A study on a protected national vernacular settlement of Iran and its unique architecture, a case study of Varkane, Hamedan

Omid Ahadian

Young Researchers Club, Hamedan Branch Islamic Azad University Hamedan, Iran.
E-mail: O_Ahadian@iauh.ac.ir

Abstract: Varkane is an Iranian vernacular settlement with an organism living stile, which shows traditional technologies and the potential of local material use, construction techniques and climate considerations. This study try to analyze the main characters of a traditional architecture in the old settlement, pointing out both the typological and the technological aspects (local materials and construction processes), focusing on their environmental sustainability (presence of bioclimatic features, integration into the landscape, minimum waste of resources). The high degree of historic authenticity of this village relate to the continuously inhabited throughout history without intervals and still presents show a traditional lifestyle in the village. In addition, the techniques of using local material by incorporating the existing environmental parameters in front of the microclimatic conditions into the design are considered based on local architectural principles that could be exhibits some part of historic architectural practice in the area, looking forward cooperation the relationship between local materials, building and climate.
[Omid Ahadian. **A study on a protected national vernacular settlement of Iran and its unique architecture, a case study of Varkane, Hamedan.** *World Rural Observ* 2017;9(2):78-85]. ISSN: 1944-6543 (Print); ISSN: 1944-6551 (Online). http://www.sciencepub.net/rural. 13. doi:10.7537/marswro090217.13.

Keywords: Vernacular architecture, Environment, Sustainable, Bioclimatic design, Building physics

1. Introduction

Decisions about technique in architecture are primarily cultural and aesthetic matters and it is impossible to base these complex choices solely upon objective technical considerations (Haweks, 1996). Evolution of architecture is influenced by many external factors including environmental, ethnical, demographical, cultural, and religious factors (Moradchelleh, 2011). Architecture is considered as a form of artificial life, subject, like the natural world, to principles of morphogenesis, genetic coding, replication and selection.

The specific field of research is one kind of traditional architecture in the Iranian Western Mountains (Alvand), which includes many ancient human settlements in the form of towns and villages. This area considered within that region of Hamedan and one of its villages, Varkane. This settlement characterizes by a compact structure of houses and contains a wealth of vernacular architectural examples that eloquently represent ingenious methods and techniques to cope with the environment prevailing in the region. This architecture of vernacular settlements reflects some especial Iranian lifestyle and cultural values of the past. These building types, their material and site planning have evolved through history and they have reached their form and layout through trial and error methods. They were able to respond to the needs and kind of their inhabitants, the climatic conditions, and the topography, because of the simplicity of the building processes, the techniques and the local materials employed like stone and timber. Vernacular architecture is conceived as a result of historic and contextual process of the society to which it belongs and, at an operative level, as made up of sets of methods and tools, scientific knowledge and technical and organizational skills, which are capable of producing goods and services relevant to satisfying human needs and wants (Filippy, 2005).

In the vernacular architecture of Varkane one can apparently observe the experiment for using purely conceptual and aesthetic purposes, and a focus on kind of building processes to conserve all considers the role of the environment as a major one, within the limits of the resources available. Within this view, the traditional builders were concerned with a variety of parameters that affected a building as well as with the quality of the building itself. Traditionally designed buildings often considered as the predecessors of modern bioclimatic design (Coch, 1996). They display years of experience built on the relationship between building and climate, implying a logical analysis, the consideration of appropriate principles, and a rational use of resources. These buildings, therefore, can consider as models of environmentally responsive and sustainable architecture. Nowadays, the need for energy thrift design has been well understood and for this purpose, appropriate regulations have been drafted (Balaras et. al 2007).

There is also a greater awareness of the importance of the social cultural identity of a place (Goh, 2009). These issues make the study of vernacular settlements, such as Varkane, very important.

The aim of this paper is to evaluate one of the Iranian vernacular settlement, Varkane, in terms of its local materials employed and building physics. This paper shows that technique of using local material, which is inherently sustainable with various bioclimatic concepts applied in its original construction, is tightly integrated with the vernacular architects and has a minimum waste of resources. The subsequent evaluation is comprised of a study concerning the kind of the built environment (typological analysis, site planning, construction materials and techniques) and an evaluation of specific vernacular dwelling types and their response to climate, based on using local materials that are responsible for the bioclimatic character of the settlement.

