spaces that not only respond to environmental challenges but also resonate with the community's cultural values. This approach enhances the quality of life for residents while preserving cultural heritage.

Overall, the study underscores the importance of preserving traditional knowledge in architecture. The Assam-type building typology serves as an excellent model for sustainable and culturally rooted design, demonstrating how local traditions and environmental adaptability can inspire modern architectural practices.

o. Prefabrication technique for low-cost housing in Assam, by Arup Deka, Hemanta Doloi, Robert H. Crawford, (Deka, Doloi and Crawford, 2017)

The paper explores the potential of prefabrication techniques as a solution to the growing housing demand in Assam, India, driven by rapid urbanization and population growth. Although it does not directly focus on traditional ATHs, the paper provides valuable insights into the current housing scenario in Assam, which has seen a shift from traditional single-story ATHs made with local materials like bamboo and timber to multi-storied buildings in urban areas.

The research highlights several challenges in the region's housing sector, including inadequate affordable housing, reliance on outdated construction methods, and the need for more efficient building processes. Prefabrication is introduced as a time- and cost-effective alternative that could address these issues. By manufacturing building components off-site and assembling them on-site, prefabrication also mitigates delays caused by weather conditions, which are common in the region.

However, the paper also identifies significant barriers to the adoption of prefabricated construction in Assam, such as high initial costs, a lack of skilled labour, insufficient infrastructure, and the need for stronger government policies. Addressing these challenges would require strategic efforts, including training local workers, improving infrastructure, and creating incentives for adopting modern construction techniques.

The study emphasizes the importance of using local materials, such as bamboo and rice husk, to integrate sustainability and affordability into the housing solution. By leveraging these materials and incorporating modern technologies, prefabricated housing could offer a solution that aligns with Assam's cultural context and environmental conditions.

Ultimately, the authors conclude that prefabrication holds significant promise in improving housing quality, reducing construction time, and generating local employment. They call for government support and policy reforms to facilitate the widespread adoption of prefabrication in Assam, ensuring that the housing needs of the region are met in a sustainable and efficient manner.

2.9.1 Synthesis of Previous Studies on Assam-type Houses

The reviewed studies collectively highlight the enduring relevance of ATHs in addressing contemporary challenges like seismic resilience, environmental sustainability, and the preservation of cultural heritage. These houses, traditionally built with locally sourced materials such as bamboo, timber, and ikra, have demonstrated resilience to earthquakes, adaptability to the region's climate, and resource efficiency. The studies explore various aspects of ATHs, including their seismic performance, material sustainability (e.g., bamboo and Bamcrete), environmental adaptability, cultural significance, and construction techniques. Additionally, the integration of new materials like Bamcrete, which combines bamboo mesh with cement mortar, has been discussed as a modern adaptation to improve durability while maintaining sustainability.

However, none of the studies provide a clear, definitive solution regarding which specific features of traditional ATHs should be incorporated into contemporary designs. While the research advocates for the continued use and adaptation of certain features, it remains unclear which elements would be most beneficial in modern construction. Furthermore, none of the studies consider the perceptions of the users those who live in ATHs, about these

designs. The final decision on which features to adopt should ultimately come from the users, as their experiences and preferences are essential in ensuring the relevance and acceptance of any new design solutions.

This chapter presents a comprehensive review of existing research on traditional and contemporary architecture, with a particular emphasis on the climatic aspects of architectural design and the role of perception in shaping architectural practices. It underscores the importance of traditional architectural knowledge and its continuing relevance in contemporary design, especially in the context of Northeast India and Assam. The chapter explores the unique architectural features of Northeast India, focusing on the Assam-type house, and investigates its climate-responsive characteristics as a significant example of vernacular architecture.

A pivotal section of this chapter examines the methodologies employed in the study of traditional architecture. Through an extensive review of the literature, the research identifies that traditional architecture is most often analysed through an exploration of building elements and their associated attributes. These elements and attributes, when considered together, constitute a set of parameters for understanding the physical, cultural, environmental, and functional characteristics of traditional buildings. This analysis reveals that these parameters are crucial for studying how traditional architecture responds to both its environment and the socio-cultural needs of its inhabitants.

Based on these insights, the next chapter, Materials and Methods, will build upon these identified parameters, integrating them into the research framework to guide the data collection and analysis processes.

Chapter III: MATERIALS AND METHODS

3.1 Chapter Overview

Research materials and methods serve as the backbone of any systematic study, providing the framework to achieve the research objectives and answer the research questions effectively. This chapter outlines the methods, techniques, and processes adopted to conduct the study, ensuring the research is scientifically valid and reliable. It begins with a general overview of research, including its types, stages, and importance, followed by a detailed explanation of the specific methodology employed in this study. The chapter further elaborates on the steps taken to explore traditional architectural elements, gather expert and user opinions, and analyse the findings to propose climate-responsive design solutions for contemporary Assam-type houses.

3.2 Research Overview

Research, at its core, is the pursuit of knowledge and understanding. It involves a systematic effort to explore new ideas, uncover facts, and contribute fresh insights to existing knowledge. The *Advanced Learner's Dictionary of Current English* describes research as a careful inquiry or investigation aimed at discovering new information and advancing what is already known. It is a process driven by curiosity and the need for answers, relying on study, observation, comparison, and experimentation.

A well-conducted research process follows a structured and objective approach to ensure accuracy and credibility (Deb et al., 2019; Bhattarai, 2013). By continuously observing, analysing, and questioning, researchers uncover valuable findings while adhering to scientific principles that guarantee reliability and validity (Bhattarai, 2013).

The objective of research is basically the systematic search of knowledge aimed at addressing certain practical problems, enhancing understanding, and contributing to societal advancement. It seeks to explain, predict, and control phenomena, enabling informed decision-making and fostering innovation (Fritzenschaft, 2014; Ridha, 2017; Pavan & Kulkarni, 2014).

Research generates new knowledge that refines existing theories and practices while exploring cause-and-effect relationships to provide actionable insights and recommendations (Fritzenschaft, 2014). Additionally, it aims to identify and solve specific problems through

scientific methods, diagnosing and exploring issues to develop effective solutions (Ridha, 2017; Pavan & Kulkarni, 2014). Beyond problem-solving, research plays a vital role in societal welfare by pushing the boundaries of knowledge and making it accessible, influencing policy formulation and driving innovation to benefit humanity. However, some critiques suggest that the focus on theoretical research can occasionally overshadow its practical applications, producing knowledge that may not be immediately relevant in real-world contexts (Oppong, 2014). This highlights the need for a balance between theoretical exploration and practical implementation in research endeavours.

The objective of this research is to investigate the potential of traditional Assam-type houses for contemporary architectural application, with a particular emphasis on their climatic responsiveness. By analysing perceptions and lived experiences, the study aims to understand how traditional design strategies contribute to thermal comfort, natural ventilation, and climate adaptability in the context of Assam.

This research is partly descriptive in nature, aiming to provide an accurate account of the existing architectural features and climatic performance of Assam-type houses as they are currently perceived and experienced. Descriptive research does not manipulate variables but rather observes and reports current or past conditions to identify patterns or possible causes of phenomena (Kothari, 2004; Welsh, 2023). Methods such as surveys and comparative analysis are employed to document trends and design attributes.

Additionally, the study is partly exploratory, seeking to uncover new insights into the relevance and applicability of traditional architectural knowledge in contemporary contexts. It aims to identify underexamined aspects of traditional design and raise questions that can inform future research and architectural practice related to climate-sensitive building strategies.

Ultimately, this study contributes to both theoretical understanding and practical implementation by promoting culturally grounded and environmentally responsive design solutions from traditional architecture for contemporary use.

3.3 Research Model

Research is a structured and systematic process that involves the collection, analysis, and interpretation of data to enhance our understanding of a phenomenon of interest. A well-

defined research model is crucial for organizing this process, ensuring clarity, and achieving the study's objectives effectively.

This study follows the Onion Model, introduced by Saunders, Lewis, and Thornhill in *Research Methods for Business Students* (Saunders, Lewis, and Thornhill, 2019). The model offers a step-by-step framework for research design, helping researchers make informed decisions at different stages of the process to ensure a well-structured and effective study.

The model is visualized as an onion with multiple layers, each representing a distinct stage of the research process. Researchers must "peel" through these layers sequentially, starting from the outermost layer and working inward.

By systematically addressing each layer, the Onion Model ensures that all elements of the research are well-coordinated and logically aligned. This structured approach enables researchers to design robust studies while considering the complexities and nuances of their research objectives.

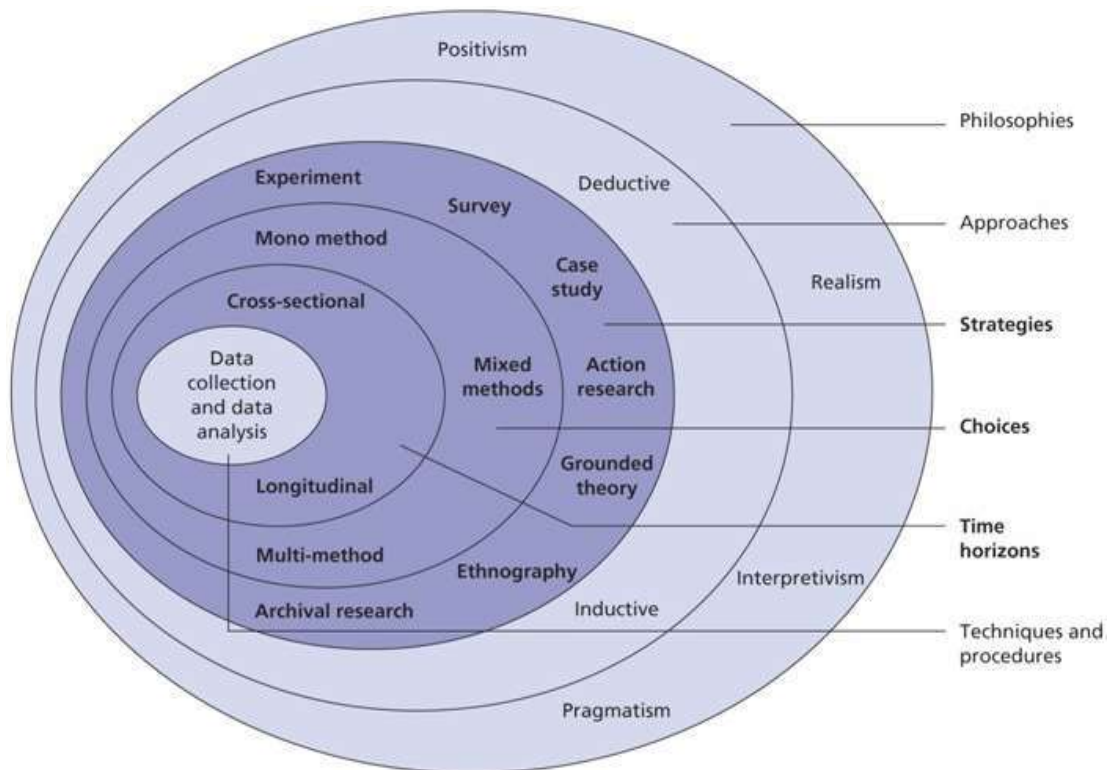


Figure 3.1: The Research Onion of Mark Saunders (Source: 15Writers, n.d.)

The Onion model helps break down the different stages of research, starting from the broader philosophical perspective and narrowing down to specific methods for data

collection and analysis. Each layer of the model plays a role in shaping how this study is conducted. The layers addressed in this research are:

- a. **Research Philosophy:** A pragmatic approach is adopted in this study, focusing on practical solutions by combining both qualitative and quantitative methods. Pragmatism allows for flexibility in research design, making it possible to incorporate expert opinions and user feedback.
- b. **Research Approach:** The research follows a mixed-methods approach, incorporating both:
 - Deductive reasoning:* Deductive reasoning moves from general theories or principles to specific observations or conclusions. It is used in the expert opinion surveys to test the theoretical relevance of traditional architectural elements for climate-responsive design.
 - Inductive reasoning:* Inductive reasoning works from specific observations to develop broader generalizations or theories. It is applied in the user perception surveys to derive insights based on the lived experiences and preferences of residents in traditional Assam-Type Houses (ATH) and contemporary houses.
- c. **Research Strategy:** The study employs a multi-strategy approach, including:
 - Expert Opinion Surveys:* Conducted to gather insights from architects and engineers about traditional architectural elements and their effectiveness in climate-responsive design.
 - User Perception Surveys:* Designed to capture residents' feedback on the climate responsiveness of traditional and contemporary Assam-type houses.
 - Expert Recommendation Survey:* Used to validate the selected features for adoption in contemporary designs.
 - Building Survey:* To understand the current scenario with respect to ATHs.
 - Triangulation analysis* used to enhance the reliability and validity of the findings.
- d. **Research Choice:** The study adopts a multi-method quantitative and qualitative approach. Quantitative methods, such as RIDIT analysis, are used for statistical ranking of architectural features, while qualitative methods, such as descriptive analysis, help interpret user perceptions and preferences. This combination ensures a balanced and holistic analysis of the research problem.
- e. **Time Horizon:** The research adopts a cross-sectional time horizon, which, in the context of the Onion Research Model, refers to the collection of data at a single

point in time rather than over an extended period. This approach is typically used to capture a snapshot of specific variables or phenomena as they exist in the present. In this study, data collection from both experts and users was conducted during specific, fixed periods. This allowed for the assessment of current perspectives on traditional and contemporary housing designs without tracking changes over time.

f. Techniques and Procedures: The final layer focuses on the data collection and analysis techniques used in the study:

Data Collection: Expert opinion surveys to identify key architectural features. User perception surveys to understand resident feedback on climate responsiveness and expert recommendation survey to validate the findings of user survey. Finally, data collection through building surveys was done to understand the current scenario and practical implications of the findings.

Data Analysis: Data analysis was carried out through various qualitative and quantitative methods. These techniques ensured that the findings are both robust and actionable.

By systematically addressing each layer of the Onion Model, this research methodology provides a structured and comprehensive framework for achieving the study's objective of integrating traditional architectural features into contemporary Assam-type houses.

3.4 Research Design

The research design serves as the blueprint for systematically conducting the study and achieving its objectives. It defines how data is collected, analysed, and interpreted while ensuring coherence between the research questions, methodology, and outcomes.

The research follows a structured, multi-phase design aimed at identifying traditional architectural features that are adoptable in contemporary house designs, specifically for climate responsiveness. The process is driven by the initial research question: How can traditional architecture be investigated?

a. Literature Study and Parameter Identification

To answer the first question, the study began with a literature review to understand existing approaches to studying traditional architecture. It revealed that traditional buildings are typically analysed through their building elements and associated attributes. A matrix

combining these identified building elements and corresponding attributes, generated 105 element-attribute combinations, referred to as parameters of traditional architecture.

b. Expert Opinion Survey I: Filtering Adoptable Parameters

These 105 parameters were presented to architects from Northeast India in an expert opinion survey to evaluate their suitability for contemporary adoption with regard to climate responsiveness. The responses were analysed using RIDIT analysis, leading to 44 adoptable parameters of traditional architecture.

c. Expert Opinion Survey II: Contextualizing the 44 Adoptable parameters to Assam-type Houses

The 44 parameters were further contextualized through a second expert survey with architects from Assam. Experts identified corresponding features in traditional ATHs for each parameter, resulting in 36 adoptable features of Traditional ATH relevant to climate-responsive design.

d. Application of 36 Features: Three Parallel Surveys

These 36 features were evaluated through three parallel studies:

i. User Perception Survey

Conducted among residents of traditional ATH and contemporary RCC houses, this survey assessed:

- Comfort-related parameters (thermal comfort during different seasons, daylight, and ventilation comfort): Comparison of the responses of users of traditional ATH and contemporary RCC houses revealed that traditional ATH generally offers better comfort conditions.
- Perceived efficiency of traditional features (F1): This helped identify specific features that may contribute to the better comfort levels observed in traditional ATHs.
- Willingness to adopt those features in future houses (W1).

ii. Expert Recommendation Survey

Experts were asked to:

- Identify challenges in adopting traditional features to contemporary house designs.
- Validate the efficiency of features of traditional Assam-type houses with respect to climate responsiveness (F2).
- Validate users' willingness from a professional perspective (W2): This was used to compare the willingness of the users to adopt traditional ATH features, with expert recommendations on the same features, enabling validation of user preferences.

iii. Building Survey

In this survey, field documentation of traditional and contemporary Assam-type houses was conducted.

The contemporary Assam-type houses were examined to understand whether the identified traditional Assam-type house features are being retained, modified, replaced, or omitted in the current construction practices of Assam-type houses. These findings were used as field evidence for triangulation.

e. Triangulation

The responses from users (F1) and experts (F2) regarding the efficiency of traditional ATH features, were compared to identify overlapping features. These were then combined with findings from the building survey to perform a triangulation analysis, resulting in 34 core adoptable features.

f. Ranking of Adoptable Features

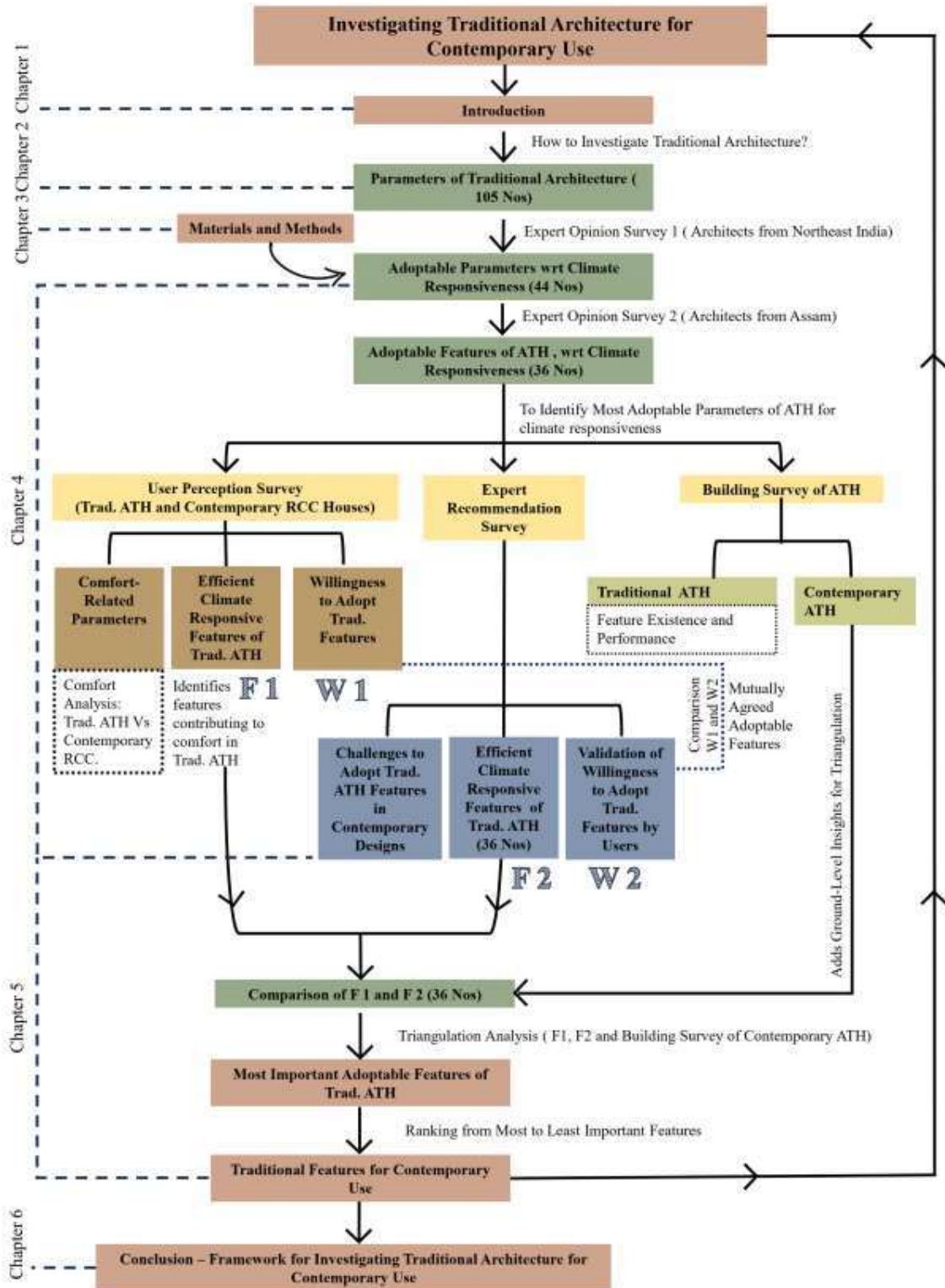
A weighted score analysis was used to rank these 34 features based on their importance and relevance for contemporary use. This produced a prioritized list of traditional features most suitable for integration in contemporary house designs.

g. Framework Development

The entire process - starting from parameter identification to feature triangulation and ranking, constitutes a framework for investigating traditional architecture for contemporary use,

which is both a methodological contribution and the central conclusion of this research. Figure 3.2, shows the flowchart of the research design and methodological framework followed in this research.

Figure 3.2: Flowchart Representing the Research Design and Methodological Framework of the Study (Source: Author)



3.5 Data Collection Techniques

The data collection techniques employed in this study are designed to systematically address the research objectives and align with the chosen methodology. The data collection is structured into six sequential stages. The table below shows each stage in detail:

Table 3.1: Summary of Data Collection Techniques Used in the Study (Source: Author)

Phase	Method	Tool Used	Target Group	Purpose
1	Literature Study	Secondary sources: Books, research papers, reports etc. on traditional architecture	Existing Literature on Traditional Architecture	To gather foundational information on how traditional architecture is analyzed or studied.
2	Expert Opinion Survey I	Structured Matrix Questionnaire and RIDIT Analysis	Architects (Northeast India)	To evaluate the parameters of traditional architecture obtained from the literature study with respect to climate responsiveness and suitability for contemporary adoption.
3	Expert Opinion Survey II	Structured Questionnaire	Architects (Assam)	To identify the features of trad. ATH which corresponds to the parameters of traditional architecture identified in the previous phase.
4	User Perception Survey	Structured Questionnaire with Rating Scale	Residents of Trad. ATH and Contemporary RCC Houses	To understand user perceptions regarding comfort, efficiency of traditional ATH features and their willingness to adopt traditional features in future houses.
5	Expert Recommendation Survey	Structured Questionnaire with Rating Scale	Architects and Civil Engineers (Assam)	To validate the efficiency of traditional ATH features based on climate responsiveness, access the challenges in adoption and recommendations for their adoption in contemporary house designs.

6	Building Survey	Direct Field Observation	Traditional ATH and Contemporary ATH	To record and compare the retention, omission, replacement, and modification of Trad. ATH features in Contemporary ATH constructions.
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3.5.1 Justification for the Data Collection Techniques

The data collection techniques employed in this study were carefully selected to align with the research objectives and the nature of inquiry. A combination of qualitative and quantitative methods was used to ensure a comprehensive understanding of traditional architectural features and their relevance to contemporary design. The literature study provided a foundational framework, while expert surveys helped evaluate and refine parameters through professional insights. User perception surveys captured occupant experiences and preferences, essential for gauging real-world relevance. The expert recommendation survey and building survey offered both validation and ground-level observations. Together, these techniques enabled a well-rounded triangulation and cross-verification of data, ensuring the reliability, relevance, and contextual suitability of the findings.

3.6 Sampling Methodology

Sampling is a fundamental aspect of research methodology that involves selecting a subset of individuals, objects, or cases from a larger population to represent the entire group. This process is critical in studies where it is impractical to examine every member of the population due to constraints such as time, resources, and accessibility (Das et al., 2022). By using an appropriate sampling method, researchers can gather data efficiently, ensure the representativeness of the sample, and draw reliable conclusions that are generalizable to the broader population.

In the context of this study, given the mixed-method approach, appropriate non-probability sampling techniques were employed at different stages of data collection to ensure contextual relevance, diversity of perspectives, and practical feasibility.

a. Expert Opinion Survey- 1 (Phase 2)

Purposive sampling was used to select experts from different states of Northeast India, including architects, researchers, and academicians with extensive knowledge of traditional architecture and regional construction practices. The 35 experts were selected based on their professional experience, regional expertise, and academic or field contributions to climate-responsive architecture. These architects had varying levels of professional experience, including senior-level architects, junior-level architects, and architectural academicians. This survey was general in nature and not focused specifically on Assam, though it provided valuable insights into traditional architecture.

b. Expert Opinion Survey- 2 (Phase 3) and Expert Recommendation Survey (Phase 5)

These two phases focused specifically on professionals from Assam. Purposive sampling was used to select both architects and civil engineers who had lived and practiced in the region and had direct experience with Assam-type houses. Initially, a larger pool of professionals was approached, which was then narrowed to a final group of 35 respondents, selected based on their years of experience and specific areas of expertise to ensure high-quality, relevant feedback.

c. User Perception Survey (Phase 4)

A combination of purposive and convenience sampling was adopted to select residents living in both traditional and contemporary house types. The survey included:

- 50 users from traditional Assam-type houses, and
- 50 users from contemporary RCC houses,

resulting in a total of 100 respondents and covering the two distinct bioclimatic zones of the state. The purposive component ensured that each respondent had lived experience in either traditional or contemporary houses, while convenience sampling facilitated logistical feasibility during the survey process. Efforts were made to include respondents from varied demographic backgrounds in terms of age, gender, and education to capture a broad spectrum of user perceptions.

The following table shows the demographics of the respondents of the User Perception Survey.

Table 3.2: Demographic Profile of the Respondents- User Perception Survey (Source: Author)

Demographic Variable	Category	Number of respondents	Percentage (%)
Gender	Male	58	58%
	Female	42	42%
Age Group	18-30 years	20	20%
	31-45 years	25	25%
	46-60 years	35	35%
	60+ years	20	20%
Education Level	No formal education	6	6%
	School level	30	30%
	Graduate	38	38%
	Post-graduate and above	26	26%
Occupation	Homemaker	14	14%
	Private sector employee	22	22%
	Government employee	18	18%
	Self-employed/Business	16	16%
	Retired/Unemployed/Other	30	30%
House Type	Traditional Assam-type House	50	50%
	Contemporary RCC House	50	50%
Location	Urban / Semi Urban	65	65%
	Rural	35	35%

d. Building Survey (Phase 6)

For the building survey, purposive sampling was employed to identify and document:

- 30 traditional Assam-type houses, and
- 30 contemporary Assam-type houses,

the latter referring to RCC structures that incorporate features inspired by traditional Assam-type houses.

However, detailed analysis was carried out on a representative subset of fifteen contemporary ATHs, selected based on completeness of data and accessibility. The selection was guided by the typological representation and physical characteristics of the houses, enabling a comparative analysis of the presence, modification, or omission of traditional features in current construction practices.

This multi-level sampling strategy ensured that each data collection stage was informed by participants and sources most relevant to the study's objectives, enhancing the reliability, validity, and depth of the research.

3.6.1 Representativeness and Diversity of the Sample

To minimize sampling bias and ensure that the study represents a wide range of living experiences, care was taken to maintain demographic, professional, and spatial diversity among participants. In the User Perception Survey, respondents were selected from both urban and semi-rural areas across the two bioclimatic zones of Assam to reflect variations in climatic exposure and settlement patterns. The selection intentionally included households of different socio-economic and educational backgrounds (Table 3.2), covering participants from no formal education to postgraduate level and occupations ranging from homemakers and private-sector employees to government staff, self-employed individuals, and retirees.

Gender and age diversity were also maintained, with both male and female respondents represented across all four age groups (18-30, 31-45, 46-60, and 60+ years). All houses surveyed, both traditional Assam-type and contemporary RCC, were individual single- or double-storey dwellings, ensuring comparability in comfort perception. This control prevented potential bias that could arise if multi-storey buildings were included, as such structures differ in microclimate and user experience.

In the Expert Opinion Surveys, purposive sampling included architects based in Assam at different stages of their professional careers, along with a selected group of specialists who possess specific experience and expertise in Assam-type houses and regional construction practices. This ensured both generational and experiential diversity within the expert group.

The Building Surveys further complemented the sample by documenting single- and double-storey houses from varied neighbourhoods across Assam, providing balanced

typological and locational representation while keeping the construction scale consistent with the traditional typology.

Although variables such as gender, locality (urban/semi-rural), and socio-economic status were not included in the formal questionnaire, these details were recorded through field notes and respondent profiling during data collection. They were used solely to confirm demographic diversity and contextual representativeness, rather than as analytical variables.

Overall, these measures strengthened the frame coverage and validity of the study by ensuring that both user and expert perspectives were drawn from a heterogeneous, demographically balanced, and contextually relevant sample across Assam.

3.7 Data Analysis Methods

The data analysis phase is a crucial component of research, as it involves interpreting the collected data to draw meaningful conclusions and address the research objectives. This section outlines the systematic methods employed to analyse the data gathered from various stages of the study, ensuring that the findings are reliable, valid, and actionable.

Systematic data analysis is essential in research to uncover patterns, establish relationships, and validate findings. In this study, both qualitative and quantitative methods have been employed to ensure a comprehensive and balanced interpretation of the data. While quantitative methods provide objective insights into numerical trends, qualitative techniques capture the depth and context of user and expert perspectives, together forming a strong analytical framework.

3.7.1 Quantitative Data Analysis Methods

Quantitative research is rooted in the measurement and analysis of numerical data. Quantitative data analysis in this study focused on numerical data obtained from the user perception surveys, expert feedback, and case studies. This approach helped in identifying patterns, relationships, and significant differences in preferences and perceptions regarding climate-responsive features in traditional Assam-type and contemporary houses (Mweshi & Muhyila, 2024). The following methods were employed to analyse the quantitative data:

3.7.1.1 Descriptive Statistics

Descriptive statistics were employed to summarize and present user responses regarding indoor comfort across both traditional Assam-type houses and contemporary RCC houses. By calculating means, medians, and frequency distributions of comfort-related parameters, this method provided a clear comparison of how each house type performs in different climatic conditions. This helped establish that traditional Assam-type houses are generally perceived as more comfortable across seasons (Alabi & Bukola, 2023).

Justification: Descriptive statistics are essential for understanding basic trends and distributions within a dataset, and were appropriate for analysing perceptual data from large respondent groups. Descriptive statistics are fundamental in housing studies to assess occupant comfort and satisfaction levels. For instance, Aristondo et al. (2024) employed descriptive statistics to analyse household discomfort perceptions in Spain, highlighting trends in thermal, acoustic, and lighting comfort across different housing types.

Beyond summarizing numerical responses, this analysis established a clear comparison of comfort levels between traditional and contemporary houses across the key parameters of summer, winter, and rainy season comfort, ventilation, and daylight. The mean and median scores indicated overall higher comfort perception in traditional Assam-type houses, while the standard deviation values reflected more consistency among users of traditional dwellings.

This pattern suggests that user's comfort perception is inherently linked to the passive design logics of traditional ATHs, where ventilation, shading and material selection collectively foster stable comfort conditions without mechanical dependency.

These results provided the initial evidence base for identifying which house type performs better climatically and guided deeper comparative and interpretive analysis in the subsequent methods.

3.7.1.2 Cross-tabulation

Cross-tabulation was used to analyse the relationship between perceived comfort in traditional houses and the efficiency of specific traditional features. This helped identify which features (e.g., sloped roofs, raised plinths, verandas) contribute most significantly to indoor thermal comfort and seasonal adaptability.

Justification: Cross-tabulation is particularly effective for comparing categorical variables, and in this study, it allowed the identification of cause-effect relationships between individual architectural features and comfort outcomes (White, 2003). Cross-tabulation is widely used in architectural studies to explore associations between building features and occupant perceptions. Adunola et al. (2016) utilized cross-tabulation to assess thermal comfort across different residential building types in Ibadan, Nigeria, revealing how architectural characteristics influence occupant comfort.

This stage connected the comfort outcomes identified through descriptive analysis with the specific architectural features responsible for them. Cross-tabulation made it possible to trace how individual elements such as verandas, roof slopes, window orientation, or pale-coloured walls influenced perceived daylight, ventilation, and seasonal comfort. By linking comfort parameters with contributing features, the analysis moved beyond general user satisfaction to reveal the functional logic behind why traditional Assam-type houses perform better.

This connection shows that user's comfort experiences arise directly from tangible spatial and material choices, rather than abstract preferences, confirming that the success of traditional designs lies in its physical responsiveness to local climate and lifestyle.

These relationships later informed the comparative interpretation and validation through expert and building surveys.

3.7.1.3 Quartile Analysis

Quartile analysis was applied in two phases. First, to compare willingness to adopt traditional features among users of both traditional and contemporary houses. This allowed classification of features into most preferred, moderately preferred, and least preferred categories. Second, quartile analysis was used in the expert recommendation survey to assess the relevance of user-preferred features from a technical and climatic standpoint.

Justification: Quartile analysis helped simplify and categorize large-scale preference data, making it possible to identify adoption trends and align them with expert perspectives (Schmidt & Dirkin, 2022).

This analysis helped to understand how willing users were to adopt traditional Assam-type house features if they built new houses. The responses, ranging from “very willing” to “not

willing”, were arranged into quartiles to group the most, moderately, and least preferred features. This showed, for example, that courtyards, elevated plinths or stilts, and sloping roofs were the features people were most open to adopting, while bamboo compound walls or purely traditional materials were less preferred.

This pattern suggests that users balance comfort and practicality, valuing traditional elements while avoiding those perceived as maintenance heavy or outdated. It reflects how cultural familiarity and modern expectations shape adaptation choices.

The results provided a clear picture of users’ practical preferences and how these align with their perception of comfort and suitability. This understanding later supported the comparison with expert and building survey findings to identify which traditional features people are both comfortable with and ready to adopt in present-day contexts.

3.7.1.4 Frequency Distribution and Percentage Categorization

These techniques were used to analyse expert recommendations regarding traditional features. Responses were categorized based on relevance, ease of implementation, and climate suitability. The frequency of expert endorsement for each feature helped determine its practical importance.

Justification: Frequency and percentage-based analysis is ideal for gauging consensus and identifying which features are most strongly supported by professionals for contemporary use.

This analysis helped to interpret expert opinions by showing how strongly each traditional feature was supported for its importance in achieving climate responsiveness and suitability for modern use. Using frequency and percentage values, the features were grouped into three categories, very important, moderately important, and not important, based on expert ratings. This made it easy to identify which features were most consistently valued by professionals and which ones received lower importance. The outcome provided a clear summary of expert priorities and served as a basis for comparing professional recommendations with user preferences and building survey results in later stages of the study.

3.7.1.5 Matrix Analysis

In the first expert opinion survey, a matrix-based approach was used to rank combinations of building elements and their attributes according to their climate responsiveness and adoptability. Architects rated combinations on a scale, and the results were tabulated and analysed to determine priority features.

Justification: Matrix analysis allows structured evaluation across multiple criteria, which was necessary for handling the complexity of element-attribute pairings.

This analysis was conducted during the initial phase, that is Expert Opinion Survey 1 to evaluate combinations of building elements and their attributes in terms of climate responsiveness and adoptability for contemporary use. Experts rated each combination through a structured matrix, producing a ranked list of the most relevant element-attribute pairs.

The top-ranked combinations, derived after RIDIT analysis, were then presented again to the experts to identify which of these corresponded with specific features of Assam-type houses. This expert-driven matching process established the first link between generalized traditional architectural parameters and the characteristic features of the Assam-type typology. The results formed the conceptual foundation for the subsequent surveys, where these features were further examined for user perception, expert validation, and field verification.

a. Use of RIDIT Analysis

To refine the expert rankings derived from the matrix, RIDIT analysis (Relative to an Identified Distribution Integral Transformation) was applied. This statistical method was chosen because the expert responses were expressed on an ordinal scale, for example, “very important,” “moderately important,” or “not important.” RIDIT analysis is particularly effective for such ordered-category data, as it converts qualitative ratings into standardized numerical scores.

The key advantage of this approach is that it measures the relative strength of agreement among respondents rather than relying only on simple averages or frequencies. While mean-ranking or Likert-averaging methods show overall trends, RIDIT identifies which responses differ significantly from the reference or average distribution, giving a clearer picture of collective consensus and relative importance.

Because the expert group size was moderate and the data were perceptual rather than continuous, alternative statistical tests (such as correlation, regression, or ANOVA) were

unsuitable. RIDIT therefore provided a robust and transparent way to prioritize qualitative judgments, yielding probabilistic scores that helped identify the top-ranked combinations of building elements and attributes for further validation in later survey phases.

3.7.1.6 Weighted Scoring Model

A weighted scoring model was applied to the final list of traditional Assam-type house features to prioritize them for adoption in contemporary designs.

Justification: This model supports rational decision-making by accounting for the relative importance of multiple criteria, making it ideal for feature ranking (Griffith & Headley, 1997).

Beyond ranking numerical outcomes, this method consolidated the overall findings of the study by prioritizing the traditional Assam-type house features most suitable for integration into contemporary design. The weighted scoring model assigned relative importance to three datasets, user perception, expert recommendation, and building survey observations, using equal ratios of 33.33 %.

Through this model, each feature was scored according to its comfort contribution, technical feasibility, and prevalence in present construction trends. The process produced a ranked list of adoptable features, from highly preferred elements such as elevated plinths, courtyards, and sloping roofs to less prioritized components like low compound walls or decorative details, thereby offering a balanced synthesis of perception, expertise, and practice. The results not only identify which traditional features remain relevant today but also highlight how selective adoption can enhance climate-responsive performance in contemporary housing.

3.7.2 Qualitative Data Analysis Methods

Qualitative analysis was conducted primarily through case-based observation and comparative description of traditional and contemporary Assam-type houses.

3.7.2.1 Descriptive Qualitative Method

Descriptive qualitative analysis was applied during the building survey to document the status of climate-responsive features. Observations were categorized under retained,

modified, replaced, or omitted features in contemporary Assam-type houses. A heatmap was created to visually represent these variations.

Justification: Descriptive qualitative methods allow in-depth interpretation of observational data. This was essential for assessing the extent of traditional feature integration in contemporary houses, beyond numerical representation (Furidha, 2024).

