

# Identification of the Mazandaran indigenous architecture concepts by studying the style of the wooden structures in the northern parts of the country: with sustainable architecture approach

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## ABSTRACT

Regarding to the specific climate of the northern part of Iran, the architecture structure of these regions is different than the other regions. Using of the indigenous materials in the construction of buildings is one of the presented solutions sustainable development in accordance with environmental conditions which has been used in this land from the past times. It's important having knowledge about the indigenous materials of each region and the possibility of using of those materials. Using wood as skeleton and structure is what is common in 90% of Mazandaran's buildings. Because of the abundance of wood in this region, it has been used as the main material in the construction of indigenous and traditional buildings. In addition to the high resistance against stretching, pressure, earthquake, high flexibility and ..., the unique feature of the wooden structures has led to their survival during long years. In this study, first of all it's analyzed the sustainable architecture and its principles, Mazandaran's indigenous structure and its formation factors and then design and construction features which is appropriate with region, the study of traditional buildings technics, especially the role of the wood in this region's buildings which has particular identity in the province and its application in indigenous architecture which has been known.

**KEYWORDS:** Sustainable architecture, indigenous architecture, Mazandaran's architecture, wooden structures, traditional materials

## 1. INTRODUCTION

There has been the wood from the Stone Age with humans and this relationship has never been stopped to this day. Perhaps it has lost its important a little bit because of the presence of materials such as steel and concrete. In the wooden structures because wood itself is a living thing, it makes more relaxation in humans and mentally living in these buildings is more suitable for human. In terms of architecture, it can be said that wooden houses make cities beautiful. Also they play an important role in human life and social relations. It is not necessary to have numerous specialties in the wooden constructions, so it reduces the error percentage during construction. Certainly the principles of sustainable architecture which is the preservation of natural energies reduce the use of fossil fuels and coexistence with the environment and climate should be considered by the designers and activists in the field of architecture. It will lead us to indigenous architecture, reflecting on sustainable architecture and its principles. Because, the architects of this country could create the best coordination with the environment in different climates. And with the use of limitations and possibilities of the plan's bed, provide the best living conditions for their users. Mazandaran's architecture is one of the successful examples indigenous architecture that is so delicately mixed with the nature as if it's as a part of the bed and natural environment. This mixture with the bed and considering its capabilities and limitations has been caused alignment of Mazandaran's indigenous architecture and sustainable architecture. Attention to the architecture and its identification and its hidden principles of sustainable architecture is one of the useful solutions to introduce sustainable architecture because it will focus on indigenous architecture again and through it architecture issues will be change into the international new issues. Certainly indigenous architecture has been sustainable in its own time and place and it's useless the pure imitation of it. Mazandaran's indigenous architecture has been mixed so with the nature and has been discovered the methods in this way that not only it is not harmful to its own environment but also it makes perfect the material.

## 2. RESEARCH METHODOLOGY

The present study considering Mazandaran province on the basis of sources and documents, construction techniques, tools and indigenous architectural structure in order to being more clear a part of architectural values in this process. In this study research methodology, is descriptive-analytical research based on library studies and existing documents in which sustainable indexes are identified and presented taking into account the climatic conditions of this province. In this research in order to getting desired results, it is used library research including book, essays and articles. And finally, the subject has been analyzed, completed and concluded.

## 3. Sustainable architecture

The application of sustainability concepts in architecture has created a new topic called sustainable, ecological, green or environmental architecture which all of them include the same meaning and refer to the architecture which is compatible with environment. Sustainability is the same direction that architecture should reach to it in the future without

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any intermediary. This type of architecture indicates the feelings of human beings to the nature. How to design our houses and how to select the materials is one of the issues that affect the future of our building process. All of the designs related to sustainable system must be able to make necessary predicts for the future. For example, a building should be designed in such a way that it's possible to reuse it or even its components. This foresight is used for the future generation needs.

