

Sustainable and Functional Architecture in Rural Areas: Case studies of Abyaneh and Masouleh in Iran

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ABSTRACT

Environmental and natural restrictions affect economic growth and show themselves as either shortages in the sources of natural resources or lack of sufficient and appropriate facilities to absorb wastes and industrial pollution. Therefore, shortages of raw materials and increasing damages to natural environment has made many scientific fields to think of the ways decreasing such a risk. Accordingly, sustainability concepts and sustainable development has come to agenda in diverse fields as well as architecture in recent decades. Although sustainability seems to be a new concern in diverse fields as well as architecture, by analyzing some of historical constructions constructed by our predecessors many centuries ago, we can see that such a concept has a long history and a rich background in vernacular and traditional architecture. Studying the valuable achievements of predecessors, which are the result of accumulated experience based on elaborately knowing their nature, can be guiding in deciding for appropriate usage of technology in a sustainable way. In this research, values of sustainable design is handled regarding Iranian traditional and vernacular architecture focusing on two popular rural areas with a rich historical and architectural background called Abyaneh village located in central part of Iran with a hot and arid climate and Masouleh located in northern part of Iran. Both of these case studies can be considered as significant examples of vernacular sustainable design with adaptation to nature. Firstly climatic and geographic characteristics of both areas are introduced and then the appropriate architecture compatible with those conditions are analyzed to put it in context of sustainability concepts being more of concern in today's world. The objective of this research is to demonstrate the sustainable methods used in vernacular architecture of these two rural areas which can be inspiring in today designs as well and tries to demonstrate that appropriate integration of today's technology with achievements of the vernacular architecture, not only will result in less consumption of energy and natural resources but also will insure more healthy and sustainable future.

KEYWORDS: Abyaneh , Masouleh, sustainability, vernacular architecture.

INTRODUCTION

Sustainability principles which encompass a great number of fields aim to improve quality of life for human parallel to preserving natural and environmental resources and guarantee their durability for coming generations. Vernacular architecture and rural heritages wherein diverse environmental, natural and cultural values are latent today have become focus of interest for advocates of sustainability.

Vernacular architecture of some significant regions in different parts of the world has valuable criteria of sustainability and they can be considered as appropriate patterns for today architecture because of several particular reasons: they are compatible with climate, majorly utilize renewable energy sources such as solar energy for heating in winter and wind energy for ventilation and cooling of inner spaces in summer, respect natural environment and have a compatible design with natural site and local climate [1].

Vernacular architecture can be classified as a significant part of the sustainable architecture because of its particular normative such as being in harmony with nature, using local and green materials etc. Indeed, vernacular architecture is a sort of an evolutionary architecture. "There has been always a feedback as a driving force from the public that affected the architecture towards a vernacular and evolutionary type in the past" [2]. Climate as the most influential factor playing a great role in vernacular architecture has always been matter of concern in architecture in different periods of history but the way of handling it has been diverse in each period.

Iran with a long valuable history owns a rich architecture heritage in which there is very particular approaches to vernacular architecture. Study of Iranian vernacular architecture can be guiding in designing more sustainable

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constructions that decrease loss of energy, minimize the damage to the nature and efficiently utilize the local materials and potentials.

Iran with a long and rich history owns a very rich and worth studying rural and climatic architecture. Iran is a rather large country with area of 1,648,195 km² located between latitudes 24° and 40° N, and longitudes 44° and 64° E and it has Caspian Sea in North and Persian Gulf and Oman Sea in the south. Accordingly it includes different sorts of climates. The northern part of Iran is covered by dense rain forests while the eastern part consists of majorly desert basins. Iran's climate ranges from arid or semiarid, to subtropical along the Caspian coast and the northern forests. Iranian rich traditional architecture over long years has developed ecologic and functional architecture according to its nature, locational characteristics and values for each of these different climates and locations. However, today most of valuable features of traditional vernacular architecture are neglected in construction of new buildings in most of the rural areas. Inappropriate use of technology not only increases loss of resources and causes more damages to the environment but also does not completely solve the problems caused by difficult climatic conditions, particularly in hot and arid climate of central part of Iran.