This method helped to qualitatively interpret how the identified climate-responsive features of traditional Assam-type houses are reflected in their contemporary counterparts. Using observations from the building survey, each feature was reviewed to determine whether it had been retained, modified, replaced, or omitted in present-day practice.

By applying this descriptive qualitative approach, the study moved beyond numerical comparisons to capture the nature of design transitions, how traditional features evolve under new materials, construction methods, and user preferences. The resulting visual mapping provided a clear understanding of the extent to which the essence of traditional climate-responsive design continues in contemporary Assam-type houses.

3.7.3 Triangulation Method

Triangulation was used to synthesize insights from the user perception survey, expert recommendation survey, and building survey. By comparing these three independent sources, a refined list of climate-responsive features was derived, validated across both lived experience and professional judgement.

Justification: Triangulation strengthens the reliability and validity of the findings by combining multiple perspectives. This was especially critical in a study aiming to bridge traditional knowledge and contemporary practice. Triangulation is a robust method in mixed-methods research, enhancing the validity of results by integrating multiple data sources. Noble and Heale (2019) emphasize its importance in confirming findings through diverse perspectives, particularly in complex studies like architectural research.

By comparing these perspectives for each traditional Assam-type house feature, the study identified areas of agreement and divergence, providing a balanced and validated understanding of which features remain relevant for contemporary application.

This comparative synthesis helped in formulating context-sensitive judgments about adoption priorities. For instance, where both experts and users valued a feature and it continued in current practice, it was classified as highly recommended for incorporation; conversely, where experts advocated for a feature that had been omitted or undervalued by users, it was marked for re-evaluation or reconsideration. Through this structured comparison, the triangulation method ensured that the final recommendations reflected a convergence of lived experience, professional insight, and observable trends, thereby strengthening the credibility and applicability of the study's outcomes.

3.8 Reliability and Validity

Reliability refers to the consistency and stability of the research instruments and methods over time and across various conditions. In this study, reliability has been ensured through the following measures:

- a. **Pilot Study:** A small informal pilot study was conducted with 6 participants representing the target demographic to assess the clarity, relevance, and understandability of the User Perception Survey questions. Based on their feedback, certain technically complex questions were revised or omitted to ensure better comprehension and more reliable responses in the main survey.
- b. **Standardized Questionnaires:** The questionnaires were designed with standardized questions to ensure that all respondents interpreted the questions similarly. The use of structured response formats, such as Likert scales and ranking, further enhanced consistency. The questionnaire for the User Perception Survey was designed in two languages, English and Assamese, to allow respondents to choose their preferred language ensuring better clarity and ease of response.
- c. **Repetition of Core Themes:** Core aspects, such as the perception of traditional features, their climate responsiveness, and willingness to adopt them, were repeated across different respondent groups (users and experts) to ensure reliability through cross-verification.
- d. **Triangulation:** Triangulation was employed by collecting data from multiple sources (users, experts, and building survey of Assam-type houses) and comparing findings to enhance the consistency and reliability of the results.

Validity refers to the extent to which the research measures what it is intended to measure. In this study, validity has been ensured through the following strategies:

- a. **Content Validity:** The research instruments were developed based on a thorough literature review of traditional architecture and climate-responsive features. Expert opinions were sought during the design of the survey instruments to ensure that all relevant aspects were included and accurately represented.
- b. **Construct Validity:** The survey questions were designed to measure specific constructs, such as user perceptions of comfort, effectiveness of traditional features, and willingness to adopt these features. Questions were aligned with the objectives of the study to ensure that they measured the intended variables.
- c. **Face Validity:** The questionnaires were reviewed by subject matter experts to confirm that the questions appeared relevant, clear, and capable of measuring the intended outcomes.
- d. **Internal Validity:** Cross-tabulation tests were used to analyse relationships between variables (comfort parameters and efficiency of traditional ATH features), ensuring that the results reflect true relationships and not random variations.
- e. **External Validity:** Stratified sampling for the user perception survey ensured representation of both users of traditional Assam-type houses and contemporary RCC houses, improving the generalizability of the findings to similar contexts and purposive sampling for experts ensured that the opinions were collected from professionals with relevant knowledge and experience, enhancing the applicability of the results to real-world scenarios.

Since user comfort and perception are inherently subjective, the study recognizes that responses may be influenced by personal expectations or recall bias. However, these limitations were mitigated by using a structured questionnaire with clearly defined parameters and by triangulating user responses with expert feedback and on-site building observations, thereby enhancing the reliability of self-reported data.

3.9 Ethical Considerations

Ethical considerations are an integral part of this research to ensure the integrity, transparency, and respect for the participants involved. The following measures were taken to address ethical concerns:

- a. **Informed Consent:** All participants, including users and experts, were informed about the purpose, scope, and objectives of the research before their participation. Taking part in the study was entirely voluntary, and participants had the freedom to withdraw at any time without any negative consequences.
- b. **Confidentiality and Anonymity:** To ensure privacy, no personal details were collected, allowing respondents to remain anonymous. All data was treated with strict confidentiality, making it impossible to trace any responses back to individual participants.
- c. **Non-Coercion:** No incentives or undue pressure were applied to encourage participation in the surveys.
- d. **Respect for Participants:** The questions were framed in a neutral, respectful, and non-intrusive manner to avoid causing discomfort or bias. Care was taken to ensure cultural sensitivity, especially given the diverse socio-cultural context of Assam and the Northeast region.
- e. **Data Integrity and Use:** The data collected was used solely for the purpose of this research and was not shared with third parties. All data analysis and presentation were carried out objectively, ensuring accurate representation of findings without manipulation.

This chapter outlined the research methodology adopted for this study, detailing the research design, data collection techniques, and data analysis methods. The use of both qualitative and quantitative methods, including user perception surveys, expert feedback, and various data analysis techniques, ensures a comprehensive understanding of the research problem. The research onion model was specifically applied to structure the methodology, providing a clear framework for the study.

Chapter IV: Survey and Analysis

4.1 Chapter Overview

This chapter outlines the core empirical phase of the research, encompassing both the collection and analysis of data in accordance with the research design. Following the identification of building elements and attributes relevant to traditional architecture, particularly ATHs, the study undertook a series of surveys to gather expert evaluations, user perceptions, and physical observations of buildings. Each stage of data collection was guided by the parameters identified in earlier chapters and was tailored to extract insights regarding the efficiency, adaptability, and acceptability of traditional features in a contemporary context.

The chapter presents how the surveys were structured, how responses were gathered, and how different quantitative methods were applied to analyse the data. It systematically moves through the multiple layers of investigation, from expert assessments to user comfort and willingness, followed by on-ground documentation of traditional and contemporary ATHs. This integrated approach lays the groundwork for the triangulation of findings and the development of a practical framework, which is discussed in the subsequent chapter.

4.2 Review of Methodologies in Traditional Architecture Studies - Identification of Building Elements and Attributes

The starting point of the study involved a thorough review of existing literature to understand how traditional architecture has been studied in previous researches. Various books, reports and research papers on traditional architecture were examined to identify the common approaches used by researchers in analysing traditional architecture. It was observed that most studies approached the analysis of traditional architecture based on specific building elements, which served as the fundamental components for evaluating architectural characteristics. By reviewing multiple sources, a comprehensive understanding of how traditional buildings are typically classified and studied was established. This process has already been discussed in detail in Chapter II, Section 2.2.5, where Table 2.1 presents the list of literature sources reviewed.

From this literature study, a consolidated list of building elements was derived, incorporating elements that were consistently mentioned across different studies. Each

book and research paper reviewed provided its own classification of architectural elements, and these were systematically compiled to form a unified framework. The final list of building elements identified from the literature includes:

- Structural System
- Roof System
- Orientation
- Spatial Arrangement
- Building envelope – Wall, Roof, Floor, Openings
- Foundation
- Open Space
- Compound Wall
- Basement / Attic
- Other elements – Ceiling, Stairs, Façade, Ornaments, Fireplace

This list, derived from extensive literature analysis, served as the foundation for studying traditional ATHs.

Building upon the identification of key building elements from the literature study, the next step involved determining the corresponding attributes for each element. These attributes are critical to understanding how traditional architecture responds to environmental conditions and how these elements can contribute to climate-responsive design. Through the review of existing literature on traditional architecture, several common attributes were identified that characterize architectural elements and their climate adaptability. Researchers have consistently emphasized the importance of certain attributes, such as the form or shape of elements, their primary material, size and dimension, and their passive design features as essential components for evaluating and enhancing the performance of buildings in different climates. Other attributes, such as colour or finish, location, and unique regional features, were also highlighted in various studies as key aspects of traditional architecture, influenced by local climate conditions, culture, and building practices.

Based on this synthesis of literature, a consolidated list of attributes of the building elements was developed, which includes:

- Form or Shape – The geometry or physical configuration of the element.
- Primary Material – The dominant material used in the construction of the element.
- Size and Dimension – The scale and proportions of the element.
- Colour or Finish – The surface treatment, colour, and texture of the element.
- Passive Design Features – The features which help in improving thermal comfort, ventilation, and light distribution naturally.
- Location or Site – The positioning of the element within the building or its relationship to the surrounding environment.
- Unique Regional Features – Distinctive characteristics influenced by local climate conditions, culture, or traditional building techniques.

These attributes were considered crucial for understanding how traditional architecture could inform contemporary, climate-responsive designs.

These identified building elements and their corresponding attributes together form a conceptual framework that defines the core aspects of traditional architecture. As already discussed in Chapter 2, Section 2.2.5, the combination of elements and attributes forms the **‘Parameters of Traditional Architecture’**, which are used in this study to systematically evaluate traditional design.

4.3 Development of Element-Attribute Matrix for Expert Opinion Survey-1

With the identified parameters of traditional architecture, the next step was to create an element-attribute matrix to systematically assess their relevance in climate-responsive design. In this matrix, the building elements were structured along the Y-axis, while the corresponding attributes were placed along the X-axis. This process resulted in 105 meaningful element-attribute combinations or parameters, ensuring that only relevant and applicable pairings were considered for further evaluation.

To determine the significance of these parameters, an expert opinion survey was conducted with 36 architects who either lived or practiced in Northeast India. The sample consisted of architects from Assam, and also included professionals from other states such as Meghalaya, Sikkim, Manipur, and Mizoram. The selection was based on the architects' years of experience and field of expertise, ensuring that each participant had a minimum of five years of professional practice in a relevant field of architecture. While a larger pool of architects was initially considered, the final group was chosen for their relevant expertise and experience in the region, ensuring a diverse yet focused representation of the architectural landscape in Northeast India.

Q3. Instruction : For each traditional building element and its respective attributes listed below, please indicate your recommendation for their adoption in contemporary buildings for a climate responsive design. For Example, if you think that the 'Primary materials' used in the 'Walls' of traditional buildings should be used in contemporary buildings too, to achieve climate responsiveness then it should be 'Strongly recommended'. The traditional building elements are listed in the first column and attributes in the top row. Please select one option for each attribute based on your understanding. Please leave it unanswered if any attribute is not applicable to the corresponding building element.

	Form / Shape			Primary Materials			Size / Dimensions			Color / Finish			Facade Design Elements			Location / Site			Unique Regional Features		
	Strongly Recommend	Somewhat Recommend	Do Not Recommend	Strongly Recommend	Somewhat Recommend	Do Not Recommend	Strongly Recommend	Somewhat Recommend	Do Not Recommend	Strongly Recommend	Somewhat Recommend	Do Not Recommend	Strongly Recommend	Somewhat Recommend	Do Not Recommend	Strongly Recommend	Somewhat Recommend	Do Not Recommend	Strongly Recommend	Somewhat Recommend	Do Not Recommend
Structural System	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>
Spatial Layout	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>
Roof System	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>
Ceiling	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>
Walls	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>
Openings	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>
Stairs	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>
Floor	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>
Foundation	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>
Facade	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>
Ornamentation	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>
Door System	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>
Roofing / Attic	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>
Compound Wall	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>
Fire Place	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>
Orientation	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>

Figure 4.1: Sample of the Matrix used in the Questionnaire for Expert Opinion Survey 1 (Source: Author)

The objective of this expert opinion survey was to assess which parameters of traditional architecture, were most crucial in supporting climate responsiveness and could be adopted to contemporary designs. Experts were asked to evaluate each combination/parameter based on the following rating scale:

- Strongly Recommend
- Somewhat Recommend
- Do Not Recommend

This expert evaluation provided a ranked list of parameters, helping identify which features play a significant role by supporting climate responsiveness in traditional architecture and are suitable for adoption in contemporary designs.

However, not all parameters hold equal significance. To refine and prioritize the most relevant parameters, RIDIT analysis was applied to the dataset.

4.3.1 Refinement of Parameters Using RIDIT Analysis

RIDIT analysis is a statistical method used to assess the relative importance of different parameters by assigning weighted scores based on expert responses. This process helps in systematically identifying the most impactful parameters for climate-responsive design.

RIDIT analysis is a non-parametric statistical technique particularly useful when the data involves ordinal or ranked variables, as it provides a method to objectively rank and prioritize items based on their relative importance or frequency of occurrence (Li, Ho and Huang, 2024). RIDIT analysis has been applied in this study for data analysis involving responses measured on an ordered categorical (semi-quantal) scale (Flora, 2006). The term RIDIT stands for "**relative to an identified distribution integral transformation.**" Originally introduced by Bross (1958), this method is widely used in fields such as econometrics, biostatistics, psychiatry, and psychology, where data is ordered but does not follow an interval scale.

As described by Jairus and Flora (2006, p.11), this approach involves assigning RIDIT scores to each category of an ordered response variable using an empirical distribution function in a probability integral transformation. These scores are then utilized for further statistical analysis, including calculations of averages, variances, and other relevant metrics.

The method of RIDIT calculation is given below in Table 4.1.

Table 4.1: Calculation of RIDITs. (Source: Bross 1958)

	(1) n_i	(2) $p_i = n_i/2$	(3) q_i	(4) $r_i = p_i + q_i$	(5) $r_i/N = R$
None	n_1	p_1	$q_1 = 0$	r_1	R_1
Minor	n_2	p_2	$q_2 = n_1$	r_2	R_2

Moderate	n_3	p_3	$q_3 = n_1 + n_2$	r_3	R_3
Severe	n_4	p_4	$q_4 = n_1 + n_2 + n_3$	r_4	R_4
Serious	n_5	p_5	$q_5 = n_1 + n_2 + n_3 + n_4$	r_5	R_5
Critical	n_6	p_6	$q_6 = n_1 + n_2 + \dots + n_4 + n_5$	R_6	R_6
Fatal	n_7	p_7	$q_7 = n_1 + n_2 + \dots + n_5 + n_6$	r_7	R_7
TOTAL	$\sum n_i = N$	$\sum q_i = N$			

Column (1): The frequency distribution in the identified distribution (reference class)

Column (2): One-half of corresponding entry in Column (1)

Column (3): The cumulate of Column (1) (displaces one category downward)

Column (4): Column (2) + Column (3)

Column (5): The entries of Column (4) divided by grand total (N). The numbers are the RIDITs (R_i)

In this study, RIDIT analysis was employed to objectively rate the parameters of traditional architecture based on experts' opinion. By analysing the ratings, this method helped highlight the most significant parameters in the context of climate responsiveness and contemporary adoption.

The steps involved in the RIDIT analysis include:

a. Data Preparation:

The initial step in the RIDIT analysis was to organize the data. The 105 element-attribute combinations/parameters, along with the rankings provided by experts (e.g., “strongly recommend,” “somewhat recommend,” “do not recommend”), were structured into a table. This allowed for a clear comparison of each combination in terms of the level of recommendation given by the expert respondents.

Table 4.2: Expert Survey Responses for Element-Attribute Parameters (Source: Author)

	Parameters of Traditional Architecture	No Opinion	Do Not Recommend	Somewhat Recommend	Strongly Recommend	Total
1	Structural system - Form/Shape	2	3	20	11	36
2	Structural system - Primary materials	1	7	15	13	36
3	Structural system - Size / Dim.	1	11	13	11	36
4	Structural system - Colour / Finish	2	8	18	8	36
5	Structural system – Passive design features	1	0	8	27	36
6	Structural system – Unique regional features	3	0	11	22	36
7	Spatial layout – Form/ Shape	2	2	12	20	36
8	Spatial layout - Size / Dim.	2	5	18	11	36
9	Spatial layout – Passive design features	4	0	6	26	36
10	Spatial layout - Location / Site	8	2	11	15	36
11	Spatial layout – Unique Regional features	3	1	14	18	36
12	Roof system - Form/Shape	2	2	17	15	36
13	Roof system - Primary materials	2	3	14	17	36
14	Roof system - Size / Dim.	2	6	17	11	36
15	Roof system - Colour / Finish	5	6	14	11	36

Table 4.2 above shows a sample of 15 parameters with the respective number of responses from experts.

b. Calculation of RIDIT Scores:

In this step, RIDIT scores were calculated for each of the 105 parameters. These scores reflect the relative importance of each combination based on expert responses. The RIDIT analysis essentially assigns a score to each combination that indicates how strongly experts recommend it for enhancing climate responsiveness, relative to other parameters. The

scoring was performed using the predefined distribution (Table 4.1) and expert input, and the resulting scores were used to rank the parameters.

Table 4.3: Weighted Values Based on RIDITs (Refer Table 4.1) (Source: Author)

	Parameters of Traditional Architecture	No Opinion	Do Not Recommend	Somewhat Recommend	Strongly Recommend	Total
1	Structural system - Form/Shape	0.14	0.591	8.92	9.009	18.66
2	Structural system - Primary materials	0.07	1.379	6.69	10.647	18.786
3	Structural system - Size / Dim.	0.07	2.167	5.798	9.009	17.044
4	Structural system - Colour / Finish	0.14	1.576	8.028	6.552	16.296
5	Structural system - Passive design features	0.07	0	3.568	22.113	25.751
6	Structural system – Unique regional features	0.21	0	4.906	18.018	23.134
7	Spatial layout – Form/ Shape	0.14	0.394	5.352	16.38	22.266
8	Spatial layout - Size / Dim.	0.14	0.985	8.028	9.009	18.162
9	Spatial layout - Passive design features	0.28	0	2.676	21.294	24.25
10	Spatial layout - Location / Site	0.56	0.394	4.906	12.285	18.145
11	Spatial layout - Unique regional features	0.21	0.197	6.244	14.742	21.393
12	Roof system - Form/Shape	0.14	0.394	7.582	12.285	20.401
13	Roof system - Primary materials	0.14	0.591	6.244	13.923	20.898
14	Roof system - Size / Dim.	0.14	1.182	7.582	9.009	17.913
15	Roof system - Colour / Finish	0.35	1.182	6.244	9.009	16.785

Table 4.3 above shows a sample of 15 parameters with the respective weighted values.

c. Ranking of Parameters:

Once the RIDIT scores were calculated, the parameters were ranked based on their scores, with higher scores representing parameters that were deemed more important for climate-responsive design. This ranking allowed us to identify which parameters were most significant for adoption to contemporary designs with respect to climate responsiveness.

d. Selection of Top Parameters:

Based on the ranking from the RIDIT analysis, the final selection was made. The 105 parameters were narrowed down to the top 44 parameters with the highest RIDIT scores which were greater than the mean of the scores. These 44 parameters were deemed most important by the experts for adoption to Contemporary RCC House designs with respect to climate responsiveness.

Table 4.4: Final Selection of Parameters of Traditional Architecture Based on RIDIT Analysis
(Source: Author)

	Parameters of Traditional Architecture	RIDIT scores
1	Structural system – Passive design features	25.751
2	Roof system - Passive design features	25.372
3	Roof system - Unique regional features	24.507
4	Orientation - Unique regional features	24.38
5	Spatial layout - Passive design features	24.25
6	Orientation - Passive design features	24.25
7	Open space - Form/Shape	23.88
8	Façade - Unique regional features	23.634
9	Open space - Passive design features	23.501
10	Structural system – Unique regional features	23.134
11	Orientation - Form/Shape	22.879
12	Spatial layout – Form/ Shape	22.266
13	Open space - Unique regional features	22.26
14	Walls - Passive design features	22.136
15	Walls - Unique regional features	22.018
16	Façade - Passive design features	21.757

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17	Openings - Form/Shape	21.644
18	Façade - Form/Shape	21.398
19	Spatial layout - Unique regional features	21.393
20	Ornamentation - Unique regional features	21.144
21	Openings - Passive design features	21.008
22	Roof system - Primary materials	20.898
23	Walls - Primary materials	20.525
24	Orientation - Location / Site	20.513
25	Roof system - Form/Shape	20.401
26	Open space - Size / Dimension	20.147
27	Floor - Passive design features	20.135
28	Ceiling - Unique regional features	20.024
29	Ceiling - Passive design features	20.01
30	Floor - Unique regional features	19.903
31	Openings - Size / Dimension	19.779
32	Openings - Unique regional features	19.643
33	Façade - Colour / Finish	19.528
34	Fire place - Unique regional features	19.151
35	Openings - Location / Site	19.143
36	Structural system - Primary materials	18.786
37	Floor - Primary materials	18.784
38	Stairs - Passive design features	18.773
39	Structural system - Form/Shape	18.66
40	Compound wall - Unique regional features	18.4
41	Open space - Location / Site	18.394
42	Stairs - Unique regional features	18.281
43	Spatial layout - Size / Dimension	18.162
44	Spatial layout - Location / Site	18.145

The result of the RIDIT analysis was a refined list of 44 parameters of traditional architecture, which represent the most crucial parameters for climate responsiveness and adoption to contemporary designs.

In the next phase of the study, these parameters will be applied specifically to traditional ATHs with the help of experts to derive a definitive list of their traditional features, which support climate responsiveness and are adoptable to contemporary designs.

Table 4.5: Refined List of Parameters of Traditional Architecture After RIDIT Analysis, which Support Climate Responsiveness and are Suitable for Contemporary Adoption (Source: Author)

	Parameters of Traditional Architecture which Support Climate Responsiveness and are Suitable for Contemporary Adoption
1	Structural system – Passive design features
2	Roof system - Passive design features
3	Roof system - Unique regional features
4	Orientation - Unique regional features
5	Spatial layout - Passive design features
6	Orientation - Passive design features
7	Open space - Form/Shape
8	Façade - Unique regional features
9	Open space - Passive design features
10	Structural system – Unique regional features
11	Orientation - Form/Shape
12	Spatial layout – Form/ Shape
13	Open space - Unique regional features
14	Walls - Passive design features
15	Walls - Unique regional features
16	Façade - Passive design features
17	Openings - Form/Shape
18	Façade - Form/Shape
19	Spatial layout - Unique regional features

20	Ornamentation - Unique regional features
21	Openings - Passive design features
22	Roof system - Primary materials
23	Walls - Primary materials
24	Orientation - Location / Site
25	Roof system - Form/Shape
26	Open space - Size / Dimension
27	Floor - Passive design features
28	Ceiling - Unique regional features
29	Ceiling - Passive design features
30	Floor - Unique regional features
31	Openings - Size / Dimension
32	Openings - Unique regional features
33	Façade - Colour / Finish
34	Fire place - Unique regional features
35	Openings - Location / Site
36	Structural system - Primary materials
37	Floor - Primary materials
38	Stairs - Passive design features
39	Structural system - Form/Shape
40	Compound wall - Unique regional features
41	Open space - Location / Site
42	Stairs - Unique regional features
43	Spatial layout - Size / Dimension
44	Spatial layout - Location / Site

4.4 Application of the Parameters of Traditional Architecture to Traditional Assam-type House: Expert Opinion Survey-2

The objective of applying the 44 identified parameters to traditional ATHs is to pinpoint the specific features of traditional ATH that contribute to climate-responsive design and are suitable for contemporary adoption as per the study so far. For example, when the building element is the wall and the attribute is primary materials, the application to traditional ATHs reveals that walls are typically constructed with materials like bamboo, ikra, and wood, which are suited for the local climate.

The process of applying the identified parameters (i.e., combinations of building elements and attributes) to traditional ATHs was carried out through a second expert opinion survey. This survey was specifically designed to map each parameter to its corresponding architectural feature as found in traditional ATHs.

Given the specialized nature of the study, which focuses on traditional ATHs, a total of ten architects were selected for the expert opinion survey. These experts included practicing architects with experience in regional construction practices in Assam and academicians with research backgrounds in traditional architecture specific to the region.

In qualitative research, especially within architectural studies that require expert elicitation in niche or localized contexts, smaller sample sizes are often sufficient. According to Boddy (2016), qualitative studies can yield meaningful insights with as few as six to ten participants, particularly when the participants are selected for their expertise and the study aims for depth over breadth. This approach is well-suited for studies like this, where the goal is to gather in-depth insights from a targeted group of experts. The selected experts in this study provided informed evaluations based on their practical and academic experience, which was sufficient for the intended qualitative and comparative analysis.

The data collection was carried out through a structured questionnaire. Each question was designed to elicit expert input on the specific architectural feature corresponding to a given parameter. For instance, if the parameter was Roof – Unique Regional Feature, the expert would be asked to identify what constitutes a unique regional characteristic of the roof in ATHs. The experts were thus required to interpret each parameter and provide the most contextually appropriate feature based on their professional and academic knowledge.

This expert-guided approach ensured that the generalized framework of parameters was translated into a set of concrete, locally relevant features, reflecting the architectural reality of traditional ATHs. Through this process, each parameter was systematically evaluated,

and its corresponding feature was derived and documented for further use in the study. Table 4.6 shows the list of thus derived features.

Table 4.6: List of Features of Traditional Assam-Type Houses that Support Climate Responsiveness and are Suitable for Contemporary Adoption, Derived from 44 Identified Parameters of Traditional Architecture (Source: Author)

	Important Parameters of Traditional Architecture	Corresponding Adoptable Traditional Assam-Type House Features Which Support Climate Responsiveness
1	Structural system – Passive design features	1a. Elevated plinth or stilt 1b. Lightweight structure – Wooden Framework.
2	Roof system – Passive design features	2a. Sloping roof 2b. CGI sheet or thatch 2c. Multi-tiered gable roofing 2d. Roof lanterns. 2e. Large Overhangs
3	Roof system – Primary Materials	3a. CGI Sheet or thatch 3b. Traditional materials 3c. Bamboo or wood ceilings
4	Orientation – Unique Regional features	4a. Longer side facing windward direction 4b. Inward-oriented spaces 4c. Shading elements on the south and west sides
5	Spatial layout – Passive design features	5a. Veranda along the longer sides of the house 5b. Courtyard
6	Spatial Layout – Form/Shape	6a. Elongated plan 6b. Rooms arranged around courtyard
7	Open space – Form/Shape	N/A
8	Façade – Unique Regional features	8a. Veranda along the longer side of house 8b. Elevated plinth 8c. Decorative bargeboards 8d. Bamboo screens

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		8e. Pale colour palette 8f. Large overhangs 8g. Bay windows
9	Open space – Passive design features	9a. Vegetation in yards.
10	Structural system – Unique Regional features	10a. Lightweight structure 10b. Slender columns 10c. Flexible joints 10d. Bam
11	Orientation - Form/Shape	11a. Longer side facing windward direction
12	Orientation - Passive design features	12a. Longer side facing windward direction 12b. Inward-oriented spaces 12c. Shading elements on the south and west sides
13	Open space - Unique Regional features	13a. Vegetation in yards.
14	Walls - Passive design features	14a. Bamboo-wood-ikra (brick masonry till sill) walls with mud mortar 14b.. Pale colour palette
15	Walls - Unique Regional features	15a. Bamboo-wood-ikra (brick masonry till sill) walls with mud mortar 15b. Pale colour palette
16	Façade - Passive design features	16a. Veranda along the longer side of house 16b. Elevated plinth 16c. Bamboo screen 16d. Pale colour palette 16e. Bay windows
17	Openings - Form/Shape	17a. Moderate sized openings
18	Façade - Form/Shape	18a. Large overhang 18b. Sloping Roof 18c. Symmetrical design
19	Spatial layout - Unique Regional features	19a. Symmetrical layout 19b. Courtyard

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		19c. Rooms arranged around courtyard
20	Ornamentation - Unique Regional features	20a. Decorative bargeboards
21	Openings - Passive design features	21a. Moderate size openings 21b. Small high-level ventilators 21c. Openings located opposite each other
22	Roof system – Unique Regional features	22a. Sloping roof 22b. Large overhangs 22c. Lightweight roofing material – CGI sheet or thatch 22d. Multi-tiered gable roofing 22e. Roof lanterns 22f. Ornamented bargeboards 22g. Bamboo/Wood truss
23	Walls - Primary materials	23a. Bamboo-wood-ikra (brick masonry till sill) walls with mud mortar 23b. Traditional materials
24	Orientation - Location / Site	24a. Longer side facing windward direction
25	Roof system - Form/Shape	25a. Sloping Roof
26	Open space - Size / Dimension	26a. Elongated yards
27	Floor - Passive design features	27a. Elevated plinth 27b. Bamboo or wood floorboard 27c. Cement/ Mud plastered floor
28	Ceiling - Unique Regional features	28a. Bamboo or wood ceiling 28b. High ceiling
29	Ceiling - Passive design features	29a. Bamboo or wood ceiling 29b. High ceiling
30	Floor - Unique Regional features	30a. Elevated Plinth 30b. Bamboo or wood floorboard 30c. Cement/ Mud Plastered floor
31	Openings - Size / Dimension	31a. Moderate size

		31b. Small high-level ventilators
32	Openings - Unique Regional features	32a. Moderate size openings 32b. Small high-level ventilators 32c. Openings located opposite each other 32d. Shading elements on the south and west sides 32e. Moderate Size openings
33	Façade - Colour / Finish	33a. Pale colour palette
34	Fire place - Unique Regional features	34a. Mud-brick elevated fireplace
35	Openings - Location / Site	N/A
36	Structural system - Primary materials	36a. Wooden framework 36b. Bamboo-wood-ikra (brick masonry till sill walls with mud mortar) 36c. Traditional materials
37	Floor - Primary materials	37a. Bamboo or wood floorboard 37b. Cement/ Mud plaster
38	Stairs - Passive design features	38a. Wooden Open Tread Staircase
39	Structural system - Form/Shape	39a. Sloping roof 39b. Rectangular Wooden framework
40	Compound wall - Unique Regional features	40a. Bamboo or wood low height compound walls
41	Open space - Location / Site	41a. Courtyard
42	Stairs - Unique Regional features	42a. Wooden Open tread staircase
43	Spatial layout - Size / Dimension	43a. Wide verandas
44	Spatial layout - Location / Site	44a. Utility areas placed separately on the rear side of site

After eliminating duplicate features from the Table 4.6, the final consolidated list of traditional ATH features is as below.

Table 4.7: Comprehensive Adoptable Features of Traditional Assam-Type Houses Which Support Climate Responsiveness (Source: Author)

	List of Adoptable Traditional ATH Features Which Support Climate Responsiveness
1	1a. Elevated plinth or stilt
2	1b. Wooden framework – lightweight structure
3	2a. Sloping roof
4	2b. CGI sheet or thatch roofing
5	2c. Multi-tiered gable roofing
6	2d. Roof lanterns.
7	2e. Large overhangs
8	3b. Traditional materials
9	3c. Bamboo or wood ceilings
10	4a. Longer side facing windward direction
11	4b. Inward-oriented spaces
12	4c. Shading elements on the south and west sides
13	5a. Veranda along the longer sides of the house
14	5b. Courtyard
15	6a. Elongated plan
16	6b. Rooms arranged around courtyard
17	8c. Decorative bargeboards
18	8d. Bamboo screens
19	8f. Pale colour palette
20	8h. Bay windows.
21	9a. Vegetation in yards
22	10b. Slender columns
23	10c. Flexible joints
24	17a. Moderate sized openings
25	19a. Symmetrical layout
26	21b. Small high-level ventilators

27	21e. Openings located opposite each other
28	23a. Bamboo-wood-ikra (brick masonry till sill) walls with mud mortar
29	27b. Bamboo or wood floorboard
30	27c. Cement/ Mud Plastered floor
31	28b. High ceiling
32	34a. Mud-brick elevated fireplace
33	38a. Wooden Open Tread Staircase
34	40a. Bamboo/ wood low height compound wall
35	43a. Wide verandas
36	44a. Utility areas placed separately on the rear side of site

These **36 features**, derived from a mapping of the 44 parameters to traditional ATH, will form the basis for identifying strategies to integrate traditional wisdom of ATHs into contemporary designs for better climate responsiveness.

4.5 Evaluating User Perceptions: Comfort, Efficiency and Willingness to Adopt Traditional Features

With the identified adoptable features of traditional ATHs that support climate-responsive design, the next step involved assessing user perceptions regarding these features. A structured questionnaire was designed to gather insights from two groups:

- a. Users of traditional ATHs and
- b. Users of contemporary RCC houses.

The survey aimed to evaluate user comfort levels across different seasons, perceptions of the efficiency of traditional features, and their willingness to incorporate these traditional features in future construction.

A total of 100 respondents participated in the survey, comprising 50 users from traditional ATHs and 50 users from contemporary RCC houses. The questionnaire was designed with careful consideration of the respondents' understanding, ensuring that all questions were simple and experience-based.

A small informal pilot study was conducted with 6 participants representing the target demographic to assess the clarity, relevance, and understandability of the questions. Based on their feedback and given that not all users had technical knowledge of building design, certain features that required specialized understanding were omitted to ensure the accuracy of responses. For example, questions related to structural aspects such as lightweight construction, flexible joints, or the arrangement of rooms around a courtyard were excluded. Instead, the focus was on aspects that users could directly perceive and evaluate based on their lived experience.

The questionnaire was divided into three parts -

- a. Environmental Comfort Parameters (Part 1):** The first part assessed user comfort levels in different seasons, summer, winter, and monsoon, as well as aspects of ventilation and daylight availability.
- b. Efficiency of Traditional ATH Features (Part 2):** The second part focused on user perceptions of key traditional ATH features, particularly regarding their efficiency in providing thermal comfort, daylight and ventilation.
- c. User's Willingness to Adopt Traditional ATH Features (Part 3):** The third part explored the willingness of users to incorporate specific traditional features into their future houses.

Additionally, questions about the frequency of mechanical ventilation (e.g., use of fans and air conditioning) versus reliance on natural ventilation were included to provide insights into the comparative climate responsiveness of traditional and Contemporary RCC Houses.

The questionnaire was administered using Google forms, ensuring standardised data collection. However, data collection was carried out through direct engagement with respondents, with surveys administered physically at their respective houses. To ensure the reliability of responses, only individuals who had resided in their current houses for a minimum of five years were considered. This criterion was particularly relevant for traditional ATHs, where long-term occupants could provide a well-rounded perspective on comfort and efficiency across different climatic conditions. In contrast, contemporary RCC houses, being relatively new, naturally had fewer long-term occupants.

The responses provided insights into how users felt about the ability of their houses to offer thermal comfort, protect against weather extremes, and ensure adequate daylight and

ventilation. These factors played a crucial role in evaluating the overall comfort experienced by the residents in both traditional and Contemporary RCC Houses. The analysis of the User Perception Survey was done using suitable statistical tools as detailed further.

A flowchart is provided below to illustrate the structure of the User Perception Survey.

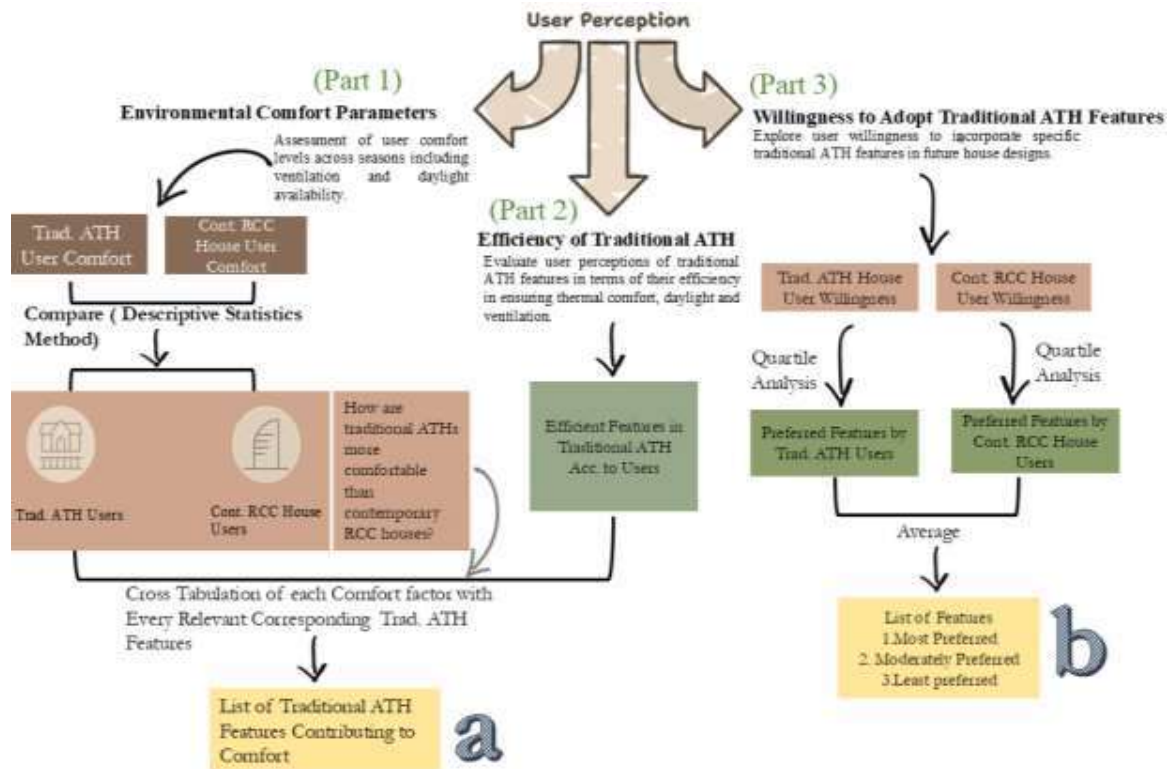


Figure 4.2: Flowchart Illustrating the Structure of the User Perception Survey Analysis (Source: Author)

4.5.1 Comparison of Environmental Comfort Parameters - Descriptive Statistics (Part 1)

The responses from the first part of the questionnaire were analysed using descriptive statistical methods, including the calculation of the mean, median, and standard deviation. This analysis aimed to compare how users perceived their comfort levels during different seasons - summer, winter, and the rainy season, as well as other key comfort parameters such as adequate daylight and ventilation.

