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Architectural Design of Climate-Responsive and Low-Cost Vernacular Housing for Returnee Refugees in Nangarhar Province, Afghanistan

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Abstract

This study presents an architectural design for climate-responsive, low-cost, and vernacular housing for returnees in Nangarhar Province based on local climate, economic constraints, and cultural values. The aim of the research is to find solutions based on Jalalabad's microclimate, Vernacular architecture, economic realities, and social needs that ensure thermal comfort, privacy, natural ventilation, and energy efficiency. The research was conducted through quantitative and qualitative methods, climatic data, field surveys, statistical analysis, and questionnaires were analyzed, and an architectural design was visualized using AutoCAD and SketchUp software. The study results show that applying passive climatic strategies such as thick mud walls, internal courtyards, mud dome roofs, fewer window openings on the western façade, planting trees, and using local materials can create a sustainable, affordable, and climate-responsive housing model. While this model is well-suited to returning refugees in Nangarhar Province, it also represents a replicable prototype for other regions with similar climatic conditions.

Keywords: Climate-Responsive, Low-Cost Housing, Nangarhar Province, Returnee Resettlement, Vernacular Architecture.

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1. Introduction

The number of displaced people in different parts of the world is increasing day by day due to climate change, natural disasters, wars, and economic difficulties. The most basic need for these people is to find a safe and secure place (shelter) to live. Afghanistan, which has experienced high levels of migration and displacement as a result of decades of conflicts and wars, is among the countries with the highest Numbers of returnees. Millions of Afghans have been displaced from their homes since the 1980s, with the largest displacement beginning with the Soviet invasion of 1979 [1]. Recently, with some of them returning to their areas of origin, the continued flow of these migrations has created a pressing need for housing, particularly in provinces with a high concentration of returnees.

Nangarhar Province, located in eastern Afghanistan, has attracted a large number of returnees. However, suitable living conditions are very limited. Due to its complex climate, which encompasses several types according to the Köppen-Geiger classification (humid subtropical climate with hot summers and mild winters, hot semi-arid climate with little rainfall and high temperatures, and oceanic climate with moderate temperatures and moderate annual rainfall [2].) This requires that the dwelling be fully adapted to the climate. Vernacular architectural experience built in accordance with climatic conditions, local materials, and cultural values shows that there are suitable solutions for climate-responsive building construction. Vernacular housing structures, such as mud houses, flat roofs, and natural ventilation systems, not only reduce energy requirements but also maintain a high level of comfort for occupants.

Climate-responsive and low-cost housing, particularly for returnees, should be designed to maximize the use of locally available materials, incorporate natural ventilation systems, minimize energy consumption, and ensure construction costs remain affordable for low-income households. In addition, climate-adaptive housing contributes to sustainable development goals and enhances communities' resilience to environmental challenges.

According to a report by the United Nations High Commissioner for Refugees (UNHCR), between September 2023 and October 2024 alone, approximately 760,000 Afghans returned from Pakistan, most of them were women, children, and female-headed households in urgent need of adequate housing and basic living necessities [3]. Furthermore, following the announcement of the second phase of the deportation of undocumented migrants by Pakistan in March 2025, approximately 217,000 Afghans had returned to Afghanistan by May, of whom 70% were undocumented individuals, and 31% of the households were female-headed [4]. This situation highlights the urgent need for permanent and climate-responsive settlements to guarantee the integration, safety, and human dignity of these families.

In light of these needs and challenges, this research raises the following question: How can we design climate-responsive and low-cost vernacular housing for returnees in Nangarhar province? The primary objective of this research is to propose an economically viable, climate-adaptive, and culturally responsive housing model that provides a permanent and sustainable solution for returnee populations.

The research framework includes a detailed analysis of Nangarhar's climatic conditions, a study of the characteristics of vernacular housing, the collection of statistical data and assessments of returnees' needs, and the development of a standardized architectural design based on these parameters. The proposed design aims to respond effectively to local climatic conditions, remain affordable within economic constraints, and align with regional cultural and social needs.

2. Research Objectives

The objective of this study is to design and propose climate-responsive, affordable, and vernacular housing solutions for returnees in Nangarhar Province that are adapted to the local climate conditions, local construction materials, economic constraints, and cultural requirements. This research seeks to present a scientific and implementable architectural design framework based on the characteristics of vernacular buildings, principles of natural ventilation and energy efficiency, and the housing needs of returnee populations. The aim is not only to provide practical solutions for permanent settlement but also to establish a replicable model applicable to other regions with similar climatic conditions.

3. Literature Review

3.1 Vernacular Architecture

Vernacular architecture is a construction approach created by communities based on their daily needs, local climatic conditions, and cultural values. Rather than being designed by professional architects, it is considered the product of collective community experience, with all construction typically carried out by local craftsmen or master builders. This form of architecture relies on locally available materials and simple construction techniques, offering flexibility and adaptability over time.

As Asadpour's analysis indicates, vernacular structures are not just remnants of the past, but a living and evolving process. Following the dominance of modernism, scholars such as Oliver, Rapoport, and Rudofsky revisited. They consider this architecture to be an important sign of cultural intelligence, social order, and harmony with the climate. Such buildings are not only well adapted to natural conditions but also provide an affordable and inspiring model for communities facing economic constraints [5].

3.2 Characteristics of Climate-Responsive Vernacular Houses

Across the world, numerous vernacular houses have been constructed in accordance with local needs and climatic conditions. These dwellings are typically built using locally available materials with construction methods developed through community experience over generations. Such buildings are not only resistant to cold, heat, wind, and rain but also harmonize well with the local lifestyle economy and culture. Accordingly, the following section presents examples from various countries and regions that illustrate these characteristics:

In India, various types of vernacular houses are built according to climatic conditions, local materials, and the lifestyle of the people. For instance, the Bhunga houses in Gujarat are circular in shape with thick mud walls and strong foundations providing excellent resistance to wind and earthquakes. In Assam, Ikra houses are built using bamboo and

wood, which are considered earthquake-resistant structures. In northern India, Koti Banal houses are constructed from stone and timber, often featuring multiple floors, and have proven to be stable under heavy snowfall and seismic conditions [6],[7],[8].

Similarly, in Iran, the people of Esfahak first built underground shelters to protect themselves from the cold winters. Over time, this practice gradually evolved into the construction of mud-built domed houses. These dwellings were built using mud bricks and dried grasses (kayan), and their roofs were constructed using a special technique in which bricks were laid in an inclined manner without the use of formwork. The four corners of the square rooms were curved to create a structural transition that enabled the formation of a domed roof. These buildings were built using simple tools, local materials, and accumulated indigenous experience, and were well adapted to the climatic conditions, economic constraints, and local needs of the community [9].

In Turkey, the vernacular domed houses of Harran are constructed using locally available mud bricks and dried grasses (kayan), reflecting a strong adaptation to the region's hot and arid climate, cultural traditions, and nomadic lifestyle. These buildings are based on a cubic form and are topped with conical domed roofs that incorporate ventilation openings to facilitate airflow and maintain thermal balance. The construction system is remarkably simple, allowing one or two housing units to be built within a single day. Without relying on mechanical or electrical systems, these houses effectively regulate summer heat and winter cold, and due to their natural ventilation and flexible interior spaces, they represent a notable example of thermal comfort in vernacular architecture [10].