2. Bioclimatic concepts and building physics

Bioclimatic architectural design is a demanding design task (Yeang, 1999); (Kowaltowski et. al 2005). Architects must compute a significant number of parameters, which concern not only the building, but also the environment totally. To establish building climatic data and use them effectively in energy design, a clear understanding of local climatic properties and building design requirements is essential (Mason & Kingston, 1993). Interpretation of the climatic data is as important as their quality (Kerschner, 2005). Building designers are interested in studying seasonal and diurnal variations of the climate in order to develop effective strategies for energy efficient buildings (Augenbroe & Park, 2005); (Wu & Clements-Croom, 2007). It considers climatic conditions, uses techniques and materials available in the region and attempts to integrate the building with its surroundings (Hyde, 2000).

Moreover, bioclimatic design relies on building physics, which is the ability and knowledge of how to allow sunlight, heat, and airflow through the building envelope when necessary, at certain moments of each day and month of the year (Pfafferott et. al 2007).

The vernacular architecture of Varkane can defined as bioclimatic since the traditional builder of Varkane understood bioclimatic concepts, using suitable local materials importance, aspects of building physics, and the strong relationship between site, climate and building that made them aware of the consequences of design choices. The ways vernacular architecture of Varkane considers the effects of climatic conditions on the buildings' envelope suggests knowledge of the building physics at an empirical level. This empirical knowledge relates to basic concepts of climate properties.

3. Varkane, an Iranian historical settlement in Hamadan

3.1. Location and history

The Zagros Mountains are the largest mountain range in Iran with a total length of 1,500 from northwestern Iran, and roughly correlating with Iran's western border the whole length of the western and southwestern.

Varkane is a mountainous village located in 6 km Southeast of Hamedan Province, in western Iran. It is located at 48°37' E and 34°4' N and at an altitude of 2250m above sea level. Varkane village surrounded by mountains in north and west, and had open and natural borders. It is one of the oldest vernacular settlements established in the area near the ancient capital of Iran, Hamedan. The important issue and attractive point of this village is relatively isolated throughout its historical course, and thus protected from outside influences. Hamedan Cultural Heritage and Tourism Organization information shows that Most of the houses in Varkane date back to the second half of the 17th century and they have totally conserved structures and saved old house-cores from any kinds of renovation.

3.2. Climatic data

Climate is by nature a complex theme and its description depends upon the specific reason and purpose of application (Tol, 2003). In Iran, climatology has a very long history and the knowledge developed from ancient climate studies has provided valuable information for agricultural and social development (Beedle, 2011).

Red Crescent organization has divided Iran into four climatic zones (Watson, 1994):

- Southern shores of the Caspian Sea – Temperate Climate (high moisture content and abundant amount of rain).
- Northern shores of the Persian Gulf & Sea of Oman – Hot and Humid Climate (high temperature and irritating moisture).
- Mountains and High Plateau Regions – Cold Climate (low temperature and long winters).
- Central Plateau Regions – Hot and dry Climate (stifling heat, dry weather, and desert winds).

Varkane is located in Mountains and High Plateau Regions – Cold Climate part of climatic zones in Iran.

Due to its location, Varkane enjoys a moderate climate with moderately summers and cold winters. Getting correct climatic data of Varkane is not easy since it is a village without a meteorological station. According to the latest statistics, the climate situation of this zone is as below:

Air temperature reaches a mean maximum of 40°C and a mean minimum of-32°C. The summer

months have an average temperature of 37.2 °C, while the winter months have an average temperature of -6°C. The annual average temperature is about 11.3 °C, Heavy snowfall is common during winter, and this can persist for periods of up to two months. During the short summer, the weather is mild, pleasant, and mostly sunny.