Descriptive statistics was chosen for this analysis as it effectively summarizes and compares user perceptions of the environmental comfort parameters in traditional ATHs and contemporary RCC houses. The primary objective was to identify trends and variations in user-reported comfort levels across different seasons (summer, winter, and rainy) and environmental aspects such as ventilation and daylight. Measures such as mean, median, and standard deviation provide a clear and concise representation of these responses, allowing for an objective comparison between the two housing typologies.

By examining these factors, the analysis sought to understand and compare the overall comfort experienced by users in traditional ATH and contemporary RCC houses.

- *Mean (Arithmetic Average)*: This represents the average response of the participants, providing an overall indication of the comfort level perceived by the users. A higher mean score, for instance, may reflect greater satisfaction with specific aspects, such as ventilation or thermal comfort.

The mean is calculated by summing all values in a dataset and dividing by the total number of values. It represents the average response.

$$\text{Mean } (\mu) = \Sigma X_i / N$$

- *Median*: This is the middle value of the responses when arranged in order, giving insight into the central tendency of the data. The median is particularly useful in identifying a typical user response, especially when there are outliers in the data.
- *Standard Deviation*: This measures the extent of variability or dispersion in the responses. A low standard deviation indicates that the participants' perceptions are relatively consistent, while a high standard deviation suggests significant variability in their experiences of comfort.

Standard deviation (σ) measures data spread around the mean. A higher value indicates greater variability. It is calculated as:

$$\sigma = \text{sqrt} (\Sigma (X_i - \mu)^2 / N)$$

The analysis of these statistics provided a quantitative foundation to assess and interpret user comfort levels in their living spaces, facilitating a better understanding of how effectively the design and construction of the houses meet the occupants' needs across various climatic conditions.

Table 4.8: Descriptive Analysis of Environmental Comfort parameters in Traditional Assam-Type Houses and Contemporary RCC Houses (Source: Author)

Comfort parameter	House Type	Mean	Median	Standard Deviation
Summer Comfort	Trad. ATH	2.48	3	0.6
	Cont. RCC	1.6	2	0.6
Winter Comfort	Trad. ATH	2.02	2	0.3
	Cont. RCC	2.08	2	0.6
Rainy Season comfort	Trad. ATH	1	1	0.0
	Cont. RCC	0.88	1	0.3
Ventilation	Trad. ATH	0.98	1	0.1
	Cont. RCC	0.88	1	0.3
Daylight	Trad. ATH	1	1	0.0
	Cont. RCC	0.76	1	0.4

Following is a detailed comparison of Traditional ATH and Contemporary RCC Houses for five comfort parameters: Summer Comfort, Winter Comfort, Rainy Season Comfort, Sufficient Ventilation, and Sufficient Daylight, based on the mean, median, and standard deviation of user responses.

- **Summer Comfort**

- a. Mean: Traditional House (2.48) > Contemporary RCC House (1.6): Traditional Houses provide significantly better summer comfort on average than Contemporary RCC Houses.

- b. Median: Traditional House (3) > Contemporary RCC House (2): A larger proportion of users rated Traditional Houses higher for summer comfort than Contemporary RCC Houses.
- c. Standard Deviation: Both Traditional and Contemporary RCC Houses (0.6): User responses are equally consistent for both house types.

Users perceive Traditional Houses as significantly more comfortable during summer than Contemporary RCC Houses. The consistency in responses suggests a general agreement among users about this perception.

a. Winter Comfort

- i. Mean: Contemporary RCC House (2.08) \approx Traditional House (2.02) : Both house types provide similar levels of winter comfort on average.
- ii. Median: Traditional House (2) = Contemporary RCC House (2): Most users rated winter comfort similarly for both house types.
- iii. Standard Deviation: Traditional House (0.3) < Contemporary RCC House (0.6): User opinions about winter comfort are more consistent for Traditional Houses compared to Contemporary RCC Houses.

There is no significant difference in winter comfort between Traditional and Contemporary RCC Houses. However, users of Traditional Houses have more consistent opinions, while responses for Contemporary RCC Houses show greater variability.

b. Rainy Season Comfort

- i. Mean: Traditional House (1) > Contemporary RCC House (0.88): Traditional Houses provide slightly better rainy season comfort than Contemporary RCC Houses.
- ii. Median: Traditional House (1) = Contemporary RCC House (1): Most users gave similar ratings for rainy season comfort in both house types.
- iii. Standard Deviation: Traditional House (0.0) < Contemporary RCC House (0.3): All users rated Traditional Houses consistently for rainy season comfort, while responses for Contemporary RCC Houses show slight variation.

Traditional Houses are slightly better in providing comfort during the rainy season. The unanimous agreement in responses for Traditional Houses reflects strong user confidence, whereas Contemporary RCC Houses show some variability.

c. Sufficient Ventilation

- i. Mean: Traditional House (0.98) > Contemporary RCC House (0.88): Traditional Houses provide slightly better ventilation on average than Contemporary RCC Houses.
- ii. Median: Traditional House (1) = Contemporary RCC House (1): Most users rated sufficient ventilation similarly for both house types.
- iii. Standard Deviation: Traditional House (1) > Contemporary RCC House (0.3): User opinions about ventilation in Traditional Houses vary significantly, while responses for Contemporary RCC Houses are more consistent.

While Traditional Houses are perceived as slightly better in providing sufficient ventilation, the variability in responses suggests that user experiences with Traditional Houses are less uniform compared to Contemporary RCC Houses, which have more consistent ratings.

d. Sufficient Daylight

- i. Mean: Traditional House (1) > Contemporary RCC House (0.76): Traditional Houses offer better daylight availability on average compared to Contemporary RCC Houses.
- ii. Median: Traditional House (1) = Contemporary RCC House (1): The majority of users gave the highest rating for daylight in both house types.
- iii. Standard Deviation: Traditional House (0.0) < Contemporary RCC House (0.4): All users gave consistent ratings for sufficient daylight in Traditional Houses, while responses for Contemporary RCC Houses show slight variation.

Traditional Houses are unanimously rated as providing sufficient daylight, with no variation in user responses. Contemporary RCC Houses, although rated lower on average, show some variability in user perceptions.

Key Finding: Traditional ATHs are rated better for Summer Comfort, Rainy Season Comfort, and Sufficient Daylight. The higher mean values for these factors indicate a clear preference for Traditional ATHs.

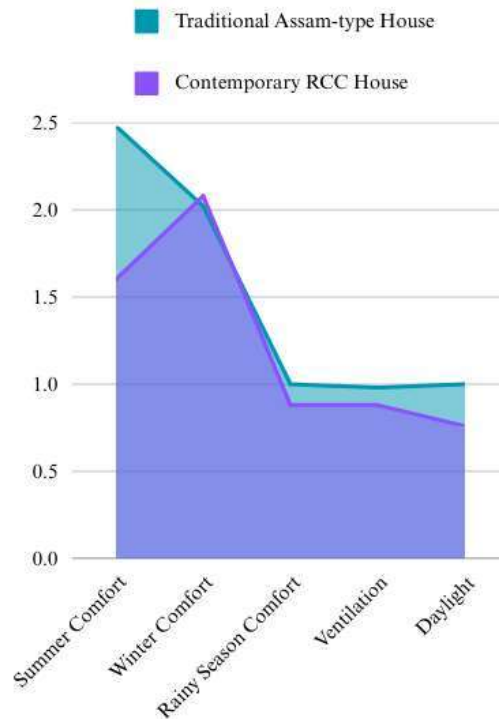


Figure 4.3: Area-chart Showing Comparison of Mean of Environmental Comfort Parameters in Traditional Assam-Type Houses and Contemporary RCC Houses (Source: Author)

- Winter Comfort is similar for both house types. Nearly identical mean and median values indicate no significant difference, though traditional ATHs have more consistent ratings.
- Ventilation is slightly better in traditional ATHs, but with more varied responses.
- Traditional ATHs are generally perceived as more comfortable across most seasons and for environmental aspects like daylight and ventilation. Contemporary RCC Houses, while comparable in winter comfort, lag in other aspects and show greater variability in user experiences.

4.5.2 Assessing the Features Contributing to Comfort in Traditional Assam Type Houses - Cross-Tabulation Analysis (Part 2)

The next step in the analysis was to identify the traditional features of ATHs that contribute to comfort, as the previous analysis revealed that traditional ATHs are perceived to be more

comfortable than Contemporary RCC Houses for various environmental comfort parameters. To achieve this, a cross-tabulation analysis was conducted for each environmental comfort parameter, including summer comfort, winter comfort, rainy season comfort, adequate ventilation, and adequate daylight. The analysis aimed to understand the relationship between these comfort parameters and specific features of traditional ATHs.

Cross-tabulation analysis was chosen for this study as it effectively identifies relationships between traditional ATH features and user-perceived comfort parameters. By cross-tabulating user perception data with architectural features, this method allows for a structured comparison of how traditional features influence comfort in different seasons (summer, winter, and rainy), as well as daylight and ventilation performance. This approach provides clear insights into the role of traditional design features in enhancing indoor comfort, making it the most suitable analysis for this study.

To ensure that the cross-tabulation analysis focused on functionally relevant relationships, the selection of features for each comfort parameter was based on professional opinions gathered from architects familiar with traditional ATHs. The identified features were mapped against the five environmental comfort parameters, i.e. summer comfort, winter comfort, rainy season comfort, adequate daylight, and adequate ventilation based on their direct contribution to each. This classification helped in understanding which traditional architectural features play a significant role in enhancing specific comfort conditions. The following table presents this relationship, highlighting the features that were considered most relevant for each environmental comfort parameter according to expert insights.

Table 4.9 Traditional features Contributing to Environmental Comfort Parameters in Assam-Type Houses (Based on Expert’s Professional Opinion) (Source: Author)

	Environmental Comfort Parameter	Traditional Features Contributing to the Environmental Comfort Parameter
1	Adequate Daylight	8f. Pale colour palette
		5b. Courtyard
		5a. Veranda along the longer sides of the house
		43a. Wide verandas
		17a. Moderate sized openings

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		21e. Openings located opposite each other
		21b. Small high-level ventilators
2	Adequate Ventilation	6a. Elongated plan
		9a. Vegetation in yards in yards
		5b. Courtyard
		5a. Veranda along the longer sides of the house
		43a. Wide verandas
		23a. Bamboo-wood-ikra (brick masonry till sill) walls with mud mortar
		17a. Moderate sized openings
		21e. Openings located opposite each other
		21b. Small high-level ventilators
		28b. High ceiling
		2a. Sloping roof
3	Rainy Season Comfort	1a. Elevated plinth or stilt
		5a. Veranda along the longer sides of the house
		23a. Bamboo-wood-ikra (brick masonry till sill) walls with mud mortar
		2e. Large overhangs
		2b. CGI sheet or thatch roofing
		2a. Sloping roof
4	Winter Comfort	27c. Cement/ Mud Plastered floor
		3b. Traditional materials
		23a. Bamboo-wood-ikra (brick masonry till sill) walls with mud mortar
		3c. Bamboo or wood ceilings

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		28b. High ceiling
5	Summer Comfort	1a. Elevated plinth or stilt
		6a. Elongated plan
		8f. Pale colour palette
		9a. Vegetation in yards in yards
		5b. Courtyard
		27c. Cement/ Mud Plastered floor
		5a. Veranda along the longer sides of the house
		43a. Wide verandas
		3b. Traditional materials
		17a. Moderate sized openings
		21e. Openings located opposite each other
		21b. Small high-level ventilators
		3c. Bamboo or wood ceilings
		28b. High ceiling
		2e. Large overhangs
2b. CGI sheet or thatch roofing		
2a. Sloping roof		

4.5.2.1 Cross-Tabulation Analysis of Traditional Assam-Type House features and Adequate Daylight

The cross-tabulation analysis for adequate daylight examines the relationship between specific traditional features of ATH and the environmental comfort parameter of adequate daylight, based on user perceptions. The results highlight how users who reported having adequate daylight in their houses also identified certain features as efficient and contributing to comfort.

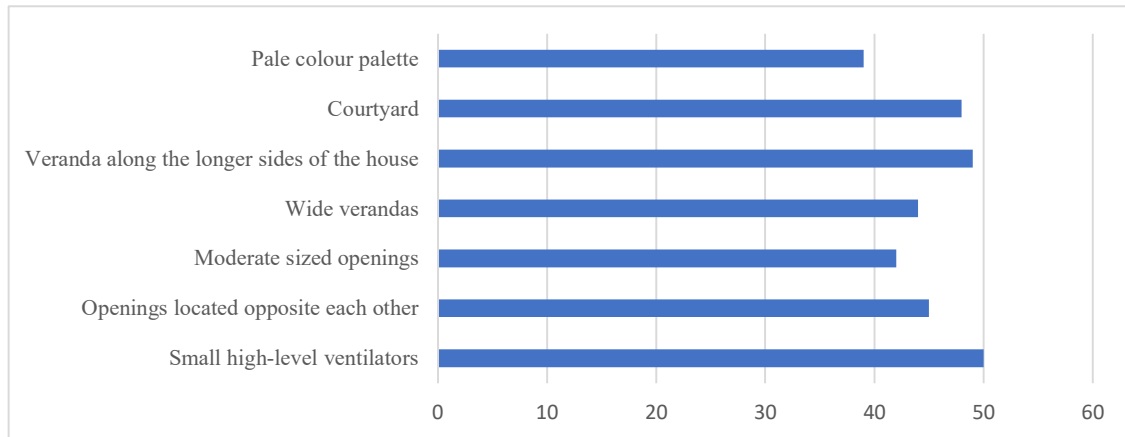


Figure 4.4: Cross Tabulation of Traditional Assam-Type House Features and User Agreement on Adequate Daylight (Source: Author)

- a. **Small high-level ventilators** were identified as the most significant contributor, with all 50 users who reported having adequate daylight also agreeing that small high-level ventilators are efficient in enhancing daylight. This suggests that small high-level ventilators play a key role in allowing natural light to penetrate deeper into the interiors of the house, improving overall daylight distribution.
- b. **Openings located opposite each other**, were identified as efficient by 45 users who also reported adequate daylight, implying that this arrangement helps distribute light evenly throughout the house.
- c. **The moderate sized openings** were noted as efficient by 42 users with adequate daylight, indicating the importance of appropriately designed windows in allowing optimal light entry.
- d. **Wide verandas and veranda along the longer sides of the house**, were significant, with 44 and 49 users, respectively, associating these features with adequate daylight. These spaces allow light to filter into the house while also preventing excessive glare.

- e. **Courtyards** were linked to adequate daylight by 48 users, showcasing their role in channelling direct sunlight into the central spaces of the house, which might otherwise lack sufficient light.
- f. **A pale colour palette** was recognized by 39 users, reflecting the role of lighter-coloured surfaces in enhancing brightness by reflecting incoming daylight more effectively.

Key Interpretations:

- **Most significant contributors to daylight:** Small high-level ventilators, veranda along the longer side of the house and courtyards. These features are consistently linked with users reporting adequate daylight in their houses.
- **Moderately important contributors:** Openings located opposite each other and wide verandas, both of which also play a significant role in improving daylight but were slightly less impactful compared to the top features.
- **Least important contributor:** Moderately sized openings and pale colour palette, while still relevant, had the lowest number of users acknowledging its impact on daylight, though it still contributes to overall light reflection within the house.

4.5.2.2 Cross-Tabulation Analysis of Traditional Assam-type House features and Adequate Ventilation

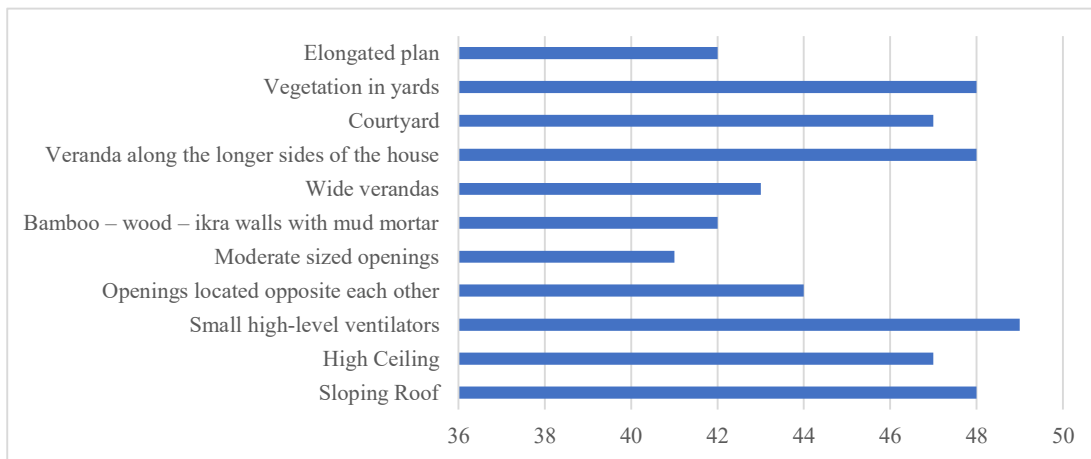


Figure 4.5: Cross Tabulation of Traditional Assam-Type House Features and User Agreement on Adequate Ventilation (Source: Author)

The cross-tabulation analysis for adequate ventilation shows the relationship between various features of traditional ATH and users' perception of having adequate ventilation.

This analysis reveals which features users consider to be efficient and links them to the users' experience of having adequate ventilation in their houses.

- a. **Small high-level ventilators** were identified by all 49 users who reported having adequate ventilation as being efficient. This indicates that users who feel their house has adequate ventilation perceive small high-level ventilators as crucial for facilitating air movement and improving airflow.
- b. **Sloping roof** was seen as an efficient feature by 48 users with adequate ventilation. A sloping roof helps in reducing heat build-up and facilitates natural airflow, contributing significantly to ventilation.
- c. **Veranda along the longer sides of the house**, were considered efficient by 48 users who reported adequate ventilation. These verandas allow for better air circulation around the house, enhancing the overall freshness of the interior.
- d. **Vegetation in yards** was identified as an efficient feature by 48 users with adequate ventilation. The presence of plants and greenery around the house helps cool the surroundings, improving air quality and promoting better ventilation.
- e. **Courtyards** were seen as efficient by 47 users with adequate ventilation. Courtyards promote cross-ventilation, allowing fresh air to flow through the house, thus enhancing overall ventilation.
- f. **High ceiling** was considered efficient by 47 users with adequate ventilation. High ceilings allow hot air to rise, improving air circulation and creating a more comfortable environment.
- g. **Openings located opposite each other**, were reported as efficient by 44 users who also reported having adequate ventilation. Cross-ventilation through windows on opposite walls allows fresh air to flow freely, improving indoor air quality.
- h. **Wide verandas** were identified as efficient by 43 users with adequate ventilation. These verandas help in facilitating airflow and maintaining a cool, fresh atmosphere inside the house.
- i. **Bamboo-wood-ikra (brick masonry till sill) walls with mud mortar**, was considered efficient by 42 users with adequate ventilation. The use of

bamboo brick allows better airflow and natural cooling, contributing to improved ventilation.

j. Elongated plan was identified by 42 users with adequate ventilation. The long layout of the house promotes better airflow, allowing for efficient circulation of air.

k. Moderately sized openings, were seen as efficient by 41 users with adequate ventilation. Appropriately sized and shaped windows help in allowing fresh air to enter and circulate within the house, enhancing ventilation.

Key Interpretations:

- **Most significant contributors to ventilation:** Small high-level ventilators, sloping roofs, verandas along the longer side of the house, and vegetation in yards. These features are most frequently identified as efficient by users who report having adequate ventilation.

- **Moderately important contributors:** Courtyards, high ceilings, and openings located opposite each other, wide veranda, all of which are linked to having adequate ventilation but were less significant compared to the top features.

- **Least important contributor:** Bamboo-wood-ikra (brick masonry till sill) walls with mud mortar, elongated plan and moderately sized openings, while still contributing to ventilation, had the lowest number of users acknowledging their role in improving ventilation.

4.5.2.3 Cross-Tabulation Analysis of Traditional Assam-type House features and Rainy Season Comfort

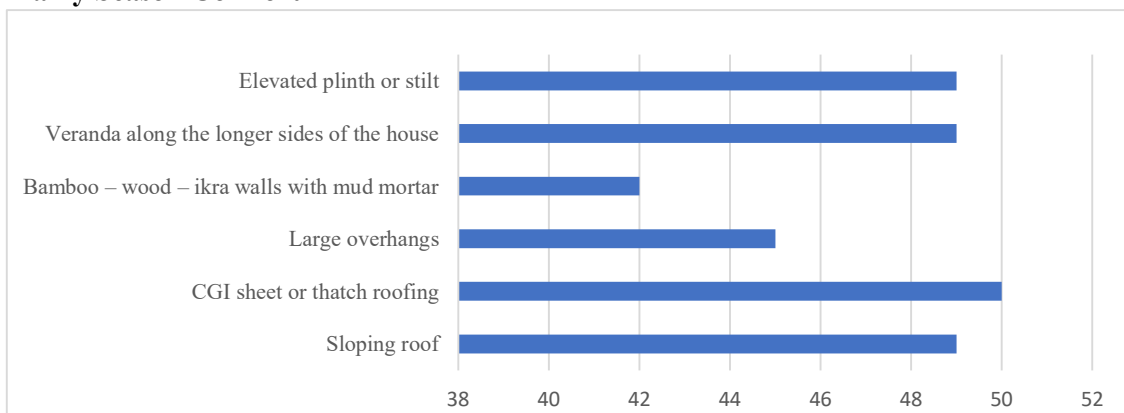


Figure 4.6 Cross Tabulation of Traditional Assam-Type House Features and User Agreement on Rainy Season Comfort (Source: Author)

The cross-tabulation analysis for rainy season comfort explores the relationship between various features of traditional ATHs and users' perceptions of comfort during the rainy season. The following features were considered efficient by users, and the same users reported feeling dry and comfortable during heavy rains.

- a. **CGI sheet** or thatch roofing was considered efficient by 50 users, who also reported experiencing comfort and dryness during the rainy season. This suggests that the presence of CGI sheet or thatch roofings in the house contributes to maintaining a dry and comfortable interior during heavy rainfall.
- b. **Sloping roof** was considered efficient by 49 users, and these users also reported feeling dry and comfortable during rainy conditions. The sloping design aids in effective water drainage, preventing water accumulation and ensuring a dry interior.
- c. **Veranda along the longer sides of the house**, were noted as efficient by 49 users, with the same users indicating they remained comfortable and dry during heavy rains. The extended verandas likely help in protecting the walls from rainwater and provide additional shelter.
- d. **Elevated plinth or stilt**, was identified as efficient by 49 users, who also felt comfortable and dry during the rainy season. This feature helps elevate the house, preventing water seepage from the ground and ensuring the interior remains dry.
- e. **Large overhangs**, were considered efficient by 45 users, who also reported comfort and dryness during rains. The overhang shields the walls and windows from direct rainfall, preventing water entry into the house.
- f. **Bamboo-wood-ikra (brick masonry till sill) walls with mud mortar**, was recognized as efficient by 42 users, and these users also stated they remained dry and comfortable during the rainy season. The moisture-resistant nature of these walls likely plays a role in preventing dampness inside the house.

Key Interpretations:

- **Most significant contributors to rainy season comfort:** CGI sheet or thatch roofings, sloping roofs, veranda along the longer sides of the house, and elevated plinths or stilts. These features were most frequently associated with comfort and dryness

during the rainy season, suggesting they play a critical role in preventing water ingress and ensuring interior comfort.

- **Moderately important contributor:** Large overhangs, which helps protect the walls and windows from rainwater, contributing to overall comfort during the rainy season.

- **Least important contributor:** Bamboo-wood-ikra (brick masonry till sill) walls with mud mortar, which, while beneficial, appears to have a less significant impact compared to the other features in maintaining dryness and comfort during heavy rainfall.

4.5.2.4 Cross-tabulation Analysis of Traditional Assam-type House Features and Winter Comfort

The cross-tabulation analysis identifies features of traditional ATHs that users considered efficient and their corresponding perceptions of thermal comfort during winter. From the total 50 respondents, only the users who considered specific features as effective were included in the analysis, with their comfort levels (“Slightly Cold”, ‘Very Cold’, and ‘Warm’) recorded.

a. High Ceiling: Out of the respondents who considered high ceilings efficient, 44 users reported feeling “Slightly Cold” in winter, while 2 users felt ‘Very Cold’, and 2 users felt ‘Warm’. This indicates that high ceilings contribute effectively to maintaining comfortable indoor temperatures during winter.

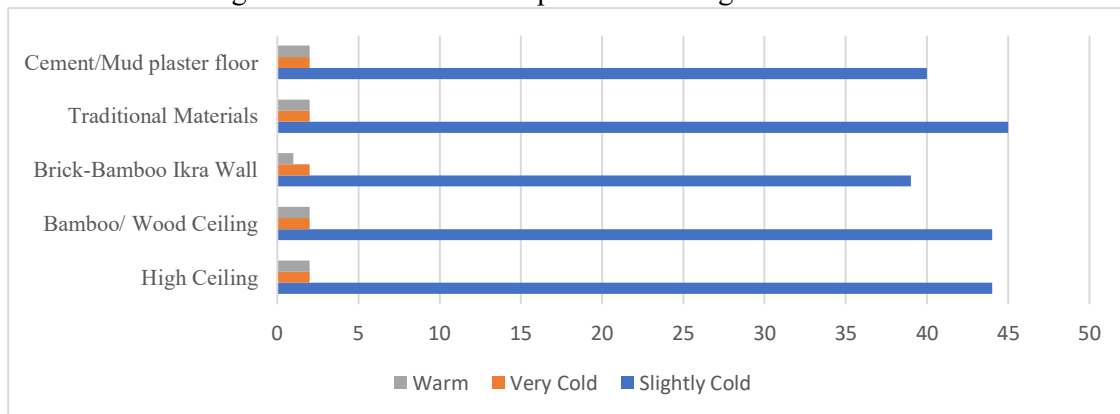


Figure 4.7 Cross Tabulation of Traditional Assam-Type House Features and User Agreement on Winter Comfort (Source: Author)

- b. Bamboo or Wood Ceiling:** Among the users who found this feature effective, 44 users felt ‘Slightly Cold’, 2 users felt ‘Very Cold’, and 2 users felt ‘Warm’. This suggests a significant contribution of bamboo and wood ceilings to thermal comfort.
- c. Bamboo-wood-ikra (brick masonry till sill) walls with mud mortar:** Of the users who considered this feature efficient, 39 users reported feeling ‘Slightly Cold’, while 2 users felt ‘Very Cold’, and 1 user felt ‘Warm’. Although slightly lower than other features, Bamboo-wood-ikra (brick masonry till sill) walls with mud mortars are still effective in maintaining winter comfort.
- d. Traditional Materials:** From the users who perceived traditional materials as efficient, 45 users reported feeling ‘Slightly Cold’, while 2 users felt ‘Very Cold’, and 2 users felt ‘Warm’. This indicates a strong association between traditional materials and maintaining comfort during winter.
- e. Cement/ Mud Plastered Floor:** Among users who considered this feature effective, 40 users reported feeling ‘Slightly Cold’, while 2 users felt ‘Very Cold’, and 2 users felt ‘Warm’. This shows that cement/ mud plastered floors contribute to thermal comfort, although slightly less frequently than other features.

Key Interpretation:

In traditional ATHs, thermal comfort is largely influenced by passive design strategies, making it important to assess whether these houses effectively moderate indoor temperatures across seasons. In winter, residents commonly report feeling ‘Slightly Cold’ rather than ‘Warm’ or ‘Very Cold’, which aligns with the expected thermal behaviour of these structures. These houses prioritize ventilation and lightweight materials over heat retention, meaning they do not naturally create a ‘Warm’ indoor environment but also do not become excessively cold. Feeling ‘Slightly Cold’ is thus the ideal condition, as it allows for easy adaptation through clothing and blankets without compromising the house’s ability to remain cool in summer.

- **Most Significant Contributors:** Traditional Materials had the highest association with users feeling ‘Slightly Cold’ (45 users), making it the most significant contributor to winter comfort. High ceiling and bamboo or wood ceiling also demonstrated a high contribution, with 44 users each reporting ‘Slightly Cold’.

- **Moderately Important Contributor:** Cement/ mud plastered floor, although efficient, it was associated with fewer users (40) reporting “Slightly Cold”, compared to traditional materials and ceilings.

- **Least Significant Contributor:** Bamboo-wood-ikra (brick masonry till sill) walls with mud mortar: With 39 users reporting “Slightly Cold”, this feature had the lowest association with winter comfort compared to other elements.

4.5.2.5 Cross-Tabulation Analysis of Traditional Assam-type House Features and Summer Comfort

This analysis examines the relationship between features users considered efficient and their perceptions of summer comfort (‘Cool’, ‘Hot’, and ‘Warm’). The analysis focuses only on users who identified a feature as efficient, showing how these features correlate with their indoor thermal comfort.

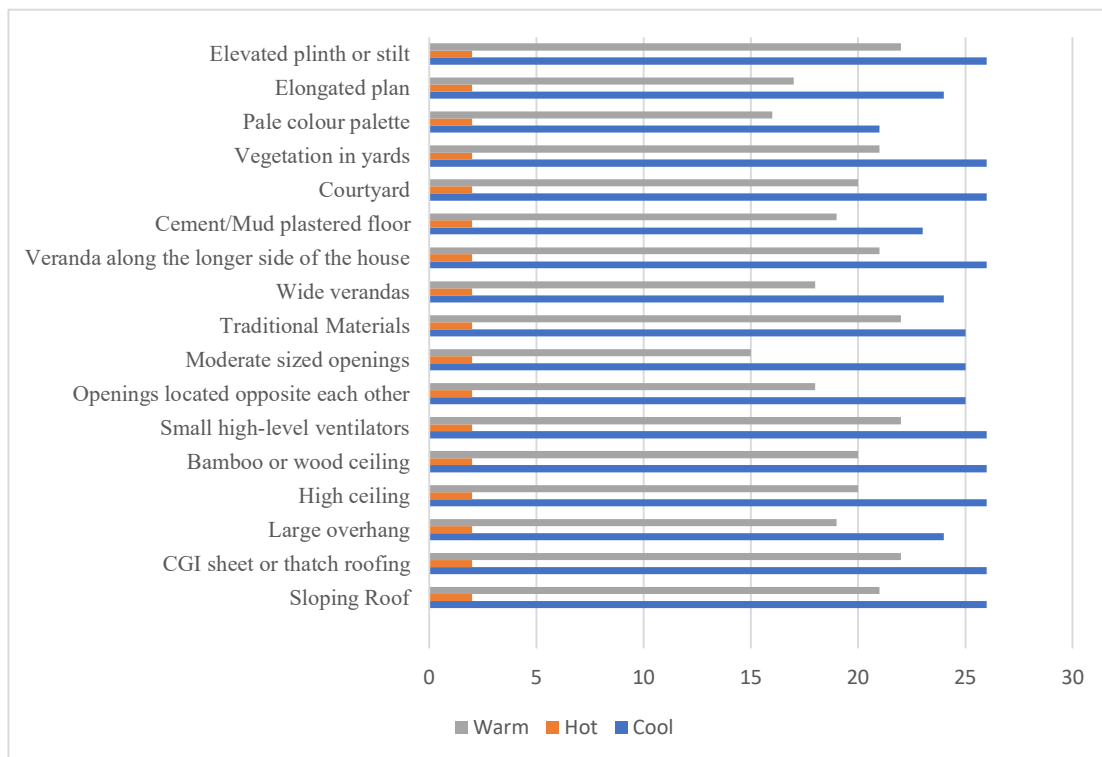


Figure 4.8 Cross Tabulation of Traditional Assam-Type House Features and User Agreement on Summer Comfort (Source: Author)

- a. **Sloping Roof:** 26 users who found sloping roofs efficient reported feeling 'Cool' during summer, 2 users felt 'Hot', and 21 users felt 'Warm'. This suggests that sloping roofs, by minimizing heat accumulation on the roof surface, play a significant role in maintaining cooler indoor temperatures in summer.
- b. **CGI Roofing Sheet:** 26 users who considered CGI roofing sheets efficient reported feeling 'Cool', 2 felt 'Hot', and 22 felt 'Warm'. CGI sheet or thatch roofings reflect sunlight and, when paired with proper insulation, can reduce heat gain, contributing to indoor comfort during summer.
- c. **Small high-level ventilator:** 26 users who considered small high-level ventilators efficient reported feeling 'Cool' and summer, 2 felt 'Hot' and 20 felt 'Warm'.
- d. **Large Overhang:** 24 users reported feeling 'Cool', 2 felt 'Hot', and 19 felt 'Warm'. Large overhangs provide shade, reducing direct solar heat gain on walls and windows, thus contributing to cooler indoor temperatures.
- e. **High Ceiling:** 26 users reported feeling 'Cool', 2 felt 'Hot', and 20 felt 'Warm'. High ceilings enhance natural ventilation by allowing hot air to rise, creating a cooler environment for occupants during summer.
- f. **Bamboo or Wood Ceiling:** 26 users reported feeling 'Cool', 2 felt 'Hot', and 22 felt 'Warm'. Bamboo or wood ceilings provide insulation, preventing excessive heat transfer from the roof to the interiors, thereby maintaining comfortable indoor temperatures.
- g. **Openings Located Opposite Each Other :** 25 users reported feeling 'Cool', 2 felt 'Hot', and 18 felt 'Warm'. Cross-ventilation enabled by windows opposite each other allows 'Warm' air to escape and cool air to flow in, ensuring effective summer comfort.
- h. **Moderately Sized Openings :** 25 users reported feeling 'Cool', 2 felt 'Hot', and 15 felt 'Warm'. Appropriately sized openings help regulate airflow and control heat gain, enhancing comfort in summer.
- i. **Traditional Materials:** 25 users felt 'Cool', 2 felt 'Hot', and 22 felt 'Warm'. Traditional materials like bamboo, mud, and clay have thermal properties that help moderate indoor temperatures by absorbing and releasing heat slowly.
- j. **Wide Verandas:** 24 users reported feeling 'Cool', 2 felt 'Hot', and 18 felt 'Warm'. Wide verandas act as a buffer zone, reducing the impact of direct sunlight on the interiors and keeping the house cooler.

- k. Veranda along the longer sides of the house:** 26 users reported feeling ‘Cool’, 2 felt ‘Hot’, and 21 felt ‘Warm’. Long verandas provide shade and create additional air movement around the house, which helps maintain summer comfort.
- l. Cement/ Mud Plastered Floor:** 23 users reported feeling ‘Cool’, 2 felt ‘Hot’, and 19 felt ‘Warm’. Cement plastered floors remain relatively cool during summer due to their thermal mass, helping regulate indoor temperatures.
- m. Courtyard:** 26 users reported feeling ‘Cool’, 2 felt ‘Hot’, and 20 felt ‘Warm’. Courtyards facilitate air circulation and act as a heat sink, reducing the overall temperature of the surrounding spaces.
- n. Vegetation in yards:** 26 users reported feeling ‘Cool’, 2 felt ‘Hot’, and 21 felt ‘Warm’. Vegetation in yards provides shade and improves the microclimate around the house by reducing heat through evapotranspiration.
- o. Pale Colour Palette:** 21 users reported feeling ‘Cool’, 2 felt ‘Hot’, and 16 felt ‘Warm’. Pale colours reflect sunlight instead of absorbing it, minimizing heat gain and keeping interiors cooler.
- p. Elongated Plan :**24 users reported feeling ‘Cool’, 2 felt ‘Hot’, and 17 felt ‘Warm’.
An elongated plan improves air circulation and reduces solar heat gain by minimizing the surface area exposed to direct sunlight.
- q. Elevated Plinth or Stilt:** 26 users who considered CGI roofing sheets efficient reported feeling ‘Cool’, 2 felt ‘Hot’, and 22 felt ‘Warm’. Elevated plinth or stilt, helps in reducing the ground moisture from seeping in keeping interior less humid and it also supports air circulation.

Key Interpretations

Unlike winter, in summer, the preferred condition is ‘Cool’ rather than ‘Warm’, as this indicates that passive cooling mechanisms, such as natural ventilation, extended eaves, and raised floors, are functioning effectively. Given Assam’s humid climate, even moderate warmth can feel uncomfortable due to the heat index, making a cooler indoor environment more desirable. Therefore, the ideal thermal conditions in ATHs, from a passive design perspective, are “Slightly Cold” in winter and ‘Cool’ in summer, ensuring comfort with minimal reliance on mechanical heating or cooling.

- **Most Significant Contributors:** Features like Sloping Roof, CGI Roofing Sheet, High Ceiling, Small high-level ventilator, Bamboo or Wood Ceiling, Courtyard,

Vegetation in yards, and Veranda along the longer sides of the house, had 26 users reporting ‘Cool’, making them the most effective features in ensuring summer comfort.

- **Moderately Important Contributors:** Large Overhang, Openings Located Opposite Each Other, Moderately Sized Openings, Traditional Materials, Wide Verandas, Cement/ Mud Plastered Floors, Elevated plinth or Stilt and Elongated Plan were identified by 23–25 users as providing summer comfort.

- **Least Significant Contributor:** Pale Colour Palette, with 21 users reporting ‘Cool’, was the least effective feature compared to structural elements, though it still plays a supporting role in minimizing heat gain.

4.5.2.6 Overall Observation

To determine the final categorization of the most important features and moderately important features, a systematic analysis was done on each feature based on **frequency of importance**. This criterion ensured that the selection process was objective and based on clear patterns in the data rather than arbitrary selection.

Frequency of Importance: The goal was to assess frequency of importance, which refers to *how often a feature appeared as either “most important” or “moderately important” across multiple comfort parameters*. Features that consistently appeared across multiple comfort categories had a higher likelihood of being classified as “most important.”