#### 4. Principles of the sustainable architecture

Some buildings have such a features and characteristics that are considered as sustainable buildings. The principles that should be taken into account to a building classified as a sustainable architecture include:

1. Saving energy: the building should be constructed in such a way that minimizes the need of building to fossil fuel.
2. Harmony with the climate: the building should be constructed in such a way that can be coordinated with the climate and energy resources available at construction site.
3. Reducing the use of new resources of materials: Buildings should be designed to reduce the use of new resources as far as possible and used as a new source for new building at the end of their working life.
4. Meeting the needs of residents: the Spiritual and physical needs of the residents is very important in sustainable architecture.
5. Coordination with the site: the building should be placed gently in the land of its site and compatible with the surrounding environment.
6. Holism: All the principles of sustainable architecture should be embodied in a complete process leading to the creation of a healthy environment. Further reflection indicates that the concept of sustainable architecture is rooted in the old customs and culture of human and in the traditional life it is revealed in the form of respect and dignity in nature and sources. Therefore the activities of the last decades of the twentieth century can be considered as an attempt to revive these ancient concepts. In discussing sustainable development and consequently sustainable architecture it's clear that any building must interact with its substrate and environment. it's controversial and considerable that how it is considered to interact and type of measures. This is something that years ago the inhabitants of this land with special skills have benefited from it and by implementing techniques and specific rules in the field of efficient use of energy and natural resources, particularly solar and wind have used coordination with the climate. We see the richness of indigenous architecture based on its compatibility with variety of climate and environmental conditions in the corners of this vast country that its civilization is the extent of the diversity of its climate. Miracle of traditional architecture in the using of regional materials and creating the special construction techniques is the best method to meet the human's physical and mental needs for the construction which is obvious to the lovers of Iran's cultural aspects. Indigenous architecture represents human effort to interact with the environment and nature and it's the symbol of culture, thinking, customs, knowledge and techniques used by the past and present people. Mazandaran's indigenous architecture has been influenced by nature, environment and climate. This architecture has been so mixed with the nature that it is called naturalistic architecture. Most of the principles of sustainable architecture can be seen as obvious and hidden in Mazandaran's architecture.

#### 5. Indigenous architecture

In indigenous architecture, in addition to the nature and ecology, another component called culture throughout history has influenced the architectural structure. In fact, it is the essence of the indigenous architecture that respects to two types of basic links. Link with the cultural environment and its current rules on the one hand and on the other hand link with the natural environment or link with the total data that provided to humans by building land: (data that are both intellectual and practical tools and concludes color, size and proportions or materials and construction elements.

#### 6. Effective factors in the formation of architecture:

Culture: beliefs, rituals and religion

Nature: geography and climate

Economy: determining livelihoods and its types

Community: tribal structure and homogeneous and heterogeneous nature of the community

#### 7. Designing features and suitable structure with climate in the area:

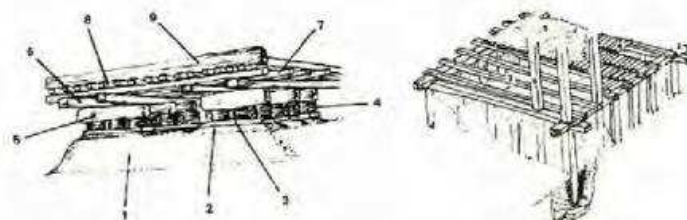
- Prevention of buildings heat loss
- Rain protection
- Wind impact reducing on buildings heat loss
- Crating interior turbulences in the hot season
- Using of the outside weather conditions
- Using of solar energy for heating buildings
- Avoiding of increased humidity

#### 8. Study of traditional wood construction techniques in northern parts

Due to the Iran's 116 forests and its positions in the northern parts, wood are used in the house as one of the main materials. This part of study refers to examining the use of wood in foundations, walls, ceilings and other parts of building.

Elements of area's architecture: one of the main factors in the formation of architecture and indigenous urbanism is continuous rain and high relative humidity in the area. In such an environment, buildings should be done in accurate ways in order to resist from the influences of interior humidity (Floor and Ceiling Humidity) [1].

Foundation and substructures: one of the constant features of indigenous architecture is the height of footing which is varied according to the humidity of soil surface. The distance between floor and muddy ground is about one or two meters in the swampy delta plain of Sefid Rood in which this kind of distance has several roles like using as a tripod for cooking, cloths hanger in rainy seasons, chickens' nest or as a barn. Nowadays this distance is used as a parking in the house of the most prosperous farmers. The height of the buildings is lower than from the ground in other parts of the plain (1 m and 70 cm). Each of these high floors has specific foundations.