For this research two rural areas are chosen as case studies: the first one is located in central arid and hot climate and the second one is located in northern part near the Caspian Sea coast with sub-tropical climate. This research, analysis how these two rural areas have controlled their difficult climatic conditions by appropriate vernacular architecture and tries to find the roots of sustainability ideology in historical architecture of Iran in case of these two case studies. The objective of this research is to demonstrate the sustainable methods used in vernacular architecture of these two rural areas which can be inspiring in today's designs as well.

Sustainable architecture is a broad term which can be described as "environmentally conscious design techniques in the field of architecture; an energy and ecologically conscious approach to the design of the built environment"[2]. Vernacular architecture inclines to respond to diverse climatic situations generally by applying strategies that provide human with maximum comfort while minimizing usage of nonrenewable energy, strategies which are integral to the orientation, form and material of the buildings. Vernacular architecture, likewise demonstrates an economical usage of local resources. Therefore, it is an ideal source for sustainable design ideas[3]. In order to attain sustainable architecture, cultural and vernacular features and sustainable design principles should be considered in a complementary relation[4].

Historical vernacular architecture considers the natural requirements, preserves natural environment, and simultaneously respects sustainability principle. However, by industrialization of architecture, nowadays, traditional architecture has changed both qualitatively and in design aspects. In such a condition, architecture as well as other scientific fields has responsibility to subscribe its role to improve human life while preserving natural and cultural resources and values. This is why sustainable architecture as a vast study area has come to agenda of architecture in recent decades.

Before rapid development of technology and entrance of globalization concepts into traditional architecture of Iran, the buildings were built as result of accumulated experience and an inclusive knowledge about the nature, land features, climate, culture and vernacular values of a place. Unfortunately today all of these valuable characteristics of traditional architecture are neglected even in rural areas and unnecessary use of technology not only increases energy and effort consumption but also does not solve the problems caused by difficult climatic conditions particularly in hot and arid climate of central Iran. Furthermore, valuable and unique architecture style and architectural elements and features of the area which are considered as national heritages and part of country's identity are neglected and are being forgotten by passing time.

In this research, firstly we give a brief information about sustainability, its concept, objectives and principles. Later, two case studies of vernacular rural areas are introduced and their architectural features are analyzed in context of vernacular and sustainable design.

MATERIALS AND METHODS

In this part of the research a range of literature about sustainable development and sustainable rural development is reviewed and based on them sustainability features of the two case studies are analyzed to study how such characteristics can be guiding in contemporary designs.

Sustainable Development

Hřebík et al. define sustainable development as a better quality of life for everybody, now and for the next generations and it is sort of development which meets the needs of the present without compromising the ability of future generations to meet their own needs. Diversity of tasks are defined in order to achieve a sustainable development. These tasks include attaining a balance between preserving the existing cultural heritage, attracting

new investments and supporting existing living and working communities in rural areas and increasing public participation in spatial development approaches and conserving and improving the natural and built environment [5]. Cultural and natural heritage as one of the significant factors of durability, identity and human dignity, is a crucial part of sustainable development and it ensures conservation of local culture, natural and landscape resources. That is the reason why it is important to analyze and study rural heritages, in order to provide a certain future and a chance for its transmission to next generations not only for the sake of conservation but also for understanding the significance of its function and meaning in the framework of current process of social alterations[6]. Rural areas are lively, active places abounding with ideas and innovation in which we can find the roots of the different cultures and much of the natural, architectural and historic heritage which make up the local and sometimes national identity. Furthermore, rural areas are places of viable activities and varied natural landscape such as forests and farmlands, unspoiled natural sites, villages and regional crafts and industries [7]. In brief, they own a boundless diversity of "natural and man-made features", which makes them rich in "amenities". This is why rural areas have a potential to make a contribution to our societies[8].