An analysis of traditional rural houses in Romania shows that composite construction systems using mud, wood, wattle, and daub provide a balanced design that responds effectively to climatic conditions, cultural values, and functional requirements [11].

A study of vernacular houses in Herat indicates that domed roofs constructed from mud and locally made bricks vary in form and scale according to the dimensions of different building spaces and prevailing climatic conditions. This flexibility is a key characteristic of climate-responsive design and offers low-cost solutions that are well-adapted to local environmental and material conditions [12].

A study analyzed the traditional houses of the Ashiqan and Arifan historic area of Kabul, which are made of mud, wood, and bricks, with 95% of them having a courtyard plan[13].

3.3 Thermal and Cultural Comparison between Vernacular Houses and Modern Shelters

Based on a study conducted in Syria, a comparison was made between traditional mud-built domed houses and modern shelters. Research shows that domed vernacular houses are climatically stable, have balanced indoor temperatures, and require less energy. In contrast, modern shelters were found to perform poorly in terms of thermal comfort and durability and are not well-suited to hot climatic conditions. These results suggest that traditional domed houses can serve as an effective and sustainable alternative for displaced populations[14].

Furthermore, a recent study proposes the design of climate-responsive and sustainable housing for Syrian refugees based on 3D printing technology. The proposed solution is

suitable for hot sandy environments and effectively meets the requirements of thermal comfort, durability, and economic affordability [15].
Similarly, a study proposed a new housing model for displaced populations in Syria based on climate-responsive design, low-cost construction, and the use of local materials. The author, inspired by traditional architecture practices, aimed to design homes that respond to climatic conditions, are affordable for the local population, and can be constructed manually by the residents themselves [16].
Domínguez Amarillo and colleagues, in their research, note that current shelters in Jordan, Afghanistan, and South Sudan lack adequate thermal and humidity control, exposing inhabitants to thermal stress and privacy challenges. They argue that, instead of traditional construction methods using local materials (referred to as C shelters), are better suited to provide thermal stability and meet cultural requirements [17].
A thermal study of the current shelters in the Azraq refugee camp in Jordan shows that indoor temperatures can exceed 45°C for more than 20% of the year, and occupants experience conditions beyond the limits of thermal comfort. Such conditions are associated with dehydration and serious health risks. Research suggests that implementing simple passive strategies, such as proper insulation, thermal barriers, shading, and natural ventilation, can reduce this problem by up to 2% [18]. These findings indicate that climate-responsive, low-cost, and vernacular solutions have the potential to improve the quality of housing for displaced populations and reduce health-related risks.

3.4 Theoretical principles of climate-responsive architecture for vernacular houses

In order to design a building according to the climatic conditions, it is essential to have a clear understanding of the climate and microclimate of the specific site. Microclimatic factors such as sun direction, wind direction, topography, surrounding structures, and vegetation play a fundamental role in controlling the thermal performance of a building. If these elements are taken into account in the building plan thermal balance, energy savings and natural comfort are ensured. The researcher said that in areas where people do not have access to mechanical cooling systems, microclimate-based design is considered an effective alternative [19].
In hot and arid climates, passive architectural techniques such as internal courtyards, thick adobe walls, wind catchers, basements, and natural ventilation are considered among the most effective solutions for providing indoor thermal comfort without relying on active mechanical systems. Such architectural strategies not only reduce energy requirements but are also environmentally compatible and economically efficient. This approach is particularly valuable for areas where access to electrical or mechanical cooling technologies is limited [20].
The impact of passive techniques is reinforced not only by the building's structural design but also through the arrangement, orientation, and form of vernacular architecture. A study of traditional houses in the Chaoshan region of China found that features such as small halls, high-pitched roofs, northeast-facing orientation, and a combination of brick and concrete walls play an important role in enhancing the thermal performance of buildings. According to thermal models, these combinations can maintain a balanced indoor temperature and reduce energy requirements [21].

The climate responsiveness of vernacular houses is not only related to climate regulation but also contributes to resilience against climate change. Comparative analysis across three different climates has shown that vernacular houses built with local materials and incorporating natural ventilation can effectively adapt to temperature variations, provide thermal comfort, and require minimal energy. In contrast, emerging modern houses, although mimicking urban forms, demonstrate reduced capacity for thermal regulation under changing climatic conditions, particularly in hot regions [22].

An analysis of traditional dwellings in Goldgadha, India, a hot climatic region, shows that vernacular houses employ effective climate-responsive strategies for achieving thermal comfort. Through the use of shared walls, internal courtyards, thick walls, and limited window openings, these dwellings regulate heat absorption, dissipation, and thermal control in an efficient manner [23].

Recent studies indicate that passive techniques commonly applied in traditional and vernacular houses can reduce cooling requirements by up to 31% and overall energy consumption by 29%, while increasing the duration of thermal comfort by 23% and lowering indoor temperatures by an average of up to 2.2°C [24]. These findings confirm that simple architectural solutions, when aligned with climatic conditions, local materials, and spatial configuration, can ensure indoor comfort without reliance on active mechanical systems.

In addition, a study conducted in India on building cost control demonstrates that alternative construction techniques should be used for low-cost housing, such as filler slabs, GFRG panels, bamboo reinforced walls, and bricks made from waste materials and mud. These approaches reduce construction costs, enhance energy efficiency, and are considered environmentally sustainable, particularly for communities facing economic constraints [25].

The reviewed research shows that traditional construction methods, particularly those employing local materials, passive techniques, and climate-responsive principles, are not only effective in achieving energy efficiency, thermal comfort, and economic affordability but also demonstrate strong compatibility with cultural values and local conditions. In contrast, most existing modern shelters have proven to be climatically inefficient, incapable of effective thermal regulation, and potentially harmful in terms of privacy and health risks.

Although impressive examples of vernacular housing for displaced populations exist in other countries, there remains a significant research gap in Afghanistan, particularly for returnees in Nangarhar Province, where no comprehensive and implementable solution has yet been proposed that simultaneously addresses climatic, economic, and cultural considerations. Therefore, this study aims to develop a climate-responsive, low-cost residential model based on the climatic conditions of Nangarhar, the needs of returnees, and traditional construction knowledge. The proposed model seeks to utilize local resources, simplify construction processes, and ensure durability, thermal comfort, and social acceptance.

4. Research Methodology

This study used a mixed methods approach, using both quantitative and qualitative methods, in order to obtain reliable results for achieving the research objectives. To collect the required data, climatic information for the study area was first obtained from the Afghanistan Meteorological Department and various online sources. This included the EnergyPlus Weather file (EPW) for Nangarhar Province as well as detailed data on temperature, humidity, wind, and precipitation.

Statistical data related to the number of returnees, their economic conditions, and household structures were collected not only from the Ministry of Refugees but also from reports and official websites of the United Nations High Commissioner for Refugees (UNHCR) and the International Organization for Migration (IOM), in order to ensure the reliability and completeness of the data.