Foundations in high humidity areas: The foundation of footing in Gilan and Caspian offshore is wooden and rarely from backed bricks. One of the most common technique is to locate short poles in a pit vertically and to tighten it by stone and thatch or sand mortar and iron.. Four thick beams are located on the poles of Pakeeneh. These beams are foundational beams. According to such a simple technical plan, several methods are used in buildings. One of the simple methods is to fill the distance between Pakeeneh by using thatch. It is better to cover floors with mud in order to have elegance and consistency. Most of the time rooms' floor are made in a way that horizontal beams were located under beams. It may use a complex way like to locate Wels on additional raw of beams which are connected to lower beams. Using this, the floor doesn't have any contact with muddy footing because the layer of air separates the two from each other.

Brick Footing:

In order to prevent floor humidity, the building is located upper than floor to establish air flow between the floor and the ground. Materials and brick footings in temperate region of the Caspian are kind of economic power because it is dependent to graphic conditions. Having access to these materials and empirical knowledge of local craftsmen and Time of using the building is a suitable economic power.

Brick footings are as follows:

1. Stone and muddy footing
2. Shakeel
3. Pile driving
4. Brick footing and building materials

The foundation material is mostly from wood, mud or stone in which its individual columns are under the infrastructure. Another solution in most of urban houses is double layer floor forming for room's floor, humidity volatilization and ventilation by air flow through the floor layer. The height of footing which is one of the indigenous features of architecture is mostly varied according to the amount of soil's humidity. The mud between the distance of floor and ground is one or two meters in Sefidrood Delta plain.

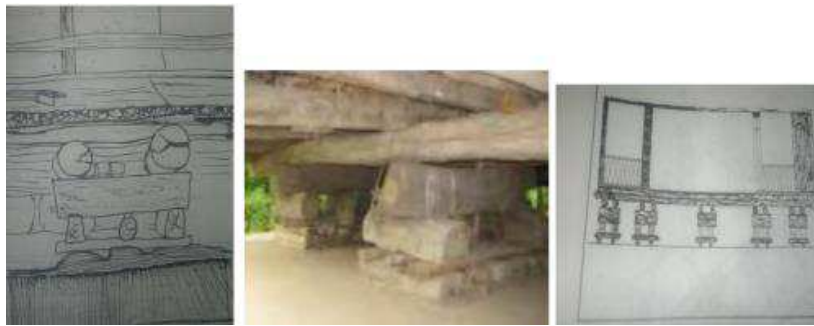
Buildings' height from the ground is lower (around 1 m and 50 cm) in plain area in which it is hard to see the underground. The buildings' subgrade is firm in foothills in which this distance is less (between 20-50 cm). Each of these three footings has specific kind of foundation type like:



1. Shakeel foundation: it is a system of accumulated beams and protects the building foundation from humidity up to the specific height. After filling the Shakeel with coal about 60 cm, some berry pollen is placed on it. Then it is placed by two woods by the name of Dhi and two woods by the name of Katel on them and a wood like trap zius by the name of Fik on it.

The name of this part is mastic. There are beams by the name of rogue on mastic and there are beams by the name of nul in the last part before building's wooden floor. There are 6 Fiks for a room, 10 for two rooms and 14 for three rooms. It can be said that there is no any connection between components in this buildings' foundation. The only reason for buildings' stability is compressive force of buildings' load.

Segaly Force:



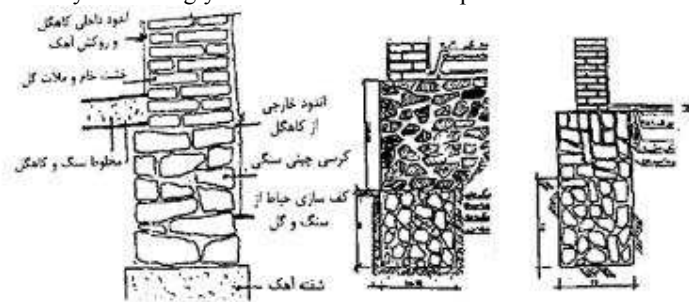
2. Brick footing by spot power transmission is named well segt. Excavation usually has made for foundational level to the firm level of ground. Solid wooden beams are placed in the hole with 20 cm diameter and a specific height space. Its surrounding has been dumped by rubble and it is filled by clay about 20 cm in order to directly prevent from Segt's humidity and waterproofing. Brick footing using spot power transmission of well segt improve buildings around 70-80 cm by the help of berry beams in short distances from each other (1-1.30 m).