Table 4.10: Frequency of Features Importance Across Environmental Comfort Parameters
(Source: Author)

Features of Traditional ATH	Adequate Daylight	Adequate Ventilation	Rainy Season Comfort	Winter Comfort	Summer Comfort	Total Occurrence
5a. Veranda along the longer sides of the house	Most Imp.	Most Imp.	Most Imp.	X	Most Imp.	4
21b. Small high-level ventilators	Most Imp.	Most Imp.	X	X	Most Imp.	3
2a. Sloping roof	X	Most Imp.	Most Imp.	X	Most Imp.	3
5b. Courtyard	Most Imp.	Moderate Imp.	X	X	Most Imp.	2

28b. High ceiling	X	Moderate Imp.	X	Most Imp.	Most Imp.	2
21e. Openings located opposite each other	Moderate Imp.	Moderate Imp.	X	X	Moderate Imp.	3
9a. Vegetation in yards	X	Most Imp.	X	X	Most Imp.	2
2b. CGI sheet or thatch roofing	X	X	Most Imp.	X	Most Imp.	2
3b. Traditional materials	X	X	X	Most Imp.	Moderate Imp.	1
3c. Bamboo or wood ceilings	X	X	X	Most Imp.	Moderate Imp.	2
17a. Moderately sized openings	Least Imp.	Least Imp.	X	X	Moderate Imp.	3
43a. Wide verandas	Moderate Imp.	Moderate Imp.	X	X	Moderate Imp.	3
2e. Large overhangs	X	X	Moderate Imp.	X	Moderate Imp.	2
1a. Elevated plinth or stilt	X	X	Most Imp.	X	Moderate Imp.	1
8f. Pale colour palette	Least Imp.	X	X	X	Least Imp.	2
23a. Bamboo-wood-ikra (brick masonry till sill) walls with mud mortar	X	Least Imp.	Least Imp.	Least Imp.	X	3
6a. Elongated plan	X	Least Imp.	X	X	X	1
27c. Cement/Mud Plastered floor	X	X	X	Moderate Imp.	Moderate Imp.	2

From Table 4.10, the final categorization of features into most important, moderately important, and least important is based on their frequency of occurrence across different comfort parameters in the cross-tabulation analysis. Each feature has been assessed based on how often it was identified as most important, moderately important, or least important in relation to the five comfort parameters: summer comfort, winter comfort, rainy season comfort, adequate daylight, and adequate ventilation. To systematically determine the significance of each feature, the total occurrences of its importance level across the comfort parameters were counted.

Based on this categorization, a final table can now be created that lists features under three categories:

1. Most Important Features (Frequently appeared as “most important” across multiple comfort parameters)
2. Moderately Important Features (Frequently appeared as “moderately important” across multiple comfort parameters)
3. Least Important Features (Frequently appeared as “least important” across multiple comfort parameters)

This table will serve as a clear summary of which traditional features contribute most effectively to comfort in traditional ATHs based on user perception.

Table 4.11 User Perceived Efficient Traditional Assam-Type House Features for Comfort and Contemporary Adoption (Source: Author)

Most Important Efficient Contributing Feature to Environmental Comfort Parameters	Moderately Important Contributing Feature to Environmental Comfort Parameters	Least Important Efficient Contributing Feature to Environmental Comfort Parameters
5a. Veranda along the longer sides of the house	21e. Openings located opposite each other	17a. Moderately sized openings
21b. Small high-level ventilators	43a. Wide verandas	8f. Pale colour palette
2a. Sloping roof	2e. Large overhangs	23a. Bamboo-wood-ikra (brick masonry till sill) walls with mud mortar
5b. Courtyard	27c. Cement/Mud Plastered floor	6a. Elongated plan
28b. High ceiling		
9a. Vegetation in yards		
2b. CGI sheet or thatch roofing		
3b. Traditional materials		

3c. Bamboo or wood ceilings		
1a. Elevated plinth or stilt		

4.5.3 Willingness to Adopt Traditional Features - Quartile Analysis (Part 3)

Quartile analysis is a statistical method used to divide a dataset into four equal parts, providing a clear understanding of the distribution of responses. In this study, quartile analysis was applied to the section of the questionnaire that focused on willingness to adopt traditional architectural features in future houses. Respondents, categorized into users of traditional ATHs and contemporary RCC houses, were given a list of traditional features and asked to indicate whether they were very willing, willing, or not willing to incorporate these features into a newly built house. A weighted score was calculated based on these responses, and quartile analysis was used to classify the features according to their level of acceptance among users.

The quartile division consists of four sections:

1. Bottom 25% (Q1) – Least Preferred Features: These features had the lowest willingness scores, indicating that most respondents were either not willing to adopt them or showed minimal interest. Features in this category may be perceived as outdated, impractical, or unsuitable for modern living.

2. Second 25% (Q2) – Low to Moderate Willingness: Features in this category received slightly higher acceptance but are still not widely preferred. They may require modifications, better awareness, or additional benefits to become more appealing.

3. Third 25% (Q3) – High to Moderate Willingness: This group includes features that received considerable interest from respondents. While not the top choices, they have the potential to be incorporated into contemporary designs with minor adjustments or improvements.

4. Top 25% (Q4) – Most Preferred Features: These are the features with the highest willingness scores, indicating strong user preference. They are the best candidates for direct integration into contemporary home designs, as they align well with user expectations and perceived benefits.

To begin the quartile analysis, the first step is to assign a weighted score to the user preferences. This is done by multiplying the percentage of users who are ‘very willing’ to adopt a feature by 2, and those who are ‘willing’ by 1. The formula for calculating the weighted score is:

$$\text{Weighted Score} = (2 \times \text{Very Willing}) + (1 \times \text{Willing})$$

Once the weighted scores are calculated, they are ranked in descending order, from the most preferred features to the least preferred. This ranking represents the overall user preference for adopting each feature, where higher scores indicate a greater willingness to adopt the feature. To calculate the quartile values, the formula for the n th quartile position (Q_n) is used:

$$Q_n = n(N+1) / 4$$

Where:

Q_n is the position of the n th quartile,

n is the quartile number (1 for Q1, 2 for Q2, 3 for Q3, and 4 for Q4),

N is the total number of features in the dataset.

For example, with 12 features, the quartile positions would be calculated as follows:

Q1 (bottom 25%): $1(12+1)/4 = 3.25$, meaning Q1 includes the bottom 3 features.

Q2 (second 25%): $2(12+1)/4 = 6.5$, meaning Q2 includes the next 3 features.

Q3 (third 25%): $3(12+1)/4 = 9.75$, meaning Q3 includes the next 3 features.

Q4 (top 25%): $4(12+1)/4 = 13$, meaning Q4 includes the top 3 features.

Given that quartile positions are often fractional, we round the values to the closest feature’s rank. For example, Q1 corresponds to the 3rd feature, Q2 corresponds to the 6th feature, and so on. By dividing the ranked features into these quartiles, it is possible to identify

which features are most likely to be adopted in contemporary designs, based on user preference.

This quartile analysis helps categorize the traditional features based on their potential for adoption, providing insights into which features are viewed as the most suitable for integration into modern housing designs. The top 25% (Q4) represents features with the highest adoption potential, while the bottom 25% (Q1) indicates features with the least potential for adoption.

By conducting this quartile analysis, the aim is to identify which traditional features have the highest potential for adoption in Contemporary RCC Houses. Additionally, features with varying preferences between the two groups highlight differences in perception and may require further study to determine their feasibility. This analysis provides a data-driven approach to selecting traditional climate-responsive features for contemporary housing, ensuring that the recommendations align with user preferences while enhancing comfort and sustainability.

4.5.3.1 Quartile Analysis of Willingness to Adopt Features – Traditional Assam-Type House Users

Table 4.12: Quartile Analysis of Willingness to Adopt Features- Traditional Assam-Type House Users (Source: Author)

Trad. ATH Features	VW %	W %	NW %	Weighted Score (2xVW + 1xW)	Descending order based on weighted score	
2a. Sloping roof	52	49	0	153	190	1a. Elevated plinth or stilt
23a. Bamboo-wood-ikra (brick masonry till sill) walls with mud mortar	10	43	49	63	173	5b. Courtyard
1a. Elevated plinth or stilt	90	10	0	190	153	2a. Sloping roof
5b. Courtyard	72	29	0	173	153	3c. Bamboo or wood ceilings
2e. Large overhangs	20	80	0	120	123	38a. Wooden Open Tread Staircase
43a. Wide verandas	24	71	6	119	120	2e. Large overhangs
3c. Bamboo or wood ceilings	56	41	4	153	119	43a. Wide verandas
38a. Wooden Open Tread Staircase	42	39	20	123	106	19a. Symmetrical layout

40a. Bamboo/ wood low height compound wall	8	6	86	22	89	6a. Elongated plan
27c. Cement/ Mud Plastered floor	12	55	33	79	79	27c. Cement/ Mud Plastered floor
6a. Elongated plan	12	65	24	89	63	23a. Bamboo-wood-ikra (brick masonry till sill) walls with mud mortar
19a. Symmetrical layout	10	85	4	106	22	40a. Bamboo/ wood low height compound wall

Note: In the table above, VW = Very Willing, W= Willing, NW = Not Willing.

Table 4.12, illustrates the quartile analysis of the willingness to adopt features in traditional ATHs. It details the process of computing weighted scores based on user responses, which are then arranged in descending order in the sixth column, with the corresponding features listed alongside. Using these weighted scores, the quartile calculation is performed to systematically divide the features into four quartiles, reflecting varying levels of user preference. Table 4.13 below presents the quartile distribution of willingness to adopt features among traditional ATH users.

Table 4.13: Quartile Analysis of Willingness to Adopt Features – Traditional Assam-Type House Users (Source: Author)

Quartile	Features	Rank
Bottom 25%	27c. Cement/ Mud Plastered floor, 23a. Bamboo-wood-ikra (brick masonry till sill) walls with mud mortar, 40a. Bamboo/ wood low height compound wall	Q1- Least Willingness
Second 25%	43a. Wide verandas, 19a. Symmetrical layout, 6a. Elongated plan	Q2 - Low-Moderate Willingness
Third 25%	2a. Sloping roof, 3c. Bamboo or wood ceilings, 38a. Wooden Open Tread Staircase, 2e. Large overhangs	Q3 - High-Moderate Willingness
Top 25%	1a. Elevated plinth or stilt, 5b. Courtyard	Q4 - Highest Willingness

4.5.3.2 Quartile Analysis of Willingness to Adopt Features – Contemporary RCC House Users

The table below presents the quartile analysis of the willingness to adopt traditional features in Contemporary RCC Houses. It outlines the process of calculating weighted scores based

on user responses, which are then used to rank the features in descending order. The sixth column displays the weighted scores, with the corresponding features listed next to them

Table 4.14: Quartile Analysis of Willingness to Adopt Features- Contemporary RCC House Users (Source: Author)

Traditional ATH Features	VW %	W %	NW %	Weighted Score (2xVW + 1xW)	Descending order based on Weighted Score	
2a. Sloping roof	40	45	16	125	157	5b. Courtyard
23a. Bamboo-wood-ikra (brick masonry till sill) walls with mud mortar	4	37	59	45	152	1a. Elevated plinth or stilt
1a. Elevated plinth or stilt	64	24	12	152	141	43a. Wide verandas
5b. Courtyard	60	37	4	157	133	3c. Bamboo or wood ceilings
2e. Large overhangs	36	45	20	117	125	2a. Sloping roof
43a. Wide verandas	44	53	4	141	117	2e. Large overhangs
3c. Bamboo or wood ceilings	44	45	12	133	117	27c. Cement/ Mud Plastered floor
38a. Wooden Open Tread Staircase	16	59	24	91	91	38a. Wooden Open Tread Staircase
40a. Bamboo/ wood low height compound wall	12	24	63	48	85	19a. Symmetrical layout
27c. Cement/ Mud Plastered floor	28	61	12	117	83	6a. Elongated plan
6a. Elongated plan	16	51	33	83	48	40a. Bamboo/ wood low height compound wall
19a. Symmetrical layout	12	61	27	85	45	23a. Bamboo-wood-ikra (brick masonry till sill) walls with mud mortar

Note: In the table above, VW = Very Willing, W= Willing, NW = Not Willing.

Following this, the quartile calculation is applied to divide the features into four quartiles, categorizing them based on user preference levels.

Table 4.15, below presents the quartile distribution of willingness to adopt features among Contemporary RCC House users.

Table 4.15: Quartile Analysis of Willingness to Adopt Features – Contemporary RCC House Users (Source: Author)

Quartile	Features	Rank
Bottom 25%	6a. Elongated plan, 40a. Bamboo/ wood low height compound wall, 23a. Bamboo-wood-ikra (brick masonry till sill) walls with mud mortar	Q1 - Least Willingness
Second 25%	2e. Large overhangs, 27c. Cement/ Mud Plastered floor, 38a. Wooden Open Tread Staircase, 19a. Symmetrical layout	Q2 - Low-Moderate Willingness
Third 25%	3c. Bamboo or wood ceilings, 2a. Sloping roof	Q3 - High-Moderate Willingness
Top 25%	5b. Courtyard, 1a. Elevated plinth or stilt, 43a. Wide verandas	Q4 - Highest Willingness

4.5.3.3 Outcome of this Analysis

- Courtyard and elevated plinth or stilt are the most preferred features across both user groups, showing strong potential for adoption in contemporary houses.
- Wide veranda ranks high among contemporary RCC house users but slightly lower among traditional house users, indicating varying spatial preferences.
- Sloping roof and bamboo or wood ceiling are moderately preferred by both groups, suggesting they have adaptation potential with suitable design or material choices.
- Symmetrical layout and elongated plan show mixed preferences, moderately accepted by traditional users but less favoured by contemporary users, reflecting evolving layout priorities.
- Features like bamboo-wood ikra walls with mud mortar and low-height compound walls are consistently the least preferred, likely due to concerns over durability and, in the case of low-height compound walls, reduced safety and security.
- This analysis highlights which traditional features are more or less likely to be accepted by users for inclusion in contemporary house designs.

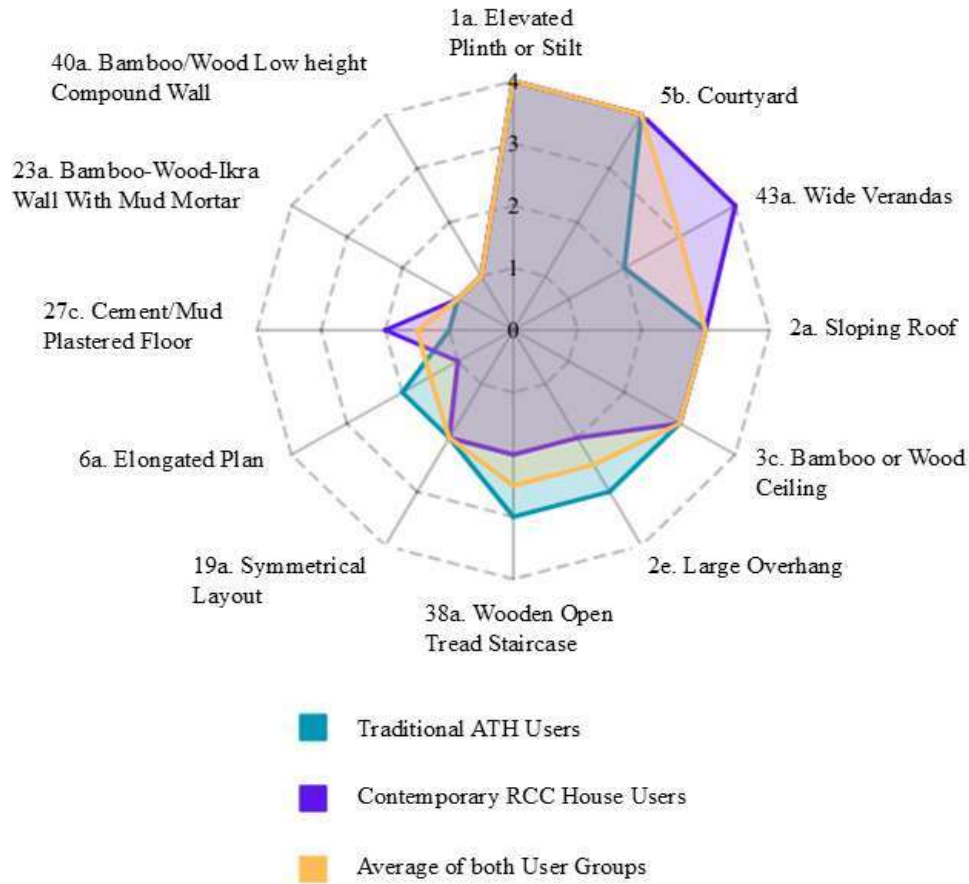


Figure 4.9: Radar Chart Showing Preferred Features by Users of Traditional Assam-Type House and Contemporary RCC House Based on Quartile Analysis (Source: Author)

4.6 Expert Recommendation Survey: Validating Traditional ATH Features for Climate Responsiveness and Contemporary Adoption

The expert recommendation survey was conducted to gain insights into the features of traditional ATHs that could be integrated into contemporary designs. This survey followed the user perception survey. The primary objective of the expert survey was to validate and expand upon the findings of user perception and the identified features from secondary sources, by consulting professionals with design experience, particularly those familiar with the nuances of climate-responsive and sustainable architecture and the context of Assam.

For this purpose, 35 professionals, including architects and civil engineers practicing in Assam, were selected to participate in the survey. Preference was given to those with experience in ATHs or climate-responsive architecture. Since their expertise was crucial in

evaluating the technical aspects of traditional features, the questionnaire was designed to include elements that required specialized knowledge, which had been omitted from the User Perception Survey to ensure accuracy. The survey was conducted using Google Forms. The questionnaire was divided into three parts.

- a. Perceived Challenges (Part 1):** The first part addressed potential challenges in adopting traditional features, such as issues related to availability of skilled labour, cost implications, regulatory constraints, and client preferences. This section helped identify practical barriers that might hinder the adoption of traditional features in contemporary house designs.
- b. Importance of Traditional Features (Part 2):** The second part focused on evaluating traditional ATH features by asking experts to assess how important each feature is in achieving climate-responsive design and whether these features should be incorporated into contemporary designs.
- c. Relevance of User Preferred Features (Part 3):** The third part aimed to validate user preferences by presenting the features that users had expressed a willingness to adopt. Experts were asked to assess the feasibility and relevance of these features in contemporary construction, helping to establish whether the user preferences aligned with professional recommendations.

Since the survey was designed as a comparative evaluation, the responses from experts were later analysed alongside user responses to identify key agreements and discrepancies. This analysis allowed the study to refine the list of traditional features, ensuring that the

final recommendations were based on both user preferences and expert validation.

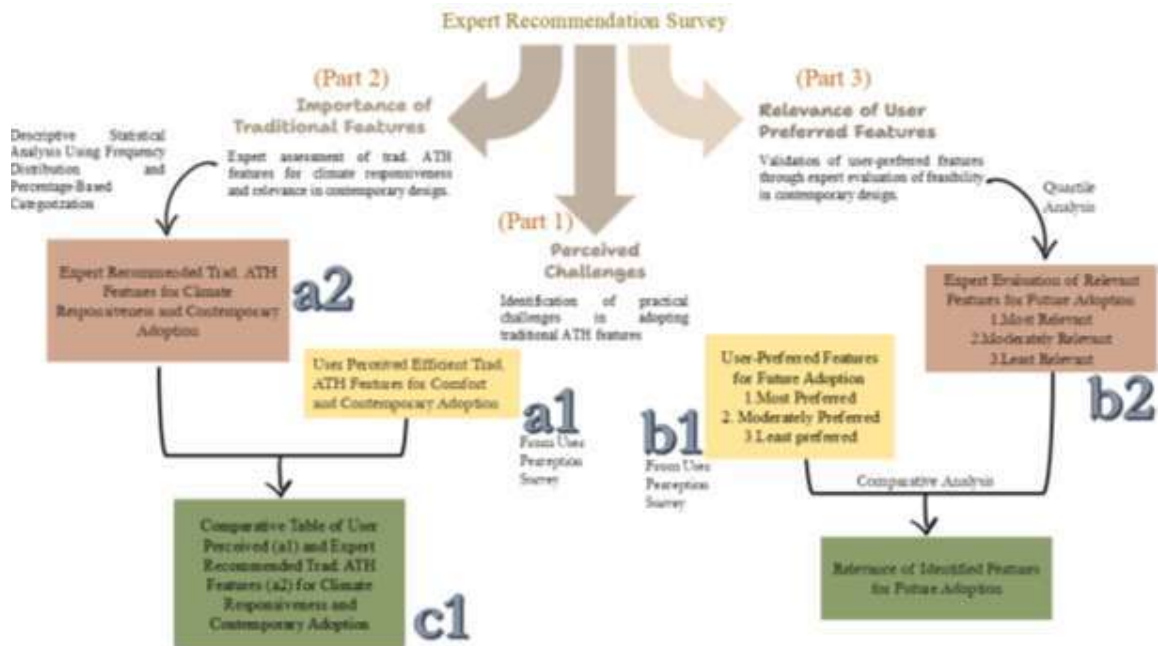


Figure 4.10: Flowchart Illustrating the Structure of the Expert Recommendation Survey Analysis
(Source: Author)

4.6.1 Challenges Identified by Experts in Integrating Traditional Assam-Type Features into Contemporary Designs (Part 1)

The expert recommendation survey highlighted key challenges in incorporating traditional ATH features into contemporary designs. The responses were analysed based on the frequency of mentions, revealing key barriers to the integration of traditional Assam-type features into contemporary housing. The most cited challenge, identified by 81.6% of experts, was the **unavailability of skilled labour**, followed closely by **maintenance concerns** (78.9%). This suggests that even if traditional features are valued, a shortage of craftsmanship and concerns about long-term upkeep hinder their widespread adoption.

Client resistance (73.7%) and **lack of awareness among architects, engineers, and homeowners** (57.9%) further highlight the disconnect between traditional design principles and modern preferences. Many homeowners may perceive traditional elements as outdated or impractical, while professionals may lack sufficient knowledge to advocate for their benefits. Regulatory and material constraints also emerged as significant concerns, with 55.3% of experts citing **restrictions in modern building codes**, and 52.6% **pointing to the unavailability of traditional materials**. Additionally, **urbanization challenges**,

such as space constraints and zoning regulations (50%), were seen as obstacles, particularly in dense urban settings where traditional layouts may be difficult to implement.

4.6.2 Analysis of Expert Recommended Important Traditional ATH Features for Climate Responsiveness: Descriptive Statistical Analysis Using Frequency Distribution and Percentage-Based Categorization (Part 2)

This analysis employs a descriptive statistical approach, utilizing frequency distribution and percentage-based categorization to determine the most and moderately important features of traditional ATHs recommended by experts for integration into contemporary designs. To identify these features, the responses from experts were analysed based on the percentage of participants who classified each feature as “very important,” “moderately important,” or “not important.”

Based on this analysis, the most important features for integration into contemporary designs are listed in the table below –

Table 4.16: Expert Recommended Important Traditional Assam-Type House Features for Climate Responsiveness and Contemporary Adoption (Source: Author)

Very Important	Expert recommendation %	Moderately Important	Expert recommendation %	Not Important	Expert recommendation %
21b. Small high-level ventilators	86	34a. Mud-brick elevated fireplace	68	44a. Utility areas placed separately on the rear side of site	49
2a. Sloping roof	83	27b. Bamboo or wood floorboard	66	40a. Bamboo/wood low height compound wall	40
21e. Openings located opposite each other	74	19a. Symmetrical layout	60		
1a. Elevated plinth or stilt	74	5a. Veranda along the longer sides of the house	60		
4a. Longer side facing windward direction	71	6a. Elongated plan	60		

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28b. High ceiling	69	6b. Rooms arranged around courtyard	54		
5b. Courtyard	68	38a. Wooden Open Tread Staircase	54		
9a. Vegetation in yards	66	2b. CGI sheet or thatch roofing	51		
4c. Shading elements on the south and west sides	66	8c. Decorative bargeboards	51		
3c. Bamboo or wood ceilings	63	8d. Bamboo screens	51		
2e. Large overhangs	57	27c. Cement/ Mud Plastered floor	49		
10c. Flexible joints	57	10b. Slender columns	48		
8h. Bay windows.	54	23a. Bamboo – wood – ikra walls with mud mortar	46		
43a. Wide verandas	54	4b. Inward-oriented spaces	46		
3b. Traditional materials	54	17a. Moderate sized openings	34		
8f. Pale colour palette	54				
1b. Wooden framework – lightweight structure	51				
2c. Multi-tiered gable roofing	40				
2d. Roof lanterns.	37				

This classification provides a structured understanding of expert recommendations and serves as a foundation for evaluating which traditional elements should be considered for contemporary architectural practices.

4.6.3 Expert Validation of User Preferred Features for Contemporary Adoption: Quartile Analysis (Part 3)

To further analyse expert opinions on the relevance of traditional ATH features for contemporary designs, a quartile analysis was conducted. This method, like the quartile analysis previously performed on user preferences, categorizes features into four quartiles based on weighted scores. The objective of this analysis was to systematically assess expert recommendations and compare them with user preferences to determine whether the features users are willing to adopt are also deemed relevant by experts.

In this section of the expert survey, professionals were asked to evaluate the relevance of various traditional features for contemporary housing, categorizing them as “very relevant,” “moderately relevant,” or “not relevant.” The features considered in this analysis were the same as those previously assessed in the user perception survey regarding their willingness to adopt these elements in future homes.

To maintain consistency in evaluation, a quartile analysis based on weighted scores was conducted for expert responses, mirroring the approach used for user preferences. Since the detailed methodology for quartile analysis has already been described in a previous section, it is not reiterated here.

Table 4.17 presents the quartile analysis of expert recommendations on the relevance of traditional features for contemporary designs. This structured classification helps in identifying the most and least relevant features, providing a clear basis for evaluating their integration into contemporary housing.

Table 4.17: Quartile Analysis of Expert Recommendation of Feature Relevance (Source: Author)

FEATURES	VR %	MR %	NR %	Weighted Score (1xVR + 0xMR)	Descending order of Weighted Score	
5b. Courtyard	74	23	3	171	171	5b. Courtyard
1a. Elevated plinth or stilt	66	34	0	166	168	2a. Sloping roof
2a. Sloping roof	71	26	3	168	166	1a. Elevated plinth or stilt
3c. Bamboo or wood ceilings	40	49	11	129	148	43a. Wide verandas

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38a. Wooden Open Tread Staircase	17	57	26	91	147	2e. Large overhangs
2e. Large overhangs	49	49	3	147	129	3c. Bamboo or wood ceilings
43a. Wide verandas	57	34	9	148	123	27c. Cement/ Mud Plastered floor
6a. Elongated plan	29	63	9	121	121	6a. Elongated plan
19a. Symmetrical layout	34	49	17	117	119	23a. Bamboo- wood-ikra (brick masonry till sill) walls with mud mortar
27c. Cement/ Mud Plastered floor	43	37	20	123	117	19a. Symmetrical layout
23a. Bamboo- wood-ikra (brick masonry till sill) walls with mud mortar	31	57	11	119	91	38a. Wooden Open Tread Staircase
40a. Bamboo/ wood low height compound wall	17	49	34	83	83	40a. Bamboo/ wood low height compound wall

Note: In the table above, VR= Very Relevant, MR= Moderately Relevant, NR = Not Relevant.

The results of this analysis, presented in the accompanying table below, highlight the features that experts strongly recommend for adoption and those with relatively lower relevance. This structured approach ensures that the final recommendations for contemporary housing are well-informed, balancing both user aspirations and expert insights.

Table 4.18: Results of Quartile Analysis: Expert-Rated Relevance of Features for Adoption in Contemporary Houses (Source: Author)

Quartile	Features	Rank
Bottom 25%	40a. Bamboo/ wood low height compound wall, 38a. Wooden Open Tread Staircase, 19a. Symmetrical layout	Q1- Least Relevance
Second 25%	23a. Bamboo-wood-ikra (brick masonry till sill) walls with mud mortar, 6a. Elongated plan, 27c. Cement/ Mud Plastered floor,	Q2 - Low-Moderate Relevance
Third 25%	3c. Bamboo or wood ceilings, 2e. Large overhangs, 43a. Wide verandas	Q3 - High-Moderate Relevance
Top 25%	1a. Elevated plinth or stilt, 2a. Sloping roof, 5b. Courtyard	Q4 - Highest Relevance

4.7 Comparison of User-Perceived Efficient Features and Expert-Recommended Climate-Responsive Features

This section presents a comparative analysis of the traditional features identified as efficient by users of traditional ATH (a1) and the traditional features recommended by experts for climate-responsive design (a2). The user-identified efficient features are categorized into two groups, the most important features that significantly contribute to comfort and climate responsiveness and the moderately important features that provide some level of comfort and climate adaptation. These are based on the perspectives of those who have lived in traditional ATHs and experienced their effectiveness firsthand.

On the other hand, expert recommendations highlight features they consider important for enhancing climate responsiveness in contemporary housing, considering technical feasibility, sustainability, and architectural principles. By comparing these two sets of features, this section aims to identify areas of alignment and divergence between lived experiences and professional assessments, offering insights into which traditional elements have strong potential for integration into modern self-built housing. The following table presents a comparison of features considered important for climate-responsive design, based on user perception and expert recommendation.

Table 4.19: Comparative Table of User Perceived (a1) and Expert Recommended Traditional Assam-Type House Features (a2) for Climate Responsiveness and Contemporary Adoption

(Source: Author)

Sl.No	Identified Traditional ATH Feature	User Perception	Expert Recommendation	Observation
1	1a. Elevated plinth or stilt	Very Important	Very Important	Strong agreement, highly prioritized by both.
2	1b. Wooden framework – lightweight structure	Not Important / No Opinion	Very Important	Experts see technical value; users probably lack awareness.
3	2a. Sloping roof	Very Important	Very Important	Strong agreement, highly prioritized by both.
4	2b. CGI sheet or thatch roofing	Very Important	Moderately Important	Users prioritise highly; experts see as beneficial but not critical.
5	2c. Multi-tiered gable roofing	Not Important / No Opinion	Very Important	Experts see technical value; users probably lack awareness.
6	2d. Roof lanterns.	Not Important / No Opinion	Very Important	Experts see technical value; users probably lack awareness.
7	2e. Large overhangs	Moderately Important	Very Important	Experts emphasize importance; Users recognise value but less priority.
8	3b. Traditional materials	Very Important	Very Important	Strong agreement, highly prioritized by both.
9	3c. Bamboo or wood ceilings	Very Important	Very Important	Strong agreement, highly prioritized by both.
10	4a. Longer side facing windward direction	Not Important / No Opinion	Very Important	Experts see technical value; users probably lack awareness.
11	4b. Inward-oriented spaces	Not Important / No Opinion	Moderately Important	Experts see value; users unaware or indifferent.
12	4c. Shading elements on the south and west sides	Not Important / No Opinion	Very Important	Experts see technical value; users probably lack awareness.
13	5a. Veranda along the longer sides of the house	Very Important	Moderately Important	Users prioritise highly; experts see as beneficial but not critical.
14	5b. Courtyard	Very Important	Very Important	Strong agreement, highly prioritized by both.
15	6a. Elongated plan	Not Important / No Opinion	Moderately Important	Experts see value; users unaware or indifferent.
16	6b. Rooms arranged around courtyard	Not Important / No Opinion	Moderately Important	Experts see value; users unaware or indifferent.
17	8c. Decorative bargeboards	Not Important / No Opinion	Moderately Important	Experts see value; users unaware or indifferent.
18	8d. Bamboo screens	Not Important / No Opinion	Moderately Important	Experts see value; users unaware or indifferent.

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19	8f. Pale colour palette	Not Important / No Opinion	Very Important	Experts see technical value; users probably lack awareness.
20	8h. Bay windows.	Not Important / No Opinion	Very Important	Experts see technical value; users probably lack awareness.
21	9a. Vegetation in yards	Very Important	Very Important	Strong agreement, highly prioritized by both.
22	10b. Slender columns	Not Important / No Opinion	Moderately Important	Experts see value; users unaware or indifferent.
23	10c. Flexible joints	Not Important / No Opinion	Very Important	Experts see technical value; users probably lack awareness.
24	17a. Moderate sized openings	Not Important / No Opinion	Moderately Important	Experts see value; users unaware or indifferent.
25	19a. Symmetrical layout	Not Important / No Opinion	Moderately Important	Experts see value; users unaware or indifferent.
26	21b. Small high-level ventilators	Very Important	Very Important	Strong agreement, highly prioritized by both.
27	21e. Openings located opposite each other	Moderately Important	Very Important	Experts emphasize importance; Users recognise value but less priority.
28	23a. Bamboo-wood-ikra (brick masonry till sill) walls with mud mortar	Not Important / No Opinion	Moderately Important	Experts see value; users unaware or indifferent.
29	27b. Bamboo or wood floorboard	Not Important / No Opinion	Moderately Important	Experts see value; users unaware or indifferent.
30	27c. Cement/ Mud Plastered floor	Moderately Important	Moderately Important	Moderate consensus on importance
31	28b. High ceiling	Very Important	Very Important	Strong agreement, highly prioritized by both.
32	34a. Mud-brick elevated fireplace	Not Important / No Opinion	Moderately Important	Experts see value; users unaware or indifferent.
33	38a. Wooden Open Tread Staircase	Not Important / No Opinion	Moderately Important	Experts see value; users unaware or indifferent.
34	40a. Bamboo/ wood low height compound wall	Not Important / No Opinion	Not Important / No Opinion	Low priority in both groups
35	43a. Wide verandas	Moderately Important	Very Important	Experts emphasize importance; Users recognise value but less priority.
36	44a. Utility areas placed separately on the rear side of site	Not Important / No Opinion	Not Important / No Opinion	Low priority in both groups

Table 4.19 highlights the features of strong agreement between users and experts and also points of divergence. These insights will be further analysed in the triangulation section to determine which traditional features are most crucial for adoption in contemporary designs.

4.8 Comparison of User-Preferences and Expert Evaluation of the Relevance of Traditional Features for Adoption in Future House Designs

This section presents a comparison between the preferences of users regarding the adoption of traditional features in contemporary ATHs (b1) and the expert evaluations of the relevance of these features for integration into contemporary designs (b2). Users were asked to indicate which traditional features they preferred to be adopted in future houses, while experts evaluated the relevance of the same features in terms of their effectiveness in enhancing climate responsiveness and their suitability for contemporary housing. Experts assessed these features on a scale of relevance, ranging from “very relevant” to “not relevant,” offering insights based on their professional experience and understanding of sustainable architecture. This comparison aims to identify areas of agreement and divergence between user preferences and expert evaluations, helping to assess the potential for incorporating traditional features into contemporary homes for improved sustainability and climate adaptability.

The table below presents a comparative analysis of feature preferences among traditional ATH users, contemporary house users, and expert evaluations of relevance for adoption in contemporary designs. Each feature is categorized based on quartile rankings: Q4 (highest preference/relevance), Q3 (high to moderate), Q2 (moderate), and Q1 (least). The last column provides observations derived from these comparisons, highlighting alignments, discrepancies, and key insights between user preferences and expert evaluations.

Table 4.20: User Preferences and Expert Evaluation of Feature Relevance in Future House Designs (Source: Author)

Sl.No	Features	Trad. ATH Users (Quartile)	Contemporary RCC House Users (Quartile)	Expert Evaluation of Relevance (Quartile)	Observation
1	1a. Elevated plinth or stilt	Q4 (Highest Preference)	Q4 (Highest Preference)	Q4 (Highest Relevance)	Strong consensus on importance
2	5b. Courtyard	Q4 (Highest Preference)	Q4 (Highest Preference)	Q4 (Highest Relevance)	Strong consensus on importance
3	2a. Sloping roof	Q3 (High-Moderate Preference)	Q3 (High-Moderate Preference)	Q4 (Highest Relevance)	Experts emphasize higher relevance

4	3c. Bamboo or wood ceilings	Q3 (High-Moderate Preference)	Q3 (High-Moderate Preference)	Q3 (High-Moderate Relevance)	Balanced recognition
5	2e. Large overhangs	Q3 (High-Moderate Preference)	Q2 (Moderate Preference)	Q3 (High-Moderate Relevance)	Lower preference among contemporary users
6	38a. Wooden Open Tread Staircase	Q3 (High-Moderate Preference)	Q2 (Moderate Preference)	Q1 (Least Relevance)	Users value it more than experts
7	43a. Wide verandas	Q2 (Moderate Preference)	Q4 (Highest Preference)	Q3 (High-Moderate Relevance)	Higher preference in contemporary house users
8	19a. Symmetrical layout	Q2 (Moderate Preference)	Q2 (Moderate Preference)	Q1 (Least Relevance)	Limited expert support
9	6a. Elongated plan	Q2 (Moderate Preference)	Q1 (Least preference)	Q2 (Moderate Relevance)	Lower preference among contemporary users
10	27c. Cement/ Mud Plastered floor	Q1 (Least preference)	Q2 (Moderate Preference)	Q2 (Moderate Relevance)	Less preference by traditional house users
11	23a. Bamboo-wood-ikra (brick masonry till sill) walls with mud mortar	Q1 (Least preference)	Q1 (Least preference)	Q2 (Moderate Relevance)	Experts recognise some relevance
12	40a. Bamboo/ wood low height compound wall	Q1 (Least preference)	Q1 (Least preference)	Q1 (Least Relevance)	Minimal significance across groups

The comparative analysis of user preferences and expert evaluations provides insights into the alignment and discrepancies between what users prefer to adopt in contemporary houses and what experts find relevant for climate-responsive design.

Certain features, such as Elevated plinth or stilt and courtyard, received the highest preference from both traditional and contemporary house users, and experts also evaluated them as having the highest relevance for contemporary designs. This strong agreement highlights their universal importance in climate-responsive architecture. Similarly, sloping roofs, while only high to moderately preferred by both user groups, were deemed highly relevant by experts, indicating that experts place greater emphasis on their functional benefits despite slightly lower user preference. Other features, such as bamboo-wood

ceilings and wide roof overhangs, showed balanced recognition, with both user groups rating them as high to moderately preferred and experts also finding them high to moderately relevant. This suggests that these features hold practical value and are well-regarded by both users and professionals.

However, some features demonstrated misalignment between user preference and expert relevance. For instance, the open-tread staircase was high to moderately preferred by traditional users and moderately preferred by contemporary users, but experts did not find it relevant enough for contemporary climate-responsive design. A similar case is seen with the symmetrical layout, which was moderately preferred by both user groups, but experts categorized it under least relevance, indicating that it may not contribute significantly to climate adaptation or efficiency.

