

# **Green Roof, a Pattern of Traditional Roofs' Architecture in Mazandaran**

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**ABSTRACT:** Building roof as an element in the building which has the maximum contact with abnormal environmental factors (wind, rain, sun and atmospheric pollutants) has always been addressed and emerged in different forms in different climates. Mazandaran is the name of a region located at the north of Iran with a mild and humid weather with high raining. The natives of this region like different regions of the word have achieved the most optimal form proportional to the climate over time, which has devoted a great portion of identity indication of this region to itself. People of this region where a mild and humid weather has, have used natural forage as a pattern in their roofs which is applied as green roof today. This green roof pattern in Mazandaran has been converted into green earthen roofs during its evolutionary steps. Green roof can be known as the result of a positive environmental, ecological procedure which attempts to balance the surrounding environment to decrease the load of abnormal environmental factors. The obvious and hidden positive effects which the green roofs in this region possess, have changed it into a unified factor in all buildings of Mazandaran. The main issue of the paper is written regarding to the survey researches, the study and recognition of different kinds of steep roofs in Mazandaran and its evolutionary direction and the effects which it has on the buildings of this region. The hypothesis of this paper is that there are equal semantic definitions in some components of building in mild and humid regions of the word but the method of facing with these components is different according to the culture of each region. Green roof in Mazandaran region has a different body but the equal meaning as like the other regions of the word.

**Keywords:** Mazandaran; Green Roof; Culture Pattern; Vernacular Architecture; Sustainable Design

## **ORIGINAL ARTICLE**

Received 18 Aug. 2013  
Accepted 04 Dec. 2013

## **INTRODUCTION**

The definition which can be considered by a sustainable design is that it should not only provide the causes of its environment destruction, but also take steps in direction of the repair and cleaning of its surroundings. This definition can be found in the indigenous houses in each region. Native people attempted to create coordination with the nature by natural and available building materials of their regions, because they saw their tranquility in these coordination and balance.

At the present age, this view was redefined in a style named as the sustainable architecture. But some aspect which is forgotten is that in each region, native people achieved different solutions to create the coordination with the surrounding environment, create the spatial welfare and these solutions can be known as special for that region with its specific culture which has been converted into a cultural pattern over time.

The best solution to create a sustainable design is recreation of sustainable patterns of each region and its adaptation with today needs by help of modern technologies until a cultural sustainability can be achieved in addition to the environmental sustainability.

Using of the steep roof with plant coverage in Mazandaran region is regarded as a key principle and

identity indication. In each evolutionary age, the natives were bound to this principle. The steep roof is used as an element to conflict against high raining and the plant tissue is applied as an anti-insect and thermal insulator. The first time when a name was chosen for this architecture phenomenon, was autonomous and innovation-like architecture. Here, the autonomous doesn't mean random but it means natural (Alpagonovlo, 2005) which was forgotten today.

The issues of this paper move in direction of two issues including the culture of northern Iran and green roof. Native architecture in Mazandaran and green roof are some topics which made many researchers for investigation and study and followed by high achievements.

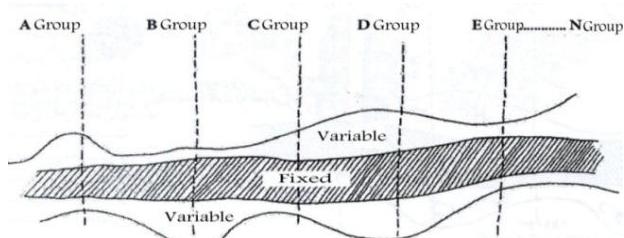
But a point which is not observed in the previous performed research is the association of these two issues. Green roof existed as a common pattern in all indigenous buildings of mild and humid regions of the word but the method that the natives face with this issue, caused that each region creates a green roof special for itself according to its culture. The present paper addresses some kind of roof cover named as earthen roof in northern region of Iran called as Mazandaran and its environmental benefits which can be named as an indigenous green roof special for this region due to

satisfying all environmental factors and creating green coverage.

### Sustaining mazandaran's sustainable architecture identity

The architecture is a common outlet which connects the past to the present and future. The architecture is a tool to express the culture and experience and if there are no historical documents and manuscripts, it is an undeniable document including human knowledge accumulation which is a necessity for his survival (Mahboub et al., 2008).

