

**Research Paper****Received: 14 September 2023, Accepted: 19 October 2023, Published online: 31 October 2023****DOI: 10.21625/archive.v7i3.1021****Palestinian Traditional Architecture and Methods in Designing  
Dwellings  
(Case Study: Old City of Hebron)****Wisam H. Shaded<sup>1</sup>***<sup>1</sup>Assistant Professor of Interior Architecture at Palestine Polytechnic University, Palestine*

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**Abstract**

This paper examines the components and elements of traditional Palestinian dwellings, focusing on those found in the historic district of Hebron. This area is renowned for its agricultural construction and peasant architecture. The study elucidates the formation of these dwellings and their structural, architectural, and constructional elements, as well as the materials employed in their construction. Moreover, this research delves into the history of Hebron, which serves as a vital resource for the study of the cultural history of Palestine, particularly within the context of Islamic civilization. It scrutinizes the urban development of the Arab city and draws parallels with various other Islamic cities, notably in terms of their primarily vernacular architecture, with formal architecture playing a limited role. The research adopts a descriptive, analytical, and documentary methodology to document these components through images and diagrams. It endeavors to address inquiries regarding the current condition and the pivotal elements that have contributed to the construction of traditional dwellings. The study underscores the substantial responsibility entrusted to society, institutions, and engineers for preserving these components during restoration or conservation endeavors. This can be achieved through a comprehensive examination of the authentic foundations of traditional vernacular construction in the city of Hebron.

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**Keywords***housing classification; vaulted system; vault work; dome system; construction techniques*

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**1. Introduction**

Architectural heritage and historical areas represent a school of thought in planning and architecture. They offer valuable insights for distinguishing architectural styles, optimizing functionality, enhancing aesthetics, and promoting the efficient use of local building materials. They also serve as models for achieving harmony between humans and their surrounding environment (El-Masry, p14). Traditional architecture, in general, is closely linked to the cultural and folk heritage of each region. The clear connection between architecture, heritage, and identity is significant, and Palestine is not significantly different from other regions in the world (Carabelli, 2019, p12). The term "Palestinian architecture" encompasses various architectural forms and innovations that have evolved throughout the stages of human development, from ancient times such as the Mamluk, Ottoman, and British periods to contemporary Palestinian architecture. It is an integral part of the cultural heritage of the Levant region (El-Ghadban, 2005).

While this heritage may vary from one environment to another, it shares a common thread with Islamic architecture in its emphasis on personalized building design and effective layout that provides comfort and encourages community interaction. In the design of these buildings, the inner courtyard, or the spacious interior, plays a prominent role. The

importance of the inner courtyard lies in its role in regulating temperatures in the rooms, entrances, and surrounding corridors, creating local climatic conditions suitable for the residents (Abu Ganima, 2013).

Traditional architecture focuses on local elements and inherited techniques passed down through generations, including construction methods, materials, and patterns. It is characterized by simplicity and the avoidance of extravagance, which is an integral part of Islamic architecture and its association with simplicity (Abu Ganima, 2013). The construction methods for traditional Palestinian homes have remained consistent for an extended period, spanning decades, and have been recently recognized and adopted by most Palestinian cities. Limited modifications have been made, such as certain additions, the type of stone used, building size, and the location of the residence in relation to the old city center (El-Ghadban, 2005).

The historical identity defines numerous components and elements of homes, shaping the architectural fabric that produced contemporary residential structures. Traditional homes in Palestine, particularly in Hebron, have preserved their architectural and structural elements throughout the Ottoman period. Traditional craftsmen and builders, drawing from the accumulated experience passed down through generations, have managed to provide architectural and construction solutions (Al-Ja'ba, 2007). To better understand traditional buildings, an analysis of the materials used in construction is crucial. This analysis allows us to assess their structural integrity and identify potential weaknesses or defects. It primarily focuses on identifying the construction techniques used in traditional architecture and deepening our understanding of the properties of building materials. Furthermore, it helps us understand the significance of each component in a building, such as the type of bricks or stones used (Dandis, 2018, p. 19).

The modernization phases in Palestinian society have resulted in changes in social and economic environments. They have distinctly highlighted the consistent character of Palestinian architecture through its simple structures, diverse building forms, resource utilization, building orientation, and stonemasonry skills (El-Ghadban, 2005). In the 20th century, Palestine experienced several occupations, including the British, and Israeli occupations, leading to a decline in architecture, deteriorating infrastructure, and urban degradation (Abuarkub .2018). The British Mandate in Palestine, which lasted from 1920 to 1948, did have a significant impact on urban planning and architecture in the region. The British Mandate authorities were involved in various aspects of governing Palestine, including urban development, and planning (Dweik . 2014. P1105) In the present day, with the ongoing occupation and the division of Palestinian territories under Palestinian and Israeli control, Palestinian architecture faces complex challenges. The historical traditional architecture of Palestine reflects various periods and cultural and architectural influences. (Abuarkub .2018).

### **1.1. Problem statement**

There is a noticeable gap in research concerning the structural and architectural aspects of traditional housing, which is essential for researchers and professionals involved in the restoration of traditional housing and the revitalization of historic cities. This research aims to address this gap by employing a systematic scientific approach to gain insight into the processes involved in traditional housing construction. The primary question guiding this study is as follows:

What is the current state of traditional housing, and which key elements have played pivotal roles in its design and construction?

### **1.2. Methodology**

This paper follows a descriptive scientific approach for analysis and documentation, utilizing a range of resources. These resources include references to literature in books, written documents, and previously published scientific research. The study employs on-site observations as well as tools like photography and computer-generated engineering drawings. The primary objective of this research is to identify the factors and causes contributing to the development and interior design of traditional dwellings. It also aims to preserve the aesthetic qualities of these dwellings, considering the fast-paced changes in building materials and construction methods.

## 2. Traditional Housing Construction

The methods of residential building construction in Palestine have evolved significantly over time, leading to diversity in construction materials and interior and exterior architectural design, including building size and interior planning. The choice of building materials always depends on the geological composition and climatic conditions of a specific region. Most local architecture was either constructed with stone or mud. In hilly areas, stone buildings were used extensively due to the availability of stone quarries. In coastal areas and the Jordan Valley, mud bricks were used due to the scarcity of stone. This trend continued until the mid-20th century (Abdulhadi, 2008). In Palestinian villages, traditional homes share similar construction patterns characterized by their shapes and building materials (Ahmad, 2008, 57). Building elements in certain cases in the farming community are similar, particularly regarding construction materials and techniques. Despite these differences, these techniques often prioritize durability and strength over ornamentation (Abdulhadi, 2008).