A feature like the elongated plan showed a clear divide, where traditional house users and experts found it moderately relevant, but contemporary house users least preferred it. This suggests that while the feature has functional relevance, it does not align with the evolving preferences of contemporary homeowners. In contrast, some materials and structural elements, such as the bamboo ikra wood wall, were least preferred by both user groups, but experts still considered them moderately relevant. This indicates that while traditional materials may hold value for sustainability, they are not widely accepted by users, possibly due to concerns about durability, maintenance, or aesthetics. The cement-plastered floor, on the other hand, was moderately preferred by contemporary users and found moderately relevant by experts, even though traditional house users least preferred it, suggesting a shift in material preferences over time. Lastly, the bamboo-wood low-height compound wall was consistently rated as least preferred and least relevant by all three groups, indicating that it is neither practical nor desirable for modern housing needs. This feature is likely to be excluded from considerations for contemporary climate-responsive designs.

This analysis highlights that while there is consensus on certain features, others require careful evaluation to balance user preferences, expert recommendations, and climate-responsive efficiency in contemporary houses designs.

4.9 Building Survey of Traditional and Contemporary Assam-Type Houses: Verifying Traditional Features and Evaluating their Adoption in Contemporary Assam-Type House designs

The building surveys were conducted to understand the practicality of traditional features that support climate-responsive design in ATHs. While previous sections of the study relied on literature reviews, user, and expert inputs, it was essential to physically examine how these features exist and function in real-world conditions. This on-site verification was necessary to assess the presence, modifications, or absence of these features in contemporary practice.

The building surveys involved two main parts:

- a. **Verifying Traditional Features:** Verifying whether the traditional features identified in Table 4.7, exist in traditional ATHs that are present today; and
- b. **Evaluating the Adoption of Traditional ATH Features in Contemporary ATHs:** Exploring how much of the climate-responsive traditional features are being incorporated into contemporary ATHs (which reflect the current practices in Assam).

This assessment helped determine the extent to which traditional design strategies are being retained, modified, or omitted in contemporary self-built houses. These building surveys were conducted across various contexts including both rural and urban to ensure a comprehensive understanding of the practicality and adoption of traditional features in ATHs across diverse regions.

In the building survey process, photographic documentation, basic measured documentation, and physical observations of the traditional features were made to ensure accuracy in the findings. While detailed measurements were not taken, the documentation and observations provided essential insights into the physical presence and modifications of traditional elements in both traditional and new ATHs. This provided a strong foundation for verifying the traditional features and understanding how they are being adopted, modified, or omitted in contemporary designs.

Figures 4.15, 4.16 and 4.17 show the side-by-side plans, elevations, interior spaces, and exterior-interior photographs of traditional and contemporary ATHs in different contexts in Assam derived from the building surveys.

4.9.1 Representation of Assam's Climatic Zones in the Building Surveys

Assam falls under two primary climatic zones, Warm and Humid and Cool and Humid. While most of the state lies in the Warm and Humid zone, certain elevated regions such as Haflong, Maibang and parts of Karbi Anglong fall under the Cool and Humid category. In order to capture regional variation and climatic adaptability, the building survey included examples from both these zones. Figure 4.11 below shows Assam (area shaded in colour) in the climatic map of Northeast India.

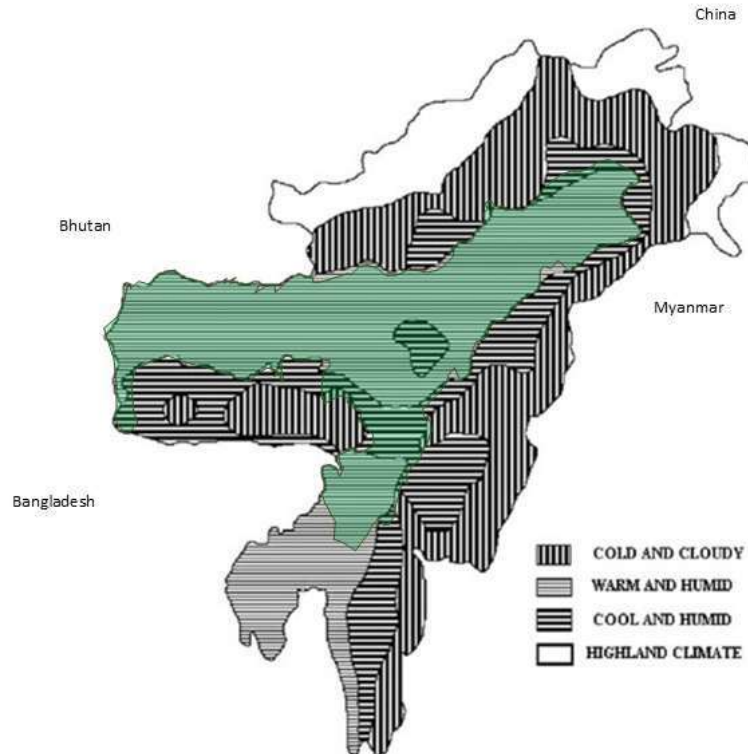


Figure 4.11: Climatic Zones of Assam (Source: Adapted and modified by the author, based on the bioclimatic map of Northeast India by Singh et al., (2009))

Although traditional Assam-type houses follow a broadly uniform typology across the state, some distinct adaptations can be observed in the cooler regions. In such areas, the use of wooden floorboards is more common, offering better insulation against the cold. Fireplaces are also integrated more closely within the main living spaces, especially in kitchens and in larger houses, in-built brick fireplaces are often found in living rooms,

primarily for heating purposes. Apart from these adjustments, most architectural features remain consistent across both zones.



Figure 4.12: Traditional Assam-Type Houses in Warm and Humid Climatic Zone, Bilasipara, Assam (Source: Author)



Figure 4.13: Traditional Assam-Type Houses in Cool and Humid Climatic Zone, Haflong, Assam (Source: Author)

4.9.2 Verification of Traditional Features in ATHs

The first part of the building survey focused on verifying the traditional features of ATHs, as identified in Table 4.7 of the thesis. To verify these identified features, the building survey involved physically examining existing traditional ATHs across different contexts. The primary objective was to confirm the presence, absence, or modification of these features in the existing houses. The verification process helped cross-check the theoretical identification of traditional features with the real-world application of these features in traditional ATHs today. This verification step was crucial in understanding how these traditional features play a role in supporting climate-responsive design and how they may need to be adapted in contemporary settings.

Table 4.21 presents the documentation of traditional features observed in the building survey of traditional ATHs, indicating whether each feature is present, absent, or modified in different houses.

Table 4.21: Evaluation of Traditional Features in Present Traditional Assam-Type Houses (Source: Author)

	Traditional ATH Features	Trad. ATH 1	Trad. ATH 2	Trad. ATH 3	Trad. ATH 4	Trad. ATH 5	Trad. ATH 6	Trad. ATH 7	Trad. ATH 8	Trad. ATH 9
1	1a. Elevated plinth or stilt	Present	Present	Present	Present	Present	Present	Present	Present	Modified
2	1b. Wooden framework – lightweight structure	Present	Present	Present	Present	Present	Present	Present	Present	Present
3	2a. Sloping roof	Present	Present	Present	Present	Present	Present	Present	Present	Present
4	2b. CGI sheet or thatch roofing	Present	Present	Present	Present	Present	Present	Present	Present	Present
5	2c. Multi-tiered gable roofing	Present	Present	Present	Present	Present	Absent	Present	Present	Present
6	2d. Roof lanterns.	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Present
7	2e. Large overhangs	Present	Present	Present	Present	Present	Present	Present	Present	Present
8	3b. Traditional materials	Present	Present	Present	Present	Present	Present	Present	Present	Present
9	3c. Bamboo or wood ceilings	Present	Present	Present	Present	Present	Present	Present	Present	Present
10	4a. Longer side facing windward direction	Present	Present	Present	Present	Present	Absent	Present	Present	Present
11	4b. Inward-oriented spaces	Present	Present	Present	Present	Present	Absent	Present	Absent	Modified
12	4c. Shading elements on the south and west sides	Present	Present	Present	Present	Present	Present	Present	Present	Present
13	5a. Veranda along the longer sides of the house	Present	Present	Present	Present	Present	Present	Present	Present	Present

Investigating Traditional Architecture for Contemporary Use: Analysis of Climatic Aspects through Perception Study of Assam-Type Houses

14	5b. Courtyard	Present	Present	Present	Present	Present	Modified	Present	Modified	Modified
15	6a. Elongated plan	Present	Present	Present	Present	Present	Present	Present	Present	Present
16	6b. Rooms arranged around courtyard	Present	Present	Present	Present	Present	Modified	Present	Modified	Modified
17	8c. Decorative bargeboards	Absent	Present	Present	Present	Present	Absent	Present	Present	Present
18	8d. Bamboo screens	Modified	Present	Absent	Present	Present	Present	Present	Present	Absent
19	8f. Pale colour palette	Absent	Modified	Present	Present	Present	Present	Present	Modified	Present
20	8h. Bay windows.	Absent	Present	Absent	Present	Present	Present	Present	Present	Absent
21	9a. Vegetation in yards.	Present	Present	Present	Present	Present	Present	Present	Present	Modified
22	10b. Slender columns	Present	Present	Present	Present	Present	Present	Present	Present	Present
23	10c. Flexible joints	Present	Present	Present	Present	Present	Present	Present	Present	Present
24	17a. Moderate sized openings	Present	Present	Present	Present	Present	Present	Present	Present	Present
25	19a. Symmetrical layout	Modified	Present	Present	Present	Present	Present	Absent	Absent	Present
26	21b. Small high-level ventilators	Present	Present	Present	Present	Present	Present	Present	Present	Present
27	21e. Openings located opposite each other	Present	Present	Present	Present	Present	Present	Present	Present	Present
28	23a. Bamboo-wood-ikra (brick masonry till sill) walls with mud mortar	Present	Absent	Present	Present	Present	Present	Present	Present	Present
29	27b. Bamboo or wood floorboard	Absent	Present	Absent	Present	Absent	Absent	Absent	Absent	Absent
30	27c. Cement/ Mud Plastered floor	Present	Present	Present	Absent	Present	Present	Present	Present	Present
31	28b. High ceiling	Present	Present	Present	Present	Present	Present	Present	Present	Present
32	34a. Mud-brick elevated fireplace	Absent	Absent	Present	Present	Absent	Absent	Absent	Absent	Present
33	38a. Wooden Open Tread Staircase	Absent	Present	Absent	Absent	Absent	Absent	Absent	Present	Absent
34	40a. Bamboo/ wood low height compound wall	Absent	Absent	Present	Present	Absent	Absent	Present	Absent	Absent
35	43a. Wide verandas	Present	Present	Present	Present	Present	Present	Present	Present	Present
36	44a. Utility areas placed separately on the rear side of site	Modified	Absent	Modified	Present	Absent	Modified	Modified	Modified	Modified

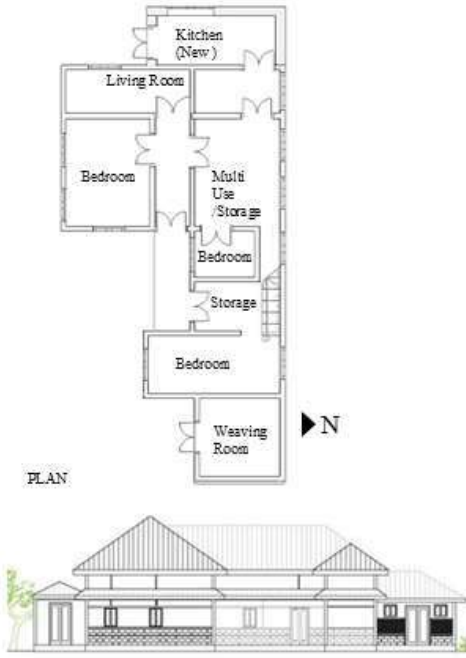
The analysis presented in Table 4.21 verifies the presence of the identified traditional features in existing traditional Assam-type houses. It was observed that most of these features are indeed present across the surveyed buildings. However, certain variations exist

in their application. For instance, roof lanterns are generally found in larger traditional houses and are rarely seen in smaller ones, where simpler solutions for daylight are used. Features like bamboo or wooden floorboards and elevated fireplaces are mostly found in houses located in cool and humid zones, and are not commonly seen in other regions. Even in such regions, many houses now use modern cooking arrangements or external open-fire setups instead of the traditional elevated fireplaces. Wooden open-tread staircases were found only in double-storeyed houses, as expected.

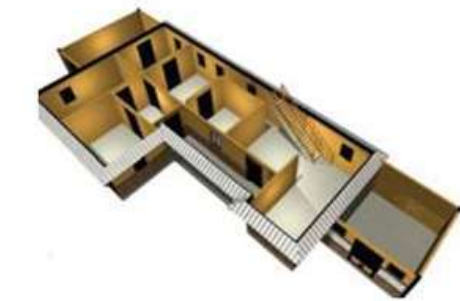


Figure 4.14: Images of Surveyed Traditional Assam-Type Houses Corresponding to Table: 4.21(Source: Author)

TRADITIONAL ASSAM-TYPE HOUSE
Historic Town – Sualkuchi-Hajo



PLAN



INTERIOR SPACE

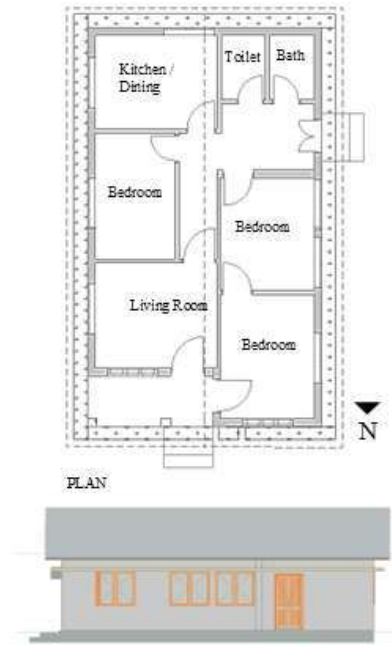


FACADE



WALL AND CEILING

CONTEMPORARY ASSAM-TYPE HOUSE
Historic Town – Sualkuchi-Hajo



PLAN



INTERIOR SPACE



FACADE

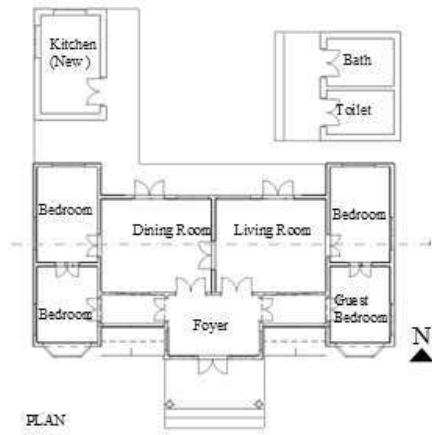


WALL AND CEILING

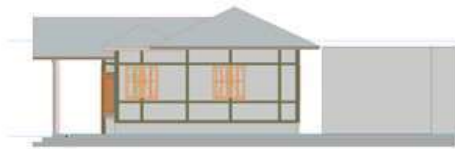
Figure 4.15: Plan, Elevation and Interior View of a Traditional Assam-Type House and a Contemporary Assam-Type House at Sualkuchi-Hajo, Assam (Source: Author)

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TRADITIONAL ASSAM-TYPE HOUSE
Urban Centre - Guwahati



PLAN



SIDE ELEVATION



INTERIOR SPACE

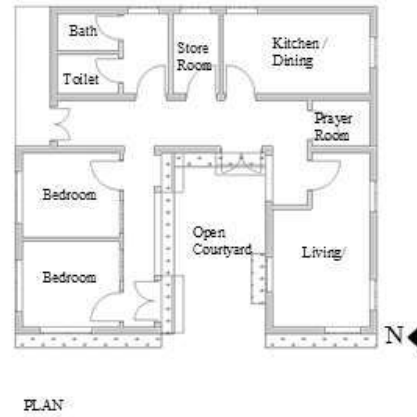


FACADE



WALL AND CEILING

CONTEMPORARY ASSAM-TYPE HOUSE
Urban Centre - Guwahati



PLAN



ELEVATION



INTERIOR SPACE



FACADE



WALL AND CEILING

Figure 4.16: Plan, Elevation and Interior View of a Traditional Assam-Type House and a Contemporary Assam-Type House in Guwahati, Assam (Source: Author)

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Figure 4.17: Plan, Elevation and Interior View of a Traditional Assam-Type House and a Contemporary Assam-Type House at Goalpara, Assam (Source: Author)

4.9.3 Exploration of Traditional Feature Adoption in Contemporary Assam-type Houses

The second part of the building survey focused on exploring how traditional features are being incorporated into contemporary ATHs, commonly referred to as “new ATHs,” which represent the current practices in Assam. Since the primary objective of this study is to identify which traditional climate-responsive features should be integrated into contemporary designs, it was crucial to analyse current residential construction trends in Assam.

In present-day construction practices, particularly in semi-urban and rural areas, contemporary ATHs have become a popular housing choice. These houses, while constructed using contemporary RCC techniques, are still self-built and incorporate certain features of traditional ATHs. They are often seen as an evolved or modernized version of the traditional ATH. Given that the research aims to determine which traditional features contribute to climate-responsive design and should be retained in contemporary architecture, it was necessary to study these houses to assess how traditional features are currently being adopted in practice.

The investigation aimed to determine the extent to which the traditional climate responsive features have been retained, omitted, modified, or replaced in the contemporary Assam-type construction. By studying these houses, it was possible to evaluate whether the current adaptation of traditional features aligns with climate-responsive principles and whether new ATHs are moving in the right direction from a sustainability perspective.

To ensure a comprehensive understanding, building survey houses were selected from diverse contexts, including urban, administrative, heritage town, semi-urban, and rural settings. While the selection process was random, care was taken to include houses from different regions to capture variations in adoption patterns across Assam.

The analysis of these case studies provided insights into the extent to which traditional features are being integrated into new ATHs. The findings categorized traditional features into four groups:

- Retained features: Traditional ATH features that remain unchanged in contemporary ATHs.

- Omitted features: Traditional ATH features that are no longer incorporated.
- Replaced features: Traditional ATH features that have been substituted with modern alternatives in contemporary ATH.
- Modified features: Traditional ATH features that have been adapted to contemporary needs in contemporary ATHs.

Through this study, a clearer understanding was gained of how traditional features are being integrated into contemporary ATHs and the extent of their adaptation. Examining these houses in different contexts provided valuable insights into prevailing construction practices and the ways in which climate-responsive elements are being retained, altered, or omitted. This understanding helps in assessing how well contemporary ATHs maintain the climate-responsive characteristics of their predecessors and whether they can serve as a viable prototype for climate-responsive housing designs in Assam.

For each building survey, a thorough review was conducted of the presence and adaptation of identified traditional ATH features in contemporary ATHs. The features were categorized based on whether they were retained in their original form, modified to suit modern requirements, replaced with new elements, or omitted altogether. The table presented here offers a detailed comparison, providing a clear overview of how traditional design principles continue to influence contemporary housing in Assam.

Table 4.22: Exploring Incorporation of Traditional Assam-Type House Features Across Contemporary Assam-Type Houses (Source: Author)

	Trad. ATH Features	Cont. ATH 1	Cont. ATH 2	Cont. ATH 3	Cont. ATH 4	Cont. ATH 5	Cont. ATH 6	Cont. ATH 7	Cont. ATH 8	Cont. ATH 9	Cont. ATH 10	Cont. ATH 11	Cont. ATH 12	Cont. ATH 13	Cont. ATH 14	Cont. ATH 15
1	1a. Elevated plinth or stilt	RT	O	RT	RT	RT	RT	RT	RT	RT	RT	RT	RT	RT	RT	RT
2	1b. Wooden framework – lightweight structure	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O
3	2a. Sloping roof	RT	RT	RT	RT	RT	RT	RT	RT	RT	RT	RT	RT	RT	RT	RT
4	2b. CGI sheet or thatch roofing	RT	RT	RT	RT	RT	RT	RT	RT	RT	RT	RT	RT	RT	RT	RT
5	2c. Multi-tiered gable	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O

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Study of Assam-Type Houses

	roofing															
6	2d. Roof lanterns.	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O
7	2e. Large overhangs	RT	RT	RT	RT	RT	RT	RT	RT	RT	RT	RT	RT	RT	RT	RT
8	3b. Traditional materials	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O
9	3c. Bamboo or wood ceilings	RP	RP	RP	RT	RP	RP	RP	RP	RP	RP	RP	RT	RP	RP	RP
10	4a. Longer side facing windward direction	RT	RT	O	RT	O	O	O	O	O	RT	O	O	O	O	O
11	4b. Inward-oriented spaces	O	O	O	O	O	O	O	O	O	O	O	O	O	RT	O
12	4c. Shading elements on the south and west sides	O	O	O	RT	O	O	O	O	O	O	O	RT	O	O	O
13	5a. Veranda along the longer sides of the house	O	O	O	O	O	O	O	O	RT	RT	O	O	O	O	RT
14	5b. Courtyard	O	O	O	RT	O	RT	O	O	O	RT	O	RT	RT	RT	O
15	6a. Elongated plan	O	O	O	O	O	O	O	O	O	RT	O	O	O	O	RT
16	6b. Rooms arranged around courtyard	O	O	O	RT	O	O	O	O	O	O	O	O	RT	RT	O
17	8c. Decorative bargeboards	M	M	M	M	O	M	O	O	O	M	O	M	O	O	M
18	8d. Bamboo screens	RP	O	O	RT	O	RP	RP	O	RP	O	RP	RP	RP	RP	O
19	8f. Pale colour palette	RP	M	RP	M	RT	RP	RT	RT	RT	RP	RT	M	RP	RP	M
20	8h. Bay windows.	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O
21	9a. Vegetation in yards	RT	RT	O	RT	M	M	M	O	O	M	O	RT	RT	M	RT
22	10b. Slender columns	M	RT	RT	RT	RT	RT	M	RT	M	RT	RT	RT	RT	M	M
23	10c. Flexible joints	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O
24	17a. Moderate sized openings	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M

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Study of Assam-Type Houses**

25	19a. Symmetrical layout	O	O	O	O	O	O	O	O	O	M	O	O	O	O	O
26	21b. Small high-level ventilators	RT	RT	RT	RT	RT	RT	RT	RT	RT	RT	RT	RT	RT	RT	RT
27	21e. Openings located opposite each other	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O
28	23a. Bamboo-wood-ikra walls with mud mortar	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O
29	27b. Bamboo or wood floorboard	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O
30	27c. Cement/ Mud Plastered floor	O	O	O	RT	O	O	O	O	O	RT	O	O	O	O	O
31	28b. High ceiling	O	O	O	RT	O	O	O	O	O	O	RT	O	O	O	O
32	34a. Mud-brick elevated fireplace	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O
33	38a. Wooden Open Tread Staircase	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O
34	40a. Bamboo/ wood low height compound wall	O	RP	O	M	RP	RT	RT	O	M	M	RP	RP	RP	RP	RP
35	43a. Wide verandas	O	O	O	RT	O	O	O	RT	O	RT	M	RT	M	RT	M
36	44a. Utility areas placed separately on the rear side of site	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O

Note: In the table above, **RT = Retained** , **O = Omitted** , **RP = Replaced** and **M = Modified** with respect to features of Traditional ATHs in Contemporary ATHs.

The analysis of the building surveys in Table 4.22 reveals an interesting trend in the evolution of ATHs. The results indicate that a large portion of the features traditionally

associated with climate responsiveness in traditional ATHs has been omitted in contemporary Assam-type constructions.



Figure 4.18: Images of Surveyed Contemporary Assam-Type Houses Corresponding to Table 4.22
(Source: Author)

a. Retained Features

Contemporary Assam-Type Houses (ATHs) continue to incorporate several traditional features that support climate-responsive design. The elevated plinth or stilt construction remains essential, offering protection from flooding and enhancing airflow beneath the structure. Sloping roofs, now typically covered with CGI sheets, ensure efficient rainwater drainage and passive cooling. These roofs are often oriented with the longer side facing the windward direction to optimize natural ventilation. Other enduring features include yard vegetation, which helps regulate the microclimate and provides shade, as well as slender columns that maintain the traditional architectural character. Small, high-level ventilators are also retained, allowing warm air to escape and improving indoor air circulation. These elements reflect a thoughtful continuation of traditional strategies adapted for modern use.

b. Omitted Features

Contemporary Assam-Type Houses (ATHs) have omitted many traditional features that once supported climate responsiveness and functional design. Courtyards and inward-facing layouts, which aided ventilation and thermal comfort, have been replaced by compact plans that reduce airflow. Wooden frameworks and bamboo-ikra walls have been substituted with masonry and concrete, while elements like multi-tier roofs, roof lanterns, and shading devices are mostly absent. Traditional spatial layouts, wide verandas, and opposite openings for cross-ventilation are no longer common. Decorative and practical features such as bargeboards, bamboo screens, bay windows, and mud-brick fireplaces have largely disappeared. Rear utility spaces are now integrated into the main structure, and open tread wooden staircases have been replaced with rigid versions.

c. Modified Features

Some traditional features of ATHs have been adapted in contemporary designs. The original pale colour palette, chosen for its heat-reflective and natural aesthetic, has been replaced with a broader range of colours, reflecting modern tastes. Opening sizes, such as windows and doors, have slightly increased due to factory-made standard fittings, though full-height windows remain uncommon.

d. Replaced Features

Lightweight bamboo or wood ceilings have been replaced with materials like POP or gypsum, which are lighter but offer less thermal benefit. Bamboo screens on verandas have given way to wrought iron alternatives, more durable but less climate-responsive. In urban areas, low bamboo or wooden boundary walls have been replaced by taller brick masonry walls, prioritizing durability and security over traditional aesthetics and climate adaptation.

This chapter brought together insights from users, experts, and building surveys to understand the relevance and status of traditional features in Assam-type houses. By systematically examining these multiple perspectives, the chapter highlighted key features that are retained, modified, replaced, or omitted in contemporary practice. These findings provide a foundation for deeper interpretation and synthesis.

The following chapter, Discussion of Findings, builds upon this by triangulating the three sources, user perceptions, expert opinions, and building observations, to derive meaningful patterns and propose a framework for the integration of traditional architectural elements into contemporary design. The next chapter, Data Analysis, will focus on analysing the collected data based on the methods discussed in the Research Methodology chapter, with the goal of deriving meaningful insights and conclusions.

Chapter V: Discussion of Findings

5.1 Background and Overview of the Chapter

In the context of this study, the Discussion of Findings goes beyond simply restating the results obtained from the individual surveys. Instead, it involves critically engaging with those findings, interpreting them, comparing them across sources, and drawing meaningful insights that can inform real-world architectural practice. The focus of this chapter is to move from isolated survey outcomes to an integrated understanding of which traditional features of Assam-type houses are both climate-responsive and suitable for adoption in contemporary design.

The previous chapter, Chapter 4: Survey and Analysis, presented the results derived from three different but interrelated sources: the User Perception Survey, the Expert Recommendation Survey, and the Building Survey. These surveys explored, respectively, the occupants' perceptions of traditional features, expert validation and recommendations, and the presence of these features in current architectural practices in Assam i.e. contemporary Assam-type houses. Together, these surveys provided a comprehensive dataset on the climate-responsive characteristics of traditional Assam-type houses from three critical viewpoints - users, experts, and built reality.

This chapter now builds upon those findings by bringing them into conversation with one another through a process of triangulation. Rather than treating each set of results in isolation, triangulation allows the study to examine where the perspectives align or differ, thereby increasing the reliability and depth of the conclusions. By cross-verifying the features identified in all three sources, the study identifies a refined list of traditional ATH features that are not only valued and recommended but also currently in use. This comparative synthesis is central to the objective of the research and forms the core discussion of this chapter.

The triangulation process ultimately leads to the identification of a final set of adoptable features, which are then prioritized through a weighted scoring method. This ranked list demonstrates the features with the greatest potential for integration into climate-responsive contemporary housing design.

While the previous chapter presented analytical results, the present discussion focuses on interpreting those outcomes through user perception, expert evaluations, and field observations. The study does not include any thermal simulations or quantitative energy modelling. This choice was intentional, as the study aims to identify adoptable climate-responsive features through perceptual and experiential evidence. Performance validation through measured data or simulation is proposed as a follow-up phase for future research.

5.2 Triangulation Analysis

Triangulation analysis involves cross verifying findings from multiple sources to enhance the reliability and depth of a study.

5.2.1 Purpose and Method of Triangulation

In this study, triangulation is employed as a systematic and robust method to enhance the validity, reliability, and depth of the findings related to the adoption of traditional features that support climate responsiveness from Assam-type houses (ATHs). The primary purpose of triangulation here is to synthesize data from three distinct but complementary sources, the User Perception Survey, the Expert Recommendation Survey, and the Building Survey of contemporary Assam-type houses, in order to identify which traditional ATH features are most relevant, preferred, and practically feasible for integration into contemporary designs with respect to climate responsiveness.

The User Perception Survey offers direct insights from residents of both traditional ATH and contemporary houses, reflecting their lived experiences, preferences, and comfort-related evaluations of specific traditional features. This provides an understanding of user expectations and perceived benefits.

The Expert Recommendation Survey, conducted with architects and building professionals, contributes a more technical and design-oriented perspective. It shows the feasibility, importance, and potential challenges of adopting traditional ATH features in contemporary constructions.

The Building Survey, consisting of studies of contemporary ATHs, which captures the current architectural practices in Assam with respect to ATHs. It documents which traditional features have been retained, omitted, modified, or replaced in the contemporary typology of ATH, thereby offering an on-ground reality check of what is being

implemented today. For the Building Survey data, the value considered for triangulation is the most frequently observed outcome across the 15 contemporary ATHs examples. For example, if a feature such as ‘Elevated Plinth’ was ‘retained’ in majority of the houses, the value ‘Retained’ was taken as the representative of that feature. This approach ensured that the building survey reflects the dominant trends in current ATH practices.

By cross-examining these three sources, the triangulation process enables the study to verify, consolidate, and prioritize features that are not only culturally and environmentally valuable but also supported by both user preference and professional recommendation and are already being put into practice to some extent. This multi-perspective analysis leads to a comprehensive and evidence-based list of adoptable features, ensuring that the final outcomes are both contextually appropriate and practically grounded.

Thus, triangulation serves not just as a method of validation, but as a critical interpretative step in the research. This process strengthens the rationale for integrating traditional features into contemporary housing in Assam, aligning climatic suitability with cultural continuity and design innovation.

Figure 5.1, visually represents this approach in the form of a triangle, where each side symbolizes one of the three surveys- User Perception, Expert Recommendation, and Building Survey. The convergence at the centre signifies the integrated set of climate-responsive features validated through all three perspectives.

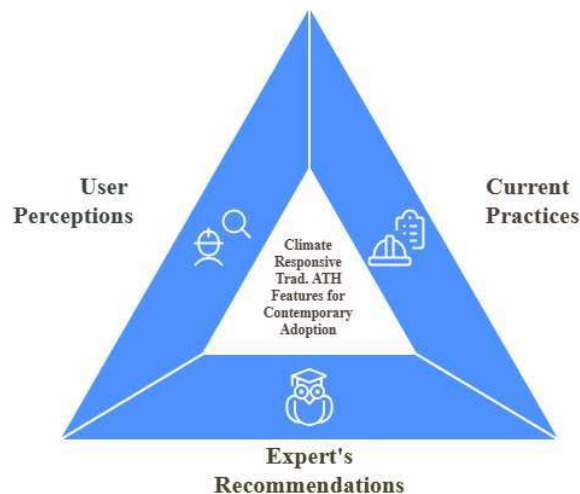


Figure 5.1: Triangulation Analysis of Traditional Assam-Type House Features for Climate Responsiveness and Contemporary Adoption from User Perception, Expert Recommendation and Building Surveys (Source: Author)

5.2.2 Triangulated Table of Features of Traditional Assam-type House for Climate responsiveness and Contemporary Adoption

The following table presents the triangulation analysis of traditional ATH features based on the three sources. By comparing responses across these dimensions, the table highlights the traditional ATH features that are widely supported and suitable for adoption in contemporary designs for climate responsiveness.

Table 5.1: Triangulation Analysis of Traditional Assam-Type House Features for Climate Responsiveness and Contemporary Adoption (Source: Author)

Sl.No	Traditional Assam-type House Features	User Perception	Expert Recommendation	Building Surveys	Comments
1	1a. Elevated plinth or stilt	Very Important	Very Important	Retained	Highly recommended for incorporation, valued by all, and retained in practice
2	1b. Wooden framework – lightweight structure	Not Important / No Opinion	Very Important	Omitted	Expert recommended feature, should be reconsidered for adoption.
3	2a. Sloping roof	Very Important	Very Important	Retained	Highly recommended for incorporation, valued by all, and retained in practice
4	2b. CGI sheet or thatch roofing	Very Important	Moderately Important	Retained	Suitable for incorporation in contemporary designs.
5	2c. Multi-tiered gable roofing	Not Important / No Opinion	Very Important	Omitted	Expert recommended feature, should be reconsidered for adoption.
6	2d. Roof lanterns.	Not Important / No Opinion	Very Important	Omitted	Expert recommended feature, should be reconsidered for adoption.
7	2e. Large overhangs	Moderately Important	Very Important	Retained	Should be adopted in new designs
8	3b. Traditional materials	Very Important	Very Important	Omitted	Crucial feature, should be reintroduced in practice.
9	3c. Bamboo or wood ceilings	Very Important	Very Important	Replaced	Should be reconsidered for adoption in new designs.
10	4a. Longer side facing windward direction	Not Important / No Opinion	Very Important	Omitted	Expert endorsed feature – should be retained despite low user awareness.
11	4b. Inward-oriented spaces	Not Important / No Opinion	Moderately Important	Omitted	Should be reevaluated by professionals or owners for potential inclusion where possible.
12	4c. Shading elements on the south and west sides	Not Important / No Opinion	Very Important	Omitted	Expert recommended feature, should be reconsidered for adoption.
13	5a. Veranda along the longer sides of the house	Very Important	Moderately Important	Omitted	Needs reconsideration in practice
14	5b. Courtyard	Very Important	Very Important	Omitted	Crucial feature, should be reintroduced in practice
15	6a. Elongated plan	Not Important / No Opinion	Moderately Important	Omitted	Should be reevaluated by professionals or owners for potential inclusion.
16	6b. Rooms arranged around courtyard	Not Important / No Opinion	Moderately Important	Omitted	Should be reevaluated by professionals or owners for potential inclusion.
17	8c. Decorative bargeboards	Not Important / No Opinion	Moderately Important	Modified	Should be reevaluated by professionals or owners for potential inclusion.
18	8d. Bamboo screens	Not Important / No Opinion	Moderately Important	Replaced	Moderate expert value-replacement
19	8f. Pale colour palette	Not Important / No Opinion	Very Important	Replaced	Adaptation should be considered to meet modern needs.

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20	8h. Bay windows.	Not Important / No Opinion	Very Important	Omitted	Expert recommended feature, should be reconsidered for adoption.
21	9a. Vegetation in yards	Very Important	Very Important	Retained	Highly recommended for incorporation, valued by all, and retained in practice
22	10b. Slender columns	Not Important / No Opinion	Moderately Important	Retained	Should be considered for adoption to new designs.
23	10c. Flexible joints	Not Important / No Opinion	Very Important	Omitted	Expert recommended feature, should be reconsidered for adoption.
24	17a. Moderate sized openings	Not Important / No Opinion	Moderately Important	Modified	Reassess for design improvements.
25	19a. Symmetrical layout	Not Important / No Opinion	Moderately Important	Omitted	Should be reevaluated by professionals or owners for potential inclusion.
26	21b. Small high-level ventilators	Very Important	Very Important	Retained	Highly recommended for incorporation, valued by all, and retained in practice
27	21e. Openings located opposite each other	Moderately Important	Very Important	Omitted	Expert recommended feature, should be reconsidered for adoption.
28	23a. Bamboo-wood-ikra (brick masonry till sill) walls with mud mortar	Not Important / No Opinion	Moderately Important	Omitted	Should be reevaluated by professionals or owners for potential inclusion.
29	27b. Bamboo or wood floorboard	Not Important / No Opinion	Moderately Important	Omitted	Should be reevaluated by professionals or owners for potential inclusion.
30	27c. Cement/ Mud Plastered floor	Moderately Important	Moderately Important	Omitted	Should consider reintroducing in new design
31	28b. High ceiling	Very Important	Very Important	Omitted	Crucial feature, should be reintroduced in practice.
32	34a. Mud-brick elevated fireplace	Not Important / No Opinion	Moderately Important	Omitted	Should be reevaluated by professionals or owners for potential inclusion.
33	38a. Wooden Open Tread Staircase	Not Important / No Opinion	Moderately Important	Omitted	Should be reevaluated by professionals or owners for potential inclusion.
34	40a. Bamboo/ wood low height compound wall	Not Important / No Opinion	Not Important / No Opinion	Replaced	Low priority – replacement is suitable while considering climate responsiveness.
35	43a. Wide verandas	Moderately Important	Very Important	Omitted	Crucial feature, should be reintroduced in practice.
36	44a. Utility areas placed separately on the rear side of site	Not Important / No Opinion	Not Important / No Opinion	Omitted	Not relevant to present context – omission is suitable.

The triangulation analysis serves as a critical synthesis point, identifying which traditional features of Assam-type houses hold consistent relevance across user preferences, expert opinions, and actual building practices. Features that receive high importance from both users and experts and are still present in contemporary ATH constructions demonstrate a strong alignment with climate-responsive design and should be considered high-priority for adoption. In contrast, features recommended by experts but rarely seen in current practice raise important questions about implementation challenges or changing design priorities,

indicating areas where traditional knowledge may need to be re-evaluated or reintroduced. Where user preferences diverge from expert recommendations or built reality, such discrepancies highlight potential gaps in design communication or adaptation strategies. This comparative assessment ultimately helps in distinguishing features that are not only culturally and climatically relevant but also practically feasible, thus offering a grounded basis for guiding future residential design in Assam.