It also connects piles by beams and filled the gap between wooden beams and ground by brick sun dried. Then it is filled by clay mixture and rice barn for flooring.



### Wooden or Zoghali foundation

Firstly the ground is dug in 150 in 150 cm square to the hard surface. Dug foundation making foundation by foundation paste up to 20 cm to the surface of ground. After self-making foundation, coal dust mixed with dry clay and is poured on the surface layer of foundation with the dimensions of 20-25 cm and completely smash it in order to creating thermal insulation. From the surface of ground and insulations resistant and hard wood are arranged next to each other with a diameter of 30-40 cm and a length of 100 in 100 square meters. The second row is laid in the reverse direction and perpendicular to the first row with the same dimension and connected to each other by a long vries. Usually the distance of foundation from each other will be 1.5-2 meters. After the creation of the desired height from the wooden foundation, for floor covering, lintel uniformly and strongly attached to the wooden parts with the diameter of 25-40 cm.



### Wood flooring

In this mode after the establishment of the round beams to horseshoe and placing them in the same level by removing horseshoe by 3 cm boards with different widths of 1.5 or 2 to 3 meters in length and 4 mm with respect to the round surface of Bineh is laid and nailed. This floor making is called Lmbh slamming. In some samples, the way of beams connections which are placed in the four sides of the building, is in the form of tongue and groove on foundations.

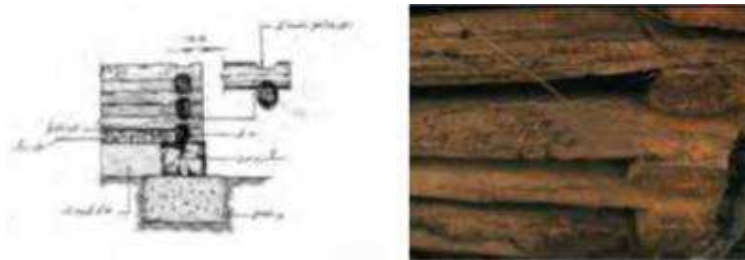


## Walls

In the Gilaki and Mazani key words in the field of wooden wall there are words indicating that there is some kind of retaining wall that are Zegmehie or Verjiny - Sect Sri- Zigaly. Zegmehie or Varjin wall refers to round timber which is stacked on each other. The bottom of the timbers is deep in order to be possible their head connects. This method also applies in the Foothills Forest and the Sefid Roud delta and areas of the plains where there are enough resources for construction timber. The result of this method of construction is very resistant and it is often a sign of antiquity and wealth of owners of residential buildings in the plain of Gilan. These buildings are multi-storey buildings. Zegaly and Secret Seri called in two distinct scaffolds which is the most common technique of making wall. Scaffold The first type is that the long diagonal pickets are closed to the two sides of girder (Nal) and beam (Sects) which is forming the wall skeleton. In the second type, mast cross (Zigal) are placed horizontally or diagonally which forms.

### Vergin wall

Round timber refers to Varjin that are stacked and is used in the mountainous areas of the north, in this type of wall the joints and crotch settlement which is called Khormehare involved in teach other are involved in the each other. The distance between the lumbers is covered by wood and thatch and in order to further insulate the entire wall can be covered with sludge.



### Zegmehie wall

Zegmehie wall is the evolution of Verjin wall. Its implementation manner is that ties and bracing of Zegmehie wooden walls is removed with the principles of crotch taking root or saddle in transverse and longitudinal beams of thickness 1.2 with regarding to rounded slope on both sides so that the bottom of the beam is healthy and top of it is deep and saddle horse. In other words, usually before they are in the form of crotch and the saddle in order to tightening the corner joints.