In addition, questionnaires have been distributed to 30 families in the Omari refugee camp, located in Torkham, Nangarhar Province, to assess the current shelter conditions of returnees, climatic challenges, construction capacity, and basic living comfort needs. This approach provided accurate, field-based information regarding housing conditions and shelter performance.

The questionnaire data were organized and analyzed using Microsoft Excel, where numerical analysis, percentages, and related tables were generated. A detailed analysis of climatic data was conducted using Climate Consultant 6.0 to identify appropriate scientific strategies related to thermal comfort, natural ventilation, and energy efficiency. Furthermore, key findings from international studies, academic articles, and scientific sources were reviewed to identify effective passive architectural techniques for hot climates and to scientifically integrate these strategies with lessons from traditional building practices.

In the final stage, based on all statistical and climatic analyses, returnee data, and identified design strategies, the final architectural design was developed using AutoCAD and SketchUp software. The design considers building orientation, the use of local construction materials, natural airflow, and principles of efficient energy use.

5. Research Findings

5.1 Geographic Location and Climatic Zones of Nangarhar Province

Nangarhar Province, located in eastern Afghanistan, has a complex climate that includes several climatic zones according to the Köppen-Geiger climate classification. Specifically, the province encompasses Cfa (humid subtropical), BSh (semi arid), Csa(hot summer Mediterranean) and Cfb (oceanic) climatic zones.

This climatic diversity has a strong effect on temperature variations across the region, with temperatures ranging from the coldest conditions in January (as low as −12°C) to extremely high levels in June, reaching up to 43°C. The average annual temperature in this area is approximately 19°C. These climatic conditions reflect the wide variability of Nangarhar's climate and have a strong influence on both the natural environment and the daily lives of the population [2].

From the above characteristics, it is clear that Nangarhar province has different climate zones. So designing a standard architecture for all zones requires a lot of work and time.

Therefore, the present study is limited to the microclimate of Jalalabad City, and the proposed Architectural design is developed specifically in response to this climatic context. Therefore, it is better to first discuss the microclimate of Jalalabad city.

5.1.1 Climatic Characteristics of Jalalabad City

The climate of Jalalabad City is summarized in Tables (1, 2, and 3) below:

Table 1. Detailed climatic data of Jalalabad City for the 12 months of the year [26], [2]

No.	Month	Average Daily Sunshine Hours		Precipitation (Rain + Snow) mm	Average Minimum Temperature (°C)	Average Maximum Temperature (°C)	Average Temperature (°C)
		hours	*minutes*				
1	**January**	10	7	9	2.9	17.9	10.3
2	**February**	10	56	39	8.9	17.8	15.6
3	**March**	11	58	60	12	23.3	17.7
4	**April**	13	3	241	14.9	25.7	20
5	**May**	13	57	2.5	22.4	34.3	27.3
6	**June**	14	24	0	24.8	39.6	32.4
7	**July**	14	10	46	28.9	39.8	32.9
8	**August**	14	22	13	28.2	37.3	34.1
9	**September**	12	21	2	25.5	36.3	30.8
10	**October**	11	17	7	17.2	31.2	23.0
11	**November**	10	21	2	11.2	24.8	17
12	**December**	9	52	1	3.1	18.7	11.8

Solar Radiation: During the summer season, sunlight provides up to 14 hours of daylight, which causes an increase in temperature in buildings.

Table 2. Maximum wind speed, direction, and date in Jalalabad City for the 12 months of the year (m/sec) [26].

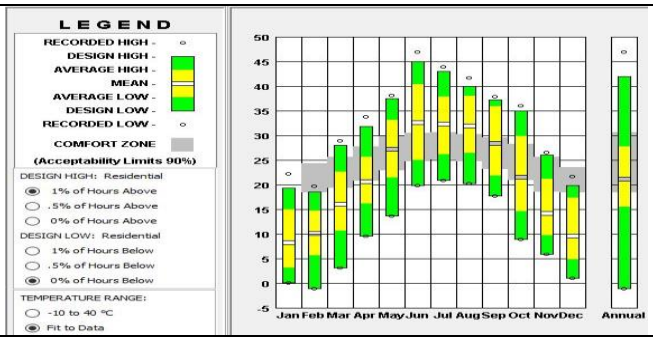
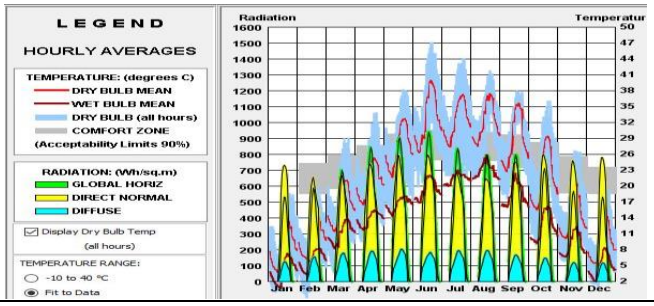
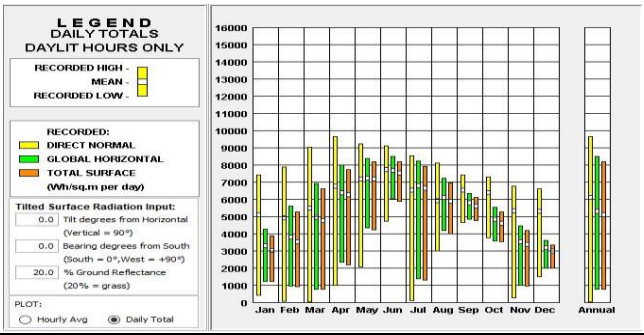
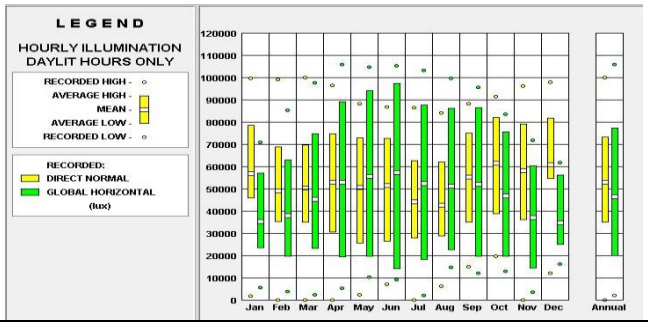
December	November	October	September	August	July	June	May	April	March	February	January	year	No.
09/08/27	14/04/36	01/06/36		27/06/13		23/06/27	36/22/27	07/04/36	18/06/36	08/04/36	31/04/36	2024	1