In the case of the old town of Hebron, traditional construction heavily relies on the use of stone as a primary building material. This is due to the mountainous nature of the city and its villages, relatively cold weather during the winter, and the ample availability of stone compared to other building materials. Additionally, iron and steel columns and ordinary cement became available in the early 20th century. Residential building structures consist of adjacent stone blocks, often taking square and rectangular forms.

Building materials play a critical role in shaping the architectural character of homes in the old town of Hebron. The impact of materials can be summarized through the following main points:

- a- The design of front facades – where differences appear in the use of building materials in window openings, variations in the arrangement and balance of stones, and fragmented ornamentation, which indicates a change in style in terms of color and the type of stones used, as well as architectural openings of doors and windows.
- b- Wall construction and the materials used, including changes in wall thickness.
- c- Roof construction and its different styles, including the vaulted roof, the intersecting vault, and the barrel vault, followed by the addition of I-beams steel structures like steel columns and ordinary cement in the early 20th century.
- d- Interior design and changes in the shape of courtyards, entrances, and prominent architectural features like balconies, supported by I-beams steel structure.

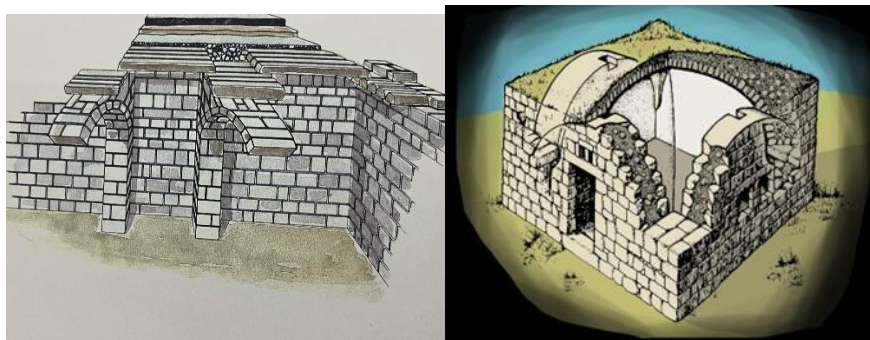


Figure 1: Construction of old traditional buildings (drawing by the author, 2020)

The methods of constructing traditional dwellings are summarized by several elements from materials to reconstruction. These are described in the following sections:

## 2.1. Building Materials (Al-Karastah):

Houses were constructed using various building materials, and the choice of materials varied from one region to another depending on the type of construction and its method. In Palestine, mud houses were prevalent in areas such as the Jordan Valley (Ahmad, 2008, p. 57), and the buildings of Palestinian farmers in villages featured similar architectural patterns and construction materials. The construction techniques were influenced by agricultural practices, emphasizing durability and strength while sometimes neglecting ornamentation. These buildings were typically constructed using the following materials:

**Earth:** Various types of soil were utilized for different purposes. Soil was readily available everywhere, and types included "jidar" soil, "huwar" Earth, ordinary Earth, clayey Earth, ash pottery, or "sakan." is obtained from fire residues or furnaces, and it is prepared and mixed with other components (Hamdan, 1996, p. 513). Usually, Earth was sourced from the construction site, mixed with straw and water to create the necessary mortar in ratios of 1:2 or 1:3. It is preferable to use firebricks after grinding and mixing them with straw for stone construction. This type of soil or sand requires less straw compared to black Earth, which is considered good but weaker. Red Earth is used only for filling inner layers of walls, facades, or foundations (Abdul Hadi, 2008).

**Pure Lime:** Pure lime is a locally manufactured material, obtained by burning limestone rocks, which primarily consist of calcium carbonate ( $\text{CaCO}_3$ ). Gypsum is extracted from rocks rich in calcium sulfate and various stone types such as mizzi and ka'kouli (Hamdan, 1996, p. 513). It is burned in special kilns known as "tun" or "aton" and was an industry at which the people of Hebron excelled. It was used either alone or mixed with other materials like clay and employed in plastering, as well as filling gaps between wall solutions and "Tirasha" (Al-Ja'bah, 2007, p. 47). "Tirasha" refers to a specific paint used for surfaces and walls, available in various types, including water-based and oil-based paints. Pure lime is produced by exposing limestone (containing calcium carbonate -  $\text{CaCO}_3$ ) to high temperatures, transforming it into calcium oxide ( $\text{CaO}$ ) through heat. This calcium oxide, or lime, is then immersed in water for a minimum of two weeks. During this period, the calcium oxide transforms into calcium hydrate, known as  $\text{Ca}(\text{OH})_2$ , which subsequently reacts with carbon dioxide from the surrounding air, leading to the reformation of calcium carbonate. The resulting product is slaked lime, which is now prepared for further processing (Abdul Hadi, 2008).

**Zeebar:** which is the residue of olive oil extraction, is free from acids, preventing permeability and promoting material cohesion when mixed with Shaid (Abdul Hadi, 2008). It also increases hardness over time. For this reason, zeebar was used in foundations after being mixed with fibers and "Shaid" lime, and applied in successive layers to improve the Earth's properties before laying the foundations. This mixture (zeebar, lime, Earth, and fibers) was also used beneath walls and floors, being well-tamped to serve as a waterproof and moisture-resistant material. Additionally, it found applications in ceilings (Al-Ja'bah, 2007, p. 47).

**Al-Qasrmal:** Al-Qasrmal is a mixture of ash and mortar, used as a bonding material between layers of walls or in plastering work (Al-Ja'ba, 2007, p. 47)

**Ash:** or "sakan" is obtained from fire residues or furnaces, prepared, and mixed with other components (Hamdan, 1996, p. 513).

**Mud:** This is clay mixed with plant residues such as straw and chaff (Abdul Hadi, 2008). Hebron's construction did not involve mud but was primarily constructed using stones. We believe that mud might have been used to fill gaps in walls, foundations, and roofs, but it was not the principal material in the old town's buildings. Its usage was more common in the buildings of Hebron's villages (Al-Ja'ba, 2007, p. 48)

**Stones:** Stones: The stones used, especially in the central mountainous regions of Palestine, are primarily of limestone. This type of stone is composed of calcium carbonate and magnesium carbonate and is characterized by its hardness. It is divided into two types:

- The first type is soft limestone and includes:

**Kakkouli Stone:** This is a white limestone with occasional reddish veins and is easy to cut.

**Fire Stone:** This is a non-pure white limestone and is considered unsuitable for any construction purposes. It is called "fire stone" because it can withstand heat and does not transform into shid. It is used for fireplaces, grinding, crushing, and for the inner layers of walls. It is also used in building stone ovens (Kabbara/Al-Latoun). (Abdul Hadi, 2008).