A Background about Iranian Vernacular Architecture

In Iran, vernacular architecture has developed intelligent solutions according to climatic conditions of each region over many years. For instance, in terms of ecological architecture, the main concern of arid and hot climate is cooling system. Extremely hot days in most months of the year in a considerable area of Iran has created an extreme need to a design providing maximum shade and minimizing the sunrays while in vernacular architecture of the northern region of Iran located in Caspian seas coastline, the main concern of architecture is appropriate ventilation and coping with excessive moisture. In central parts with hot and arid climate due to scarcity of wood and stone to be used in constructions, which is because of the excessive presence of sandy lands in central plains of Iran, use of mud-bricks in construction of buildings in vernacular architecture is a response to the Iranian Plateau's arid climate. Indeed, Iran's traditional architecture not only is designed according to its climatic conditions, but also has 'a unique remarkable creative background of Persia make-up for the seemingly lack of natural resources and beauty'[9]. In the past time, vast inheritances of delightful and often beautiful vernacular buildings are survived in Iran Plateau and mainly, most of them were located in rural areas, but others had their grand counterparts in towns. Today some of them can be considered as prototype of buildings in such places and even elsewhere. A wide range of researches has been done to explore and classify these buildings, meanwhile various visitors or even local people have collaborated to keep most of them as common places, but the fact is that having such an artistic heritage represents the wealth of vernacular architecture and requires the prior attention [10].

Location of Case Studies and Their Historical and Cultural Background

Abyaneh is a village at the foot of Karakas Mountains located at Central District of Natanz County, Isfahan Province, Iran. Masouleh, the second case study of this research is about 60 km southwest of Rasht and 32 km west of Fuman located in northern part of Iran. The village is 1,050 meters above sea level in the Alborz mountain range, nearby the southern coast of the Caspian Sea. Figure 1 demonstrates the location of case studies.

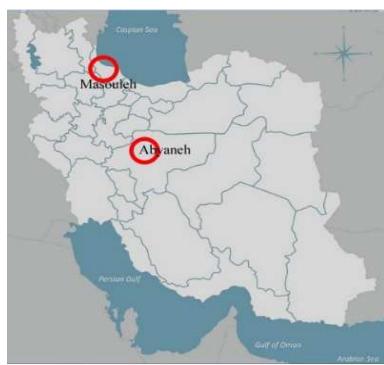


Figure 1. Location of Abyaneh and Masouleh Iran map.

Abyaneh

At the 2006 census, Abyaneh's population was 305, with about 160 families. Abyaneh is placed on a steep slope of the northern feet of a valley. The difference between the highest point and lowest point of the village is about 70

meters and it is extended from the east to the west. Abyaneh with its unique reddish color is one of the oldest villages in Iran which has conserved its architecture, ceremonies, culture, language and even clothing style from ancient times up to now. The inhabitants of Abyaneh have maintained their culture and customs for thousands of years. For instance, wearing outfits being used in this area are said to have been worn in Sassanid times. In addition, the ruins of a Sassanid era fort sits on top of the village. The dialect spoken by Abyunaki people is believed to have been the language of ancient Persia. One of the most notable issues about this village is its people's sensibility and sense of responsibility about their village. Despite its high potential to attract numerous tourists and visitors from different parts of the country and the world, it has preserved its original rural culture and identity. Abyaneh is an authentic and operational village, not a showcase and there is not anything fake and inconsistent with village's original context. It is possible to see people with their local clothes, the elderly sitting in front of their house chatting with each other and this enables the tourists to see a lively and completely natural village. That is to say that, the rural and natural identity of the village is not sacrificed for the sake of tourist attraction as it has happened in many rural areas, which has been changed to touristic poles with modern buildings and nonnative inhabitants. There are many wrong examples in which the rural and vernacular values of village is lost among the newly built modern hotels, restaurants and urban facilities. This area of Iran is considered as one of the pre-historical cradles of human civilization.

Masouleh

The first village of Masouleh was established around 1006 AD, 6 km northwest of the current city, and it is called Old-Masouleh (Kohneh Masouleh in Persian). Old Masouleh dates back to 8th century (After Hegira) as excavation on ancient site. Furthermore, new Masouleh was established near the ruined one and people moved from Old-Masouleh to the current one after outbreak of plague (1565) in Old Masouleh and also due to pestilence and attacks from neighboring [11]. Masouleh is surrounded by forest from valley to mountain. It is majorly affected by two climates, which are humid and temperate weather in summers and dry and cold weather in winters. Fog is the predominant weather feature of this region. In Masouleh the difference between highest point and the lowest point of the area is approximately 100 meter, hence row of house roofs constitute alleys and these alleys are connected to each other via stony stairs. There are about 700 houses in the village and a considerable number of them approximately date back to 9th century.