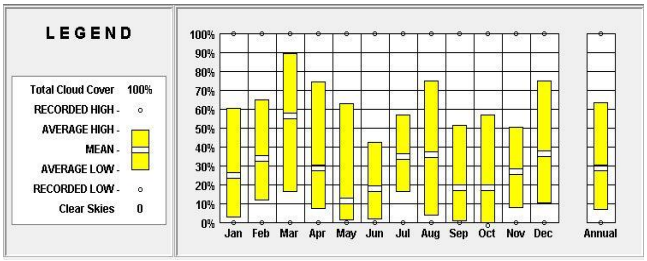
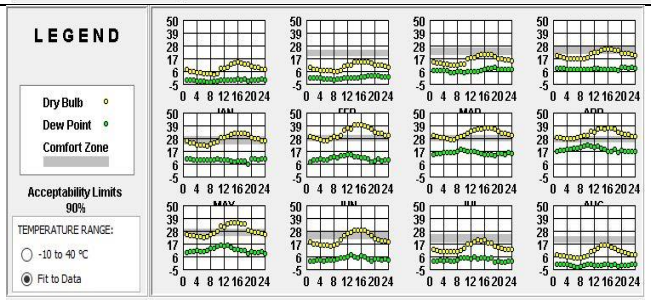
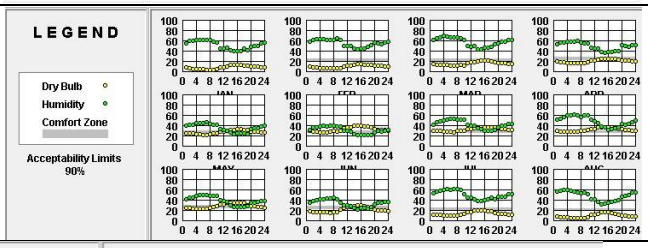
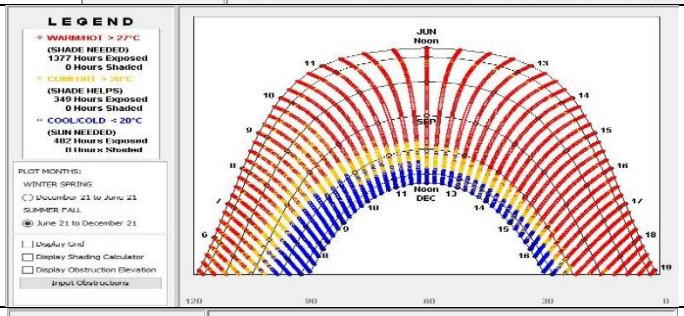
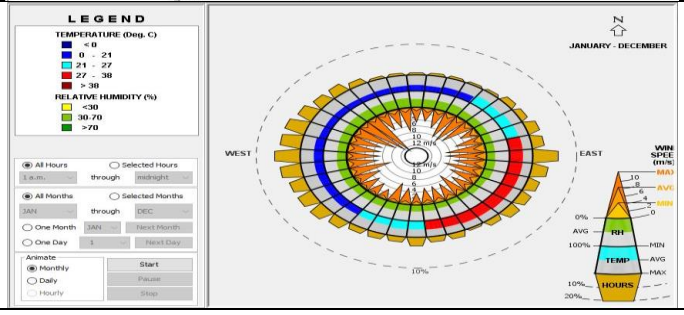
Table 3. Average relative humidity (%) in Jalalabad City for the 12 months of the year [26].

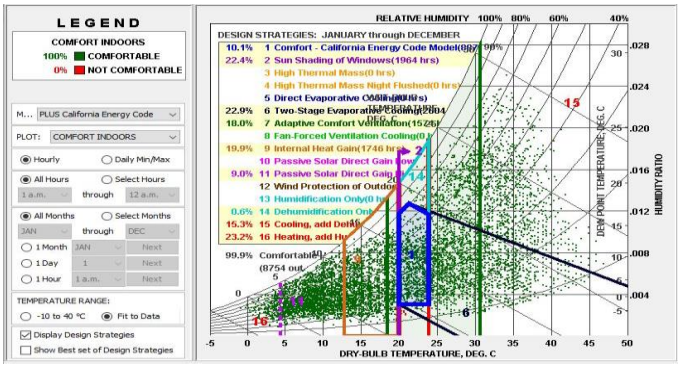
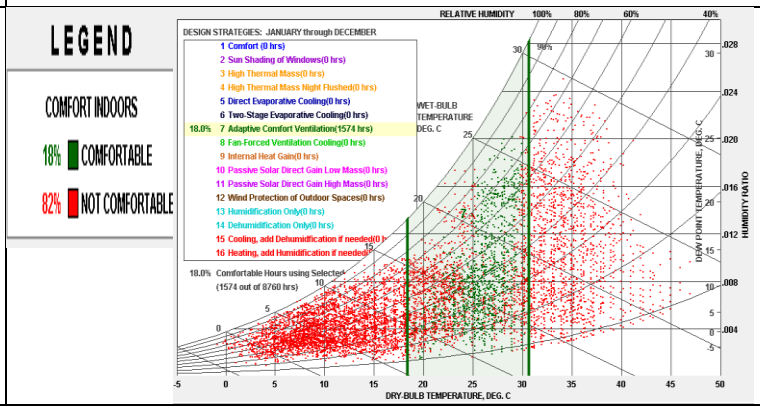
December	November	October	September	August	July	June	May	April	March	February	January	year	No.
60	63	59	54	60	54	42	46	46	66	58	67	2024	1

Considering the above climatic data, the following graphs were generated using Climate Consultant 6.0 software based on the EPW file data for Jalalabad City, covering the period from 2009 to 2023 [27], in order to provide visual documentation for climate-responsive building analysis.

Table 4. Analyzed climatic graphs of Jalalabad City based on Climate Consultant 6.0 software [28]

No	Name	Chart
1	TEMPERATURE RANGE ADAPTIVE COMFORT	
2	MONTHLY DIURNAL AVERAGES ADAPTIVE COMFORT	
3	Radiation Range	
4	ILLUMINATION RANGE	

5	Sun Shading chart	
6	DRY BULB X DEW POINT	
7	DRY BULB X RELATIVE HUMIDITY ADAPTIVE COMFORT	
8	Sun shading chart	
9	Wind wheel	

10	Psychometric Chart by California Energy Code modle(1521hrs)	
11	Psychometric Chart by adaptive comfort model in ASHRAE Standard 55-2010	

5.2 Analysis of the Current Conditions, Challenges and Needs of Returnees

This research section presents an analysis of the questionnaire results collected from 30 returnee households in the Omari refugee camp in Nangarhar Province, illustrated through graphs and charts. Based on these findings, the current shelter conditions of returnees, climatic challenges, construction capacity, and basic living comfort needs are assessed. The results of the analysis are presented in the following Figures:

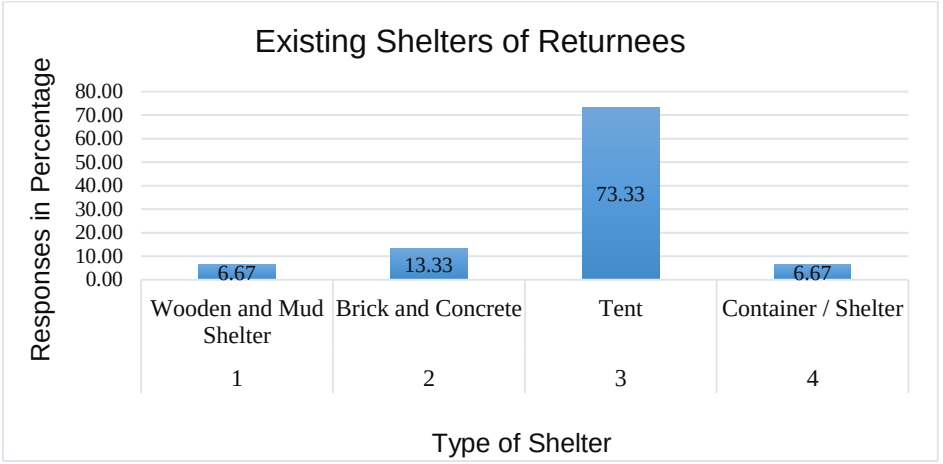


Fig. 1. Types of shelters and their corresponding percentages in the Omari camp

Fig. 1 shows that most households have temporary shelters that are inadequate in terms of thermal control, providing poor living conditions considering the climatic context and posing health risks.