- The second type is hard limestone as referred to by the locals:

**Angelic Stone:** This is a soft white limestone that gains hardness when exposed to air and turns yellow. Because of its initial softness, it is easy to cut and is considered one of the best stones for construction.

- **Mazz Stone:** This type of stone is further divided into three subtypes:
- **Red Mazz:** A hard stone with a light-yellow color.
- **Sweet Mazz:** White stone with yellow veins.
- **Jewish Mazz:** A hard stone with a grayish color and is the hardest among limestone stones. (Al-Ja'ba, 2007, p. 47).

### **Wood (timber):**

Wood has been an integral component in construction due to its natural straightness and strength. This material is celebrated for its ability to evenly bear tensile and compressive stresses in parallel directions to its fibers (Torroja, 1962, p. 39). In the construction process, wood planks and branches, often sourced from the nearby forests, have played a crucial role. These wooden elements were frequently employed in various aspects of construction, particularly in the construction of beams. The gaps between these wooden planks were meticulously filled with mortar, and for added stability, sesame stems and veins were ingeniously utilized (Hamdan, 1996, p. 521). Furthermore, wood extended its utility into finishing works, where it was applied to construct door frames, windows, balconies, flooring, foundations, and framework roofing in various Palestinian buildings (Al-Ja'ba, 2007, p. 47). The selection of wood types is deliberate, with considerations for both strength and local availability. Olive, cypress, and pine woods are among the varieties commonly chosen for their suitability in construction (Abuarkub, Mumen. 2018). These wooden materials, serving as columns, beams, and roof framing, are frequently used for structural purposes. Traditional Palestinian homes consistently incorporate wooden elements, emphasizing the historical significance of forests as an abundant and valuable resource. (Al-Ja'ba, 2007, p. 47)

**Pottery:** Pottery, or "kezan," refers to clay vessels with a height of 20-30 cm and a diameter of 10 cm. It was used for roofing some rooms to reduce the load on the supporting roof. Broken pottery was also used as a filler, whether in ceilings or between walls, mixed with mud (Al-Ja'bah, 2007, p. 47). Kezan pottery was also used to introduce lighting and ventilation in various areas of the dwelling, such as ceilings and ventilation openings (Ahmad, 2008, p. 93)



Figure 2: Image of construction materials such as small pieces of stone, pottery, and lime, used in building a traditional dwelling in the old city of Hebron (rehabilitationcomity in Hebron 2020)

## **2.2. Architectural methods of construction of traditional buildings in the old town of Hebron**

Construction methods used on traditional buildings in the old town of Hebron are described below.

### **Stone Walls:**

The construction process of these buildings relies on two rows of stones with filler materials. Some variations are observed in certain walls (Amiry 2017. 148) with the use of mud being more common in the construction of affluent households due to the relatively high cost of materials at that time. Once the foundation is established on the ground surface, the walls are constructed with two layers of stone. The outer wall is crafted from engraved stone, locally

known as "Maliya Buraniya," signifying the external facade of the wall. The inner wall is comprised of both carved and non-carved stones, which are subsequently covered with a layer of lime plaster (Qawasmi, 2016, p. 53). The facade is smoothed using straight edges, and is locally known as "Maliya Juwaniya." The space between the two layers is filled with broken stones referred to as "dabsh," along with binding materials. The total width of the wall is known as "Al-Klin" or "Al-Kalil." To withstand varying weather conditions, durable stones are used on the exterior, while unpolished stones may be used in certain buildings. The same facade may feature multiple types of engravings and sizes due to variations in the construction period (Qawasmi, 2016, pp. 52-53). As for the interior stones, they are of lower hardness and are extracted from upper rock layers, after which they are shaped.

Stone walls are built in courses, with the height of each course typically ranging from 35-20 cm. These walls are typically constructed on rocky ground, but in cases where such ground is not available, a trench is excavated around the building's perimeter to reach a suitable layer for construction. In some instances, buttresses are used in construction. These buttresses are stone sections that connect the inner and outer walls to enhance the wall's strength. Upon reaching a certain level in construction, openings are created for doors, windows, or niches. Additionally, arches are constructed within the walls; these arches are not windows but are employed as storage cabinets. In the kitchen wall, a unique feature called "Al-Wajaq" is introduced (Al-Ja'ba, 2007, p. 48). It's an arched opening that terminates with a chimney that extends to the ceiling. Particular attention is given to the selection of stones for these openings, emphasizing their strength and refinement. The walls may feature gaps that were utilized for storing grains. Moreover, they contain channels extending from the roof to the well, serving for rainwater drainage or channeling smoke from the "Wajaq" to the roof and outside of the building. (Figure 3)



Figure 3: Image of construction material used in building a traditional. (Rehabilitation comity in Hebron, 2020) (Drawing by Author 2023)

### Roofs:

The need to protect buildings from the elements has driven the development of various roofing materials and techniques (Abdulhadi, 2008). From the very beginning, arches have been used, evolving from barrel vaults to domes through the intersection of arches at a single point, which includes the term "Qubba," representing a diverse range of arches (Qawasmi, 2016, p. 59).

Roofs in the vaulted system appear to be supported from a fixed pivot point and are spaced without exerting any load on the supporting walls. Small openings are made in these walls for ventilation and lighting without expanding them to ensure continuity, which the vault is subjected to. This architectural style was widely used in traditional Palestinian architecture and housing in the old town of Hebron. The reason for their extensive use is that their curved surfaces are not exposed to sunlight during daylight hours, unlike horizontal surfaces. This reduces thermal pressure on the interior spaces (Rizk, 2000, 222).

The transition from the cubic base to the dome was accomplished through pendentives. The domes can sit directly on the circular base of the dome, or the circular wall called the Drum (the wall between the base of the dome and the dome itself) to increase the dome's height. In Palestine, firestone was used in building domes with low heights (one or two stories), while in high stories (e.g., the fourth floor), pottery was used instead of firestone to reduce the weight (Abdulhadi, 2008).

The following types of roofs were used, in addition to modern roofing, which includes the use of cement and steel in roofing buildings. Roofing styles varied based on the construction stages, including:

**a) Barre Vault:**

This type of Vault is built directly above the walls and consists of a series of adjacent curved arches that rely on walls instead of columns or supports (Rizk, 2000, 234). The arch is oriented vertically towards the longer dimension of the space, and the openings decrease in the longitudinal direction. This is because the walls carry the load, and doors and windows are created in the shorter dimension of the space (Qawasmi, 2016, 62). It is also known as "Yakhour" in the local terminology, indicating the level beneath the main dwelling, which is often used for wells, storage, or animal stables. (Figure 4)



Figure 4: Image of the vault's construction (Drawing and photo taken by Author 2023)

**b) Simple Dome and Shallow Dome:**

Including the simple dome, which is built directly above the four walls, and the shallow dome, which takes the place of the level circular nave where the four arches' edges end at the base circumference of the dome (Figure 5).

