

Sustainable Architecture Analyses of Walls in Miyaneh Village Houses, Iran

Zohreh Salavatizadeh, Feridoun NahidiAzar, Sara Salavatizadeh, Seyyed Hossein Salehi, Ahadollah Azami

Abstract—Even though so many efforts have been taken to renovate and renew the architecture of Miyaneh villages in cold and dry regions of Iran's northwest, these efforts failed due to lack of significant study and ignoring the past and sustainable history of those villages. Considering the overpopulation of Iran's villages as well as the importance in preventing their immigration to cities, recognizing village architecture and its construction technology is of great significance to attain sustainable residence in villages. As the only vertical surface in the space, wall possesses its unique special characteristics, and it is also a very important architectural element able to provide the immunity and comfort space for the residents. This article analyzes the characteristics of this vertical element, main types of adobe and stone walls, locally constructed technologies, implementation, the elements forming the walls in the frame of village house typology of Miyaneh, which has the most villages in East Azerbaijan, based on sustainable architectural construction materials of walls.

Keywords—Typology, Sustainable Construction, Wall Architecture

I. INTRODUCTION

SINCE house is one of the main needs of human beings and the overall shape of Iran's villages has encountered several changes due to the variations caused by implementing different plans and interference of different external factors and parameters as well, therefore, if house designing in the form of new architecture isn't based on the issues such as natural environment, life style, production process, technology evolution, artistic taste, social criteria, customs and beliefs, and in one word, the life and sustainable construction, the house would not only lack tranquility, which is one of the three main characteristics of a house, but also increase suffering and discomfort. As a vertical surface which stands alone in the space, wall has its own special characteristics. It can manifest as a part of an unlimited surface or longer than that; it can penetrate the space and divide its volume. Two facades of a surface would be similar, overlook the same space; or have different forms, colors or textures to conform to different spatial conditions or partitioning those conditions [1].

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II. TYPES OF WALLS

Soil and stone are the main local construction materials in building walls in the villages of Miyaneh (north-west of Iran), concerning its location in mountainous base areas. However, along with the development of roads and transportation facilities, the implementation of new materials has, gradually, become common in recent decades in bigger villages, especially those located near main roads.



Fig. 1 A house with stone wall (left), A house with adobe wall (right)

Therefore, the houses constructed by brick or iron and also the use of horizontal and vertical concrete panels may be found in this village. But, the main construction materials used in the houses of the village are the traditional local ones, and even in most of the newly-constructed houses these materials are used. The walls of traditional houses in villages of Miyaneh are of two types: either adobe or stone walls [2].

III. ADOBE WALLS

Due to lack of transportation facilities in most places of the villages, construction of house or any buildings with adobe or mud bricks is easier compared to other similar methods; thus, the construction of such walls was would be common in most of the villages of country and Miyaneh's villages as well. Most of the time the soil needed is taken from the same construction areas of the same building; otherwise, it is provided from the nearest place adjacent to the village [3].

A. Elements of Adobe Walls

The main element of these walls is adobe, which is mostly prepared in 22*22 cm in dimensions and nearly 5 to 7 cm in thicknesses. One-space mold and four-space molds are used to prepare the adobe. After preparing mortar, it is kept for one or two weeks or more, so that the water and mud would mingle

well. The prepared adobe is exposed to the sun for some days to become strong enough to be used in construction. It should be mentioned that the mortar used in construction of walls is the same as the mortar used for preparing adobe [4].

B. Dimension of Adobe Walls

In a general classification, walls are divided into two groups of load-bearing and non load-bearing. The load-bearing types are 60 to 80 cm in thickness and their free length is about 6 m. The height of these walls is around 2 to 3.5 m. In the second floor, the thickness of these walls decreases and falls to 45 to 60 cm. Although the walls having no load-bearing are less in thickness, they are also made thick enough (around 45 cm) to retain room temperature.