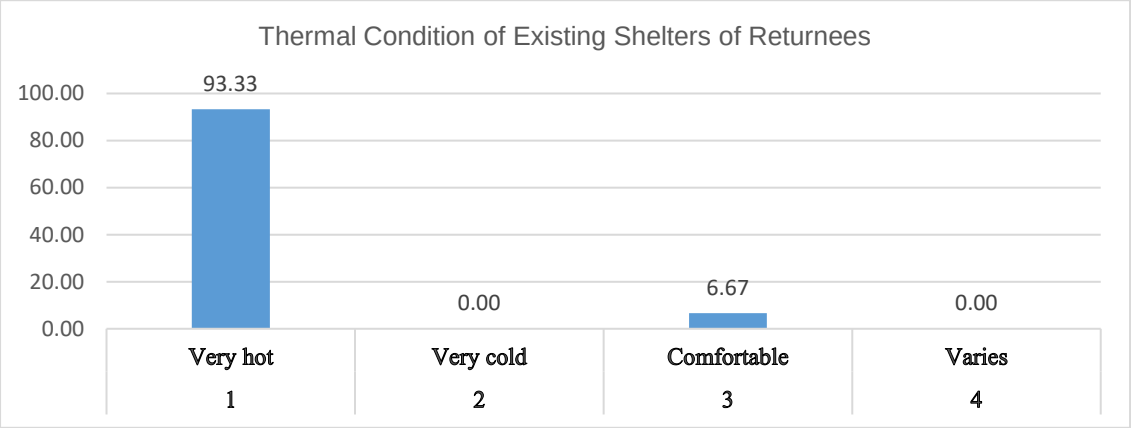


Fig. 2. Thermal condition of existing shelters in the Omari camp

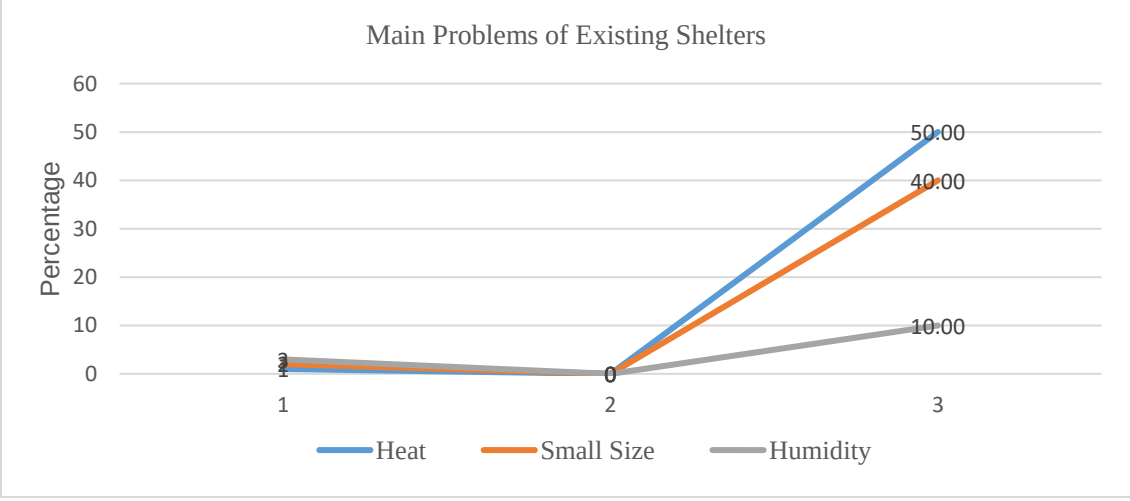


Fig. 3. Main problems of existing shelters in the Omari camp

Fig. s 2 and 3 show that heat and smallness are the main and major problems of these shelters, requiring urgent attention. Overall, the analysis of the collected questionnaires shows that the current housing conditions of returnee households face serious challenges. Most households live in temporary tents or container-based shelters, which do not provide adequate thermal comfort in terms of climate. Indoor temperatures are often very hot, reflecting the adverse effects of local climate change.

Among the respondents, the summer season was reported as the most uncomfortable period. Lack of natural ventilation, direct sunlight, and insufficient lighting negatively

affect the quality of life. The lack of privacy, adequate sleeping areas, and proper ventilation created particular challenges for women and children.
Furthermore, technical knowledge in construction among the population is limited, as most are only familiar with traditional materials such as mud or wood. Financial capacity is also a concern, with most households able to spend only between 50000 to 100000 Afghanis. Nevertheless, a significant percentage of the population is willing to accept climate-responsive housing, especially if the designs are well planned and use reliable materials.
Overall, these findings indicate that returnees face challenges not only in terms of thermal comfort, privacy, and ventilation but also have a dire need for durable, affordable, and climate-responsive housing. Their willingness to adopt climate-adaptive architecture sends a clear message that must be carefully considered in the design of future housing solutions.

5.3 Essential Architectural Strategies and Solutions for the Design

5.3.1 Solutions Based on the Needs of Returnees

In this section, several solutions presented in Table 5 are developed based on the needs of returnee migrants. These needs are derived from the field-based analytical data of the study and the review of relevant literature. Accordingly, for each identified need, the corresponding architectural solution, explanation, and specific reference are provided so that they can be effectively used in the development of a climate-responsive architectural design for returnees.

Table 5. Essential solutions and strategies for the architectural design of vernacular houses based on the needs of returnees

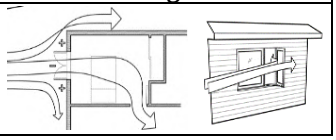
No.	Need	Architectural Solution / Strategy	Reference	Description
1	Lack of Thermal Comfort	Thick mud walls, basements, thermal insulation, and proper building orientation	[9], [10],[20] , [21]	Traditional experiences from Iran, Turkey, and China show that thermal insulation and basements are effective in controlling heat.
2	Insufficient Natural Ventilation	Courtyards, cross ventilation, and windows aligned with prevailing wind directions	[19], [21], [23]	Studies conducted in India, China, and Syria confirm that regulated ventilation is a fundamental component of climate-responsive housing.
3	Heat Gain Due to Solar Radiation	Shading devices or sun breakers, verandas, and limited window openings	[18], [23]	Research from the Azraq refugee camp in Jordan and studies in India show that shading reduces thermal stress.
4	Lack of Privacy	Courtyard-based plan, separate rooms, and in some cases, tree planting	[13]،[6]	Housing layouts of some traditional homes in Kabul and India demonstrate that courtyards provide a solution for cultural privacy.