### Zegali wall or Nefar

#### 1. Zegali diagonally wall

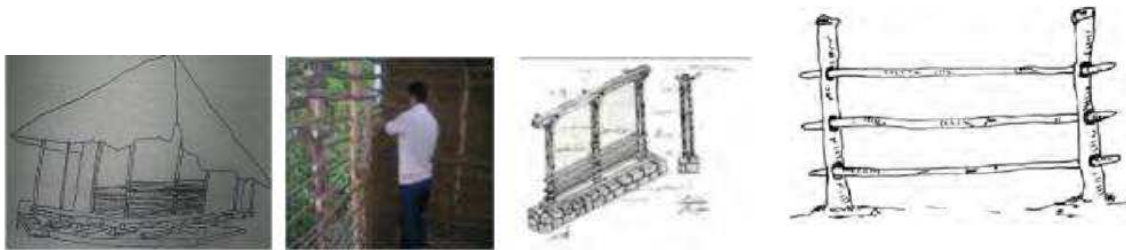
At first the vertical beams are placed on lintel with a space height and 15 cm diameter. This connects lintel by using pin to them from both sides (left and right sides). 3 cm kevels are fastened diagonally from each other to 10-15cm of main beams. So that one of the rows is placed on exterior surface and another on interior surface of wall.



#### 2. Simple Zegali wall

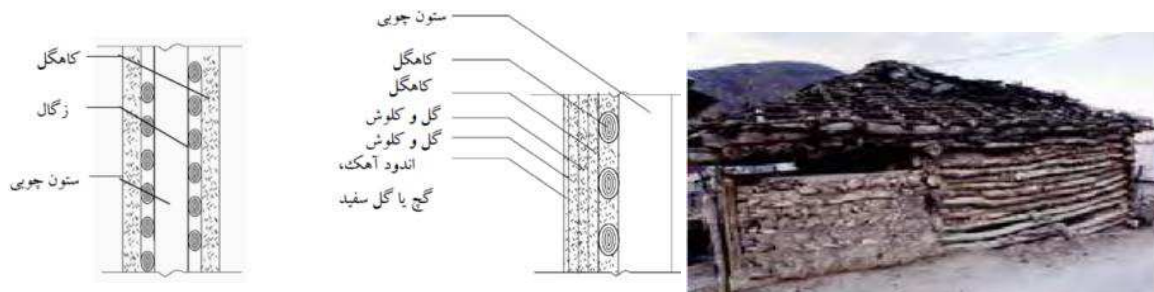
At first and after break footing, vertical beams by the name of Vadar with space height and 10-15 diameters and 1-1.5m space are placed on Nul. In this method beams are selected in a way that their endings are placed for collision of upper lintel on 7 tracks. Then horizontal beams are fastened by plant ropes to both sides of vertical beams.





### Structure of Zegali wall

Void houses are filled by thatch and adobe between transverse cracks. Then scaffolding is lined either from round lumber or beams.



### Details of cross sectional Zegali wall

The face view of house is almost covered by the elegant thatch mixture while lateral walls and behind of walls are lined by a hard layer of mud Stover. Only wealthy people can cover their walls by such an elegant thatch mixture.

### Steps of Zegali structure's construction



Connecting the Nuls to each other by using mortise and Tenon method.

Connectivity of Nul to beam

Connecting beam to Nul

Zegali connection details to Nul and beam

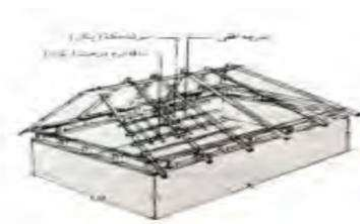
### Roof (gable-multi header-four header)

One of the most difficult steps in construction is assembling the roof scaffolding. As it is mentioned the roof is made by connecting wood pieces in which is a kind of rural wood making technique. There are three kinds of roof which its slope is steep according to the quality of coverage materials. (The relatively 20degrees less slope for wooden or clay roofs 40 degrees of steep slope for rice wool or Gali roofs):

1. Gable roof which technically is the easiest type of tectonic structures (temporary ambush of predators' traps)
2. Four heads roof in which its two slopes are triangular and varied
3. Pyramid shaped roof with 4 equal slopes

### Gable slope roof

There is the final band by the name of lintel after walling which is a band on four sides of the frame and under the lenter. The exact place of diagonal beams of final cache is pin-shaped and it is connected to others by pin and the skeleton is formed like truss. After the approximate 50cm ties and bracing diagonal beams are connected to the lower and final tendon in order to make truss ties and bracing. Checkered grills of 40-50cm are connected to diagonal beams from trees' branches and ready layers.