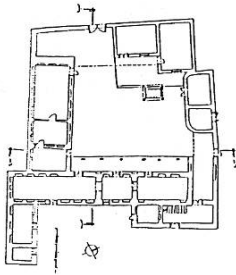


Fig. 2 House plan and façade with adobe wall in Kazraj village

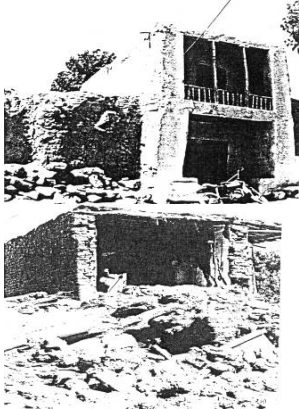


Fig. 3 Thickness of adobe walls

C. Wooden Panels

It is not popular to use wooden panels in adobe and stone buildings, but some of them are seen in three villages: Toshmanlu, Balsin and Afkand with low quality and lack of architectural grace.

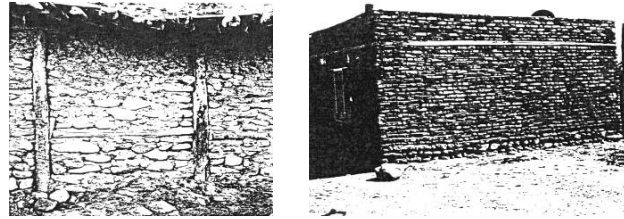


Fig. 4 Vertical (left) and horizontal (right) wooden hasps in adobe walls

IV. STONE WALLS

Since the villages of this region are located in mountainous bases, the stones with the capability of implementation in construction processes are available; however, not all of them are suitable concerning the quality to be used in construction. However, the determining factor, while they are being used, exists in the villagers' accessibility to any of the available stones. On the other hand, using stone in groundwork and foundation of the building is more common and can be seen almost everywhere, even though, these kinds of walls used to exist in most of the selected villages, only one of these villages used stone as the main local construction material.

A. Type of Stones

In this part, the quality of the stones is considered regarding their shape and size. In a general classification, stones can be divided into two groups of mountain and river stones. The river type can be found mostly in the margins of Ghiziluzan River, although they can also be found in spring basin and lateral streams as well. However, their use is more common in the rivers at the side of villages.

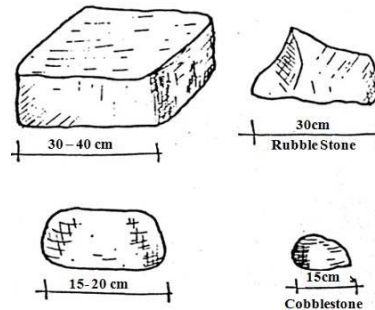


Fig. 5 Types of building stones



Fig. 6 Stone in the building's walls

Having the diameter of 15 cm, river rubbles (broken pieces of stones) can be found in fairly smaller sizes than mountain stones. In addition, since they are polished, the river stones are less strong, lack better arrangement when put on each other to make a wall and lack better adherence to mortar compared to mountain stones. Therefore, these kinds of stones are not suitable except for temporary or more minor use. Using rubbles in the walls are limited and are mostly used in the walls of yards or minor spaces of secondary degree.

Mountain stones are known as rubble stone and distinguished in different small and big dimensions to meet the needs of stone-crushing equipment and transportation facilities. The bigger sizes of them with 40 to 50 cm in length are suitable for construction of fairly strong and durable stone walls [5].



Fig. 7 Stone walls in Balsin Village (left) and Ashlagh Village (right)

B. Methods of Laying Grains

Considering the shape and size of the stone and local capabilities and care of the local people, the methods of laying stones in the walls are different in these villages. In some parts, the least attention is paid to laying the grains, and houses or stone walls no longer possess the least quality. On the contrary, much more delicacy is applied in some villages.