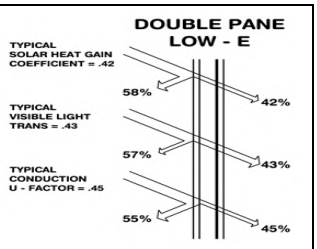
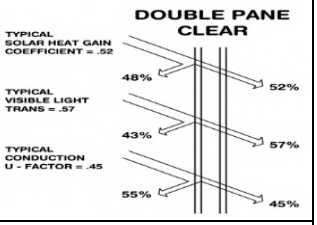
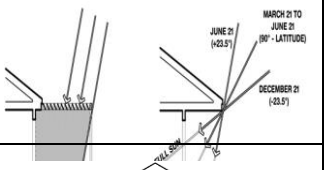
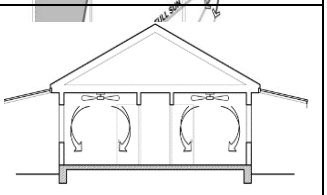
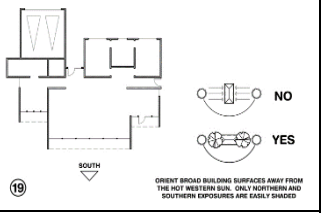
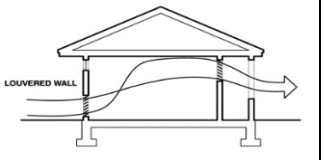
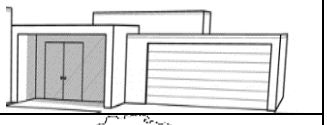
5	Poor Indoor Daylighting	Skylights and high-level windows	Author	Author
6	Financial Constraints	Local low-cost materials, simple plans, mud walls, and domed, vaulted, or flat roofs	[25] ،[12]	Research on low-cost housing in India and a case study of traditional buildings in Herat Province confirm that affordable techniques are effective.
7	Limited Familiarity with Construction Techniques	Use of simple, traditional construction methods and community labor	[5], [10], [12]	Experiences from vernacular architecture show that such buildings can be constructed by local people themselves.
8	Need for Durable Structures	Low-maintenance systems and climate-responsive materials	[17], [24], [25]	Most studies indicate that C-shelter and passive design strategies are beneficial for durability.
9	Low Energy Consumption	Passive strategies, natural ventilation, thermal insulation, and thick walls	[24]	According to research findings, these strategies reduce energy consumption and regulate indoor temperatures.
10	Roof Strategies for Heat Reduction	This issue can be addressed through shaded roof covers, light colored finishes, green roofs, and pond-like roof designs	[19]	Studies show that these techniques are effective for roof performance against heat.
11	Strategies Specific to Humid Climates	Air movement, shading of walls and roofs, lightweight materials, and appropriate window sizing are essential for humid climates.	[19]	Research indicates that these techniques are effective for roof performance in humid conditions.

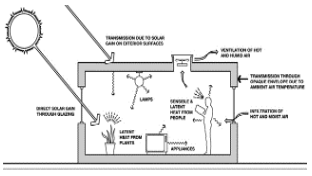
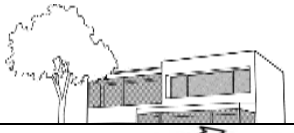
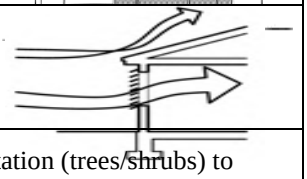
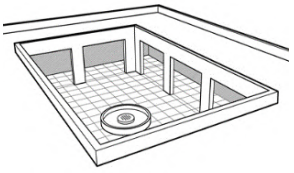
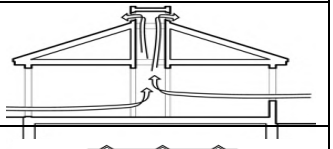
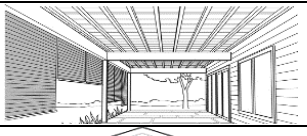
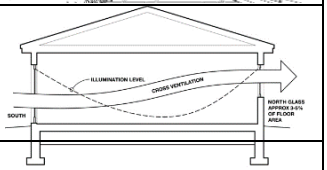
5.3.2 Required Strategies Based on the Microclimate of Jalalabad City

Based on the analysis of the microclimate of Jalalabad City, the following table proposes active and passive climate-responsive building strategies. These strategies were extracted from the Climate Consultant 6.0 software and the adaptive comfort model of ASHRAE Standard 55-2010, as well as the California Energy Code, with the aim of expanding the building comfort zone, reducing thermal loads, and optimizing the use of natural resources.

Table 6. Essential Solutions and Strategies for Climate-Responsive Architectural Design

No.	Need	Architectural Solution / Strategy	Fig.
1	Providing Natural Ventilation to Indoor Spaces	Install windows facing the main wind direction and use sunshades.	

2	Maintaining Indoor Thermal Comfort and Energy Efficiency	Install double High-Performance Low-E glass on windows facing west, north, and east to reduce heat loss and thermal transmission.	
3	Gaining Natural Solar Heat During Winter	Use simple, clear double glazing on south-facing windows to maximize solar heat gain during winter and keep the building warm.	
4	Reducing or Eliminating the Need for Mechanical Cooling Systems	Incorporate latitude-oriented shading roofs or movable sun-shading devices (awnings) for windows to block direct summer sunlight and maintain cool indoor spaces.	
5	Reducing Cooling Demand and Saving Energy	Use ceiling fans or internal air circulation devices in hot weather, as they can reduce perceived temperature by approximately 2.8°C (5°F).	
6	Gaining Natural Heat in Winter and Protecting from Summer Heat	Most of the windows should be designed to face south to maximize the winter sun while at the same time creating shading roofs that provide full shade to these windows in the summer.	
7	Ensuring Natural Ventilation in Indoor Spaces	Use of open areas, jump ducts, and louvered doors inside the building	
8	Reducing Heat and Cooling Demand in Hot and Arid Climates	Use flat roofs, especially with light colors, to reflect solar radiation and keep the building cool.	
9	Preventing Excess Heat Gain in the Afternoon During Summer and Autumn	Minimize or eliminate windows on the west side of the building to prevent indoor heat gain from the afternoon sun.	
10	Controlling Heat and Providing Coolness in Hot and Arid Climates	Construct traditional houses with high thermal mass materials such as mud, stone, or concrete to absorb heat during the day	