Architectural and Morphologic Characteristics of Abyaneh Village

The village is one of the oldest in Iran which is characterized by a peculiar reddish hue. Abyaneh is compact, with narrow and sloped lanes, and houses located on the slope. Houses are built in a way that the roof of the each house serves as the courtyard of its neighborhood house being located down the lower slope in its front in a tiered form. In some parts of the village, there are about four tiers of houses. The layout of houses is demonstrated in the Figure 2a.

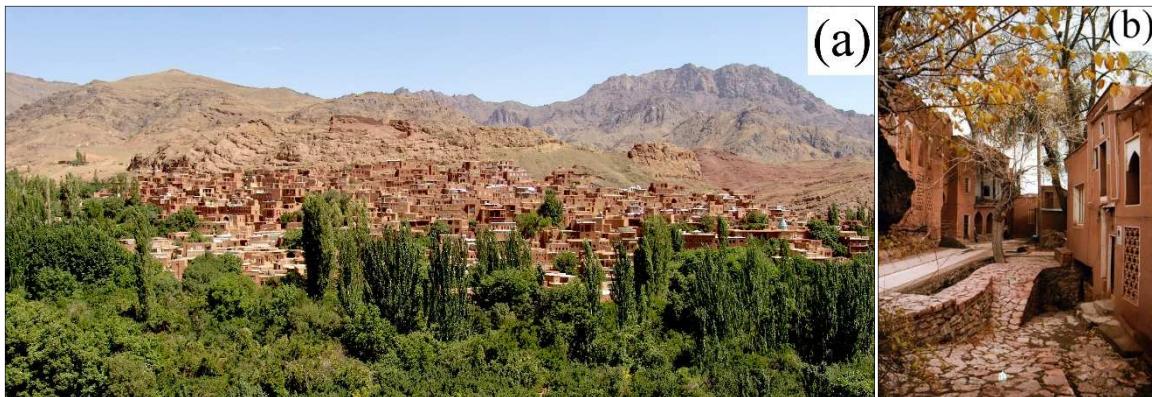


Figure 2.Abyaneh's (a) Perspective,(b) Alley.

Abyaneh is a village of living architectural traditions and styles (all in red clay) and it is considered as one of the most interesting examples of human-environment interaction and adaptation to nature, in which one can go beyond the boundaries of time and space and experience the ancient civilization, life and culture of rural settlements in Iran. The village has a compact fabric, with narrow and sloped alleys as shown in Figure 2b. Houses are located on the slope as if placed on a stairway, which are accessible from stepped passages. Therefore, the roofs of some houses can serve as the yard of other houses located on the higher level. In addition, houses of Abyaneh have been built 1500 years ago, and they are examples of the oldest human residences built by adobe on the rocks. Such houses are