The simplest and the most elementary type includes laying the stones with no neat order and without paying attention to their sizes and the distance between grains, except that the thickness of the wall is kept. In this method in which mud mortar is used, the only goal is just to fill in the wall and less attention is paid to put stones in an unchanged and strong way one over another. The stones are often small and their sizes are extremely different from each other. In a more precise method, an attempt is made to lay the stones in noticeable grains, even though in these occasions less attention is paid to lay grain completely horizontal and keep their thickness as well.



Fig. 8 Village's stone walls

On the other hand, more precise details are roughly seen in these regions too. As an instance, there are some methods, which have been roughly taken into consideration in some villages including leveling the heights of the grains, approximate equalization of the height of different grains, employing bigger stones (rooted) and placing them in corners, implementing intersections and different parts of the wall to enhance the amount of attractiveness of inner parts of the wall and façade-making of the walls through placing the stones of an almost flat side in the façade of the wall or trimming them. Threading stone walls is not common in these regions, and in older or weaker samples, mud mortar is used, while in new buildings where more attention is paid to applying stones, sand and cement mortar is used.



Fig 9 Arranged (left) and unarranged (right) stone wall

V. PROVIDED SUGGESTIONS AND SOLUTIONS

At present, the nature of this region is rich in regarding most of the construction materials available such as soil and stone. The construction materials used are not so diverse and include soil, stone and wood; hence, construction techniques are limited and are mostly dependant on the potentials and facilities that these materials have provided. To reinforce soil in mud buildings, some materials are added to it, so that soil pieces adhere better to each other, soil retains water completely, consequently preventing shrinkage and swelling. Whatever remains from traditional mud-reinforcing materials is the straw left in mud materials that are very common. In present day, many of the soil-reinforcing mud has been identified, however, their synchronization with the region's soil is an important item in their selection, in addition, they should be easily available, economical and meet the goals needed. Cement is supposed one of the best soil stabilizing materials. An adobe can be prepared through the mixture of cement, which is resistance to the buildings more than two stories buildings. Among the disadvantages of cement its high price and the unavailability of it can be mentioned.

Quicklime and hydrated lime are two other best clay-reinforcing compounds acting differently from cement. Mixing lime water with mud and soil makes the extra water not to penetrate into inner parts. Lime is cheaper compared to cement and it is easily available in the region, but its preparation time is longer than that of cement and soil mixture. Tar is another additive, whose proper amount can prevent alteration of adobe shape and its demolition against humidity. Sand with less gravel content can be a good material to prepare compressed adobe. Soil should be first sieved and dried during its process, and then be compressed together with reinforcing materials by manual or mechanical molds. The adobes compressed are exposed to moisture for seven days to attain enough strength. Stone is another construction material common in the region and is used in different ways in buildings. Owing to high coldness in mountainous regions, it is recommended that stone be laid. Regarding the use of stone, it should be attempted that the stone be placed in the wall in its natural form, in a way that the direction of the forces on each piece of stone should be vertical upon the natural grain. The bracing needed may be accomplished by suitable implementation of short and long stones in any kind of stone wall construction. Generally speaking, for each two rows of stones, at least one head stone may be used and for each square meter of wall façade, at least one base stone shall be employed. In the walls located between the internal and external space of a building in a damp area, it is recommended that the root of stones based on the depth be two third of wall thickness, as it is possible that the stone whose root has covered the whole thickness of the wall might let the moisture enter the building externally. In stone walls constructed with mortar, it is necessary that stones not adjoin directly and be affixed by mortar for a better transfer of forces.

Long rooted and big stones (head and base) must be used in the lower rows of stone walls immediately placed on foundation and groundwork. The same stones must be employed in corners and intersecting parts of the walls. In stone walls, where mortar is employed, beveled stones shall be put on foundation or groundwork using mortar for placing the stones on the first row. In most walls, including those constructed with or without using mortar, which do not have a well-ordered outer façade, there should be a horizontal threading in one and half meter height in the thickness of the wall in order to limit this disorder as well as transferring vertical forces down to the foundation, so that the wall can stand balanced. For more equality in the walls, the horizontal distance between two vertical openings should be at least half of the height of two successive rows.