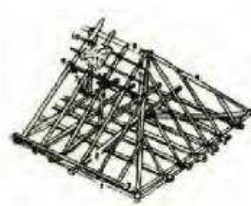
#### Multi heads roof

One of the most popular kinds of roofing in Gilan plain is slope and double slope roof which building matches with rectangular rules. Wooden scaffold of roof is formed from 4 horizontal beams. These beams are placed on the exterior view of porch's pillars in order to place directly on 4 beams rule of horizontal wooden roofs. This position formed the floor of under space roof. These thick 4 horizontal beams are loaded and then have formed the roof.

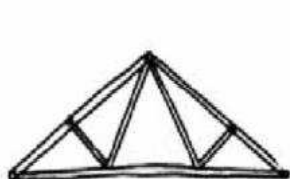


#### Four head roof with 4slope and equal surface

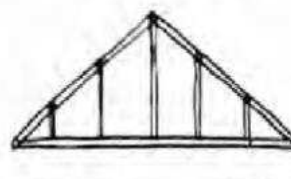
In every rule of scaffolding, triangular shaped scaffolding is formed. These scaffoldings by using bail beams. These bail beams scaffoldings which is placed on scaffolding rules are kept 4 horizontal beams. Every wood is placed on scaffoldings and horizontal beams and finally are connected to each other on roof trestle. In fact, these bricks that are tightened to truss are supporter of roof covers. Wooden connection equipments are: rope, bail landed woods and pin. One of the specific features of buildings is using wooden truss.



The differences between Iranian and foreign truss is that internal beams of Iranian truss are horizontal and vertical while internal beams of foreign truss are diagonal [2]. One of the advantages of Iranian truss is that its distance can be used for residential and warehouses usage. But its disadvantages are its instability against lateral forces like wind and earthquake [3,4].



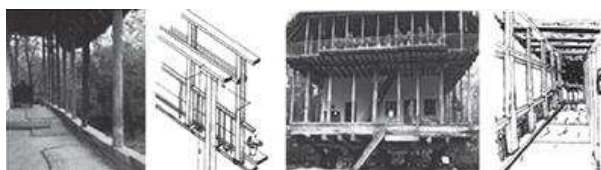
خرپای فرنگی



خرپای ایرانی

#### Northern buildings' decoration (artistic and technical aspects)

It is tried to make the exterior part more beautiful. Because of that the quality of materials, using decorative and outstanding elements in exterior part of building, it is possible to mix the elegant thatch of exterior with colorful materials in which using yellow or red ocher soil in thatch or using it in exterior parts with ocher flower in contrasting with exterior color. In some cases it is decorated by plant or geometric patterns with a dark color comparing with exterior. It is not used in Iranian architecture.



Considering the role of trees in people's beliefs, it is not surprising to use such decorations. Mostly the cypress tree is used which is one of the old trees and shows that plants have important roles in public ideas. One of the interesting decorative elements in building is from wood like fencing around the porch. Stacked plates are used in poor people's houses while in wealthy houses there is a complex system like cross fences around sun rays in the form of bulgy length of truss. Sometimes there is some decoration elegant on the wooden colors of porch. In rural plain houses, it is rarely seen wooden windows with colorful glasses while this kind of windows can be seen in the architecture urban mountain areas and also in shrines all around province. The only vent houses are: wooden swing doors and sunny windows.

### Conclusion

Architecture is formed as a result of passing time in northern parts of the country. The main features of the indigenous architecture are: using local products, local applicable and suitable techniques, using local products as a cheap studying different kinds of Gilan's rural area for using positive aspects of indigenous architecture and using climate and structural solutions is a suitable way for optimization of today's houses. Using of wood and thatch that are not harmful for environment and creates a relaxing atmosphere. They are useful and easy to connect in the time of construction. It increases the productivity and local economical growth and development.

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