		and release it at night; also consider smaller doors and windows.	
11	Maintaining Indoor Temperature and Reducing Heat Demand	Ensure the building is well sealed and insulated to prevent heat generated from occupants, lights, and appliances from escaping, maintaining thermal balance.	
12	Reducing Solar Heat Gain and Preventing Heat Transfer	Use light colored exterior materials and high-emissivity reflective roofs to reduce heat absorption and transfer.	
13	Providing Natural Cooling and Preventing Insects in Hot Weather	Install lattice screens to allow natural airflow while preventing insect entry.	
14	Natural Ventilation (Cross Ventilation)	Position windows and doors on opposite sides of the building, and if possible, orient large windows toward the incoming wind direction to improve ventilation.	
15	Increasing the Effectiveness of Natural Ventilation	Use external wing walls and surrounding vegetation (trees/shrubs) to redirect wind up to 45° toward the building, enhancing air entry.	
16	Creating Cool and Comfortable Indoor Spaces in Hot Arid and Windy Climates	Include well-shaded courtyards in traditional houses with a small fountain or water feature to create a wind-protected microclimate.	
17	Facilitating Stack (Vertical) Ventilation	Increase vertical air height between entry and exit points using open staircases, double-height interior spaces, or rooftop air vents.	
18	Cooling for Hot and Humid Climates	Provide high ceilings, tall operable windows, deep overhangs, and verandas in exterior spaces to enhance cooling and ventilation.	
19	Providing Large Usable Spaces for Hot or Humid Climates	Orient shaded outdoor living areas (porch, patio, lanai) toward the wind direction to expand usable living spaces.	
20	Natural Lighting and Airflow	Install windows or glazing on the north side covering approximately 5% of the floor area to provide daylight and cross ventilation.	
21	Reducing Solar Heat Gain	Use plants, trees, or trellised walls on the west side, provided summer rains support their growth.	

If residential buildings for Jalalabad and other areas with similar climates are designed using both the above active and passive strategies, Climate Consultant 6.0 analysis and the California Energy Code model indicate that these buildings would be fully climate-responsive and thermally comfortable. However, if only passive strategies are applied, the adaptive comfort model in ASHRAE Standard 55-2010 shows that such buildings would respond to only about 18% of Jalalabad's climatic conditions. In this study, we have considered only the passive strategies from the above set, and the following architectural design has been developed based on these passive strategies, as active strategies can still be implemented after the plan has been executed.

5.4 Architectural Design

This architectural design is based on information and statistical data provided by the Afghan Ministry of Refugees and Repatriation. According to the ministry, the average returnee household consists of seven members [29], therefore, this design is specifically designed to meet the needs of a seven-person family. The plan includes three rooms, two designated as bedrooms and one for guests. Additionally, it features a central hallway that provides a suitable space for family gatherings, seating, and internal circulation. A kitchen is also incorporated, which can be used as an additional living room if needed, due to its sufficient area. The design is organized based on the microclimate of Jalalabad, local construction materials, and passive climate-responsive strategies, ensuring not only physical living requirements but also climatic, cultural, and social adaptability. The physical layout, spatial arrangement, climatic balance, and construction elements of the design can be observed in the following graphical illustrations:

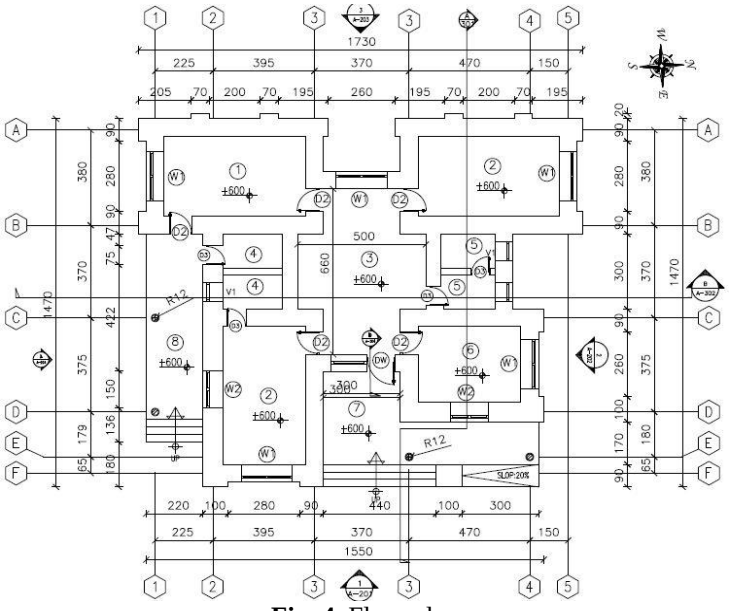


Fig. 4. Floor plan

Table 7. space legend

Spaces Legend		
S.NO	Name	Size(CM)
1	Guest Room	320x550
2	Bed Room	320x550
3	Main hall	500x660
4	Bath and toilet	138x230
5	Bath	138x210
6	kitchen	300x400
7	Porch	170x840
8	porch	220x740



Fig. 5. (a). Front view, (b). back view, (c). Right view, (d). left view

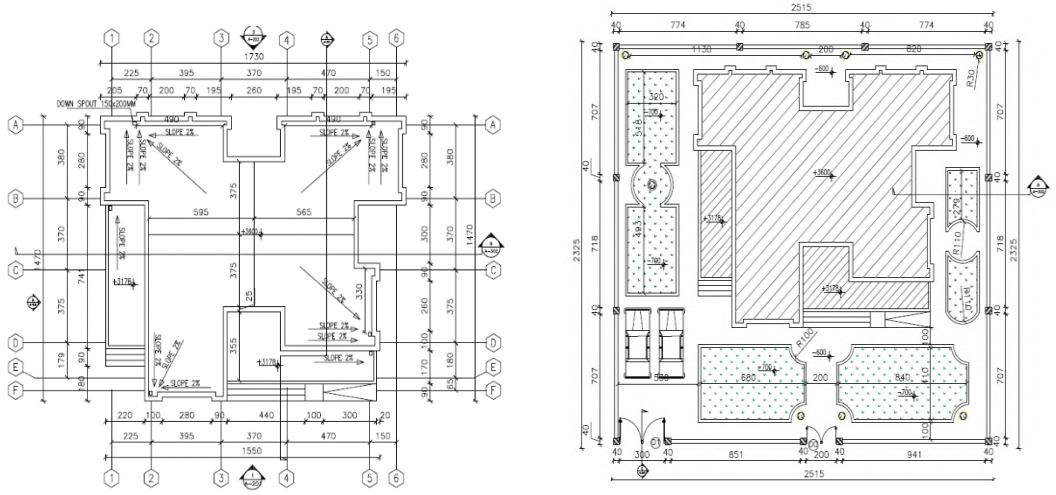


Fig. 6. (**a**). Roof plan, (b). Site plan

Table 8. Building Materials

Materials schedules
Interior walls materials & size
1- different Size of Mud wall 2- Both sides gypsum soil Plaster 3cm 3- Both side whitewashing layer 4- Both sides Plastic paint 75% - 3 coats
Exterior wall materials & size
1- Mud wall 70cm, and in some places 80 2- Wiremish layer 3- Cement Plaster 3 cm 4- Plastic Paint 100% - 3 Coat
Interior wall of the bathroom
1- Mud Block wall 25 cm 2- Wiremesh layer 3- Cement Plaster 3 cm 4- plastic paint 100% - 3 coat
Floor of the Bathroom
1- Ceramic Tile (30x30x0.8) cm 2- Cement Morter 3 cm 3- PCC 5 cm 4- Isogam 2-layer 5- sand 3 cm 6- bolder filing 20 cm 7- compacted Soil 95%: 20 cm 8- Natural Soil
Floor of the other Part
1- PCC 10 cm 2- bolder filing 20 cm 3- compacted Soil 95%: 20 cm 4- Natural Soil (d)
Roof materials & size
1- mud straw Plaster (kahgile) 5 cm 2- Plastic insulation 2-layer 3- Soil or (Ghoragail) Filing 4- mud Brick Arch with Gypsum Mortar 25cm 5- Gypsum + Soil Plaster 3cm 6- Whitewashing layer 7- Plastic Paint 75% 2 or 3 Coat