5.2.3 Ranked List of Traditional Assam-Type House Features for Climate Responsiveness and Contemporary Adoption

The final ranking of traditional Assam-type house features was determined using a Weighted Scoring Model, incorporating inputs from user perception, expert recommendations, and current practices. Each feature was assigned a weighted score based on its significance in these three categories. The assigned Features that received high importance from users and experts, and were also retained in current practices, ranked the highest. The weights used in the model were as follows:

- User Perception: 33.33%
- Expert Recommendation: 33.33%
- Current Practices: 33.33%

The weighted scores for each category were assigned as follows:

- Very Important: 3 points
- Moderately Important: 2 points
- Not Important / No Opinion: 1 point
- Retained: 3 points
- Modified / Replaced: 2 points
- Omitted: 1 point

The overall weighted score for each feature was calculated by multiplying the score assigned to each category by their respective weights. The formula is:

Weighted Score =

$$(User\ Perception\ Score * 0.3333) + (Expert\ Recommendation\ Score * 0.3333) + (Current\ practices\ Score * 0.3333)$$

For example, the feature “Sloping Roof” had the following scores:

- User Perception: Very Important (Score = 3)
- Expert Recommendation: Very Important (Score = 3)
- Current Practices: Retained (Score = 3)

Using the formula:

$$Weighted\ score = (3 * 0.3333) + (3 * 0.3333) + (3 * 0.3333) = 2.9997$$

Thus, the weighted score for “Sloping Roof” is approximately 3.0, indicating that it is highly valued by both users and experts, and retained in current practices.

This weighted scoring model provides a comprehensive method to rank features based on user needs, expert recommendations, and current practices, helping identify those with the greatest potential for climate-responsive design.

The ranked list presented below represents the outcome of this analysis, revealing the traditional ATH features for climate responsiveness and suitable for adoption to contemporary houses in Assam.

Table 5.2: Ranked List of Traditional Assam-type House Features for Climate Responsiveness and Adoption to Contemporary Housing Design (Source: Author)

	Identified Traditional Assam-type House Feature	User Perception (33.33 %)	Expert Recommendation (33.33%)	Current Practices (33.33%)	Weighted Score
1	1a. Elevated plinth or stilt	Very Important	Very Important	Retained	2.9997
2	2a. Sloping roof	Very Important	Very Important	Retained	2.9997
3	9a. Vegetation in yards	Very Important	Very Important	Retained	2.9997
4	21b. Small high-level ventilators	Very Important	Very Important	Retained	2.9997
5	3c. Bamboo or wood ceilings	Very Important	Very Important	Replaced	2.6664
6	2b. CGI sheet or thatch roofing	Very Important	Moderately Important	Retained	2.6664
7	2e. Large overhangs	Moderately Important	Very Important	Retained	2.6664
8	3b. Traditional materials	Very Important	Very Important	Omitted	2.3331
9	5b. Courtyard	Very Important	Very Important	Omitted	2.3331
10	28b. High ceiling	Very Important	Very Important	Omitted	2.3331
11	10b. Slender columns	Not Important / No Opinion	Moderately Important	Retained	2.3331
12	5a. Veranda along the longer sides of the house	Very Important	Moderately Important	Omitted	1.9998
13	21e. Openings located opposite each other	Moderately Important	Very Important	Omitted	1.9998
14	43a. Wide verandas	Moderately Important	Very Important	Omitted	1.9998
15	8f. Pale colour palette	Not Important / No Opinion	Very Important	Replaced	1.9998
16	4a. Longer side facing windward direction	Not Important / No Opinion	Very Important	Omitted	1.6665
17	1b. Wooden framework – lightweight structure	Not Important / No Opinion	Very Important	Omitted	1.6665
18	2c. Multi-tiered gable roofing	Not Important / No Opinion	Very Important	Omitted	1.6665
19	2d. Roof lanterns.	Not Important / No Opinion	Very Important	Omitted	1.6665
20	4c. Shading elements on the south and west sides	Not Important / No Opinion	Very Important	Omitted	1.6665
21	8h. Bay windows.	Not Important / No Opinion	Very Important	Omitted	1.6665
22	10c. Flexible joints	Not Important /	Very Important	Omitted	1.6665

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		No Opinion			
23	27c. Cement/ Mud Plastered floor	Moderately Important	Moderately Important	Omitted	1.6665
24	8d. Bamboo screens	Not Important / No Opinion	Moderately Important	Replaced	1.6665
25	17a. Moderate sized openings	Not Important / No Opinion	Moderately Important	Modified	1.6665
26	8c. Decorative bargeboards	Not Important / No Opinion	Moderately Important	Modified	1.6665
27	4b. Inward-oriented spaces	Not Important / No Opinion	Moderately Important	Omitted	1.3332
28	6a. Elongated plan	Not Important / No Opinion	Moderately Important	Omitted	1.3332
29	6b. Rooms arranged around courtyard	Not Important / No Opinion	Moderately Important	Omitted	1.3332
30	19a. Symmetrical layout	Not Important / No Opinion	Moderately Important	Omitted	1.3332
31	23a. Bamboo-wood-ikra (brick masonry till sill) walls with mud mortar	Not Important / No Opinion	Moderately Important	Omitted	1.3332
32	27b. Bamboo or wood floorboard	Not Important / No Opinion	Moderately Important	Omitted	1.3332
33	34a. Mud-brick elevated fireplace	Not Important / No Opinion	Moderately Important	Omitted	1.3332
34	38a. Wooden Open Tread Staircase	Not Important / No Opinion	Moderately Important	Omitted	1.3332
35	40a. Bamboo/ wood low height compound wall	Not Important / No Opinion	Not Important / No Opinion	Replaced	1.3332
36	44a. Utility areas placed separately on the rear side of site	Not Important / No Opinion	Not Important / No Opinion	Omitted	0.9999

This chapter presented a detailed discussion of the key findings derived through triangulation of three primary data sources: user perception, expert recommendation, and building surveys. The triangulation process, supported by a weighted scoring method, enabled a comprehensive and nuanced assessment of traditional features of Assam-type houses in terms of their climate responsiveness and suitability for contemporary adoption.

The top-ranked features align with well-understood passive mechanisms: shading/overhangs reduce solar gains and mean radiant temperature; cross-ventilation and high ventilators promote wind and buoyancy-driven heat and moisture removal; courtyards/vegetation improve microclimate and air movement; elevated plinths manage

damp and flood risk as discussed in chapter 2. Linking preferences to these mechanisms strengthens confidence that the perceived benefits have a physical basis.

The resulting ranked list of features reflects an informed synthesis that incorporates the lived experiences of users, the technical expertise of professionals, and the realities of current architectural practices. This list not only validates the significance of certain traditional elements but also illuminates areas where further attention or reintegration may be necessary.

Although several top ranked features align with intuitive comfort factors, their relative positions across users, experts and current practices reveal where preferences, professional judgement and real-world construction converge or diverge under contemporary constraints.

The insights drawn from this discussion directly inform the final chapter, which consolidates the outcomes of the research. Chapter 6 will present the final list of traditional features identified as adoptable for climate-responsive contemporary housing in Assam. It will also introduce the methodological framework developed through the study, a systematic process for investigating and integrating traditional architectural knowledge into contemporary designs. This framework aims to support future efforts toward climate responsive and culturally grounded architectural practices.

5.3 Interpretive Insights from the Triangulated Findings

While several findings align with what might seem intuitive, such as a shared preference for features that enhance comfort and ventilation, the triangulated analysis reveals deeper socio-cultural and practical dynamics that influence these choices.

First, the results expose a clear preference-practice gap. Many features that users and experts alike value for comfort and climate responsiveness are still omitted or altered in current constructions. Beyond cost or material availability, this gap is strongly shaped by the influence of trends and globalization, the visual and material choices people see around them. Popular preferences for POP ceilings, bright or contrasting exterior colours, and modern finishes reflect a tendency to replicate what is perceived as “modern” or socially aspirational. As these aesthetic norms spread through imitation, they often override climatic

logic. When such trends become dominant, materials and labour supporting those choices are more easily available and economical, further reinforcing the cycle.

Second, the findings show a priority divergence between users and experts. Users focus on immediate comfort, familiarity, and visual appeal, while experts emphasize long-term performance, maintenance, and environmental response. This divergence is compounded by limited awareness and systemic inertia, that is, many homeowners hesitate to deviate from common trends even when aware of better climatic alternatives, perceiving “different” solutions as riskier or more expensive.

Third, the ranked list reveals a feasibility hierarchy. Certain traditional elements, such as elevated plinths, roof forms, and shaded verandas, remain both desirable and easy to implement within modern frameworks. Others, particularly those relying on traditional materials or craftsmanship, face resistance linked to cultural perceptions, maintenance demands, and shrinking market support.

Taken together, these insights transform apparently “expected” preferences into a diagnostic understanding of the social, economic, and perceptual forces shaping present-day building choices. They reveal where awareness, incentives, and design guidance could help bridge the gap between what users value and what actually gets built.

5.4 Comparative Context of Assam-type Houses within Indian Traditional Architecture

The previous sections explained the climate-responsive features of Assam-type houses in detail. To understand their wider relevance, it is important to compare them with other traditional building styles found in different parts of India. Across the country, traditional houses have evolved in response to local climate, materials, and ways of living, each using natural design solutions for comfort and protection from the environment. This section places the Assam-type house in that broader context by comparing it with examples from regions such as Kerala, Rajasthan, Ladakh, Pune, and Delhi which have been discussed in Chapter 2, under section 2.2.4.1. Through this comparison, we can see both the similarities and differences in how each region deals with heat, humidity, rainfall, and ventilation, showing that Assam’s traditional architecture is part of a larger system of climate-responsive design while also having its own unique local adaptations.

Table 5.3: Comparative Analysis of Climate Responsive Features in Traditional Indian Houses across Climatic Zones and Assam-type Houses (Source: Compiled by the author based on literature reviewed in Section 2.2.4.1, Chapter 2)

	Climatic Aspect / Function	Representative Vernacular Systems (Examples)	Regional Strategy / Key Features	Assam-Type House Features	Comparative Note
1	Protection from Rainfall	Kerala (warm-humid): steep tiled roofs, deep eaves, verandas. Pune (temperate): moderate roof pitch, extended chajjas for monsoon. Rajasthan (hot-dry): flat roofs due to minimal rainfall.	Roof slope and material chosen according to rainfall intensity.	Sloping CGI-sheet roofs, multi-tiered gable roofing, and long overhangs efficiently drain heavy monsoon rain.	Assam parallels Kerala in roof form but adapts lighter CGI material and steeper pitch for intense rainfall and faster runoff.
2	Flood and Ground Moisture Control	Kerala: raised plinths in flood-prone areas. Delhi: moderate plinths for surface drainage.	Elevation prevents water seepage and improves durability.	Elevated plinths or full stilts for flood resilience.	Shares Kerala's plinth logic but extends it further for sustained floodwater management.
3	Humidity Regulation and Breathability	Kerala: laterite and lime walls that breathe. Pune: semi-porous stone-brick walls.	Porous wall materials enable air exchange and moisture evaporation.	Ikra walls (woven bamboo with mud-lime plaster) and bamboo/wood ceilings for	Similar breathable design adapted with lighter, faster-drying materials suited for Assam's

				vapour permeability.	continuous humidity.
4	Thermal Comfort and Insulation	Ladakh (cold): thick earthen walls for heat retention. Rajasthan: high-mass walls for diurnal lag.	Mass-based insulation to stabilize temperature.	Bamboo or wood ceilings, mud-lime plaster, and lightweight structure for quick heat dissipation.	Inverts thermal logic: Assam prioritizes fast cooling over heat storage due to warm-humid climate.
5	Ventilation and Airflow	Kerala: opposite openings and large verandas. Rajasthan: internal courtyards and jalis for air movement.	Passive airflow via pressure and temperature differences.	High-level ventilators, opposite openings, wide verandas, and roof lanterns for cross and stack ventilation.	Same airflow principle applied to moisture relief rather than dry heat removal.
6	Solar Control and Shading	Delhi: deep chajjas and balconies on south and west façades. Rajasthan: narrow openings, shaded courts.	Minimize solar gain through shading and façade orientation.	Wide verandas, shading elements, slender columns, and pale colour palette reduce direct heat absorption.	Uses openness and reflectivity rather than mass to manage solar exposure.
7	Daylight Optimization	Kerala: shaded verandas and courtyards allow	Balanced daylight without	Bay windows, roof lanterns, inward-	Common daylighting intent, Assam

		diffused light. Ladakh: south-facing openings for solar gain.	glare or overheating.	oriented spaces, and rooms around courtyards for soft daylight.	substitutes reflective pale interiors and roof lanterns for courtyards.
8	Microclimate Modification	Kerala and Delhi: courtyard vegetation, ponds for evaporative cooling.	Vegetation reduces ambient temperature and glare.	Vegetation in yards and courtyards improves microclimate and reduces heat gain.	Shared vegetative strategy scaled for humid regions with continuous canopy cover.
9	Orientation to Prevailing Wind	Kerala and coastal regions: long axis facing breeze; perforated screens.	Orientation planned for airflow and shading.	Longer side facing windward direction, open tread staircases, bamboo screens, low compound walls to aid ventilation.	Orientation logic consistent with other warm-humid typologies, optimized for cross-ventilation at multiple levels.

Since Assam-type houses form an integral part of India’s wider traditional architectural system, comparing them with other regional house types helps place the findings of this study in a national context. As seen from the table, many of the identified climate-responsive strategies in Assam, such as sloping roofs, shaded verandas, and ventilated interiors, resonate with approaches found in other traditional systems across different climatic zones. This reinforces that the analytical framework developed in this thesis is not limited to the Assam context alone but can be applied to study and interpret other traditional typologies of India and abroad, enabling the identification and adaptation of region-specific features for contemporary climate-responsive design.

5.5 Economic and Policy Dimensions of Climate-Responsive Adoption

Building on the interpretive insights discussed earlier, which highlight gaps between perception, practice, and feasibility, this section extends the discussion to the economic and policy conditions that influence the adoption of climate-responsive features. The findings suggest that successful translation of traditional wisdom into contemporary housing depends not only on design awareness but equally on affordability, material access, and regulatory support.

Many homeowners, especially in semi-urban and rural areas, make building decisions based on cost, ease of construction, and the availability of trained labour. Features such as sloping roofs, courtyards, and elevated plinths are widely recognized for their comfort benefits, yet they are often omitted when budgets are tight or when modern materials appear more affordable and convenient. This pattern highlights that design preferences are deeply linked with financial feasibility and access to local resources.

Public policy can play a decisive role in overcoming these barriers. Integrating climate-responsive principles into government housing programs and building regulations could help bridge the gap between awareness and adoption. Incentives such as tax benefits, material subsidies, or inclusion of traditional elements in housing schemes like Pradhan Mantri Awas Yojana (PMAY) and the National Urban Housing & Habitat Policy (NUHHP) can encourage homeowners to use sustainable local materials, design, and techniques. Similarly, local building by-laws in flood-prone or humid zones could mandate elevated plinths, shading verandas, or sloped roofing as adaptive measures. Demonstration projects in important historic traditional towns such as Sivasagar or Sualkuchi, which are towns with higher density of traditional ATHs and are culturally and touristically important; and thus, changes could be more visible and impactful, could further showcase how traditional features can be integrated within modern RCC systems while supporting regional identity and sustainability.

Together, these insights underline that climate-responsive housing is not only a design issue but also an economic and governance challenge. Aligning affordability, regulatory support, and design awareness can make the adoption of traditional features both achievable and scalable in contemporary contexts.

Chapter VI: Conclusion

6.1 Chapter Overview

This chapter brings together the key outcomes of the research, highlighting two major contributions. The first is the development of a comprehensive framework for analysing traditional architecture with the aim of contemporary application. This framework, established through a structured, multi-step process, provides a replicable method that can be adapted to various design goals, such as climate responsiveness, energy efficiency, disaster resilience etc. The second key contribution is the formulation of a validated and ranked list of architectural features from traditional Assam-type houses that effectively support climate-responsive design and are suitable for adoption in contemporary housing. This list has been derived through triangulation of expert opinion, user perception, and building surveys, ensuring both relevance and practical applicability. Together, these outcomes offer a valuable resource for architects and researchers aiming to integrate traditional architectural knowledge into modern design practices.

6.2 Research Outcome: A Framework to Analyse Traditional Architecture for Contemporary Use

This research proposes a comprehensive framework to analyse traditional architecture for contemporary application, which serves as one of the core outcomes of the study. The framework provides a step-by-step method to systematically identify and evaluate features of any traditional architectural typology based on a clearly defined design goal, such as climate responsiveness, energy efficiency, disaster resilience, affordability, cultural continuity etc. By following this process, relevant architectural features can be mapped, assessed, and prioritized for their suitability in contemporary construction. The framework is flexible and replicable, making it applicable to a wide range of traditional contexts beyond the scope of this study. Its effectiveness is validated through this research, as it was successfully applied to traditional Assam-type houses to derive a ranked list of features that support climate-responsive design and are suitable for contemporary adoption. This outcome demonstrates the framework's practical utility in bridging traditional knowledge with contemporary design needs.

Figure 6.1 below, illustrates the framework for analysing traditional architecture for contemporary use, as derived from this research.

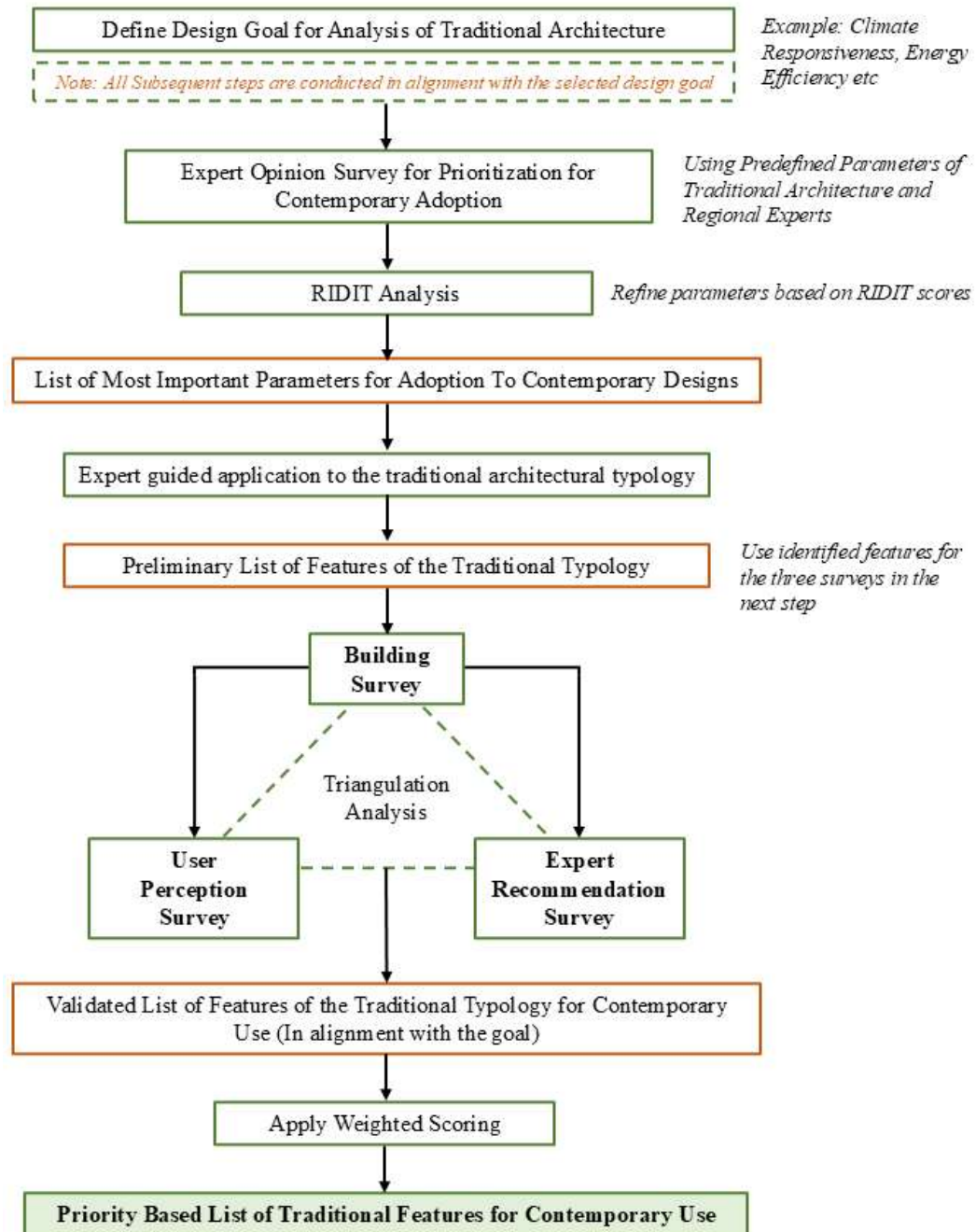


Figure 6.1: Framework to Analyse Traditional Architecture for Contemporary Use (Source: Author)

6.3 Answers to Research Questions

a. How should traditional architecture be studied to gain a comprehensive understanding of its important characteristics and design logic?

Answer: To establish an effective approach for studying traditional architecture, a comprehensive review of existing literature was undertaken. The analysis revealed that the most insightful and methodologically sound studies focus on examining the architectural elements of traditional buildings in relation to specific performance attributes. Commonly studied building elements include the structural system, roof system, orientation, open space etc. These are typically assessed alongside attributes such as primary materials used, form or shape, passive design features etc. This element-attribute approach helps organize the study of traditional buildings in a clear and structured way.

b. What are the defining architectural features of traditional Assam-type Houses that make it climate responsive?

Answer: The defining architectural features of Traditional Assam-type houses with respect to climate responsiveness are as follows -

1. 1a. Elevated plinth or stilt
2. 1b. Wooden framework – lightweight structure
3. 2a. Sloping roof
4. 2b. CGI sheet or thatch roofing
5. 2c. Multi-tiered gable roofing
6. 2d. Roof lanterns.
7. 2e. Large overhangs
8. 3b. Traditional materials
9. 3c. Bamboo or wood ceilings
10. 4a. Longer side facing windward direction
11. 4b. Inward-oriented spaces
12. 4c. Shading elements on the south and west sides
13. 5a. Veranda along the longer sides of the house
14. 5b. Courtyard

15. 6a. Elongated plan
16. 6b. Rooms arranged around courtyard
17. 8c. Decorative bargeboards
18. 8d. Bamboo screens
19. 8f. Pale colour palette
20. 8h. Bay windows.
21. 9a. Vegetation in yards
22. 10b. Slender columns
23. 10c. Flexible joints
24. 17a. Moderate sized openings
25. 19a. Symmetrical layout
26. 21b. Small high-level ventilators
27. 21e. Openings located opposite each other
28. 23a. Bamboo-wood-ikra (brick masonry till sill) walls with mud mortar
29. 27b. Bamboo or wood floorboard
30. 27c. Cement/ Mud Plastered floor
31. 28b. High ceiling
32. 34a. Mud-brick elevated fireplace
33. 38a. Wooden Open Tread Staircase
34. 40a. Bamboo/ wood low height compound wall
35. 43a. Wide verandas
36. 44a. Utility areas placed separately on the rear side of site

c. How do users perceive these traditional features of Assam-type houses in terms of comfort and efficiency, and what is their willingness to adopt them in their future houses?

Answer: The user perception survey indicates that traditional features of Assam-type houses are generally viewed positively, particularly in terms of their contribution to comfort, ventilation, and protection from climatic extremes. Users recognize the effectiveness of elements such as raised plinths, high ceilings, and courtyards in enhancing indoor thermal conditions and overall liveability.

However, willingness to adopt these features in future houses varies. While some features receive strong support, others are viewed as less practical or desirable due to changing lifestyles, aesthetic preferences, or limitations posed by urban living, such as reduced plot sizes and modern construction norms. This suggests that although there is a clear appreciation for the functional value of traditional features, their adoption in contemporary housing may depend on how well they can be adapted to current needs and constraints.

d. What is the feasibility and relevance of integrating tradition Assam-type house features into contemporary house design practices in Assam?

Answer: Integrating traditional Assam-type house features into contemporary design is both feasible and highly relevant, especially for improving climate responsiveness. Experts highlight, that elements, like raised plinths, sloping roofs, high ventilators, vegetation, and wide roof overhangs can be directly adopted with minimal changes, and many of these continue to appear in contemporary Assam-type houses.

However, some features, particularly those that rely on traditional materials or skilled craftsmanship, such as lightweight wooden structures and flexible joints, are increasingly being omitted in present practices. Despite such challenges, the continued presence of key elements affirms their relevance. With greater awareness and professional guidance, the integration of traditional features into contemporary houses remains both practical and valuable for achieving climate-responsive design in Assam.

e. What outcome can be developed from the analysis of traditional Assam-type Houses to facilitate the identification of priority features for contemporary climate responsive design?

Answer: The outcome developed through this study is a generalizable framework for identifying and prioritizing traditional architectural features for contemporary use. While the framework itself is structured as a generic process (as shown in Figure 6.1), it has been derived from the specific case of Assam-type houses with a focus on achieving climate-responsive design. By applying this framework to Assam-type houses, the study demonstrates how traditional features can be systematically evaluated through expert validation, user perception, and contextual analysis. The resulting process not only identifies features suitable for climate-responsive design but also offers a replicable method that can be adapted to other traditional architectural contexts and design objectives.

6.4 Prioritized list of Recommended Traditional Assam-type House Features for Climate Responsiveness and Adoption to Contemporary Designs

The following table presents a ranked list of traditional Assam-type house features based on their potential for integration into contemporary housing to enhance climate responsiveness.

The prioritization does not imply a rigid framework but rather serves as a guideline for designers, builders, and homeowners seeking to incorporate climate-adaptive elements from traditional Assam-type houses. While the highest-ranked features are strongly recommended for integration due to their widespread validation across multiple perspectives, features with lower rankings still hold value and may be adopted based on contextual suitability, spatial constraints, and material availability.

Table 6.1: Prioritised Recommendations for Integrating Traditional Assam-Type House Features in Contemporary House Designs (Source: Author)

Priority	Identified Traditional Assam-type House Feature	Contribution to Climate Responsive Design
1	1a. Elevated plinth or stilt	Protects against flooding and dampness; essential for areas prone to waterlogging.
2	2a. Sloping roof	Fundamental for rainwater drainage and heat dissipation; should be retained and adopted in contemporary housing.
3	9a. Vegetation in yards	Improves microclimate and reduces heat gain; recommended for integration in contemporary houses and site planning.
4	21b. Small high-level ventilators	Crucial for indoor air circulation and thermal comfort; strongly recommended for adoption in contemporary houses.
5	3c. Bamboo or wood ceilings	Enhances insulation and aesthetics; adoption depends on skilled labour and material sourcing.
6	2b. CGI sheet or thatch roofing	Commonly used but should be improved with proper insulation to reduce heat gain.
7	2e. Large overhangs	Provides shading and protects walls from rain; recommended for heat and moisture control.

8	3b. Traditional materials	Beneficial for thermal comfort and sustainability; adoption depends on material availability and awareness.
9	5b. Courtyard	Provides ventilation and daylight; beneficial for passive cooling and should be incorporated by adapting to available space.
10	28b. High ceiling	Reduces indoor heat buildup; should be encouraged in contemporary houses for thermal comfort.
11	10b. Slender columns	Reduces heat retention and provides structural flexibility.
12	5a. Veranda along the longer sides of the house	Enhances indoor-outdoor transition and thermal comfort; should be retained where space allows.
13	21e. Openings located opposite each other	Enhances cross-ventilation; should be incorporated where feasible in contemporary designs.
14	43a. Wide verandas	Contributes to shading and airflow; can be adapted to contemporary house plans.
15	8f. Pale colour palette	Reduces heat absorption and improves indoor comfort; a simple yet effective strategy for climate responsiveness.
16	4a. Longer side facing windward direction	Improves natural ventilation; should be incorporated in site planning where possible.
17	1b. Wooden framework – lightweight structure	Improves seismic resilience and helps to cool the interior quickly, will require proper structural reinforcement in contemporary houses.
18	2c. Multi-tiered gable roofing	Improves ventilation, reducing heat built up and facilitating rain water drainage efficiently
19	2d. Roof lanterns.	Improves natural ventilation and increases daylight entry, should be encouraged in spaces with insufficient ventilation or daylight from regular openings.
20	4c. Shading elements on the south and west sides	Effective for heat reduction; should be encouraged in contemporary house design.
21	8h. Bay windows.	Enhances daylighting and aesthetics; can be incorporated selectively.
22	10c. Flexible joints	Beneficial for earthquake resistance; should be studied for integration into modern construction methods.
23	27c. Cement/ Mud Plastered floor	Can be adopted for heat moderation.

24	8d. Bamboo screens	Provides shading and ventilation; requires material availability and maintenance awareness for modern adoption.
25	17a. Moderate sized openings	Impacts ventilation and daylighting; should be optimized for passive cooling strategies.
26	8c. Decorative bargeboards	Primarily aesthetic but also protects roof edges; can be adapted for visual appeal and durability.
27	4b. Inward-oriented spaces	Improves daylight while minimizing solar exposure, reduces heat gain and enhances ventilation.
28	6a. Elongated plan	Improves ventilation efficiency; should be encouraged where site constraints allow.
29	6b. Rooms arranged around courtyard	Enhances ventilation and daylighting; adoption depends on space constraints.
30	19a. Symmetrical layout	Traditional aesthetic but may not always fit modern functional requirements; can be adapted selectively
31	23a. Bamboo-wood-ikra (brick masonry till sill) walls with mud mortar	Prevents heat built up, maintains indoor air quality, reduces humidity, keeps interiors cooler in summer.
32	27b. Bamboo or wood floorboard	Enhances aesthetics and insulation but requires maintenance; adoption depends on user preference and availability.
33	34a. Mud-brick elevated fireplace	Useful in colder regions; should be adapted based on local climate needs.
34	38a. Wooden Open Tread Staircase	Allows airflow; adoption depends on safety and material durability considerations.
35	40a. Bamboo/ wood low height compound wall	Allows airflow across the site.
36	44a. Utility areas placed separately on the rear side of site	Keeps heat and moisture away from the main living spaces, helping maintain thermal comfort, dryness and better indoor air quality.

The functional contributions listed are synthesized from expert-based understanding and align with established passive design literature as discussed in Chapter 2, under section 2.4.1, where solar control, natural ventilation etc play critical roles in maintaining indoor comfort.

6.5 Implications for Contemporary House Designs

The interpretive findings in Chapter 5, section 5.3 point to three recurring frictions that shape adoption:

A preference–practice gap (people value climate-responsive features but current builds often omit or alter them, influenced by trends, cost, codes, and market habits), a user–expert priority divergence (users prize immediate comfort and familiarity; experts emphasize long-term performance), and a feasibility hierarchy (some features are easy to integrate in RCC construction, others face material/skill or regulatory hurdles).

This section translates those insights and highlights the practical implications of the identified prioritised features, addressing both opportunities and challenges in contemporary housing design.

The implications are organized to:

- Close the preference–practice gap through clear prioritization, flexible pathways, user awareness, and demonstration (a, b, e).
- Bridge user-expert divergence by communicating performance rationales and offering phased, context-sensitive adoption (g, h, i).
- Work with feasibility realities by aligning materials/skills, construction interfaces, and supportive policy/incentives, while foregrounding net sustainability gains (c, d, f).

a. Prioritization of Features

The ranked list of traditional features provides a structured approach for integrating traditional climate-responsive features into contemporary houses. Higher-ranked features, such as high ventilators and sloping roofs, should be prioritized due to their significant impact on thermal comfort and ventilation. While all features contribute to better climate responsiveness, this prioritization helps in making informed decisions based on feasibility and effectiveness.

b. Flexibility in Adoption

The ranking does not imply a rigid set of rules but rather serves as a guideline for selective adoption. Some features may be more suitable in certain contexts than others, depending on factors like space constraints, budget, and personal preferences. Even features ranked lower in priority can be beneficial if adapted creatively to fit modern housing needs.

c. Material and Skill Availability

One of the key challenges in adopting traditional features is the availability of materials and skilled labour. Traditional Assam-type houses rely on materials like bamboo, timber, and Ikra, which are gradually being replaced by concrete due to perceived durability and modern aesthetics. Reviving these materials would require efforts in sustainable sourcing and training skilled labour.

d. Construction Feasibility

Integrating traditional features into RCC-based contemporary houses requires careful consideration of structural compatibility. Features like sloping roofs, high ventilators, and raised plinths can be incorporated with minimal changes, whereas others, such as flexible joints and bamboo ceilings, may need modification or hybrid approaches to suit modern construction techniques.

e. User Awareness and Acceptance

A major barrier to the adoption of traditional features is the lack of awareness about their benefits. Many homeowners associate modern concrete structures with progress and status, often overlooking the thermal comfort and energy efficiency of traditional features. Public awareness campaigns, demonstration projects, and homeowner education initiatives can help bridge this gap.

f. Policy and Incentives

Government policies and building regulations play a crucial role in promoting traditional climate-responsive designs. Incentives such as tax benefits, subsidies for sustainable materials, and relaxed building codes for incorporating traditional elements can encourage homeowners to adopt these features. Integrating such strategies into policy frameworks can drive wider acceptance.

g. Architectural Adaptation

To make traditional features more adaptable, architects and builders need to develop hybrid designs that balance traditional wisdom with modern needs. For example, long verandas and wide roof overhangs can be incorporated without compromising structural integrity.

h. Sustainability and Long-Term Benefits

Adopting traditional features contributes to sustainability by reducing dependence on artificial cooling and heating and lowering energy consumption. Features like windward orientation, high ceilings, and shading elements improve indoor comfort, reducing the need for air conditioning. Promoting these features can lead to long-term environmental and economic benefits.

i. Challenges and Mitigation Strategies

Despite the advantages, challenges such as cost perceptions, changing lifestyle preferences, and material shortages hinder adoption. Strategies like providing financial support for traditional construction methods, conducting skill-training workshops, and integrating these features into urban planning policies can help overcome these barriers.

6.6 Future Research

This study offers a base that can inform and support future research on traditional architecture in a contemporary context. The framework developed here, while applied specifically to Assam-type houses for climate-responsive design, can be adapted to study other traditional typologies with varied objectives. It can guide investigations into sustainability, affordability, cultural continuity, or any context-specific design goal.

Researchers can build on this process to evaluate and prioritize traditional architectural features for modern use, depending on local needs and aspirations. It also offers a reference point for developing comparative studies between different regional traditions. Future studies could also focus on the regional variations of Assam-type houses across Northeast India, which remains a rich but underexplored area. Examining these local adaptations would enhance our understanding of the typology and strengthen the relevance of findings across diverse climatic and cultural contexts. Further research may also assess the practical aspects of implementation in urban and multi-storey housing, such as material availability, construction skills, and cost-effectiveness, thereby supporting more grounded applications of traditional wisdom in today's architectural practice.

Looking ahead, the same framework can be applied to other traditional systems and across different climatic contexts to explore features related not only to climate responsiveness but others like seismic resilience, flood resistance, affordability, cultural identity etc. This flexibility allows the approach to evolve as a methodological tool for studying any traditional building type in its own environmental and social setting.

The findings of this study can also serve as a starting point for developing pilot applications or prototype houses that integrate selected features within contemporary designs. Such initiatives could help understand the practical feasibility, cost factors, and real-world performance of traditional features when adopted to contemporary contexts.

Future explorations could also include post-occupancy evaluations or selective simulation-based assessments to measure thermal comfort, ventilation efficiency, and daylight performance in buildings that incorporate these features. This would help in verifying and complementing perception-based results with measurable performance data.

The ranked list developed in this research may also be further refined into a practical toolkit or guide with drawings and construction details, for use by architects, engineers, masons, and self-builders. Presented as a flexible reference rather than a fixed checklist, it could support design decisions suited to local contexts, resources, and user needs.

Although the present study focused on climatic comfort and user perception, future work could expand the framework to include structural and seismic resilience, a defining aspect of the Assam-type house that evolved in response to recurring earthquakes. Integrating seismic analysis and economic feasibility assessments with the current climate-responsive framework would provide a more comprehensive understanding of traditional housing systems. Such interdisciplinary studies, combining architectural, structural, and financial perspectives, could strengthen the framework's applicability to policy, construction practice, and regional housing programs.

At a broader level, the research findings may inform policies and programs that promote the inclusion of traditional, climate-responsive elements in housing schemes. By aligning with sustainable housing initiatives and local planning guidelines, these insights could encourage contextually appropriate and environmentally sensitive architecture across regions.

6.7 Concluding Remarks

This study makes a significant contribution to the understanding and application of traditional architecture in the context of contemporary housing. By focusing on the Assam-type house, it highlights how traditional design features rooted in cultural knowledge and environmental sensitivity hold valuable insights for addressing climatic challenges in housing design. The research emphasizes the need for a thoughtful synthesis of traditional wisdom and modern construction practices, not merely for preservation but to enhance comfort, climate responsiveness, and contextual relevance.

Building on this foundation, the study contributes in two major ways.

First, it develops an evidence-based and replicable framework for studying traditional architecture across different regions and climates. This framework systematically combines literature, expert opinions, user perceptions, and field observations, turning diverse insights into a structured method to identify which traditional features are most suitable for contemporary use. It thus moves beyond descriptive understanding and provides a transferable process that can guide similar research or design decisions elsewhere.

Second, the research produces a prioritized list of climate-responsive features specific to Assam-type houses. This ranked list serves not as a prescriptive checklist but as a context-sensitive guide, enabling architects, homeowners, and policymakers to make informed decisions about what to adopt or adapt based on feasibility, comfort, and material availability.

Together, these contributions bridge traditional wisdom and present-day needs, showing how culturally rooted designs can remain relevant in modern contexts. The findings reaffirm the climatic intelligence embedded in India's traditional architecture while offering a structured pathway for its adaptive and sustainable integration in future housing development.

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Chapter II: Literature Study

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Chapter III: Materials and Methods

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Chapter IV: Survey and Analysis

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APPENDIX I

Additional Study: Comparative Study of Traditional and Contemporary Houses Across Climatic Zones of India

This comparative study presents an analysis of traditional and contemporary residential buildings across the different climatic zones of India. The comparison is based on key architectural aspects such as building form, site orientation, spatial arrangement, materials, climate-responsive features, and elements reflecting regional identity.