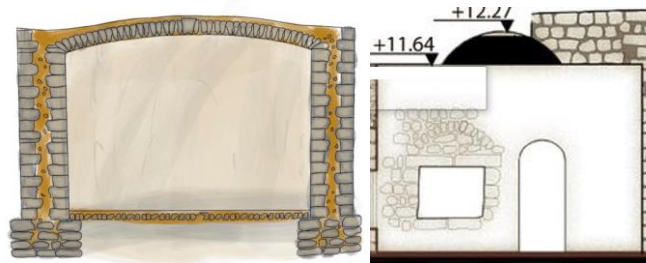


Figure 5: Simple Dome and Shallow Dom found in the old town of Hebron e (Drawing by Author 2023)

**c) Fan Vault:**

The use of fan vaults or semi-circular vaults dates to the Mamluk era (Rizk, 2000, 235), a period that coincided with its appearance in Gothic architecture. This type is characterized by the dome resting on fan-shaped "legs". It has three legs that converge at a hexagonal hub, with a small hexagonal dome in the middle. These complex fan vaults led to the use of single stones for ribs and vault edges (Al-Eisawi, 2015, 10). The next step involves covering this framework with branches, especially hazel branches, and then applying a layer of binding materials like lime, ash, and stone fragments (reish) to reach the desired thickness. It has been found in historical residential vaults that the roof was filled with clay tiles to reduce the loads on it. It transfers the load triangularly from the arches to the "knee", which is then transferred to the foundations. Fired clay was used as the main material in these joints, designed in specific shapes to replace the "dabsh" in the joints of perpendicular arches, especially at the knee. (Figure.6)



Figure.6: Photos represent construction examples of fan vaulting (drawing and photos taken by the author, 2022)

**d) Cross Vaults:**

Cross vaults are composed of two intersecting vaults, referred to as "Cruciform" by Orientalists. While cylindrical vaults were used in passages and corridors, regular cross vaults were used to cover some "iwans" (semi-open spaces, closed from the top, open from the side) in various ancient buildings. In these cases, if the chamber covered by the intersecting cross vault had a rectangular shape, the horizontal plan of the intersection lines of its half-vaults would be composed of straight lines (Rizk, 2000, p. 235). It was extensively used during the Ottoman era and was named so because the arch contains branches or legs at each knee (Qawasmi, 2016, p. 59). Voussoir stones were used in such a way that these stones would rise from the knees or piers in an arch shape until reaching the closing stone, which is the last stone placed in the ceiling. Cement and steel were used as primary materials in these joints. Fired clay was also used in the binding material to reduce loads on the joints.



Figure 7: Represents the plan and section of the layers used in the process of establishing the vault in a traditional dwelling. (Drawing by Author 2023)

**e) Cement Roofs with Steel I-Beams:**

The upper-floor ceilings were constructed using cement and structural steel I-beams, a technology that emerged during the British Mandate period in Palestine between 1932 and 1965 (Carabelli, 2019, p. 31). This period marked the evident influence of British architecture on the local architectural landscape, whereas, in the early stages of colonization, local architecture was influenced by late Ottoman architectural styles (Dandis, 2018, p. 167). The structural system initially relied on the use of iron beams and concrete to efficiently distribute and transfer loads from the roof to the supporting walls (Qawasmi, p. 62).

These roofs were used for both upper-floor ceilings and to create distinct balconies. The process involved installing beams along the shorter spans, followed by pouring concrete between them in a curved arch shape to distribute and transfer loads to the beams and the supporting walls. Afterward, the concrete surface was smoothed, and the lower parts of the beams were painted. This shift led to a reduction in the use of bricks as the primary building material and the widespread adoption of concrete.

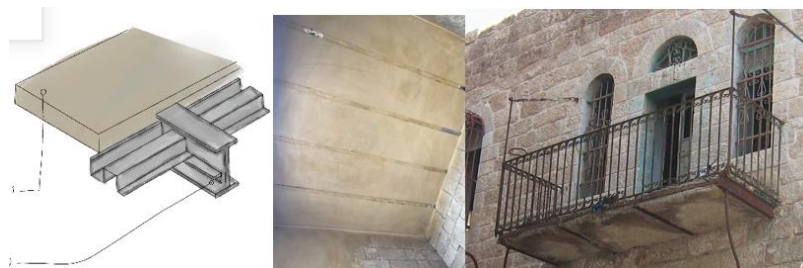


Figure 8: Image of the construction of Structural steel I-beams (drawing and photo taken by the author 2023)

**f)"The Taşwīnah" from Al-Kayzan:**

The rooftops of residential buildings were used to raise the surrounding wall of the building, as well as for ventilation, air renewal, and ensuring privacy for women when they needed to go up to the roof to carry out daily tasks such as hanging laundry, drying vegetables and fruits, and other household chores. This allowed them to see the street without being exposed to passersby (Al-Hajj, R. via telephone, 2020). They were also used in the ceilings of public bathrooms

to allow for natural light and ventilation. Some of them were covered with colored glass to introduce light. They were predominantly used in residential buildings, where they were covered with a latticed screen on the rooftop to provide privacy for the central courtyard. Figure 7



Figure 9: Image of the Al-Kayzan: (photo taken by the author 2023)

### 2.3. Stages of Construction and Methods of Traditional Housing

**The first stage is the preparatory:** which includes everything related to the first preparation for the construction process, including the preparation of the site, the builders, and the " Al-Karistah. The stages of building a traditional house can be divided into five stages as follows:

Preparing site: this is done by following the next steps:

- a) The first step is to contact the builder or the construction master to determine the work steps in the dwelling. The process of stone construction involves several skilled workers, including "al-Hajjar" (stonecutter) and "an-Naqash" (stone engraver). The actual construction is carried out by "al-Banna" (mason) with the assistance of "al-Fa'ila" (laborers). "Al-Qanawati" (water carriers) bring water to the construction site, while "al-Muballit" (tiler) is responsible for the flooring works, and so on. In Palestine, there were talented builders known as al-Hajjar, al-Banna, and an-Naqash. the building master "al-Banna" mason or (muealim albina) assigned to build the dwelling. Figure 9. shows Ratib Abu Haikal, one of the most famous building teachers in the Old City of Hebron the opinion of the construction master is taken in the technical aspects of the work (Hamdan 1996. 602).
- b) Marking the foundation to start excavating.
- c) Inventory of the quantity and types of stones and their preparation in advance at the site to be built in.
- d) Determining the number of materials required to start the construction process.