properly suitable for the restricted space of the village. The houses are located in various directions. Some of them, which have been influenced by the pre-Islamic architecture, are facing the east and some being built after Islam are facing the south or Qibla. As there has not been sufficient space for all the houses, some of them do not have any particular direction. However when one looks at the village from a distance, it is possible to see a dissimilar and florid assembly on the feet of a gray rock situated over an attractive green valley[12]. There are significant buildings reflecting intelligence of predecessors in use of local materials and producing functional constructions as well as artefacts of craftsmen in creating gorgeous ornamentations with limited facilities of the ancient time[2]. All of the buildings in Abyaneh, are made from the typical red clay which have a unique visual integrity. In the elevation of buildings, we can see different kinds of passive environmental modulation strategies. For instance, use of thick clay adobe walls with deep setbacks on the ground floor which provide the required shadow for window areas. Moreover, a wide overhanging roof shades the first floor of each building. Additionally, in order to provide more cool environment and decrease effect of extremely hot weather, all the openings of buildings have simple screen walls, which facilitate natural ventilation and protect the interior space from visual surveillance as demonstrated in Figure 3a. In such a vernacular pattern of rural settlement, spatial arrangements and building elements work in a complete synergy. All of these patterns are possibly accomplished by a rural migratory pattern of habitation in response to temperature changes at diverse times of the day and various seasons of the year. The significant characteristics of vernacular architecture of arid climate of Abyaneh are briefly discussed and categorized as follows: a) the design and implementation of domes and vaults in mud-brick which result in creation of striking functional buildings, b) the Persian creativity and inventiveness, which is unsurpassed in making the best use of water in a hostile desert environment(limited water sources coming down from mountains in proximity of the village is used very efficiently as drinking water and also for watering the trees and agricultural products; likewise with a creative design, spring of running water has provided a pleasant sound of water for people walking through the lanes of the village). d) Employing local materials in construction and restoration works which have many advantages such as utilizing the original materials that are close to the site and decreasing the costs and loss of energy and effort. The terrain around Abyaneh contains iron oxides, which give it a reddish color. All the rural constructions are built of mud bricks taken from local resources. Therefore, they approximately have the same color with the rock above the village. An especial importance also has been given to planting and generating gardens in this village. Therefore, a wonderful contrast between reddish buildings and green trees is observable in this village. The Figure 3b perfectly demonstrates such a contrast.

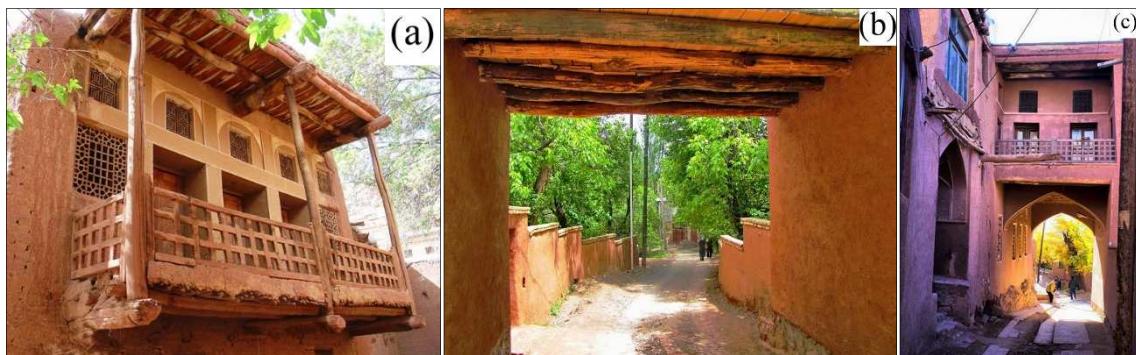


Figure 3.a) Dominant opening typology of Abyaneh, b) contrast between reddish buildings and green trees, c) shade element.

Condensed and compact context of the village and appropriate exposure surface to the sun rays in each building lead to the least penetration of exterior heat into the interior space of buildings. Use of clay also plays a great role in preventing extreme heat penetration into buildings. Likewise, in order to provide shade in hot days, some parts of alleys are covered with elements called Sabat which also are considered as structural elements retaining stability of two opposite walls. Figure 3c demonstrates one of these shade elements.

Architectural Characteristics of Masouleh Village

Masouleh has a unique fabric and architecture. Similar to Abyaneh, the buildings are interconnected and built on the slope of a mountain and roof of each building serves as courtyard of the other building and in some cases as pedestrian alleys. No motor vehicles are allowed into the village, due to its unique layout. Masoule his one of the scarce places in Iran where there is such a prohibition. The narrow alleys and too many stairs connecting those alleys