The traditional house examples were primarily drawn from literature sources, focusing on regionally rooted, traditionally architectural practices. Corresponding contemporary houses were selected from the same or nearby regions, based on publicly available online resources. Contemporary examples were sourced from real estate listings, YouTube videos (especially walk-throughs or promotional videos), and articles or magazines featuring architectural case studies. For instance, in the cold and cloudy climate zone, a traditional house from Srinagar, Kashmir, was compared with a contemporary house from the same city, as seen in a real estate video available on YouTube.

This study aims to highlight the shifts in design principles and material usage over time, and to observe the presence (or absence) of climate-responsive strategies in modern-day housing within the same environmental context.

1. Hot and Dry Climatic Zone – Jaisalmer-Jaipur, Rajasthan

SL. NO	COMPARATIVE FACTOR	TRADITIONAL HOUSE	CONTEMPORARY HOUSE	REMARKS	SOURCES
1	Form	A Haveli features ornate facades and balconies in multi storey buildings with flat roofs.	Double storey building with flat roof. No ornamentation.	Contemporary houses showcase minimal design, neat and straight lines and often without central courtyards.	https://www.instagram.com/p/CmvgWK-PQhD/?img_index=2&igsh=bThjdm4ya2RtbDNj
2	Site	Street frontage of each building is narrow to cut the heat gain.	Located on a secondary street separated by compound walls and a front yard.		
3	Spatial Arrangement	The rooms are laid around the courtyard which is main source of light and ventilation. Sometimes multiple courtyards are also present.	Open floor plan and functional spaces. Courtyard may or may not be present.		
4	Materials (Primary)	Locally available stone and timber.	Bricks, Cement, Steel		
5	Climate responsive features	Hot air rises by convection from courtyard and the cool air is channelled from the street ensuring cross ventilation. Jharokha and Chajjas are designed to shade the facade. As the buildings are clustered side by side, they cast shadow on each other keeping streets cool.	Large windows for cross ventilation.	Most contemporary buildings rely on mechanical cooling.	



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6	Features of Unique Regional Identity	Domes, Arches, carved balconies (Jharoka), Intricate ornamentation on façade reflecting a blend of Mughal and Rajput influence.	None		
7	Image				

2. Warm and Humid Climatic Zone – Kerela

SL. NO	COMPARATIVE FACTOR	TRADITIONAL HOUSE	CONTEMPORARY HOUSE	REMARKS	SOURCES
1	Form	Usually, two or more storey building with sloping roofs cover with terracotta tiles. Verandas run along the façade with visible wooden columns as support.	Two or more storey building, with either flat, sloping or partial sloping roof. Front porch/veranda may be present.	Most individual contemporary houses are built either in global architectural style or the he ‘Kerela Style’, which is based on traditional Kerala architecture but often constructed either in	നടു മുറ്റം വീടിനു പുറകിലോ കണ്ടാൽ ഞെട്ടും 2500 sqft 50ലക്ഷം രൂപക്ക് നിർമ്മിച്ച സുന്ദര ഭവനം.. (youtube.com)
2	Site	Usually, the individual houses are surrounded by compound walls with ample front and back yards to facilitate daylighting and ventilation.	Usually surrounded by compound walls with front yard. Back yard may or may not be present. Space to accommodate cars or garage usually located beside the house.	contemporary materials or a combination of contemporary and traditional materials and usually have a sloping roof with terracotta tiles or roofing sheets.	
3	Spatial Arrangement	Square or rectangular layout with a central courtyard and deep verandas around the house allows cross-ventilation in the rooms.	Open floor plan and functional spaces. Courtyard may or may not be present.		
4	Materials (Primary)	Granite is used for foundation, laterite is for walls, timber is for wall facing and roof frame, Mangalore tiles are for roofing.	Brick, stone, cement, roofing sheet or terracotta tiles.		

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5	Climate responsive features	Sloping roof, deep eaves and elevated floors are provided to protect from the heavy rain-fall of the region. Large windows are used for air circulation.	Large openings for cross ventilation, in some houses sloping roofs are used. Chajjas above openings used for shading and prevent rain entering inside.		
6	Features of Unique Regional Identity	Central courtyards with intricate wooden columns supporting the roof. Intricate woodwork in doors and windows, terracotta tiles used for sloping roofs.	Some houses use terracotta roofing tiles and jalīs.	Contemporary houses have simple facades with no ornamentation.	
7	Image				

3. Moderate Climatic Zone – Pune, Maharashtra

SL. NO	COMPARATIVE FACTOR	TRADITIONAL HOUSE	CONTEMPORARY HOUSE	REMARKS	SOURCES
1	Form	The traditional Wadas are two or three storey buildings with sloping tiled roofs. Façade is characterised by wooden or stone pillars, intricate carvings, balconies with wooden railings.	Double storey building with flat roof. No ornamentation. Balconies may be present.	Some contemporary individual houses have small front yards and side yards.	https://youtu.be/rd-Uj3KJnF4?si=zksSBzv3O782O6zX
2	Site	Usually located adjacent to the road. Some wadas may have the lower floor for commercial activities.	May be located adjacent to streets within compound walls or larger residential compounds.		Alapure, George and Bhattacharya, 2015
3	Spatial Arrangement	Typically have square or rectangular layouts with a central courtyard. Courtyard	Open plan with lesser partition walls. No central courtyard.		

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Study of Assam-Type Houses**


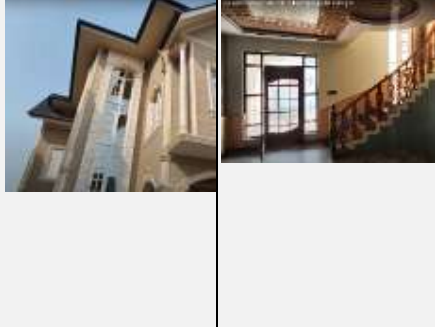
		<p>serves as a gathering space.</p>			
4	Materials (Primary)	Stone, Brick, Wood, Lime plaster	Bricks, Cement, Steel		
5	Climate responsive features	Deep eaves for shading, Central courtyard provides natural ventilation and light to all surrounding rooms.	Large windows for cross ventilation and natural light.		
6	Features of Unique Regional Identity	Central courtyard, Wooden pillars and ornate balconies (Jharokas).	None		
7	Image				

4. Cold and Cloudy Zone – Traditional Architecture - Srinagar, Kashmir

SL. NO	COMPARATIVE FACTOR	TRADITIONAL HOUSE	CONTEMPORARY HOUSE	REMARKS	SOURCES
1	Form	Two or three storey houses with sloped roofs covered in wooden shingles or CGI sheets, with long eaves. Projecting windows and balconies with intricate carvings.	Double storey independent house with multiple sloping roof covered in GI sheets. Glazed wooden doors and windows and external walls are clad with tiles.		https://iitk.ac.in/nicee/wcee/article/14_09-02-0008.pdf

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2	Site	Often built on elevated or sloping ground with spacious front yards for gardens, courtyards and ancillary structures like storage sheds or livestock pens. Integrated with natural surroundings.	Located adjacent to the street. Front yards are often present with landscaping if possible. The plot is usually enclosed with brick compound walls, and has single or double car parking space within. Servant's quarter may be present.		https://www.youtube.com/watch?v=QI5-Xxs5LIQ
3	Spatial Arrangement	Ground floor typically features living quarters, kitchen and storage while upper floors accommodate the bedrooms.	Open floor plan. Ground floor consists of living-dining rooms, kitchen, guest bedrooms while upper floors are left for bedrooms and study.		
4	Materials (Primary)	Timber, brick, stone, wooden shingles, CGI sheets	Brick, reinforced concrete, GI sheets, wood (for doors, windows and railings)		
5	Climate responsive features	Sloping roof to drain off snow and rain, thick walls provide insulation, large windows and balconies located appropriately, provide maximum sunlight exposure.	Sloping roof to drain off rain and snow. Large windows for cross ventilation.	Contemporary houses often use modern insulation methods.	
6	Features of Unique Regional Identity	Sloping roofs with wooden shingles, intricate wood work on railings, bargeboards, balconies.	Retention of traditional Kashmiri motifs and wooden carvings, usually for railings and door panels.	The contemporary wooden carvings are usually more streamlined, and sometimes are minimal in design compared to traditional ones. Carved wooden false ceilings are also used often.	

7	Image			https://scroll.in/magazine/837729/how-traditional-kashmiri-architecture-was-designed-to-withstand-even-severe-tremors
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5.Cold and Sunny Zone – Traditional Architecture – Leh, Ladakh

SL. NO	COMPARATIVE FACTOR	TRADITIONAL HOUSE	CONTEMPORARY HOUSE	REMARKS	SOURCES
1	Form	The houses in Ladakh typically consist of two to four stories, with stone foundations, low walls and a flat roof supported by wooden beams. Windows are generally small and decorated with wooden carvings. The houses often feature balconies towards the south or west.	Usually consists of two to three storeys, with flat roofs and balconies positioned based on convenience. Wooden carvings are used on windows most of the times, and sometimes on the doors.		Edoardo Paolo Ferrari, High altitude Vernacular Architecture of Ladakh
2	Site	Traditional houses in Ladakh are situated in high-altitude regions, these sites are typically nestled among valleys. The sites often exhibit a harmonious integration of architecture with the surrounding topography.	Houses in urban areas are located along streets and usually surrounded by compound walls.	The site for contemporary houses depends on the real estate value of the locality it is located in. Some houses may directly open to streets and are without compound walls.	
3	Spatial Arrangement	Houses are not always built with a regular shape, as they are often adapted to the terrain, allowing for flexibility in adding new rooms or	Contemporary houses often have open flexible layouts with integrated spaces. Balconies and terraces are used		

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		<p>storeys based on the family's needs.</p> <p>Larger homes are built around a courtyard, whereas smaller homes are not. The Ground Floor is usually a dwarf floor that is not intended for human use. It serves as a holding area for cattle, as well as a storage facility and a collection point for lavatory waste.</p>	to maximize natural light.		
4	Materials (Primary)	Unbaked bricks, rammed earth, stone, wood	Concrete blocks, steel, wood	Stone is also utilized in some areas where it is readily available, although its use is limited to locations where transportation costs are not prohibitive.	
5	Climate responsive features	Thick masonry walls made of local materials like mud provide excellent thermal mass, The orientation of the houses is carefully planned to maximize solar gain, Flat roofs are a common feature in Ladakhi architecture, serving as additional living spaces during the warmer months and allowing for the collection of rainwater or snowmelt for domestic use, small windows help to minimize heat loss.	Insulating materials for walls, solar panels on roof or terrace, flat roofs.		



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6	Features of Unique Regional Identity	Compact form with thick walls and small windows, windows and doors decorated with intricate wooden carvings.	Wooden carving on windows is a common feature.		
7	Image				https://www.youtube.com/watch?v=z4_HUrPOCVs https://df0b18phdhzpx.cloudfront.net/ckeditor_assets/pictures/1383648/original_hhll.JPG

6. Composite Zone – Traditional Architecture - Delhi

SL. NO	COMPARATIVE FACTOR	TRADITIONAL HOUSE	CONTEMPORARY HOUSE	REMARKS	SOURCES
1	Form	Usually, double storey buildings with ornate facades, carved wooden doors and windows, balconies and ornated brackets.	Usually, multi storey buildings with terrace and balconies.		Jaikumar, P. (2017). Haveli: A Cinematic Topos. positions, [online] 25(1), p.223. Available at: https://www.academia.edu/33280691/Haveli_A_Cinematic_Topos [Accessed 30 May 2024].
2	Site	Typically, do not have front yards, and instead the havelis open into narrow streets. They may be enclosed in high compound walls or sometimes these are planned in a way such that the building walls itself act like compound walls.	Typically opens to narrow streets or sidewalks, may have compound walls and small front yards. Parking space or garage is located within compound walls if possible.	The site of individual contemporary houses depends on the real estate demand of the location as well as budget of construction.	जड़ से अपना घर/villa at wave city/approved property/independent house in Delhi ncr/real estate vlog (youtube.com)
3	Spatial Arrangement	Usually feature a central courtyard surrounded by interconnected rooms. The ground floor contains the public spaces while living quarters are located on	Open floor plan. Ground floor consists of living-dining rooms, kitchen, guest bedrooms while upper floors are left for bedrooms and study.		

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		the upper floors. Semi open verandas provide the transitional spaces between courtyards and rooms.			
4	Materials (Primary)	Sandstone, brick, wood, marble, iron and brass.	Brick, reinforced cement, steel, glass		
5	Climate responsive features	Central courtyard for air circulation, thick walls provide thermal mass keeping interiors cool in summer and warm in winter, high ceiling reduces heat accumulation, balconies and verandas offer shading, small windows and lattice work minimize sunlight while allowing air flow.	Shading devices, solar panels, cross ventilation are seen in some houses.	The climate responsive features in contemporary houses are not consistent and mostly depends on the available space and facility as well as budget of the construction.	
6	Features of Unique Regional Identity	Ornated facades, balconies and jali (lattice work), Courtyard layout.	None		https://indianexpress.com/article/lifestyle/food-wine/haveli-dharampura-brings-in-fine-dining-mughal-style-to-delhi-6-chandni-chowk-old-delhi/
7	Image				

The comparison shows that different climatic regions also have different traditional dwellings such as Jaisalmer-Jaipur, Kerala, Pune and the like that resonate each region's climatic conditions in minute architectural elements. Its traditional homes possess sloping roofs that are laid with terracotta tiles and have been cleverly designed to combat the warm and humid environment of the region. These masterpieces of architecture combine the use

of climatic responsive elements such as central courtyards provide for optimum natural ventilation and cross-ventilation, in built robust walls act as thermal masses and shading devices are strategically placed to control temperature allowing comfort in extremely hot summers and cold winters alike. These houses show an understanding of the microclimates and the architectural heritage of the areas in which they exist, placing traditional homesteads vigorously to their surroundings.

In contrast, a contemporary house in many different climates can have similar or almost identical architectural designs with only minor changes. These houses frequently prioritize sleek aesthetics and practical utility over climate responsiveness, resulting in a uniform aesthetic regardless of geographic location. Where contemporary houses might address specific climatic design elements such as shading devices and cross-ventilation, the level of integration will inevitably vary and be subject to such influences as site orientation, land use planning considerations and cost of development. In conclusion, traditional dwellings distinguish themselves through their unique architectural features tailored to specific climates, embodying a strong commitment to climate responsiveness. Meanwhile, contemporary houses exhibit a degree of architectural homogeneity and may not consistently prioritize climate-responsive design elements to the same degree as their traditional counterparts.

APPENDIX II

Survey Questionnaires and Supporting Visuals

A. Expert Opinion Survey- I Questionnaire

3/2/25, 1:57 AM

Qualtrics Survey Software

Default Question Block

In recent years, the need for climate-responsive architecture has become increasingly critical as we face the challenges posed by climate change. Traditional architecture, with its rich history of climate adaptive designs offers valuable insights. This study seeks to explore which features of traditional architecture can be integrated into modern architectural practices to enhance their climate responsiveness. The purpose of this survey is to gather expert recommendation on the specific building element-attribute combination of traditional architecture that can be adopted to contemporary architectural designs to achieve better climate responsive quality.

Please provide the following details :

Name

Specification

Location

E-mail

Block 1

Instruction : For each traditional building element and it's respective attributes listed below, please indicate your recommendation for their adoption in contemporary buildings for a climate responsive design. For example, if you think that the 'Primary materials' used in the 'Walls' of traditional buildings should be used in contemporary buildings too, to achieve climate responsiveness then it should be 'Strongly recommended'.

The traditional building elements are listed in the first column and attributes in the top row. Please select one option for each attribute based on your understanding.

Please leave it unanswered if any attribute is not applicable to the corresponding building element.

	Form / shape			Primary materials			Size / dimensions			Color / finish			Passive design features			Location / site			Specialty/region features		
	Strongly Recommended	Somewhat Recommended	Do Not recommend	Strongly Recommended	Somewhat Recommended	Do Not recommend	Strongly Recommended	Somewhat Recommended	Do Not recommend	Strongly Recommended	Somewhat Recommended	Do Not recommend	Strongly Recommended	Somewhat Recommended	Do Not recommend	Strongly Recommended	Somewhat Recommended	Do Not recommend	Strongly Recommended	Somewhat Recommended	Do Not recommend
Structural System	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Roof system	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Wall system	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Ceiling	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Floor	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Doors	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Windows	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Stairs	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Basement / attic	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Compound wall	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Site plan	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Orientation	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

B. Expert Opinion Survey- II Questionnaire

Expert Opinion Survey - 2

Expert Mapping of Traditional Building Element-Attribute Combinations (Parameters) to Traditional features of Assam-Type Houses

This survey seeks your expert input to map specific combinations of building elements and their corresponding attributes to traditional features found in Assam-type houses.

A total of 44 such combinations have been derived from prior analysis. Your responses will help in identifying real, context-specific features that embody these combinations in traditional Assam-type architecture.

Your valuable inputs will contribute toward developing a framework for integrating traditional knowledge into contemporary designs.

* Indicates required question

For the given list of combinations , kindly provide the feature(s) of Assam-type houses that correspond to each combination, based on your knowledge and experience. You may skip a combination if unsure or write "Not sure."

1. 1. Structural system – Passive design features *

2. 2. Roof system - Passive design features *

3. 3. Roof system - Unique regional features *

4. 4. Orientation - Unique regional features *

5. 5.Spatial layout - Passive design features *

6. 6.Orientation - Passive design features *

Note: The rest of the questions follow the same format and are excluded from the Annexure for brevity.

C1. User Perception Survey Questionnaire: Traditional Assam-Type House Users

3/20/25, 2:01 AM

Traditional Assam Type House - User Perception Questionnaire

Traditional Assam Type House - User Perception Questionnaire

The questionnaire aims to gather your views on climate responsive features of traditional Assam-type houses and understand your opinion in adopting these features in modern houses.

The information will be used solely for academic research and your response will remain confidential.

এই প্রশ্নাবলীৰ লক্ষ্য হৈছে পৰম্পৰাগত অসম প্ৰকাৰৰ ঘৰৰ জলবায়ু প্ৰতি সহায়ী জনোৱা বৈশিষ্ট্যসমূহৰ ওপৰত আপোনাৰ মতামত সংগ্ৰহ কৰা আৰু আধুনিক ঘৰত এই বৈশিষ্ট্যসমূহ গ্ৰহণ কৰাৰ ক্ষেত্ৰত আপোনাৰ মতামত বুজা।

তথ্যসমূহ কেৱল শৈক্ষিক গৱেষণাৰ বাবে ব্যৱহাৰ কৰা হ'ব আৰু আপোনাৰ সহায়ী গোপনীয় হৈ থাকিব।

* Indicates required question

Respondent Information

1. Name / নাম

2. Location / স্থান

3. Age / বয়স *

4. Duration of stay in traditional Assam Type House(in Years) / বসবাসৰ সময়সীমা (বছৰত) পৰম্পৰাগত অসম টাইপৰ ঘৰত *

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Traditional Assam Type House - User Perception Questionnaire

5. How many floors is your house? (Enter single floor, if you have only ground floor, double floor if you have ground + first floor and so on) / আপোনাৰ ঘৰটো কিমান মহলীয়া?(যদি আপোনাৰ কেৱল তলৰ মহলা আছে তেন্তে এককত নিৰ্বাচন কৰক, যদি আপোনাৰ তলৰ + প্ৰথম মহলা আছে তেন্তে দুমহলীয়াত নিৰ্বাচন কৰক) *

Mark only one oval.

- Single floor / এক মহলীয়া
 Double floor / দুমহলীয়া
 Other: _____

General Comfort

Please answer all questions based on your personal experience. / অনুগ্রহ কৰি আপোনাৰ ব্যক্তিগত অভিজ্ঞতাৰ ভিত্তিত সকলো প্ৰশ্নৰ উত্তৰ দিব।

6. During summer, how does it feel inside your house ? (Without fan or AC) / গৰমৰ দিনত আপোনাৰ ঘৰৰ ভিতৰত কেনে অনুভৱ কৰে ? (ফেন বা এচি অবিহনে) *

Mark only one oval.

- Cool / শীতল
 Warm / অলপ গৰম
 Hot /অতি গৰম

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Traditional Assam Type House - User Perception Questionnaire

7. In Summer, how often do you use each of these to keep your house cool? *
- / গ্ৰীষ্মকালত আপুনি আপোনাৰ ঘৰটো ঠাণ্ডা কৰি ৰাখিবলৈ এইবোৰৰ প্ৰতিটো কিমান সঘনাই ব্যৱহাৰ কৰে?

Mark only one oval per row.

	Never / কেতিয়াও নহয়	Sometimes / কেতিয়াবা	Often / প্ৰায়ে	Always / সকলো সময়তে
Fan / পাংখা	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
AC / এ চি	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Natural Ventilation (like open windows and doors) / প্ৰাকৃতিক বায়ু চলাচল (খোলা খিৰিকী আৰু দুৱাৰৰ পৰা)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

8. Does your house get enough fresh air from open windows and doors to stay cool in summer and dry in winter? *
- / আপোনাৰ ঘৰত খোলা খিৰিকী আৰু দুৱাৰৰ পৰা গৰমৰ দিনত ঠাণ্ডা আৰু শীতকালত শুকান হৈ থাকিবলৈ পৰ্যাপ্ত পৰিমাণে শুদ্ধ বতাহ পায়নে?

Mark only one oval.

- Yes / হয়
- No / নহয়

3/20/25, 2:01 AM

Traditional Assam Type House - User Perception Questionnaire

9. During winter days, how does it feel inside your house ? (without heater) / শীতৰ দিনত আপোনাৰ ঘৰৰ ভিতৰত কেনে অনুভৱ কৰে? (হিটাৰ অবিহনে) *

Mark only one oval.

- Warm / উষ্ণ
 Slightly Cold / অলপ ঠাণ্ডা
 Very Cold / বৰ ঠাণ্ডা

10. Does your house stay dry and comfortable during the rainy season ? / বাৰিষাৰ সময়ত আপোনাৰ ঘৰখন শুকান আৰু আৰামদায়ক হৈ থাকে নেকি ? *

Mark only one oval.

- Yes / হয়
 No / নহয়

11. Do you need to use lights during the day, even when it is bright outside? / বাহিৰত পোহৰ হ'লেও দিনত লাইট ব্যৱহাৰ কৰিব লাগেনে? *

Mark only one oval.

- Yes / হয়
 No / নহয়

House Design Features

Please answer all questions based on your experience and understanding. / অনুগ্রহ কৰি আপোনাৰ অভিজ্ঞতা আৰু বুজাবুজিৰ ভিত্তিত সকলো প্ৰশ্নৰ উত্তৰ দিব।

12. 1. Do you feel the pitched/gable roof is helpful in keeping your house cooler? / আপুনি ভাবিছেনে যে আপোনাৰ ঘৰটো ঠাণ্ডা কৰি ৰখাত ঢালযুক্ত চালখনে সহায়ক?

Mark only one oval.

- Yes / হয়
 No / নহয়

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Traditional Assam Type House - User Perception Questionnaire

13. 2. Do you think a thatch or CGI sheets on the roof help keep the house cooler than a concrete roof? / চালত খেৰ বা চিজিআই টিনে, চিমেন্টৰ ছাদতকৈ ঘৰটো ঠাণ্ডা কৰি ৰখাত সহায় কৰে বুলি আপুনি ভাবেনে?

Mark only one oval.

- Yes / হয়
 No / নহয়

14. 3. Do you feel that the wide roof edges (roof overhangs) help in reducing direct sunlight and heat inside your home? / আপুনি অনুভৱ কৰেনে যে বহল ছাদৰ প্ৰান্ত (ছাদৰ সম্প্ৰসাৰণ)ই আপোনাৰ ঘৰৰ ভিতৰত প্ৰত্যক্ষ সূৰ্যৰ পোহৰ আৰু তাপ কমোৱাত সহায় কৰে?



Roof Overhang /
ছাদৰ সম্প্ৰসাৰণ

Mark only one oval.

- Yes / হয়
 No / নহয়

15. 4. Do you have a ceiling? / আপোনাৰ চিলিং আছে নেকি?

Mark only one oval.

- Yes / হয়
 No / নহয়

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Traditional Assam Type House - User Perception Questionnaire

16. 5. Do you think that having a high ceiling helps in keeping the inside of your house cooler? / আপুনি ভাবেনে যে ওখ চিলিং থাকিলে আপোনাৰ ঘৰৰ ভিতৰখন ঠাণ্ডা কৰি ৰখাত সহায় কৰে?

Mark only one oval.

- Yes / হয়
 No / নহয়

17. 6. Do you feel the bamboo or wood ceilings contribute to keeping your house cooler? / বাঁহ বা কাঠৰ চিলিং আপোনাৰ ঘৰখন ঠাণ্ডা কৰি ৰখাত অৰিহণা যোগায় বুলি অনুভৱ কৰেনে?

Mark only one oval.

- Yes / হয়
 No / নহয়

18. 7. Do you think the high ventilators on the walls help cool the interior of your home? / বেৰৰ ওপৰৰ ওচৰৰ ভেণ্টিলেটৰবোৰে আপোনাৰ ঘৰৰ ভিতৰৰ অংশ ঠাণ্ডা কৰাত সহায় কৰে বুলি আপুনি ভাবেনে?

Mark only one oval.

- Yes / হয়
 No / নহয়

19. 8. Do you think having windows located opposite each other helps in cooling and better air flow? / আপুনি ভাবেনে যে খিৰিকীবোৰ ইটোৱে সিটোৰ বিপৰীতে স্থাপন কৰিলে ঠাণ্ডা হোৱা আৰু বায়ুৰ প্ৰবাহ ভাল হোৱাত সহায় কৰে?

Mark only one oval.

- Yes / হয়
 No / নহয়

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Traditional Assam Type House - User Perception Questionnaire

20. 9. Do you think the size and shape of your windows are sufficient to allow natural light and air flow? / আপুনি ভাবিছেনে যে আপোনাৰ খিৰিকীৰ আকাৰ আৰু আকৃতি সূৰ্য্যৰ পোহৰ আৰু বায়ু প্ৰবাহিত হ'বলৈ যথেষ্ট?

Mark only one oval.

- Yes / হয়
 No / নহয়

21. 10. Do you think having a brick wall at the bottom and bamboo-ikora wall above it, helps in stability of the wall during heavy winds ? / তলত ইটাৰ বেৰ আৰু ওপৰত বাঁহ-ইকোৰাৰ বেৰ থাকিলে প্ৰচণ্ড বতাহ আৰু বৰষুণৰ সময়ত বেৰখনৰ স্থিৰতাত সহায় কৰে বুলি আপুনি ভাবেনে ?

Mark only one oval.

- Yes / হয়
 No / নহয়

22. 11. Do you believe that the traditional materials used in walls (like mud, bamboo, ikora) help in regulating indoor temperature? / বেৰত ব্যৱহাৰ কৰা পৰম্পৰাগত সামগ্ৰী (যেনে বোকা, বাঁহ, ইকোৰা) ঘৰৰ ভিতৰৰ উষ্ণতা নিয়ন্ত্ৰণ কৰাত সহায় কৰে বুলি আপুনি বিশ্বাস কৰেনে?

Mark only one oval.

- Yes / হয়
 No / নহয়

23. 12. Do you think the wide verandas contribute to better airflow and cooling? / বহল বাৰাণ্ডাবোৰে বায়ু প্ৰবাহ আৰু শীতলতা উন্নত কৰাত অৰিহণা যোগায় বুলি আপুনি ভাবেনে?

Mark only one oval.

- Yes / হয়
 No / নহয়

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Traditional Assam Type House - User Perception Questionnaire

24. 13. Do you think long verandas around the house helps in shading the walls and keeps it cooler ? / ঘৰৰ চাৰিওফালে দীঘলীয়া বাৰাণ্ডাই বেৰবোৰ ছাঁ দিয়াত সহায় কৰে আৰু ঠাণ্ডা কৰি ৰাখে বুলি আপুনি ভাবেনে ?

Mark only one oval.

- Yes / হয়
 No / নহয়

25. 14. Do your main rooms, like the bedroom and living room, feel warm in winter from sunlight and stay cool and shaded in summer? / আপোনাৰ মূল কোঠাবোৰ, যেনে শোৱা কোঠা আৰু বহা কোঠা, শীতকালত সূৰ্যৰ পোহৰৰ পৰা গৰম অনুভৱ হয় আৰু গ্ৰীষ্মকালত ঠাণ্ডা আৰু ছাঁযুক্ত হৈ থাকেনে?

Mark only one oval.

- Yes / হয়
 No / নহয়

26. 15. How is your house oriented ? / আপোনাৰ ঘৰ কোন দিশলৈ মুখ কৰে ?

Mark only one oval.

- East Facing / পূব
 West Facing / পশ্চিমে
 North Facing / উত্তৰদিশ
 South Facing / দক্ষিণ
 Other: _____

27. 16. Based on the direction that your house faces ,do you get good airflow or breeze inside the house ? / আপোনাৰ ঘৰৰ মুখৰ দিশৰ ওপৰত ভিত্তি কৰি ,ঘৰৰ ভিতৰত ভাল বায়ু প্ৰবাহ বা বতাহ পায় নে ?

Mark only one oval.

- Yes / হয়
 No / নহয়

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Traditional Assam Type House - User Perception Questionnaire

28. 17. Do you think the raised plinth of your house is necessary to protect the house during heavy rains or floods? / প্রচণ্ড বৰষুণ বা বানপানীৰ সময়ত ঘৰখনক সুৰক্ষা দিবলৈ আপোনাৰ ঘৰৰ উঠা প্লিন্থ / মজিয়া টো প্ৰয়োজনীয় বুলি আপুনি ভাবেনে?

Mark only one oval.

- Yes / হয়
 No / নহয়

29. 18. Do you think that mud plastered and cement plastered floors helps keep your home cooler? / মাটিৰ লেপ কৰা আৰু চিমেণ্টেৰে প্লাষ্টাৰ কৰা মজিয়াই আপোনাৰ ঘৰখন ঠাণ্ডা কৰি ৰখাত সহায় কৰে বুলি আপুনি ভাবেনে?

Mark only one oval.

- Yes / হয়
 No / নহয়

30. 19. Do you feel that the presence of a courtyard or backyard help in cooling your house and draining rain water ? / চোতাল বা পিছফালৰ চোতালৰ উপস্থিতিয়ে আপোনাৰ ঘৰখন ঠাণ্ডা কৰি বৰষুণৰ পানী নিষ্কাশন কৰাত সহায় কৰে বুলি অনুভৱ কৰেনে ?

Mark only one oval.

- Yes / হয়
 No / নহয়

31. 20. Does vegetation around the house improve comfort by providing shade and cooling? / ঘৰৰ চাৰিওফালে থকা গছ-গছনিয়ে ছাঁ আৰু শীতলতা প্ৰদান কৰি আৰাম বৃদ্ধি কৰেনে?

Mark only one oval.

- Yes / হয়
 No / নহয়

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Traditional Assam Type House - User Perception Questionnaire

32. 21. Do you feel a pale colour palette of the house help in reducing heat in the house?
/ ঘৰৰ শেঁতা ৰঙৰ পেলেটে ঘৰৰ তাপ কমোৱাত সহায় কৰে বুলি অনুভৱ কৰেনে?

Mark only one oval.

- Yes / হয়
 No / নহয়

33. 22. Do you think the elongated shapes of Assam Type houses helps with better air flow?
/ অসম টাইপৰ ঘৰৰ দীঘলীয়া আকৃতিয়ে বায়ুৰ প্ৰবাহ ভাল হোৱাত সহায় কৰে বুলি আপুনি ভাবেনে?

Mark only one oval.

- Yes / হয়
 No / নহয়

34. OPTIONAL - If you are comfortable, please upload an exterior picture of your house that shows the architectural features like roof style, plinth height or materials. This image will help me to better understand the architectural characteristics. All images will remain confidential and will be used solely for research purpose. / ঐচ্ছিক - যদি আপুনি আপত্তি নকৰে তেন্তে আপোনাৰ ঘৰৰ বাহিৰৰ ছবি এখন আপলোড কৰক য'ত ছাদৰ আকৃতি, মজিয়াৰ উচ্চতা, দুৱাৰ আৰু খিৰিকী আদিৰ দৰে স্থাপত্যৰ বৈশিষ্ট্যসমূহ দেখুওৱা হৈছে। এই ছবিখনে মোক স্থাপত্যৰ বৈশিষ্ট্যসমূহ ভালদৰে বুজিবলৈ সহায় কৰিব। সকলো ছবি গোপনীয় হৈ থাকিব আৰু কেৱল গৱেষণাৰ উদ্দেশ্যে ব্যৱহাৰ কৰা হ'ব।

Files submitted:

Willingness to Adopt Traditional Features

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Traditional Assam Type House - User Perception Questionnaire

35. What traditional features would you consider adopting if you have to build a new house? / নতুন ঘৰ সাজিবলগীয়া হ'লে কি কি পৰম্পৰাগত বৈশিষ্ট্য গ্ৰহণ কৰাৰ কথা চিন্তা কৰিব? *

Mark only one oval per row.

	Very Willing / অতি ইচ্ছুক	Willing / ইচ্ছুক	Not Willing / ইচ্ছুক নহয়
Sloping Roof / ঢাল খোৱা ঢাল	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Bamboo/ Ikora/ Wood walls / বাঁহ, কাঠ, ইকৰা দেৱাল	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Raised Plinth or floor / উচ্চ ঘৰৰ ভেটি/ মজিয়া	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Courtyard , Backyard/ চোতাল , পিছফালৰ চোতাল	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Wide roof edges (large overhangs)/ ঢালৰ বৃহৎ বৰ্ধিত অংশ	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Wide open/ semi open verandas / বহল মুকলি/ অৰ্ধ মুকলি বাবাণ্ডা	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Bamboo or Wood Ceiling / বাঁহ বা কাঠৰ চিলিং	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Wooden open tread Stairs / মুক্ত কাঠৰ চিৰি	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

<https://docs.google.com/forms/d/1n5lgaAUtzS84z-m7P9ecHyaiFruaNYJkDyA8lMAa4N0/edit>

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Traditional Assam Type House - User Perception Questionnaire

Wood or Bamboo low height compound wall / কাঠ বা বাঁহৰ কম উচ্চতাৰ সীমানা প্রাচীৰ	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Cement/ mud plastered floor / চিমেন্ট/ মাটিৰ প্ৰাষ্টাৰ কৰা মজিয়া	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Elongated shape of house / ঘৰৰ দীঘলীয়া আকৃতি	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Symmetrically laid rooms in the house / ঘৰত প্ৰতিসমভাৱে নিৰ্মাণ কৰা কোঠা	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

36. What do you think is the reason that Traditional Assam Type houses are rarely built nowadays? / আজিকালি পৰম্পৰাগত অসম টাইপৰ ঘৰ খুব কমেইহে নিৰ্মাণ হোৱাৰ কাৰণ কি বুলি আপুনি ভাবে?

Check all that apply.

- Cost of implementation / কাৰ্যকৰীকৰণৰ খৰচ
- Ignorance about how traditional Assam Type houses stay comfortable and suit the climate/ পৰম্পৰাগত অসম টাইপৰ ঘৰবোৰ কেনেকৈ আৰামদায়ক হৈ থাকে আৰু জলবায়ুৰ লগত খাপ খাই থাকে সেই বিষয়ে অজ্ঞানতা
- Non-availability of materials/ সামগ্ৰীৰ অনুপলব্ধতা
- Not good to look at / চাবলৈ ভাল নহয়
- Concerns about maintenance / বৰ্দ্ধণাবেৰ্দ্ধণৰ বিষয়ে চিন্তা
- Non-availability of skilled labor / দক্ষ শ্ৰমিকৰ অনুপলব্ধতা
- Just because everyone else is building in RCC/ কাৰণ বাকী সকলোৱে আৰু চি চিত নিৰ্মাণ কৰি আছে
- Other: _____

Investigating Traditional Architecture for Contemporary Use: Analysis of Climatic Aspects through Perception Study of Assam-Type Houses

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Traditional Assam Type House - User Perception Questionnaire

37. If given an opportunity, which type of house would you like to live in ?

Mark only one oval.

- Traditional Assam Type House / পৰম্পৰাগত অসম প্ৰকাৰৰ ঘৰ
- Contemporary House / Apartment / আধুনিক ঘৰ / এপাৰ্টমেণ্ট
- Modern house with features of Assam Type house for more natural comfort / অধিক প্ৰাকৃতিক আৰামৰ বাবে অসম টাইপৰ ঘৰৰ বৈশিষ্ট্য থকা আধুনিক ঘৰ

Thank you for your time and insights. Your responses are invaluable for this research.
আপোনাৰ সময় আৰু অন্তৰ্দৃষ্টিৰ বাবে ধন্যবাদ। এই গৱেষণাৰ বাবে আপোনাৰ সঁহাৰি অমূল্য।

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C2. User Perception Survey Questionnaire: Contemporary House Users

Contemporary (RCC) House in Assam - User Perception Survey

The questionnaire aims to seek your views on design features of contemporary/modern houses in Assam and your perspective on traditional Assam Type houses in a context of climate responsiveness and comfort.

The information will be used solely for academic research and your response will remain confidential. / প্রশ্নাবলীৰ লক্ষ্য হৈছে অসমৰ সমসাময়িক ঘৰৰ ডিজাইন বৈশিষ্ট্য আৰু জলবায়ুৰ প্ৰতি সঁহাৰি আৰু আৰামৰ প্ৰেক্ষাপটত পৰম্পৰাগত অসম প্ৰকাৰৰ ঘৰৰ প্ৰতি আপোনাৰ দৃষ্টিভংগী বিচাৰি উলিওৱা।

তথ্যসমূহ কেৱল শৈক্ষিক গৱেষণাৰ বাবে ব্যৱহাৰ কৰা হ'ব আৰু আপোনাৰ সঁহাৰি গোপনীয় হৈ থাকিব।

* Indicates required question.

Respondent Information

1. Name / নাম

2. Location / স্থান

3. Age/ বয়স *

4. Duration of stay (In years)/ বসবাসৰ সময়সীমা (বছৰত) *

5. How many floors is your house? / আপোনাৰ ঘৰটো কিমান মহলায়া? *

Mark only one oval.