Note: It should be noted that the architectural details in the ancient era were not done by plans but during the stages of determining the construction on the land by the owners of the land or the building master, before starting the construction process.

#### **Procuring Building Materials:**

Procuring building materials involves the preparation of stones as requested by the designated builder (Hamdan, 1996, p. 602). These stones are sourced from various locations and transported using camels or donkeys (Amiry, 2017, p. 148). The stones are prepared by cutting and trimming, a process often overseen by skilled craftsmen. Trimming may even occur on-site, where different types of stones are sorted and cut according to the specific requirements and approved measurements. It's noteworthy that high-quality, polished stones are typically used for the exterior facades, while irregular stones find application in the interior (Amiry, 2017, p. 148).

Additionally, materials such as "shaid" (lime plaster), clay, sand, and the specific wood used in construction and for making the "Al-Tawbar" trusses are also prepared. All these materials play a vital role in the construction process (Hamdan, 1996, p. 602)

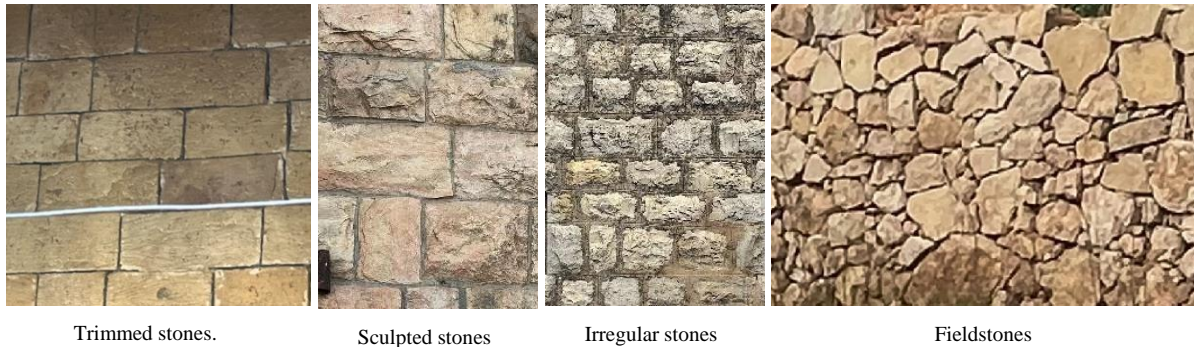


Figure 10: Illustrates the types of stones used in the construction of houses in Palestinian vernacular architecture (drawing and photo taken by the author 2023)

### **The preparation of the brick kit:**

Preparing the Tools for Rubble Construction: The preparation includes gathering the necessary construction tools and equipment for its completion. These tools consist of the "shakoush," which is used for pounding and shaping. It has one end for driving nails and the other end for removing them. Additionally, nails and screws, and tools with a long handle are used for disassembling the rubble. There's also a measuring line and the "alum" used for arches. Various measuring tools are used, including the commonly recognized meter (Hamdan 1996, 618).

### **Preparing the Necessary Means for Transporting Building Materials to the Site and Facilitating Workers' Access to All Construction Sites:**

Adequate means for material lifting are prepared, utilizing ladders and scaffolding. A well is also prepared, typically dug a year before construction, for future use by the inhabitants, as well as the preparation of the "qurb" (a goatskin bag used for water transportation) (Amiry 2017, 148).



Figure 11: This image dates to the early 1970s when construction was carried out by one of the most famous builders in the city of Hebron, Rabieh Abu Hikal with his tools (source Hirschfeld, Yizhar.1995)

### **Marking building lines (threads, bulbs, and others):**

The designation threads are necessary to define straight lines for construction and to determine the exact location of the building, and this is done by what is said to determine the baseline on the ground so that the angles are right. corresponding to determine the length of the side of the facade of the walls.

### **The second stage is foundations, which include:**

- Foundation Preparation: The width of the foundation typically ranges from 80-120 cm, depending on the building's size and the nature of the ground. In most cases, the foundation width is around 1 meter, except for large buildings. This is to ensure it can support the weight of the structure.
- Excavating Foundations: The cost of excavating the foundation is usually borne by the building owner. Workers are hired either on wages or by labor exchange. If the building owners are from a lower-income background, their family members, relatives, neighbors, women, and children may also participate in the excavation process (Hamdan, 1996, p. 605). When excavation begins, the depth of the foundation depends on the site and soil type. In cases of soft or rocky ground, the foundation may need to reach the bedrock for added strength (Amiry, 2017, p. 148). Workers involved in excavation gradually remove the soil and

fill baskets with it (a basket made of leather with handles used for transporting soil and other materials). The depth of the foundation is determined by the nature of the soil, and sometimes, construction continues until bedrock is reached for added structural stability (Hamdan, 1996, p. 606).

- Foundation Reinforcement: The foundation floor is covered with sand to prevent moisture penetration. Depending on its hardness, the ground is treated by applying a layer of Zibar, a mixture made from olive residue after oil extraction, lime, sand, fiber threads, and water, which is then thoroughly compacted. Additionally, sand is applied, and sometimes tree branches are added to bind the materials together.
- Building Foundations: The foundation is filled with crushed stones (Dabbash) and clay, thoroughly compacted, and then the wall is constructed on top of it. In cases where the rocky ground is weak, reinforcement is added, or the foundation is made thicker than the wall itself (Al-Ja'bah, 2007, p. 48). Refer to Figure 11 and the symbols (a), (b), and (c) to see the various types of foundations used in the construction process, including handcrafted and sun-dried mud bricks, which are shaped to bear the loads placed upon them.
- This phase encompasses foundation preparation, excavation, reinforcement, and construction. Different foundation types are employed, including handmade and sun-dried mud bricks, which are designed with concave shapes to withstand the loads they carry (Al-Ja'bah, 2007, p. 48).