VI. WALL CONSTRUCTION TECHNIQUES

The existing load-bearing wall system is still reliable for most the residential buildings, but it should be strengthened. Since the regional necessities imply construction of thick wall, the need for an integrated skeleton system is not considered.

The walls surrounding the yard with stone and compressed mud materials can continue to function without any change as they would, but it is better that their mud be polished, however, if their mud has big grains and also unfavorable ones, they should be covered with mud and straw mixture and,

finally, to avoid erosion, a cap should be devised. The inner part walls are prone to the most alteration; therefore, it is better to perform a two-layer wall by embedding an enclosed air layer between the two layers of the wall [6].

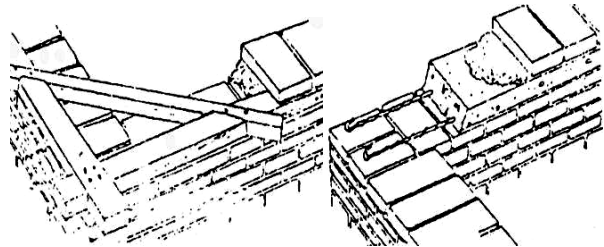


Fig 10 Strengthening mud walls using wooden frame (left) and concrete foundation (right)

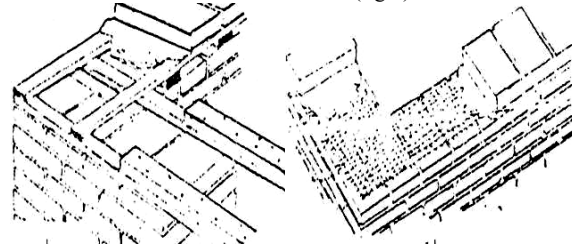


Fig 11 Strengthening mud walls using wood (left) and wire net (right)

To construct a two-layer wall, stabilized mud material or new stone materials can be used; a combination of new and old material (local) can also be used in case of necessity. Two-layer walls not only fulfill regional needs, but also are thinner compared to existing walls. In the figure below, stabilized mud materials including compressed mud make both layers of the wall whose outer façade and inner surface are suitable for covering with mud straw or mud wire. In another sample, it is proposed to cover the outer surface with compressed mud and the inner one with cement block. In addition to being hollow and light, the inner surface of cement block is a good place for covering with new materials such as lime, cement and sand and it is a good surface for painting. In the figures below, both layers of the wall are made of new construction materials. Stone is proposed for the outer layer as a delicate material and resistance against erosion; and cement block is suitable for coating the inner layer. Different parts of the building should join horizontally and connecting hoops of concrete or wood should be placed in the middle of the wall and under the ceiling so as to strengthen the walls with stabilized mud materials [7].