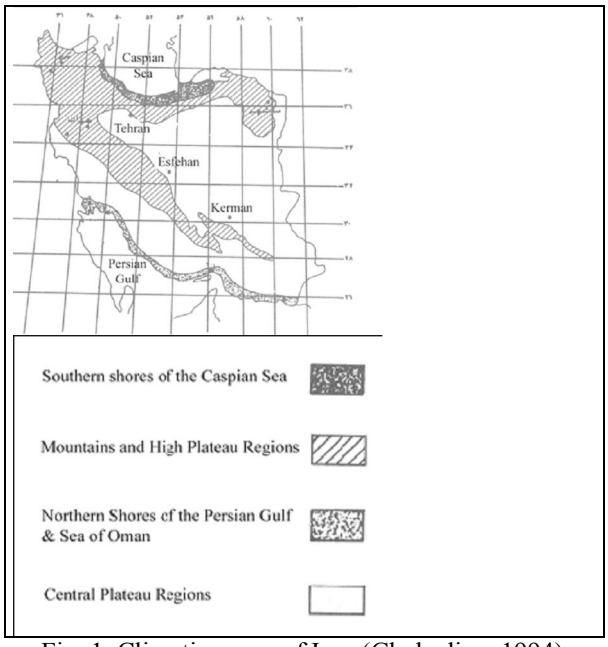


Fig. 1. Climatic zones of Iran (Ghobadian, 1994).

3.3. Mahoney indicators

The climatic data has been incorporated in the Mahoney Tables, which provide preliminary design recommendations. This table relates to eight headings: layout, spacing, air movement, openings, position of openings, and protection of openings, walls, and roofs. The researcher studies recommendations in Varkane shows:

- Layout: buildings oriented on an east–west axis to maximize absorbing of sun exposure.
- Spacing: compact planning.
- Air movement: rooms double-banked with temporary means for wind passage.
- Openings: medium-sized openings, 10-35% of wall area.
- e) Position of openings: openings in north and south walls at body height on windward elevation, as well as including openings in internal walls.
- Protection of openings: protection from direct wind.
- Walls: high mass.
- Roofs: high mass (Harimi et.al 2005).

4. Vernacular architecture

The concept of vernacular architecture and local material use needs to be met more effectively, first because local people are involved in identifying and working to address these needs, allowing the integration of local traditions and values (Cultural research association, 2007). Second, it allows a more economical operation by minimizing the transport of goods in an era of expensive energy, allowing greater interaction of local industry and permitting greater use of local resources – both material and human, skills and knowledge (Shearer, 1986). Third, it makes unnecessary many expensive or unavailable finance, transportation, education, and advertising, management, and energy services; and avoids the loss of local control that use of such outside services implies (Filippy, 2005).

The vernacular material using in Varkane is an elaborate text that exhibitions a pure expression of the local heritage, the social system, and the cultural customs of their inhabitants. These can described as a beautiful authentic manifestation of the local culture.

4.1. Typological analysis

The general form of the village looks like modesty touching the earth and nature. In other words, buildings do not govern the natural setting and they naturally organized along East-West direction with special facing that provides every house the best sun light. Roads as fundamental elements of the settlement pattern have several kinds of orientation in effect of topography.

This old settlement has a clear-cut organization, which specifies the use of space and determines the private, semi-public and public areas, varying in degree of accessibility and stockade. The vernacular design of the built environment based on a conceptual process of the vernacular living, the basic needs and the associated functions that were present in the cultural of the inhabitants. In the vernacular settlements of Iran, the arrangements of the urban fabric relate to social structures, economic necessities, defense requirements and climatic adaptations (Cultural research association, 2007). The vernacular settlements typically consisted of confined residential sectors which looking to create suitable public places. The kind of vernacular settlement designed to provide privacy and security, through specific elements built in for these purposes and through severance of space: private and semi-private.

These spaces have several aims; each has a defined primary use and function. The physical aspect of the neighborhoods elements make a specific network where common messages exchanged. Some parts of the house fabric determinate contact between inhabitants and outsiders, while others invite it. Public open spaces have directly connected with the

settlement's gates while the semi-private spaces work as physical traps.

This ancient village developed accordingly to the typical aspect architecture, as a complex settlement with concentric and radial connecting roads to allow internal communications within the village, walls of brick surrounding on all sides, closely packed buildings, houses connected to one another by narrow alleys.

Fig. 2. Varkane's mixed manner of construction-stone ground floor and adobe for floors above.

4.2. Site planning

The typical structure of the village developed from a historic centre on the top of a hill toward the bottom. The built-up areas surrounded by cultivated fields and the palm groves. In Varkane houses layout provides a sort of convection comfort since the streets are very narrow and the ascending walls of houses on both sides create impediment spaces against blast from the over valley.

Meanwhile those walls also provide absorbing sun light for the rooms and internal spaces. In whole village spaces, this scale of walls covered streets provide extra cooling and protection from the sun during the summer, which can also find in the house scale as well.