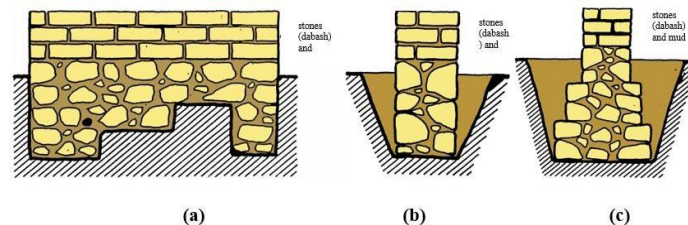


Figure. 12: The foundations of the walls of residential buildings

### The third stage is building walls,

The external walls are constructed using regular stones, usually by skilled masons, while the internal walls are built with irregular stones, either by laborers or by the building owners (Amiry, Suad. 2017, p. 148). The width of the walls, as mentioned earlier, typically ranges from 80 to 120 centimeters. Several factors determine the thickness of the wall, including:

- Building materials used (stone, bricks, etc.), their size, shape, and stability.
- Quality and strength of the mortar used.
- The load on the wall, including the weight of the wall itself and anything placed upon it (roof, upper floors, etc.).
- Construction methods or techniques, and the precision of wall construction.
- External surface forces, especially wind.
- The architectural form of the wall, its length, and its location within the building, including angles, connected ceilings... etc.

**Filling the Gap Between Walls:** The gap between the walls is filled with excavated earth mixed with small stones, and the resulting gap between the rows is filled with small stones, clay, and mortar. Additionally, a horizontal stone is placed between the inner and outer rows (see Figure 11), and voids are created between the walls to make wall niches (Al-Ja'bah, 2007, p. 29). When construction reaches a certain stage, various openings are created, including doors, windows, or skylights. Additionally, arches are constructed within the impermeable walls, serving as storage niches. In the kitchen wall, a structure known as "Al-Wajaq" is built, which is an arch that terminates with a chimney extending through the roof. Particular attention is paid to the selection of stones

used in this opening, focusing on their strength and refinement, with the best types of stones chosen for this purpose. Furthermore, gaps are often integrated into the walls, some of which are made of pottery, for storing grains. These gaps also include channels that extend from the surface to the well, serving the purpose of draining rainwater or transporting smoke from "Al-Wajaq" to the exterior (Al-Qawasmi .53).

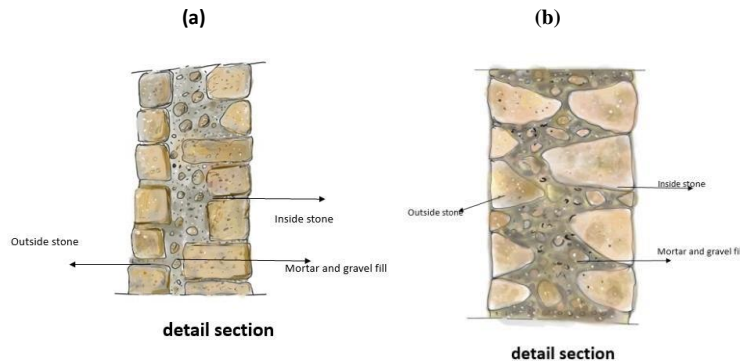


Figure. 13: Types of walls, a wall with two equal-shaped stone faces, the outer face of regular polished stones, and inside, small, irregular stones. (Drawing by author 2023)

- The construction of the Vault is established at the four corners to support the arches and is often built simultaneously with the construction of the walls. There are different types of Vaults, some starting from the foundation, while others have lateral bends. The construction of these vaults depends on the size and height of the arch. In the case of small arches measuring 3x3 meters, the height is less than 5 meters, and they begin at a height of approximately 1 meter from the architectural void floor. The corners are elevated above the ground. Subsequently, robust stone vaults are constructed at the corners of the room to serve as the main supports for transferring loads to the foundations. The Vault may start from the architectural void floor (Al-Ja'bah, 2007, p. 29).
- The creation of arches in walls involves constructing the four walls in an arched shape. Architectural openings such as doors and windows are crafted by the builder (Amiry, 2017, p. 148). This process is referred to as "Tahleel," where the crescent shape is formed at the top. It's named "Tahleel" because the interior of the wall takes the form of an arch resembling a crescent (see Figure 13). These arches are created in various dimensions, with some reaching up to 25x50 centimeters, along with other openings determined by the builder (Hamdan, 1996, p. 615).

**The fourth stage is the Vault Work, which consists of:**

Preparation of the Wooden Truss Structure: After preparing the truss, which consists of a wooden framework to support the piers or the dwelling's roofs, a process known as "Tasteev" is carried out. This involves placing the wooden beams and arranging them in the roof structure. These wooden beams are robust and well-reinforced (Hamdan, 1996, p. 616). The installation of the beams starts with the creation of the "Arousah," which is considered the most important piece of the truss. It consists of a wooden post positioned vertically at the intersection point of the arches. Its dimensions vary depending on the intended purpose, ranging from 3-5 meters in length and 20-25 centimeters in width. The "Arousah" is supported by inclined and horizontal wooden supports to secure it in place (Hamdan, 1996, p. 616), as shown in Figure 14.

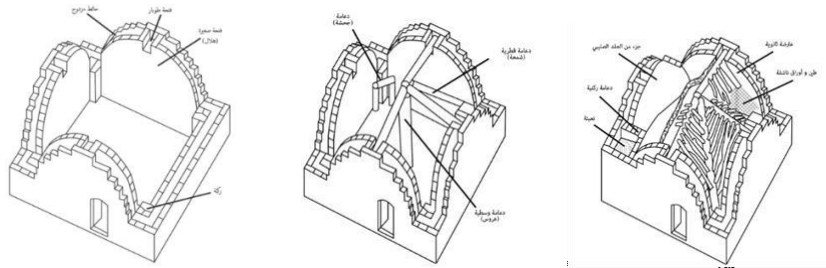
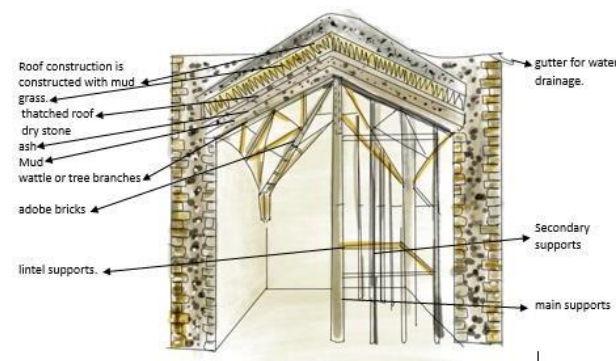


Figure 14: Represents ("Tahleel") in the walls bearing the vault. (Drawing by author 2020)

- **Roof Structure Reinforcement:** In this stage, wooden supports are created, extending from the "Arousah" to the walls' sides. These supports are called "Al-Maddad" and are reinforced with various-sized wooden struts. They are placed within "Taqaat" prepared in the wall's crescents. Additionally, horizontal reinforcement, known as "Al-Maddad," is implemented, varying in width. From below, wooden pieces extending from the "Al Arousah" to the sides provide further support. Wooden beams, called "Al-Jahsh," are prepared to serve as support during construction (Hamdan, 1996, pp. 616-617), as depicted in Figure 14.
- **Covering the Truss:** In this stage, the truss is covered with different materials. Olive branches (Amiry 2017, p. 148), grapevines (Al-Ja'bah, 2007, p. 50), straw, and tree leaves (Hamdan, 1996, p. 617) are used for this purpose. Terracotta fragments may also be placed to reduce the load on the truss (Al-Ja'bah, 2007, p. 50). These materials are secured in place with adhesive substances, often composed of mud and water. Firebricks may be added to the covering, constructed over arches, and secured with adhesive materials like mud and water (see Figure 11). Limestone is used for its heat resistance, as it is lighter than other types of stones (Amiry, 2017, p. 148), as shown in Figure 15.