Sustaining identity heritage is followed by a great goal, a goal which involves all aspects of the society including the body, meaning, and values. The culture of each region has fixed and variable dimensions. Fixed dimensions include a special regional signs (such as the steep roof) which was sustained during different periods and was changed into a principle. The variable dimensions consisted of some parameters which change and evolve under the shadow of basic principles, proportional to different periods. Figure 1 shows the changing procedure of fixed and variable dimensions of indigenous architecture over time. The fixed dimension is followed by low change but the variable dimension is followed by high changes.



**Figure 1.** Fixed and variable aspects in cultural patterns over time (Rappaport , 2005).

### Steep earthen roof in mazandaran

Simultaneously with formation of cities in Mazandaran, baking clays propagated and caused the roofs of the houses take a cover of earthenware. The earthenware which was built of the soil of this same region, resulted in creating an indigenous code and a unity element among the buildings.

These roofs consisted of several layer.

1: The roof-truss which was built by a resistant wood named as Azad.

2: Bunches of straws or thin woods which are knotted and connected to the roof-truss, which the role of drainage can be attributed to it.

3: Plaster of clay and straw or mud-bran which are placed on the reed bunch.

4: And at last, the earthenware is placed on the mud.

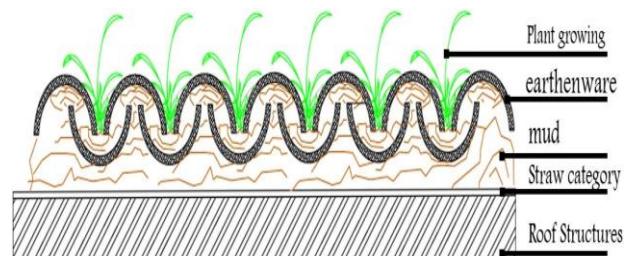
The straw prevents the mud sliding and equally, the mud prevents the earthenware collapse. The used earthenware was in the shape of truncated semi-cones which were inter-paired as turned inside out such that the outer earthenware covers the seam created in the beneath earthenware. There is no connection between the earthenware and the rood-truss and just the heavy weight of earthenware and the fiction between the earthenware

and it's beneath layers prevent the earthenware sliding. Figure 2 shows an old view of one of the cities in Mazandaran along with the earthenware used in the roofs.



**Figure 2.** A perspective of one of the cities in Mazandaran in 1914 (Shokri et al., 2006).

Because of the placement of mud in the earthenware infrastructure, wild plants begin to grow on the roofs. The same plants which are seen abundantly in the nature around the buildings, caused some kind of coordination between the nature and buildings by growing on the roofs of buildings. Confining the surrounding air and preventing the direct sunlight on the roof, this wild plant caused to create an insulation on the roof coverage and prevented the erosion and collapse of the earthenware and mud during raining by its roots, and displayed a definition of green roof in this region. This definition of the roof is special for this region. Figure 3 shows different layers of this roof.



**Figure 3.** Details of traditional steep roof in Mazandaran. (Writers, 2013).



**Figure 4.** Plant growing on the earthenware cover of traditional roofs in Mazandaran (writers, 2013).

Each region has definite and specific identity and cultural elements which are formed during historical periods of the same society (Razeghi , 2010). The history which is the backing of an identity pattern, is the result of the interaction and view kind of people of that region towards the surrounding problems and abundant trials and errors which support it.

A history which gradually expresses these symbols like a fingerprint for an individual as his special identity, by natural building materials available in their

region, the natives attempted to create adaptation with the nature, because they saw their tranquility in these adaptation and balance. And this view displays more manifestation in the roof of building as an element in the building which has the maximum contact with abnormal environmental factors (wind, rain, sun). Using of green coverage on the roofs of rainfall regions can be known as the common approach of the natives of these regions. For example, green roofs or lawn roofs in northern Scandinavia have a several-year-old history and during the last centuries, most houses of Vikings had roofs covered by lawn (Berg, 1989). Figure 5 shows a view of green coverage in earthen roofs of Mazandaran and proportional with it, figure 6 displays a green coverage in indigenous buildings of Norway.



**Figure 5.** Plant growing on the earthenware coverage of traditional roofs in Mazandaran (writers, 2013).



**Figure 6.** Lawn roofs in rural house in Norway (Brandada, 2007).

During the future 30 – 40 years, most of the atmospheric changes will be determined which have been created as the result of greenhouse gases at present, and regarding to long-lasting life of carbon dioxide in the atmosphere.