to each other simply do not make it possible for vehicles to enter. The buildings have openings at least in two and in some cases even in four directions to maximize natural ventilation and to cool the building interior. The form of the buildings in Masouleh are designed in a way to better cope with high rate of rain and humidity, hence most of the buildings are elevated from the ground and the main functional spaces are majorly located in upper floor. The ground floor is majorly non-residential and is used either as a barn or a storeroom. The entrance to the house is also from the ground floor, and the upper floors are generally dedicated to residential units. The interior of houses mainly include these spaces: 1) Entrance, 2) Winter room which is a room behind the house which catches the majority of sun light during winter days, 3) Summer part which is a counter mostly with a balcony which is more shadowy and cool in summer, 4) Living room, the main and commonly used part of the house, 5) Staircase, 6) Warehouse located in ground floor, 7) Restroom, 8) Balcony usually found in the 1st floor. The interior design of houses as well as its exterior are compatible with the climatic, topographic, and social conditions of the area. Efficient use of sun light for heating, instant management of rain water to be used for diverse needs of village and accurate design controlling extra humid within the buildings, are among the most significant criteria of house design in Masouleh. The exterior of most buildings in Masouleh are coated with yellow clay and this provides better visibility in the fog. Different sorts of materials are used in diverse parts of the building which are all local materials. Generally combination of stone, adobe, and wood are more common as dominant building material in Masouleh. The foundations of the buildings reconstructed on a solid piece of rock. Due to the problem of excessive moisture, local architects do not break solid rocks into pieces. Therefore, they use them to construct two or three-storeyed buildings on the natural slope and in this way, they not only make a sustainable integration of architectural product with natural topography of the environment, but also create a magnificent view[13]. Buildings' roofs serve as a rural pass way and provide pedestrians with a flat platform for walking in such a sloppy location. Since walkability is one of the significant factors of a sustainable society, the design of this passway is a perfect example of sustainable design. A particular sort of local gray soil is used on roofs as an insulation material against the heat and moisture and this material also serves as material of walking paths.

DISCUSSION

In this research firstly the features and elements of Iranian vernacular architecture is handled by analyzing two rural case studies. According to studies of this research, Iranian vernacular architecture particularly in rural areas is closely compatible with sustainability principles. Vernacular architecture of the case studies have certain significance since it is reflection of experiences and skills being achieved through a long time period. Gorgeous harmony of buildings with nature, appropriate adaptation with difficult climatic conditions of the region and economical use of local construction materials are merely some of the outstanding characteristics of these villages making them worth studying. The most significant sustainability features and principles, which can be seen in analysis of the case studies are: 1) Usage of renewable energy resources such as wind energy for ventilation and cooling of interior spaces by use of netted windows and skylight windows, 2) Respect to environmental and climatic conditions and harmony with site, 3) Using local materials in construction and reparation works, 4) Appropriate orientation of buildings according to ecological and climatic conditions. Table 1 summarizes dominant features of both villages and Table 2 compares their similarities and differences which gives us opportunity to better discuss on valuable sustainability aspects of the case studies.

Table 1: Dominant architectural features of the case studies.

	Masouleh	Abyaneh
Context	Compact, stair-like	Compact, stair-like
Location	Northern part of Iran, Gilan-Fuman	Central part of Iran, Kashan-Natanz
climate	Humid-hot summers and cold winters	Arid and hot
Roof forms	flat	flat
openings	Maximum opening to provide ventilation	Less openings, small netted windows
Alleys	Narrow, walkable, forbidden for motor vehicles	Narrow, walkable, shadowy
Dominant Materials	stone, adobe, and wood	Clay and wood
Dominant color	red	yellow
language	Talesh (Talysh)	Parthian Pahlavi
orientation	South	South-east
Walls	Walls insulated from moisture	Thick clay walls

Although the two case studies being chosen for this research have several important similarities in their form and function, they have interesting differences in accordance with their climatic and geographic conditions.

Table 2: Similarities and differences between the two case studies.

Sustainability aspects of rural and vernacular architecture of the case studies		
Case studies	Abyaneh, central part of Iran	Masouleh, northern part of Iran
Climate	Arid and hot Climate	Cold winters and temperate summers
Architectural similarities	<ul style="list-style-type: none"> • Being step-like and being located on outskirts of a mountain • Use of local materials for constructions • Providing appropriate paths for walking • Having compact form 	
Architectural Differences	<ul style="list-style-type: none"> • Abyaneh's buildings have very limited small netted windows while Masouleh's buildings have several large windows • Dominant building material in abyaneh is red clay and wood as structural element while stone, adobe, and wood are commonly used in Masouleh • Sabat is the dominant characteristic of Abyaneh alleys whereas flat and walkable roofs functioning as walkway is dominant feature in Masouleh's paths 	