The arrangement of layers used in the foundation process of traditional construction represents the kneeler reaching the ground level.

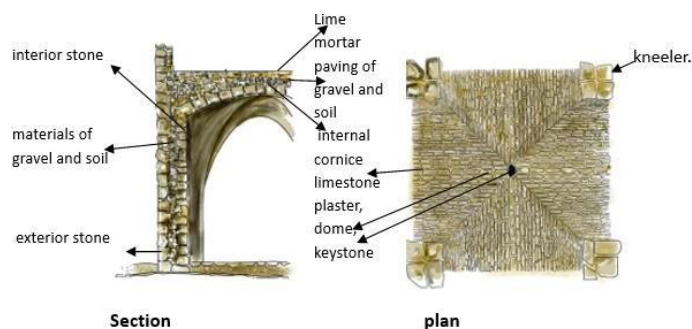


Figure 15: Represents the plan and section of the layers used in the process of establishing the vault in a traditional dwelling. (Drawing by Author 2023)

- **Vault Construction Process:** Preparation for this stage involves labor and materials. The process is carried out collectively, with teams assigned to prepare the clay mixture (Al-Jabal) and another team to pour the mud bricks (Al-Jablah). The builder starts by arranging the "Aqad" or irregularly cut stone (riash"), used in the construction of the vault before the "Qasharah" Plaster (a mixture of equal parts of stone powder, lime, and ashes process. These stones are carefully placed in a tightly bonded arrangement with a layer of mud to ensure the cohesion and strengthening of the vault. This process is an essential part of traditional construction techniques and contributes to the strength and stability of the vault, followed by the placement of stones with mud, creating a tightly bonded layer with the mud. Care must be taken to ensure that the gaps between the reeds are filled with mud. The builder continues to construct the vault's layers until it reaches the top of the vault Figure (15) represents.
- **Closure Installation:** This is the area where the reinforced vault arches intersect, and it marks the closure of the vault. There are various methods for closing the closure, including the use of a "Sahn Qashani" (Hamdan, 1996, p. 625), which was commonly used during the Ottoman period. The open side of the "Sahn" is oriented downwards. It serves both aesthetic and functional purposes. Once the closure installation is completed, it signifies the completion of the vault.
- **Truss Dismantling:** The process of dismantling the truss occurs after ensuring that the mud within the vault has dried to ensure the vault's strength and cohesion. This process may take 25-30 days in summer. Dismantling the supports is done gradually, with the main support being the "Arousa". (Al-Ja'ba. 2007) remaining until the final stage of dismantling to ensure the strength and cohesion of the vault (see Figure 17). Afterward, cleaning is carried out to prepare for finishing touches such as "Qasharah" Lime mortar was used as a binding material between the soft stone (al- riash) and for plastering the ceilings and walls. It is worth noting the presence of some decorations in the large room's vaults on the first floor, with the intersections of the four vaults forming an inverted dish shape.( Al-Ja'ba. 2007) If the interior walls are made of stones that do not require "Qasharah," (see Figure 14.15). Kohla'Castle of old building stones is a traditional technique used to enhance the appearance of stones in historic structures and give them a clean, uniform look. This process involves several steps (Hamdan, 1996, p. 627)



Figure 16: Shows the final shape of the vault after the decoding of the bricks (rehabilitation comity in Hebron 2020)

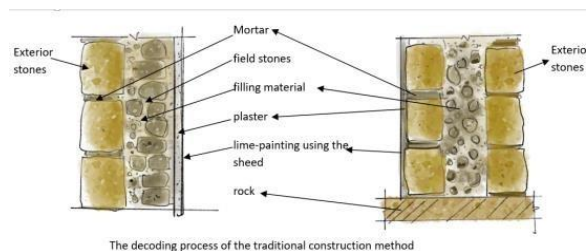


Figure.17: Final finishing of the internal and external walls and 'Kohla' and their types of wall stone (hard stones for the outer courses, and soft stone for the inner courses (drawing by the author 2023)

#### - Flooring Work:

After completing the roof construction, attention is directed toward the floors, which are cleaned of impurities before laying the flooring material. "Al-Muballit" (tiler) is responsible for flooring works. The types of flooring used in traditional houses in Hebron varied. "Qasara" or "Mudah" floors were commonly found, typically used in kitchens or

rooms. These floors were made by spreading mud or lime mortar, and they were popular due to their relatively low cost (Ahmad, 2008, 86).

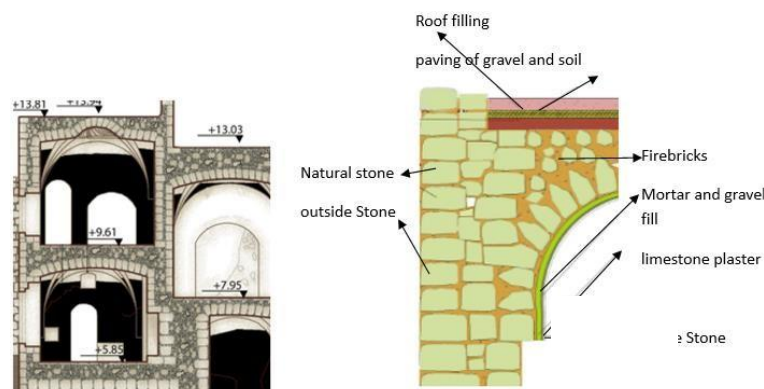
Stone tiles, a common choice for interior finishing, involve the meticulous arrangement of individual stone units on the floor, seamlessly integrating them into the overall flooring. These units are carefully placed and securely affixed to the ground using stones or similar materials, often bound together with adhesive. Hebron's builders displayed remarkable craftsmanship in crafting a variety of tiles designed for house flooring (Rizq, 2000, 27).