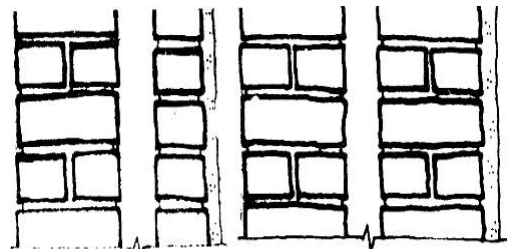


Fig. 12 Two-layer walls constructed by compressed adobe

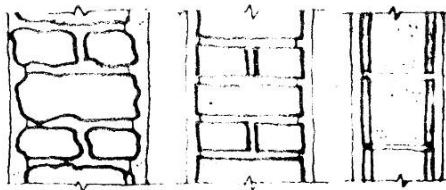


Fig 13 Two-layer wall constructed by new construction material

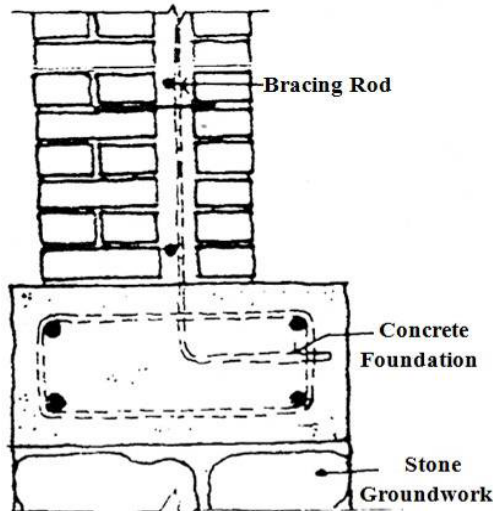


Fig 14 Concrete foundation on stone groundwork

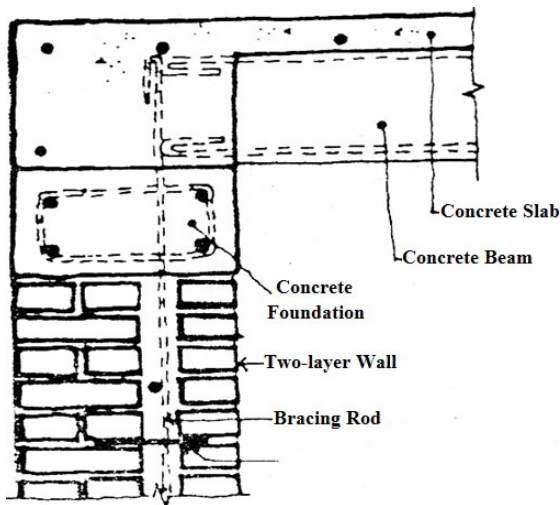


Fig 15 Attaching a two-layer wall to ceiling

VII. CONCLUSION

The existing houses of Miyaneh villages have been evaluated and selected among hundreds of samples and after necessary classifications they are divided into two groups of adobe and stone wall houses. In spite of significant differences among these houses, they possess some common characteristics determining the architecture of walls in Miyaneh villages; the most primarily constructed wall types are of mud laid and unevenly stone laid walls which have reached perfection as compressed and molded mud and evenly laid stone walls.

This characteristic is common among residential houses of this region, which have simple plans any may have yards or be without them. In some villages the architecture of city houses is seen, and these buildings completely separate themselves from village texture and it seems that not even the least attention is paid to local culture, local material and region's weather in their construction; the architectural identity of the people, hidden in village warp and woof during many years, is easily forgotten. It is an impossible and unpleasant affair to have people to live in what kind of house and with what architecture as well. However, if the architects and designers of the houses keep their mind on the customs, beliefs and facilities of the people, the non-sustainable and disorderly houses will no longer exist villages be replaced with orderly houses constructed based on sustainable architecture principles and present needs of the village.

REFERENCES

- [1] A. Zarghar, *Introduction to the Village Architecture*, Tehran, TEH: Shahid Beheshti University, 2006, pp. 74-77.
- [2] R. Taheri, *Geography of Miyaneh Town*, Tabriz, TBZ: Sepid Miyaneh, 2008, pp. 31-37.
- [3] Y. Farid, *Geography Application in Research Method of Urban and Rural*, Tabriz, TBZ: Tabriz University, 1993, 69-78.
- [4] H. Zomorshidi, *Iran Architecture-Understanding of Iranian Masonry Construction Materials*, Tehran, TEH: Azadeh, 2006, 55-63.
- [5] P. Moory, *Status of Rural Studies in Rural Development Planning*, Mashad, KHR: Mashad, 1994, 22-37.
- [6] G. Memarian, *Introduction to Iranian Architecture*, Tehran, TEH: Iran University of Science and Technology, 2001, pp. 103-113.
- [7] H. Zomorshidi, *Iran Architecture-Understanding of Iranian Masonry Construction Materials*, Tehran, TEH: Azadeh, 2006, 44-52.

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