Dissemination of these gases at present will severely influence climatic changes in the future, and a fundamental part of the countries planning focuses on decreasing the dissemination of greenhouse gases (Hulme et al., 2002). The climatic changes influence the urban environment. These effects are felt on people and the built infrastructures (Gill et al., 2009).

Regarding to the pollutions resulted from these gases and their destructive effects on climatic condition of the earth, paying attention to indigenous sustainable patterns in each region as a method for adaptation with the nature to improve the present and future situation of the earth seems necessary. Below, we view the positive

environmental effects of green roof as a sustainable factor and a cultural pattern in different points of the world.

### Studying the quantitative and qualitative advantages of green roof

In the following, we address the environmental effects which a green roof can have at micro and macro scales.

#### Increase in thermal capacity of the roof:

A study which was performed by Bass Brad from University of Toronto, indicates that green roofs can significantly help decreasing the heat loss and decreasing energy consumption during winter conditions (University of Toronto, 2008) Decreasing the coldness of winter wind and regulating micro – region on the roof, the plants help increasing heat sustainability.

Of course, the effect of decreasing the wind blowing is more than the effect of its shadowing (Bass, 2007). Also, absorbing the water by the plants and the evaporation created by them, green roofs cause to decrease the cold load of the building from 50% to 90% ([www.roofgreening.ca](http://www.roofgreening.ca)). Greening and alive plant coverage sustain the humidity inside itself and by this method, it plays an effective role to adjust the temperature of the building. The water, as a thermal insulator, prevents thermal fluctuations and causes becoming cool the building in summer and relative heating of it in winter (Mahmoudi zarandi, 2012).

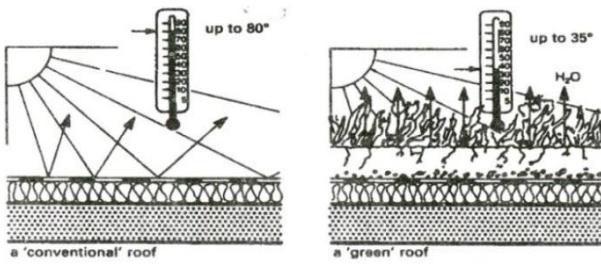
The researches of Nottingham University and Toronto University in Peterborough and Canada, respectively about the space temperature under the ordinary roof and green roof in summer and winter represent the effect of this roof on decreasing thermal transmission (table1 and table2). Figure 7 shows the effect of absorption level of sun heat.

**Table 1.** Research of Nottingham University about space temperature under the conventional and green roof in summer ([Livingroofs.org](http://Livingroofs.org))

Average Temperature / Daily Temperature	Equivalent to 18.4 ° C
Space Temperature Under Conventional Roof	Equivalent to 32 ° C
Space Temperature Under A Green Roof	Equivalent to 17.1 ° C

**Table 2.** Research of Peterborough University about space temperature under the conventional and green roof in winter ([Livingroofs.org](http://Livingroofs.org))

Average Temperature / Daily Temperature	Equivalent to 0 ° C
Space Temperature Under Conventional Roof	Equivalent to 0.2 ° C
Space Temperature Under A Green Roof	Equivalent to 4.7 ° C



**Figure 7.** Cool and humid weather (Neufert , 2005).

#### Acoustic insulator:

Discomforts resulted from noises in the streets are considered an important problem in urban regions. Although the walls insulation considerably helps in balancing the sound load to reduce the sound pressure level from outside to inside, but roof and its type is effective on the amount of effecting of this factor in welfare of the citizens (Mahmoudi zarandi, 2012).

Green roofs increase the acoustic insulation in roof system ([www.roofgreening.ca](http://www.roofgreening.ca)). The existing soil plays the performance absorption of low frequencies and the plants play the role of absorption of high frequencies in green roof (Livingroofs.org). Green roofs whose soil layer thickness is equal to 12 cm, decrease the sound penetration up to 40 dB and green roof whose soil layer thickness is equal to 20 cm, decreases the sound penetration up to 46 dB (Mahmoudi zarandi, 2012). Increase in the bed depth up to 15 to 20 cm, improves decreasing the noise. But a green roof with a deeper layer does not provide more profit (Bradley Rowe, 2010).