The two case studies being analyzed for this article are spectacular examples of design with respect to nature and compatibility with sustainability principles. Some of significant issues of sustainability being discussed in urban design and architecture disciplines within recent decades are the ways of increasing walkability as a means of transportation and decreasing use of motorized vehicles. Additionally, compact form is another significant new topic suggesting strategies to reduce energy consumption and minimizing damages to natural environment which has many advocates. Appropriate location of building which provides a better adaption to climatic conditions also is another significant solution in accordance with sustainability principles.

Walkability which is one of the significant factors of sustainability means the extent to which a place is friendly and convenient to people for walking and also for spending time. With regard to this definition walkability is encouraged in both of these villages. The alleys in both of the case studies are appropriate and attractive for walking. By use of intelligent systems in design of alleys it has been tried to maximize convenience of pedestrians in difficult climatic conditions. For instance, Sabat in arid climate of Abyaneh is one of the interesting elements, which provide pedestrians with a shadowy convenient path in hot sunny days. Likewise, direct paths without slope provided by rows of house roofs provide a flat and easy-to-walk path for pedestrians in a sloppy land and makes walking easier in Masouleh. Construction of stony stairs between alleys is also another intelligent way of connecting the alleys to each other which provide pedestrians with more comfort to easily go from one alley to another in both of case studies.

Compact form is one of the significant discussions in field of morphological studies about the built environment. Compact form as an inclusive issue is a crucial feature affecting sustainable development due to several reasons such as decreasing distances of traveling and being appropriate for non-motorized transportation and walking, providing more efficient energy consumption and decreasing extra costs of infrastructure provision[9]. Both of the case studies of this research carry the advantages of their compact form.

Additionally, **appropriate orientation of buildings according to sun**, which expose them to sun rays in winter days, provide them a natural heating and decrease use of fossil fuels consumption. For instance, such respect to nature and optimization of natural resources can be observed in design of Masouleh. Due to several reasons concerning sustainability, the middle part of the foothill in Masouleh has been preferred for establishment of the buildings. Firstly, because it is inconsistent with the natural slope, and is likely to receive optimal solar radiation. Secondly, lower parts of skirts are not used for dwellings since it is too vulnerable to the risk of flood due to excessive raining in this region. Likewise, the village is not developed through the higher levels of the mountain due to being located in the shade, being exposed to strong winds and being too cold during winter. Hence, heating the buildings during winter would necessitate more energy consumption [14].

In Masouleh, the buildings are elevated from the ground in order to prevent the penetration of moisture into the building and they are in concordance with the humid-and-temperate climate. Moreover, in contrast to buildings of Abyaneh which has minimum and small openings, in Masouleh there are balconies and large windows in majority of the buildings. These balconies and large windows not only cause the combination of outer and inner space of the building but also maximizes natural ventilation. Finally, in both of these villages step-like morphology with the extrovert form provides natural ventilation and better comfort during hot seasons.

Conclusion

According to analytical researches of this study, it is required that the architects should have a practical approach toward considering traditional and climatic features in their architectural designs. This does not mean exactly to

use the methods of traditional architecture but it means that the new achievements such as construction technology, new materials and new perspectives in architecture can be more affective when architects reconsider the achievements of local and traditional architecture of the region in their design. It is concluded that sustainable architecture and design can be better achieved by utilizing accomplishments of traditional architecture and rationally combining them with achievements of modern industry. Vernacular architecture of each region in Iran has always tried to solve the climatic difficulties of the region and retain human convenience with less energy consumption and with the least harm to the nature. Such strategies in vernacular architecture have always been integral to the, orientation, material and natural form of the field.

The techniques and design strategies being used in both of case studies can be considered as an appropriate pattern for design, renewal or revitalization of rural areas and heritages with similar climatic features in any part of the world. Moreover, studying such valuable traditional concepts regarding sustainable design of vernacular architecture, which are developed throughout centuries, can be guiding in designing various sorts of modern eco villages.

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