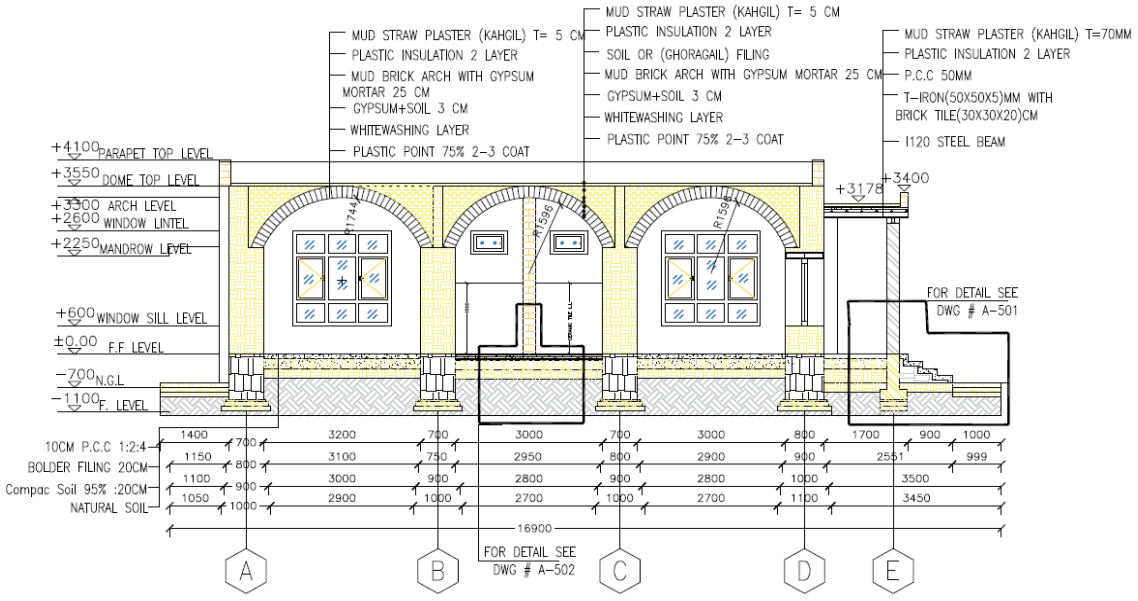


Fig. 7. Longitudinal Section

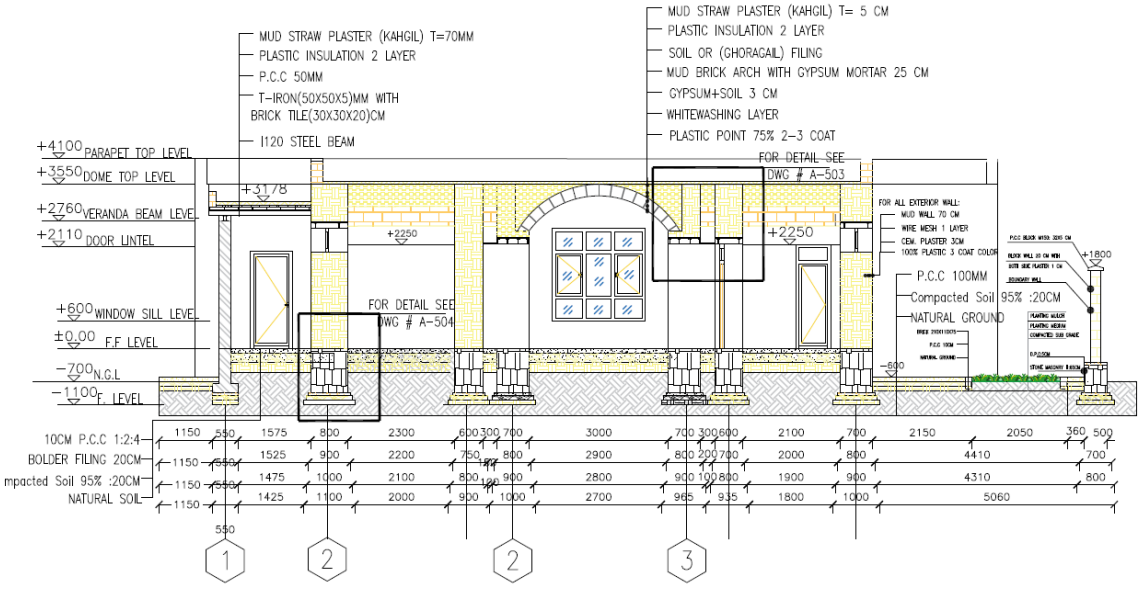


Fig. 8. Cross Section



(**a**) (**b**)

Fig. 9. (**a**). Front View, (**b**). Isometric View

6. Conclusion

This study, based on climate analysis, field surveys, and vernacular architectural experiences, provides a climate-responsive, culturally appropriate, and needs-based housing design for returnees. Important findings emerged from the research process, demonstrating strong relationships between climate, building materials, economic conditions, cultural values, and architectural strategies. The following are some of the practical achievements of this research:

1. Current temporary shelters, mostly tents and containers, are very poor in terms of climate, ventilation, privacy, and thermal comfort, and pose a serious threat to the quality of life.
2. Climatic analysis indicates that Jalalabad is characterized by high temperatures, extended sunshine hours, and limited wind availability. These conditions necessitate architectural solutions capable of effective heat control, shading provision, and natural ventilation.
3. The study presents 31 active and passive climate-responsive architectural strategies and solutions that are fundamental and vital for providing thermal comfort, ventilation, lighting, privacy, and shade.
4. A final housing prototype designed for a seven-member family is proposed, incorporating thick mud walls, an internal courtyard, semi-open spaces, a domed roof, and appropriate building orientation. This model offers a practical and culturally compatible response to local climatic challenges.
5. The proposed design demonstrates an 18% level of climate responsiveness when relying solely on passive strategies. However, the integration of active strategies increases this responsiveness to nearly 100%, indicating a high degree of alignment between the design outcomes and climatic analysis and confirming the scientific validity of the proposed model.
6. Beyond addressing climatic concerns, the proposed housing model aligns with the economic capacities of returnee households, respects local cultural values, and supports socially sustainable living conditions.

Overall, the findings demonstrate that when architectural and engineering processes are systematically aligned with climatic analysis, economic realities, and cultural contexts, it

is possible to develop sustainable, affordable, and human-centered housing solutions for returnee populations.

7. Recommendations

Based on the outcomes of this study, it is recommended that similar climate-responsive and vernacular-based housing designs be developed and tested across other climatic zones of Afghanistan. Given the country's diverse thermal, humidity, and wind conditions, region-specific architectural strategies are essential. Such an approach would contribute to the development of a comprehensive, realistic, and culturally integrated architectural framework capable of addressing housing challenges nationwide.

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