Throughout different historical periods in Hebron, distinct flooring patterns gained popularity within its houses. One prevalent style featured rectangular stone flooring, meticulously cut from stones of a uniform color. The thickness of these stones varied, with larger pieces typically being thicker. They were typically placed atop a substantial layer of densely compacted soft soil known as "Munah." These stones boasted a straightforward shape and found common usage in paving courtyards, passageways, and occasionally alcoves (Ahmad, 2008, p. 86).

Another flooring option consisted of ceramic tiles crafted from clay or clay-like materials. These tiles underwent a firing process to transform into pottery, subsequently receiving a glass layer before undergoing a second firing process to achieve a porcelain finish.

**Important note:**

It was noted that in the case of installation of a second floor above the vault, the spaces that form the dome from above are filled with dirt, stones, 'Al-Sheed', water, and other filling materials to make a bench in the upper layers, and other domes are made. In this case, it must be ensured that the dome bears the other layers in terms of wall thickness (malya Arabic word means wall) and the materials used in the construction process and that the upper surface is established to be the roof of the second floor, where tiles and other types of floors can be installed. Figure. 15 shows a section between the two floors.



Arches construction |detailed section

Figure. 16 sections of the Load-bearing walls support the Jack-vault superstructures, showcasing traditional construction methods in detail. (Drawing by author 2020)

**3. Conclusions and Recommendations**

The study of traditional buildings and their history is essential for their preservation and continuation for future generations. It provides additional information to bridge the gap resulting from the scarcity of historical sources in this field. This source serves as an analytical tool and study of the history of traditional buildings. The subject of traditional housing requires further research to improve its understanding, focusing on all aspects of construction, architecture, and interior design, which play a vital role in the preservation and development of these dwellings.

Studying and analyzing residential buildings comprehensively, following scientific approaches, can help find solutions to all the problems and obstacles that hinder the preservation of their structural, constructional, and aesthetic elements without compromising their inherent beauty. This can be achieved by following these steps:

- Conduct a historical study of the building and gather all the information that helps understand its cultural significance.
- Study the building materials and loading methods specific to residential buildings. If traditional building materials are not available, new materials can be used in a way that does not harm or diminish the building's value, importance, or structural integrity.
- Study the architectural elements and create plans to understand the residential building.
- Conduct an in-depth study of the aesthetic components and preserve these from distortion and alteration.
- Pay attention to the structural and architectural aspects of traditional residential buildings and building materials by raising awareness about the importance of preserving these buildings. This can be achieved by raising residential buildings and creating engineering plans that study the spatial arrangement, entrances, rooms, and courtyards to document them. Architectural plans should also be created to study the spaces and components of residential buildings, including precise and studied measurements, as well as sections and facades. Structural plans should be developed to study the loads specific to residential buildings and identify areas that need reinforcement to ensure their preservation and prevent collapse. Historical studies should also be conducted to understand the timeline of residential buildings' construction in order to properly preserve their historical structure.

Support scientific and academic research focused on ancient residential buildings to increase awareness and attention to these dwellings and their occupants. This can be done by dedicating more advanced studies to research the general evolution of housing, specifically the old town's residences. These studies are of great importance to academic researchers and those interested in cultural, civilizational, and interior design components. Field studies and documentation of residential buildings should be conducted to develop engineering and design solutions for the problems they face.

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#### **Conflict of interest:**

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## Appendix A. Glossary

### Architectural Terminology mentioned in the study:

- "Al-Tawbar": a wooden structure used to support the roof beams or ceilings of the dwelling. The process of installing these wooden beams is called "Tastiif." These beams are strong and well-reinforced (Hamdan, 1996, p. 616).
- "Al-Karistah": It refers to the tools and materials used in the construction process.
- "Al-Qasramil," is a traditional building material used in constructing traditional buildings in Hebron, and other Palestinian regions. It is a mixture of ash and lime, used as a binding material between the layers of walls or in plasterwork. The term "Qasramil" is derived from the Arabic word "Qasr," which means what remains in the sieve of the waste ash, collected from the chimneys of the public baths. (Al-Asadi, 1983.p.211). It is a natural form of plaster that is created by combining the ash, often collected from the chimneys of public baths, with lime. This mixture is then used as a binding material to connect the layers of walls or in plasterwork. (Al-Ja'ba, 2007, p. 47) .

This material is distinctive for its high calcium content and clay-like consistency, making it ideal for covering walls and ceilings in traditional buildings. It is mixed with water to form a paste and is then applied to provide the final appearance and appropriate finish. The use of Qasramil is a part of the traditional building practices in the region and reflects the traditional Palestinian architectural heritage.

- "Zibar Mixture": It is a mixture made from the remnants of olives after pressing.
- "Al-Kayzan" is a term used in traditional Palestinian architecture. The singular form is "Koz," and a "Koz" is a container, typically made of pottery or other materials, with a handle, which is used for drinking from or pouring liquids. The pottery vessel is usually around 20-30 cm in height and has a diameter of about 10 cm. It was used for various purposes, including reducing the weight of the roof, as found on the upper parts of buildings

surrounding the building's roof. Additionally, it served for ventilation and the intake of air. Source: Al-Mu'jam Al-Wasit Dictionary

- "Al-Shaid" also known as "gypsum" lime serves as an alternative to cement and is used in various applications. It is used for bonding stones together and in foundation casting. Additionally, it is utilized in plastering and basic construction works (Hamdan, 1996, p. 513).
- "Al-Arousa": a crucial component of the wooden structure. It is a vertical wooden leg placed at the intersection point of arches. Its dimensions vary depending on the size of the intended roof, with a length ranging from 3 to 5 meters and a width of 20 to 25 cm. The "Al-Arousa" is supported by inclined and leveled wooden supports to stabilize it (Hamdan, 1996, p. 616).
- "Al-Qaffa" is a leather pouch with two handles used to transport dirt and other.
- "Al-Rukub": Al-Rakab is the corner support that caresses the roof. They are established in the four corners and are constructed simultaneously with the walls. There are different types of al-Rakab, some starting from the foundation, while others have side projections. The construction of these al-Rakab depends on the size and height of the roof. For smaller roofs with dimensions of around 3x3 meters and a height of fewer than 5 meters, the al-Rakab begins at a height of approximately 1 meter from the floor level of the architectural space, and the corners are elevated above the ground.
- "Al-Fanah" (Courtyard): The courtyard is defined as an open space surrounded by walls. Some courtyards have areas for planting trees and plants, and some may have a water fountain. The courtyard can be enclosed by four walls or three.

Note: Please note that the translations provided here are approximate, as the terms mentioned may have specific cultural or historical connotations that may not have direct equivalents in English