1

2

Other: _____

Investigating Traditional Architecture for Contemporary Use: Analysis of Climatic Aspects through Perception Study of Assam-Type Houses

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Contemporary (RCC) House in Assam - User Perception Survey

General Comfort

Please answer all questions based on your personal experience. / অনুগ্রহ কৰি আপোনাৰ ব্যক্তিগত অভিজ্ঞতাৰ ভিত্তিত সকলো প্ৰশ্নৰ উত্তৰ দিব।

6. During summer, how does it feel inside your house ? (Without fan or AC) / গৰমৰ দিনত আপোনাৰ ঘৰৰ ভিতৰত কেনে অনুভৱ কৰে ? (ফেন বা এচি অবিহনে)

Mark only one oval.

- Cool / শীতল
 Warm / অলপ গৰম
 Hot / অতি গৰম

7. In Summer, how often do you use each of these to keep your house cool? / গ্ৰীষ্মকালত আপুনি আপোনাৰ ঘৰটো ঠাণ্ডা কৰি ৰাখিবলৈ এইবোৰৰ প্ৰতিটো কিমান সঘনাই ব্যৱহাৰ কৰে? *

Mark only one oval per row.

	Never / কেতিয়াও নহয়	Sometimes / কেতিয়াবা	Often / প্ৰায়ে	Always / সকলো সময়তে
Fan / পাংখা	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
AC / এচি	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Natural Ventilation (like open windows and doors) / প্ৰাকৃতিক বায়ু চলাচল (খোলা খিৰিকী আৰু দুৱাৰৰ পৰা)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Investigating Traditional Architecture for Contemporary Use: Analysis of Climatic Aspects through Perception Study of Assam-Type Houses

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Contemporary (RCC) House in Assam - User Perception Survey

8. Does your house get enough fresh air from open windows and doors to stay cool in summer and dry in winter? / আপোনাৰ ঘৰত খোলা খিৰিকী আৰু দুৱাৰৰ পৰা গৰমৰ দিনত ঠাণ্ডা আৰু শীতকালত শুকান হৈ থাকিবলৈ পৰ্যাপ্ত পৰিমাণে শুদ্ধ বতাহ পায়নে?

Mark only one oval.

- Yes / হয়
 No / নহয়

9. During winter days, how does it feel inside your house ? (without heater) / শীতৰ দিনত আপোনাৰ ঘৰৰ ভিতৰত কেনে অনুভৱ কৰে? (হিটাৰ অবিহনে)

Mark only one oval.

- Warm / উষ্ণ
 Slightly Cold / অলপ ঠাণ্ডা
 Very Cold / বৰ ঠাণ্ডা

10. Does your house stay dry and comfortable during the rainy season ? / বাৰিষাৰ সময়ত আপোনাৰ ঘৰখন শুকান আৰু আৰামদায়ক হৈ থাকে নে ?

Mark only one oval.

- Yes / হয়
 No / নহয়

11. Do you need to use lights during the day even when it is bright outside? / বাহিৰত পোহৰ হ'লেও দিনত লাইট ব্যৱহাৰ কৰিব লাগেনে?

Mark only one oval.

- Yes / হয়
 No / নহয়

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Contemporary (RCC) House in Assam - User Perception Survey

12. Do you think that Traditional Assam-Type houses which rely on natural cooling and lighting features are more comfortable, compared to contemporary/modern houses (which often require fan, AC , Heater etc)? / আপুনি ভাবেনে যে প্ৰাকৃতিক শীতলতা আৰু পোহৰৰ বৈশিষ্ট্যৰ ওপৰত নিৰ্ভৰশীল পৰম্পৰাগত অসম-টাইপৰ ঘৰবোৰ আধুনিক ঘৰৰ তুলনাত (যিবোৰত প্ৰায়ে ফেন, এচি , হিটাৰ আদিৰ প্ৰয়োজন হয়) অধিক আৰামদায়ক?

Mark only one oval.

- Yes / হয়
 No / নহয়

House Design Features

Please answer all questions based on your experience and understanding. / অনুগ্ৰহ কৰি আপোনাৰ অভিজ্ঞতা আৰু বুজাবুজিৰ ভিত্তিত সকলো প্ৰশ্নৰ উত্তৰ দিব।

13. 1.What type of roof does your house have ? / আপোনাৰ ঘৰৰ চাল কেনেধৰণৰ? *

Mark only one oval.

- Sloping / ঢাল খোৱা
 Flat / সমতল
 Combination of Sloping and flat / ঢাল আৰু সমতলৰ সংমিশ্ৰণ

14. 2. Do you think the type/structure of your roof helps in keeping the house cooler ? / আপোনাৰ চালৰ প্ৰকাৰ/গাঁথনিয়ে ঘৰটো ঠাণ্ডা কৰি ৰখাত সহায় কৰে বুলি আপুনি ভাবেনে ?

Mark only one oval.

- Yes / হয়
 No / নহয়

15. 3. Do you experience any issues like water accumulation on the roof, leaks or damp ceilings? / ছাদত পানী জমা হোৱা, লিক হোৱা বা ভিজা চিলিঙৰ দৰে কোনো সমস্যাৰ সম্মুখীন হয়নে?

Mark only one oval.

- Yes / হয়
 No / নহয়

Investigating Traditional Architecture for Contemporary Use: Analysis of Climatic Aspects through Perception Study of Assam-Type Houses

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Contemporary (RCC) House in Assam - User Perception Survey

16. 4. Do you have a suspended / false ceiling? / আপোনাৰ ওলমি থকা / ফল্ছ চিলিং আছে নেকি?

Mark only one oval.

Yes / হয়

No / নহয়

17. 5. What type of material does your suspended/false ceiling have?

Mark only one oval.

Traditional materials (Bamboo, Wood, Ikora) / পৰম্পৰাগত সামগ্ৰী (বাঁহ, কাঠ, ইকোৰা)

Modern materials (POP, Gypsum, Asbestos etc)/ আধুনিক সামগ্ৰী (POP, Gypsum, Asbestos ইত্যাদি)

Do not have suspended/false ceiling / ওলমি থকা/ফল্ছ চিলিং নাই

18. 6. Do you feel the material of the ceiling helps in keeping the interior cooler? / চিলিঙৰ নিৰ্মাণ সামগ্ৰীয়ে ঘৰৰ ভিতৰখন ঠাণ্ডা কৰি ৰখাত সহায় কৰে বুলি আপুনি অনুভৱ কৰেনে?

Mark only one oval.

Yes / হয়

No / নহয়

19. 7. Do you think a concrete roof makes it harder to keep a house cool as compared to traditional Assam Type roof (with suspended/ false ceiling)? / পৰম্পৰাগত অসম টাইপৰ চালৰ তুলনাত সমতল পকী চালে ঘৰৰ ভিতৰখন শীতল কৰি ৰখাটো কঠিন কৰি তোলে বুলি আপুনি ভাবেনে (ওলমি থকা / ফল্ছ চিলিঙৰ সৈতে)?

Mark only one oval.

Yes / হয়

No / নহয়

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Contemporary (RCC) House in Assam - User Perception Survey

20. 8. Do you think high level ventilators in the house, help with indoor airflow and cooling? / ঘৰত উচ্চ পৰ্যায়ৰ ভেণ্টিলেটৰ, ঘৰৰ ভিতৰৰ বায়ু প্ৰবাহ আৰু শীতলতাত সহায় কৰে বুলি আপুনি ভাবেনে?

Mark only one oval.

Yes / হয়

No / নহয়

21. 9. Do you think the size and arrangement of windows in your house allow for good air flow and cooling specially during summer? / আপোনাৰ ঘৰৰ খিৰিকীৰ আকাৰ আৰু ব্যৱস্থাই বিশেষকৈ গ্ৰীষ্মকালত বতাহৰ ভাল প্ৰবাহ আৰু ঠাণ্ডা হোৱাত সহায় কৰে বুলি আপুনি ভাবেনে?

Mark only one oval.

Yes / হয়

No / নহয়

22. 10. Do you think the brick-cement walls make the house hotter as compared to traditional bamboo or lkora walls? / পৰম্পৰাগত বাঁহ বা ইকোৰাৰ বেৰৰ তুলনাত ইটা-চিমেন্টৰ বেৰবোৰে ঘৰখন অধিক গৰম কৰি তোলে বুলি ভাবে নে ?

Mark only one oval.

Yes / হয়

No / নহয়

23. 11. Do you think wide open / semi open verandas (if present) adds to better airflow and shading ? / আপুনি ভাবেনে যে বহল মুকলি / অৰ্ধ মুকলি বাৰাণ্ডাই (যদি আছে) বায়ু প্ৰবাহ আৰু ছাঁ দিয়াত উন্নত অৰিহণা যোগায়?

Mark only one oval.

Yes / হয়

No / নহয়

Investigating Traditional Architecture for Contemporary Use: Analysis of Climatic Aspects through Perception
Study of Assam-Type Houses

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Contemporary (RCC) House in Assam - User Perception Survey

24. 12. Do you think the shade above the window (chajja) is sufficient to shade the walls and keep the house cooler during hot weather ? / যিৰিকীৰ ওপৰৰ ছাঁদখন (চাজ্জা) গৰমৰ সময়ত বেৰত ছাঁ দিবলৈ আৰু ঘৰটো ঠাণ্ডা কৰি ৰাখিবলৈ যথেষ্ট বুলি আপুনি ভাবেনে?

Mark only one oval.

- Yes / হয়
 No / নহয়

25. 13. Do you think your house would stay cooler in hot weather, if the outside walls were more shaded from the sun? / আপুনি ভাবেনে যে গৰমৰ দিনত আপোনাৰ ঘৰটো অধিক ঠাণ্ডা হ'লহেঁতেন, যদিহে বাহিৰৰ বেৰবোৰ ৰ'দৰ পৰা বেছি ছাঁযুক্ত হ'লহেঁতেন?

Mark only one oval.

- Yes / হয়
 No / নহয়

26. 14. How is your house oriented ? / আপোনাৰ ঘৰ কোন দিশলৈ মুখ কৰে ?

Mark only one oval.

- East Facing / পূব
 West Facing / পশ্চিমে
 North Facing / উত্তৰদিশ
 South Facing / দক্ষিণ
 Other: _____

27. 15. Do your main rooms, like the bedroom and living room, feel warm in winter from sunlight and stay cool and shaded in summer? / আপোনাৰ মূল কোঠাবোৰ, যেনে শোৱা কোঠা আৰু বহা কোঠা, শীতকালত সূৰ্যৰ পোহৰৰ পৰা গৰম অনুভৱ হয় আৰু গ্ৰীষ্মকালত ঠাণ্ডা আৰু ছাঁযুক্ত হৈ থাকেনে?

Mark only one oval.

- Yes / হয়
 No / নহয়

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Contemporary (RCC) House in Assam - User Perception Survey

28. 16. Is your house raised high enough above the ground, so that rainwater during heavy rains, doesn't enter inside? / আপোনাৰ ঘৰটো মাটিৰ পৰা যথেষ্ট ওখকৈ উঠা হৈছেনে, যাতে প্ৰচণ্ড বৰষুণৰ সময়ত বৰষুণৰ পানী, ভিতৰলৈ সোমাই নাযায়?

Mark only one oval.

- Yes / হয়
 No / নহয়

29. 17. Do you feel that the type of flooring in your house (tiles, marble etc.) keeps the floor comfortable in all seasons? / আপোনাৰ ঘৰৰ মজিয়াৰ ধৰণ (টাইলছ, মাৰ্বল আদি)ই সকলো ঋতুতে মজিয়াখন আৰামদায়ক কৰি ৰাখে বুলি অনুভৱ কৰেনে?

Mark only one oval.

- Yes / হয়
 No / নহয়

30. 18. Do you believe a courtyard helps in cooling the house? / চোতালে ঘৰখন ঠাণ্ডা কৰাত সহায় কৰে বুলি ভাবে নে?

Mark only one oval.

- Yes / হয়
 No / নহয়

31. 19. Do you think vegetation around the house or in the courtyard helps in keeping the house cooler? / ঘৰৰ আশে-পাশে বা চোতালত থকা গছ-গছনিয়ে ঘৰটো ঠাণ্ডা কৰি ৰখাত সহায় কৰে বুলি আপুনি ভাবেনে?

Mark only one oval.

- Yes / হয়
 No / নহয়

Investigating Traditional Architecture for Contemporary Use: Analysis of Climatic Aspects through Perception Study of Assam-Type Houses

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Contemporary (RCC) House in Assam - User Perception Survey

32. 20. Do you think your house is well suited for the climate of Assam? / আপোনাৰ ঘৰখন অসমৰ জলবায়ুৰ লগত ভালদৰে উপযুক্ত বুলি ভাবেনে?

Mark only one oval.

Yes / হয়

No / নহয়

33. OPTIONAL - If you are comfortable, please upload an exterior picture of your house that shows the architectural features like roof style, plinth height or materials. This image will help me to better understand the architectural characteristics. All images will remain confidential and will be used solely for research purpose. / ঐচ্ছিক - যদি আপুনি আপত্তি নকৰে তেন্তে আপোনাৰ ঘৰৰ বাহিৰৰ ছবি এখন আপলোড কৰক য'ত ছাদৰ আকৃতি, মজিয়াৰ উচ্চতা, দুৱাৰ আৰু খিৰিকী আদিৰ দৰে স্থাপত্যৰ বৈশিষ্ট্যসমূহ দেখুওৱা হৈছে। এই ছবিখনে মোক স্থাপত্যৰ বৈশিষ্ট্যসমূহ ভালদৰে বুজিবলৈ সহায় কৰিব। সকলো ছবি গোপনীয় হৈ থাকিব আৰু কেৱল গৱেষণাৰ উদ্দেশ্যে ব্যৱহাৰ কৰা হ'ব।

Files submitted:

Willingness to adopt

Investigating Traditional Architecture for Contemporary Use: Analysis of Climatic Aspects through Perception Study of Assam-Type Houses

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Contemporary (RCC) House in Assam - User Perception Survey

34. If you have to built a new house , what would be the features of traditional Assam type ^{*} houses that you might consider adopting in the new house? / যদি আপুনি নতুন ঘৰ সাজিবলগীয়া হয়, তেন্তে পৰম্পৰাগত অসম টাইপৰ ঘৰৰ কি কি বৈশিষ্ট্য আপুনি নতুন ঘৰত গ্ৰহণ কৰাৰ কথা চিন্তা কৰিব পাৰে?

Mark only one oval per row.

	Very Willing / অতি ইচ্ছুক	Willing / ইচ্ছুক	Not Willing / ইচ্ছুক নহয়
Sloping Roof / ঢাল খোৱা ঢাল	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Bamboo/ Ikora/ Wood walls / বাঁহ, কাঠ, ইকৰা দেৱাল	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Raised Plinth or floor / উচ্চ ঘৰৰ ভেটি/ মজিয়া	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Courtyard, Backyard/ চোতাল, পিছফালৰ চোতাল	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Wide roof edges (large overhangs)/ ঢালৰ বৃহৎ বৰ্ধিত অংশ	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Wide open/ semi open verandas / বহল মুকলি/ অৰ্ধ মুকলি বাৰাণ্ডা	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Bamboo or Wood Ceiling / বাঁহ বা কাঠৰ চিলিং	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Wooden open tread Stairs / মুক্ত কাঠৰ চিৰি	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

<https://docs.google.com/forms/d/12Y4Z0UjJQfIGZ0vI7wUJ3xDUHITziHDAUJLjYHEvpdM/edit>

10/13

Investigating Traditional Architecture for Contemporary Use: Analysis of Climatic Aspects through Perception Study of Assam-Type Houses

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Contemporary (RCC) House in Assam - User Perception Survey

Wood or Bamboo low height compound wall / কাঠ বা বাঁহৰ কম উচ্চতাৰ সীমানা প্রাচীৰ	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Symmetrically laid rooms in the house / ঘৰত প্ৰতিসমভাৱে নিৰ্মাণ কৰা কোঠা	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Elongated shape of house / ঘৰৰ দীঘলীয়া আকৃতি	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Cement/ mud plastered floor / চিমেন্ট/ মাটিৰ প্ৰাষ্টৰ কৰা মজিয়া	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

35. What do you think is the reason that Traditional Assam Type houses are rarely built nowadays? / আজিকালি পৰম্পৰাগত অসম টাইপৰ ঘৰ খুব কমেইহে নিৰ্মাণ হোৱাৰ কাৰণ কি বুলি আপুনি ভাবে? *

Check all that apply.

- Cost of implementation / কাৰ্যকৰীকৰণৰ খৰচ
- Non-availability of materials/ সামগ্ৰীৰ অনুপলব্ধতা
- Ignorance about how traditional Assam Type houses stay comfortable and suit the climate/পৰম্পৰাগত অসম টাইপৰ ঘৰবোৰ কেনেকৈ আৰামদায়ক হৈ থাকে আৰু জলবায়ুৰ লগত খাপ খাই থাকে সেই বিষয়ে অজ্ঞানতা
- Not good to look at / চাবলৈ ভাল নহয়
- Concerns about maintenance / ৰক্ষণাবেক্ষণৰ বিষয়ে চিন্তা
- Non-availability of skilled labor / দক্ষ শ্ৰমিকৰ অনুপলব্ধতা
- Just because everyone else is building in RCC/ কাৰণ বাকী সকলোৱে আৰু চি চিত নিৰ্মাণ কৰি আছে
- Other: _____

Investigating Traditional Architecture for Contemporary Use: Analysis of Climatic Aspects through Perception Study of Assam-Type Houses

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Contemporary (RCC) House in Assam - User Perception Survey

36. If given an opportunity, which house will you prefer to live in - *

Mark only one oval.

- Traditional Assam-Type House / পৰম্পৰাগত অসম-টাইপ হাউচ
- Contemporary or Modern House / Apartment / আধুনিক ঘৰ / এপাৰ্টমেণ্ট
- Modern house with features of Assam Type house for more natural comfort / অধিক প্ৰাকৃতিক আৰামৰ বাবে অসম টাইপৰ ঘৰৰ বৈশিষ্ট্য থকা আধুনিক ঘৰ

Thank you for your time and insights. Your responses are invaluable for this research.
আপোনাৰ সময় আৰু অন্তৰ্দৃষ্টিৰ বাবে ধন্যবাদ। এই গৱেষণাৰ বাবে আপোনাৰ সঁহাৰি অমূল্য।

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Google Forms

C3. Compiled Photographs of Traditional Assam-Type and Contemporary RCC Houses Surveyed in User Perception Study

i. Traditional Assam-Type Houses



Investigating Traditional Architecture for Contemporary Use: Analysis of Climatic Aspects through Perception Study of Assam-Type Houses



ii. Contemporary RCC Houses



Investigating Traditional Architecture for Contemporary Use: Analysis of Climatic Aspects through Perception Study of Assam-Type Houses



D. Expert Recommendation Survey Questionnaire

3/20/25, 2:06 AM

Expert Feedback on the Adoption of Traditional Assam-type House Features in Contemporary Designs in Assam for Enhanced ...

Expert Feedback on the Adoption of Traditional Assam-type House Features in Contemporary Designs in Assam for Enhanced Climate Responsiveness

Please read the following before proceeding with the questions.

Thank you for taking the time to share your insights. This questionnaire is part of my research for a PhD program, focusing on architectural features of traditional Assam-type houses and their potential and relevance in today's context, to enhance the climate responsiveness of contemporary house designs in Assam.

I have surveyed people living in both traditional Assam-type houses and contemporary detached houses in Assam to understand which traditional features they prefer to be adopted, for new house designs with respect to climate responsiveness. Based on their responses, this questionnaire has been prepared to get your professional feedback.

Please note: All the following questions refer only to detached, standalone houses (not apartments or multi-unit housing).

Your responses will greatly help in understanding how traditional Assam-type design features can be integrated into contemporary designs to create more climate-responsive houses.

I kindly ask that you provide thoughtful and accurate answers based on your professional experience. **Please refrain from submitting random answers, as your input is crucial in shaping the findings of this research.**

This form will take around 5-7 minutes to complete.

* Indicates required question

Note: Your responses will be used for academic purposes only and will remain confidential.

1. Please indicate your profession. *

Check all that apply.

Architect

Civil Engineer

Other: _____

Investigating Traditional Architecture for Contemporary Use: Analysis of Climatic Aspects through Perception Study of Assam-Type Houses

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Expert Feedback on the Adoption of Traditional Assam-type House Features in Contemporary Designs in Assam for Enhanced ...

2. Please indicate your experience level *

Mark only one oval.

Less than 5 years

5-10 years

10+ years

3. May I know your name please ? (If you'd like to remain anonymous, you can leave this blank)

4. May I contact you for follow-up questions if necessary later in the study ? If yes, please provide your email.

Assessing Traditional Features for Climate Responsiveness in Contemporary Designs

This section seeks your opinion on the relevance of traditional Assam-type house features in enhancing climate responsiveness in today's context.

Investigating Traditional Architecture for Contemporary Use: Analysis of Climatic Aspects through Perception Study of Assam-Type Houses

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Expert Feedback on the Adoption of Traditional Assam-type House Features in Contemporary Designs in Assam for Enhanced ...

5. How important do you think the following traditional **roof-related** features of Assam-type houses would be, in enhancing climate-responsive design if incorporated into contemporary detached/standalone houses in Assam? *

Mark only one oval per row.

	Highly important	Moderately important	Not important	Not sure
Pitched/gable Roof (Facilitates water drainage, prevents waterlogging)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
CGI roofing sheet (Lightweight, reflects heat, durable in heavy rain)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Wide roof overhang (Provides shade, protects walls from rain)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Multi-tier gable roof (Enhances ventilation)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Roof lantern (Facilitates natural lighting)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Bamboo or wood ceiling (Insulates against heat)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
High ceiling (Promotes air circulation)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Barge boards (Prevents water seepage and wind damage)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

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Expert Feedback on the Adoption of Traditional Assam-type House Features in Contemporary Designs in Assam for Enhanced ...

6. How important do you think the following traditional **fenestration-related** features of Assam-type houses would be, in enhancing climate-responsive design if incorporated into contemporary detached/standalone houses in Assam? *

Mark only one oval per row:

	Highly important	Moderately important	Not important	Not Sure
Narrow and moderate size windows and doors (Reduces heat gain, limits direct sunlight)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Windows located opposite each other (Facilitates cross-ventilation)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
High-level ventilators (Releases hot air)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Bay windows (Increases natural light)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Bamboo screens on verandas (Provides shade, allows airflow)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

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7. How important do you think the following traditional **planning-related** features of Assam-type houses would be, in enhancing climate-responsive design if incorporated into contemporary detached/standalone houses in Assam? *

Mark only one oval per row.

	Highly important	Moderately important	Not important	Not sure
Courtyard (Enhances ventilation, promotes cooling)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Rooms arranged around courtyard (Facilitates airflow)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Vegetation within courtyard and around the house (Reduces heat gain, natural shade)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Symmetrical plan (Balances air circulation)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Wide semi open verandas (Shaded outdoor space, promotes airflow)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Long verandas around (Shades walls)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Elongated plan of the house (Promotes passive cooling)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

<https://docs.google.com/forms/d/1kcY0S30jEKTFy5CkThmQowkenOq-N9ealzUiz1KWEt0/edit>

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Investigating Traditional Architecture for Contemporary Use: Analysis of Climatic Aspects through Perception Study of Assam-Type Houses

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Elongated plan of the house (Promotes passive cooling)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
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8. How important do you think the following traditional **structure-related** features of Assam-type houses would be, in enhancing climate-responsive design if incorporated into contemporary detached/standalone houses in Assam? *

Mark only one oval per row.

	Highly important	Moderately important	Not important	Not sure
Lightweight structure (Minimizes heat retention, faster cooling)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Raised plinth (Protects from rainwater and flood)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Flexible joints (Reduces impact of temperature variation on building)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Slender columns(Unobstructed airflow)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Elevated fireplace (Provides warmth in colder areas)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Open tread wooden staircase (Enhances vertical airflow)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

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9. How important do you think the following traditional **materials-related** features of Assam-type houses would be, in enhancing climate-responsive design if incorporated into contemporary detached/standalone houses in Assam? *

Mark only one oval per row.

	Highly important	Moderately important	Not important	Not sure
Use of traditional materials like bamboo, ikra, wood (Provides insulation, breathability)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Cement plastered floors (Provides thermal mass for temperature regulation)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Brick wall till sill level and bamboo-ikra wall above (Resists rain damage, stability against heavy winds)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Bamboo or wood floorboards for upper floors (Enhances insulation)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Pale color palette (Reflects sunlight, reduces heat absorption)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

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10. How important do you think the following traditional **orientation-related** features of Assam-type houses would be, in enhancing climate-responsive design if incorporated into contemporary detached/standalone houses in Assam? *

Mark only one oval per row.

	Highly important	Moderately important	Not important	Not sure
Windward orientation (Promotes cooling by capturing prevailing winds)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Inward orientation of rooms (Protects from direct sun)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Shading elements on South and East (Blocks harsh sunlight)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

'Willingness to Adopt' Traditional Features in Future Homes

Residents of traditional Assam-type houses and contemporary detached houses were asked which traditional features of Assam-type houses they would like to include in their future homes. The following question is based on their willingness to adopt traditional features.

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11. How relevant do you think is it to include the following traditional Assam-type house features in contemporary detached house designs in Assam to enhance their climate responsiveness?

Mark only one oval per row.

	Very relevant	Moderately relevant	Not relevant
Courtyard	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Raised Plinth	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Sloping Roof	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Bamboo or Wood Ceiling	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Wooden open Tread Staircase	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Wide Overhangs of Roof	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Wide Open Veranda	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Elongated Layout/Plan	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Symmetrical Layout/Plan	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Cement/mud Plastered Floor	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Bamboo-lkra Walls with wood framework	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Bamboo/Wood Low height boundary wall	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Investigating Traditional Architecture for Contemporary Use: Analysis of Climatic Aspects through Perception Study of Assam-Type Houses

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12. For the features you consider important for a climate responsive design, what challenges might arise in using them in contemporary detached/standalone house designs? Check all that applies. *

Check all that apply.

- High Cost
- Unavailability of Traditional Materials
- Unavailability of Skilled labor
- Maintenance Issues
- Concerns about aesthetics
- Clients may resist opting for traditional features
- Lack of awareness among architects, engineers and homeowners.
- Modern building codes may not allow for the incorporation of certain traditional features
- Urbanization limitations like space constraints or zoning regulations.
- Other: _____

13. (Optional)
Are there any other features of a traditional Assam-type house, not listed above that you believe should be incorporated in contemporary designs to improve climate responsiveness??

14. (Optional)
Do you foresee any other challenges in adopting these traditional features into contemporary house designs in Assam ? If yes, please elaborate.

15. Do you think it would be useful to compile a list of recommended features of traditional Assam-type houses, along with relevant information about the features, to guide architects, engineers, and homeowners in incorporating those elements into contemporary detached/standalone house designs? *

Mark only one oval.

- Yes
- No
- Not Sure/No Opinion

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16. Do you think there should be public policies or government incentives to encourage incorporation of traditional Assam-type house features into new houses for improved climate responsiveness?? *

Mark only one oval.

- Yes, strong government support and incentives are needed.
- No, public policy is not necessary for this.
- Not Sure/ No opinion

Thank you for your time and valuable opinion .

Please click on submit.

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APPENDIX III

Comparative Global Perspectives on Traditional / Vernacular and Climate-Responsive Architecture

This addendum supplements the main Literature Review chapter by incorporating recent and globally comparative research published between 2020 and 2025. While the primary chapter emphasizes regional studies within Northeast India, this section broadens the analytical scope through examples from Southeast Asia, the Middle East, the Mediterranean, and other regions with comparable climatic and cultural contexts. The reviewed works critically explore how vernacular and traditional architectural principles continue to inform sustainable, climate-responsive, and user-centred approaches in contemporary design. Together, these studies highlight cross-cultural parallels in material adaptation, spatial configuration, and environmental performance, underscoring the continued relevance of vernacular wisdom in shaping resilient, context-sensitive modern architecture.

1. **Mabborang, M.H., Nozaleda, B.M., Maguddayao, R.N., Udaundo, L., Laggui, N., Martin, E.B. and Sibal, C. (2022) 'Vernacular House Architecture and Climate Change Adaptation: Lessons from the Indigenous Peoples of Cagayan, Philippines', *Journal of Climate Change*, 8(4), pp. 25-33. Available at: <https://doi.org/10.3233/jcc220027>**

This study explores how three indigenous communities in Cagayan, Philippines, the Ibanag, Itawit, and Malaweg, integrate climate-adaptive principles into their traditional houses. Using a qualitative descriptive approach that included interviews, focus group discussions, and field observations, the research identifies several architectural strategies shaped by local climate and culture. These include stilted floor levels that protect homes from flooding and allow ventilation beneath the floor, permeable bamboo walls and large sliding windows that enhance cross-ventilation and daylighting, and open interiors without fixed ceilings that encourage air circulation. The

use of locally available, renewable materials such as bamboo, rattan, and cogon grass reinforces both environmental compatibility and construction sustainability. A distinctive feature is the detached kitchen connected by a lightweight bridge, designed to minimize fire risk, a simple yet effective form of spatial hazard management.

The paper argues that such dwellings represent dynamic knowledge systems that respond directly to environmental conditions while sustaining community identity. It highlights that both material choices and communal practices, such as collective labour (bayanihan), are central to long-term resilience. The study's strength lies in linking form, material, and social practice within a single adaptive framework rather than treating vernacular architecture as purely cultural expression. For this thesis, the research is especially relevant as it demonstrates how traditional housing in a tropical monsoon context can inform contemporary climate-responsive design. The parallels with Assam-type houses, such as raised plinths, breathable envelopes, and simple solutions like that of having a detached kitchen, underscore how regional knowledge can guide sustainable housing strategies in changing environmental and urban conditions.

2. Yang, N., Chen, B. and Xi, J. (2024) 'A Theoretical Design Framework of Contemporary Vernacular Architecture Based on a Scoping Review of the Best Practices Worldwide', *Buildings*, 14(3525). doi: 10.3390/buildings14113525.

The paper by Yang, Chen, and Xi discusses how vernacular architecture can evolve to meet modern needs while still keeping its local identity. It studies several contemporary examples and reviews existing literature to create a framework for designing what they call “contemporary vernacular architecture.” Through a review of many projects and writings, the authors identify 41 design factors that influence such architecture. These are grouped into two main types, ‘tangible factors’, which include physical and design-related aspects such as site, form, materials, construction techniques, spatial layout, environmental performance, and interior quality; and ‘intangible factors’, which include people, culture, policy, and social participation. These factors are then linked to different stages of the building process, such as planning, design, construction, and use.

From these, the study highlights 10 key tangible factors including form, material, structure, construction method, layout, adaptation to climate and terrain, ventilation, and thermal comfort strategies and 5 important intangible factors such as community involvement, cost, governance, sustainability awareness, and cultural meaning. This detailed classification helps explain how each stage of a project should consider both the physical and social sides of design.

The authors emphasize that modern vernacular design should balance tradition and innovation. Buildings should respond to local climate and topography, use locally available materials and skills, and maintain cultural identity, but at the same time they should allow for new technologies, modern lifestyles, and sustainable practices. They highlight that “passive-first” design using natural ventilation, daylight, and thermal control should come before adding active or mechanical systems. The study also shows the importance of community and stakeholder involvement: architects, users, and local authorities must work together to make such architecture practical, affordable, and socially relevant.

The strength of this paper lies in its effort to combine theory with practice. It provides a clear structure that can help designers and researchers think about all influencing factors, physical, social, and environmental, together. The framework is broad and flexible, allowing it to be applied to different regional contexts. However, because it is general, it does not give detailed design guidelines or specific solutions, which would depend on each place’s unique conditions.

Overall, the study offers a holistic understanding of how vernacular principles can inform modern design. It encourages architects to view local building traditions as living and adaptable systems, rather than fixed historical models. This understanding helps reinforce the idea that climate-responsive and culturally rooted design can work together to create sustainable contemporary architecture.

3. Shetty, S.S. and Patil, S. (2025) 'Vernacular architecture and indoor environmental satisfaction: a systematic review of influencing factors', *Architecture*, 5(4), p. 87. doi: 10.3390/architecture5040087.

Shetty and Patil (2025) present a systematic review of how vernacular architecture contributes to indoor environmental satisfaction by linking environmental, cultural, and behavioural factors. Drawing from 105 peer-reviewed studies published between 2004 and 2024, the authors use the SALSA framework and PRISMA 2020 guidelines to ensure transparency and depth in their analysis. Their review identifies five main theoretical perspectives, Sustainability Theory, Bioclimatic Architecture Theory, Ecological Systems Theory, Social Cognitive Theory, and the Theory of Planned Behaviour, that together explain how climate, culture, and human behaviour influence user comfort in vernacular settings.

From the literature, the authors categorize 62 key variables into eight design-related themes: natural ventilation, orientation and layout, use of local materials, shading devices, thermal comfort, air quality, natural lighting, and overall satisfaction with indoor environments. These clusters show how traditional design strategies, such as courtyards, verandas, deep overhangs, and breathable wall materials, work together to enhance comfort and energy efficiency. Most studies analysed are qualitative and context-based, focusing on how people perceive and adapt to their environment rather than relying only on measured data.

This study stands out for connecting theory, design, and human experience into a clear framework. It moves beyond describing features to show how comfort arises from both environmental responses and cultural behaviour. The authors argue that understanding vernacular architecture requires considering how people interact with their spaces through identity, habit, and social practices, as much as the materials or climate itself. This approach broadens the meaning of climate responsiveness, emphasizing that satisfaction in housing is not only about temperature or ventilation but also about well-being, belonging, and adaptability.

4. Saylam, S. (2024) 'Vernacular Iranian housing as a sustainable model of functional and aesthetic comfort in contemporary passive dwellings', *Journal of Infrastructure, Policy and Development*, 8(16), p. 10562. doi: 10.24294/jipd10562.

Saylem (2024) explores how traditional Iranian houses can serve as reference models for designing modern passive dwellings that combine functional and aesthetic comfort. The paper examines four main climatic zones of Iran - hot-dry, hot-humid, cold-dry, and temperate/humid and identifies how vernacular forms, materials, and spatial arrangements respond to each. Key features include courtyards, windcatchers, thick earthen walls, shaded iwans, and vegetated courtyards that moderate temperature and airflow. These architectural solutions are paired with sensory and cultural qualities such as light control through patterned screens (orosi), privacy layering, and textural richness, all of which enhance comfort beyond purely thermal performance.

Rather than relying on field experiments, the paper compiles and compares data from existing literature to create climate-strategy tables that link environmental conditions with suitable design responses. It then translates these vernacular principles into contemporary passive-house strategies, suggesting hybrid applications such as coupling windcatchers with solar chimneys, improving insulation with new materials, and integrating energy-harvesting shading devices. The study stresses that these traditional ideas can be adapted to modern contexts without losing their identity, proposing a synthesis of low-energy performance with cultural continuity.

The strength of Saylem's work lies in its balanced treatment of aesthetic and functional comfort, recognizing that sensory and cultural experiences are integral to sustainable design. By offering clear, climate-specific guidance and bridging vernacular wisdom with advanced technologies, the paper provides a practical framework for architects designing in diverse climates. Although it is a conceptual synthesis rather than an empirical study, its structured comparison and adaptation model make it highly relevant for research linking traditional architectural knowledge to contemporary climate-responsive design a central concern of the present thesis.

- 5. Chkeir, A., Bouzidi, Y., El Akili, Z., Charafeddine, M. and Kashmar, Z. (2024) 'Assessment of thermal comfort in the traditional and contemporary houses in Byblos: a comparative study', *Energy and Built Environment*, 5(6), pp. 933-945. doi: 10.1016/j.enbenv.2023.07.006.**

Chkeir et al. (2023) investigate how traditional and contemporary houses in Byblos, Lebanon, perform in terms of thermal comfort under a humid Mediterranean climate. The study combines occupant surveys with field monitoring of temperature and humidity to evaluate how architectural form, material, and orientation influence comfort levels across summer and winter. Traditional Byblos houses, built with thick stone walls, lime-based breathable plasters, high ceilings, and cross-ventilating openings, were compared to newer dwellings constructed with hollow concrete blocks and cement plasters.

Results reveal that traditional houses maintained more stable indoor temperatures and humidity levels, staying within adaptive comfort bands for much of the year without mechanical cooling or heating. Their massing, breathable materials, shaded verandas, and cross-ventilation ensured passive moderation of indoor climate. In contrast, contemporary dwellings experienced larger temperature fluctuations, high humidity, and greater occupant discomfort, largely due to sealed envelopes, poor orientation, and limited airflow. The findings confirm that passive design strategies embedded in traditional construction, particularly thermal mass, permeability, and microclimate sensitivity, remain effective and climatically appropriate even under present-day conditions.

This paper's value lies in its evidence-based comparison that connects occupant perception with measured performance. It shows how simple, locally adapted design decisions like orientation, operable openings, wall assemblies, and roof forms, achieve greater comfort than modern buildings that rely on heavy materials and mechanical systems.

For the present thesis, this study strengthens the argument that traditional housing typologies embody proven climate-responsive strategies which are often neglected in newer constructions. It reinforces the importance of identifying which specific

vernacular features, such as ventilation geometry, wall composition, and thermal massing, can be reinterpreted within contemporary design frameworks to enhance indoor comfort and reduce energy dependence. It also upholds the vital role of user perception in validating comfort outcomes, showing that occupants lived experiences often align closely with measured thermal performances of traditional dwellings, reinforcing the need to integrate user perspectives into climate responsive design research.

Across these recent global studies, a consistent theme emerges: vernacular and traditional building systems remain vital references for designing contextually appropriate, energy-efficient, and occupant-centred architecture. Whether through passive cooling in Southeast Asian stilt houses, thermal massing in Mediterranean dwellings, or spatial layering in Middle Eastern courtyard homes, these examples demonstrate that adaptive design principles grounded in local materials, climate, and culture continue to offer relevant solutions for present challenges. Collectively, they affirm that the study of vernacular architecture extends beyond historical appreciation, it provides practical frameworks for sustainable adaptation. This understanding also reinforces the significance of examining Assam-type houses within a similar continuum, as a living example of how traditional wisdom can inform climate-responsive and culturally rooted architectural practice in contemporary contexts.

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17.11.2025

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