#### Reducing the effect of urban heat island:

Because of possessing broad and hard surfaces, big cities absorb the sun heat and give it back to the surrounding space and cause to increase the temperature of surroundings (Mahmoudi zarandi, 2012). The cities are at least 4 °C (7 °F) warmer than their surrounding regions (National Geographic News, 2010). Green roof can act as a system to fight against the effect of urban thermal island (NASA, 2000).

In Chicago city hall, in addition to the characteristics of green roof, the roof temperature in a hot day is usually 1.4 to 4.4 °C (2.5-8.0 °F) cooler than traditional roofed buildings around there (National Geographic News, 2010). By absorption of sun heat and evaporation and transpiration, green roofs cause to cool their surrounding environments and if a lot of houses use green roofs, this action can decrease thermal pressure in urban environment.

#### The positive effect on physical and psychological health:

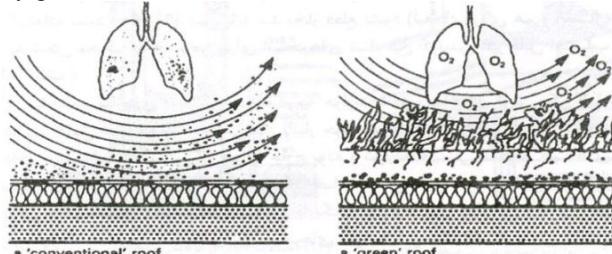
Green roofs can act as a filter against carbon dioxide and other pollutants and create a suitable space for the patients, especially respiratory organ-damaged patients ([www.roofgreening.ca](http://www.roofgreening.ca)).

Green roof can refine the rains contaminated by heavy metals and separate their impurities. The creation of green landscapes in the city helped significantly destroying daily tensions and it can have a positive effect on decreasing the crime and fear for the residents.

Access to green space causes to decrease the heart beat and blood pressure, and can help general health.

A study in Texas shows faster recovery after surgery and the patients who had visual or touching contacts with green space, had very little chance of relapse of illness after surgery (Livingroofs.org).

Figure 8 shows the absorption level of suspending particles and prevention of their distribution in the space by green roofs.



**Figure 8.** Improvement of city climate (Neufert , 2005).

#### Prevention of flood occurrence:

Research conducted in Germany show that during heavy raining, approximately 200 liters water falls down on 18 m<sup>2</sup> broad green roofs from which just 15 liters water conveys into the earth (Livingroofs.org). Green roof is effective on decreasing surficial water flow, improving the quality of surficial water flows and decreasing wastewater's overflowing. Green roofs can usually sustain 70% to 80% of water in themselves in summer and 25% to 40% of water in winter (Mahmoudi zarandi, 2012).

#### Economic justification:

Green roofs can be a place to plant local fruits and provide food source for the society. Enhancing the visual perception and the above mentioned advantages, this roof can be a potential to increase the value of commercial or residential buildings. They can improve the environmental performance of the building and consequently, they can decrease using of heater and cooler systems and help the Family economy. Dispute with the services facility's manager in London shows that using of green roof in the building is followed by a 25.9 MW saving yearly due to decreasing heat and cold loads of the building and minimal use of heat and cold producing tools (Livingroofs.org). Protecting the roof against UV-ray of the sun, they increase the shelf life of the roof.

## CONCLUSION

Today, due to the crisis of energy and excessive pollution of the ecological environment, human is seeking for some methods to minimize the consumed energy, maximizing the adaptation with the environment. By a little study, it can be found that during the ancient times, the natives of each region using of the resources and energies available in their surrounding nature, created a spatial welfare for themselves in addition to they were able to create this adaptation with the environment.

Another factor which had a considerable effect on the environmental behavior of each region, was the culture. The culture can be known as the collection of

patterns and mental image of a region's people which are formed proportional with the region during time. Today, because of non-observation of the basic regional principles and traditional architecture methods, Mazandaran is regarded as the second polluted province in Iran after Sistan & Baluchistan (MehrNews Agency) and the fundamental electricity problem in Mazandaran is in the sector of cooler systems (Iran's Energy Production Organization, 2011). Green earthenware roof with the characteristic of air conditioning and cooling can be named as a suitable solution for today's problem in Mazandaran, a solution which has been forgotten today. Green earthen roof can be referred as an identity indication in Mazandaran as a sustainable option for the buildings of present age in this region. And finally, this view can be achieved that the energy sustainability is dependent on cultural sustainability and if we can create the cultural sustainability by implementing the architecture patterns and indigenous methods of each region, the energy sustainability will be emerged autonomously.

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