4.3. Construction materials and techniques

Stone, timber and bricks (sometimes mixed with straw) are the building material and techniques used most widely in this area, which best fits the local conditions: a cold climate, the need to save appreciable heights over small surface areas and to control progressively the masonry wall thickness. Originally house form try to control solar radiation saving and ventilation, witch are two important aspects.

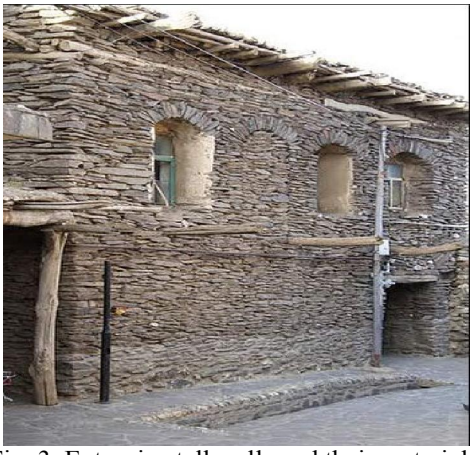


Fig. 3. Extensive tall walls and their materials.

Mud and plastering were applied by hand on the stone walls surface. This material makes the walls special solidarity to the supports and absorbs expansion and shrinkage phenomena. At the same time, it is conserving enough to keep the internal thermal energy behind the walls.

5. Evaluation

Settlement structure and its form of the built environment determine both the efficiency of resource uses and the quality of life of the inhabitants. Study the settlement and its behavior with environment depends to quality of life regard the quality of environment. Table 1 shows more interrelationships between settlement quality and the natural environment providing sustainable inhabitation.

The vernacular architect of Varkane have been utilized the natural conditions to make a sustainable settlement, also high natural potentials like access to clean drinking water of abundant wells and suitable air quality of adjacent valleys have been supply the scarce basis for them.

5.1. Architectural typology and building physics

Using the vernacular materials in buildings and have a close relationship with the environment is the most common experience that the traditional architectures use in Varkane. Moreover, the evaluation base on the design variables proposed by Mahoney as the ones that promote the creation of buildings responsive to the climate. These are: a) the layout of the buildings (orientation in relation to sun and wind, aspect ratio); b) spacing (site planning); c) air movement; d) openings (size–position, protection); and e) building envelope (walls: construction materials- thickness, roof construction detailing) (Harimi et. al 2005).

Table 1: Interrelationship between "livable housing" and the natural environment described by core sustainability indicators (Hartman & Kwon, 2005).

'Quality of Life'- Livable housing	
Indicator	*Issue*
Adequate and affordable housing	**Shelter**
Adequate sanitation	**Health**
Access to clean drinking water	
Air quality: Indoor and ambient	
Absence of disease vectors	
Access to health care	
Threat of natural or man-made disasters	**Safety**
Quality of Natural Environment	
Indicator	*Issue*
Freshwater use Land use	**Resource use**
Energy use	
Waste produces Water quality	**Pollution and degradation**
Air quality	
Conservation (land having formal protection status)	**Protection of environment**

5.1.1. Layout

Orientation: Dwellings are oriented on a usual north–east axis.

Aspect ratio: The term ‘‘aspect ratio’’ is used to denote the ratio of the longer dimension of a rectangular plan to the shorter. The direction of main alleys and passageways are in a way absorbing sunshine and against the stormy winds, and based on the field location to make the best use of existing weather. Most of the houses are faced to the complex and their walls in relation with passageways, gain more height, which leads to more absorbing from, winds. Structure in this area is concentrated and the buildings linked to each other. Narrow alleys with stone walls are have an organic grown.

5.1.2. Spacing

Site planning: The lifestyle in Iranian reigns generally promotes introversion in the design of space inverse of extroversion, and type of climatic in this reign demanded an exposure to sun light and conserve of thermal energy.

Attached dwellings of compact geometry and restricted courtyards are designed considering climate conditions.

Gardens and cool places that become the main living units of the summer months.

Fig. 4. over view of the historic buildings.

5.1.3. Openings

Openings are highly affected by climate, cultures and available materials for kind of design. Dimensions of openings have a strong effect on absorbing sunlight and special effect on view condition. Openings divided in three major types by their sizes: doors, windows and depths in walls used as shelves. They also categorized according to their construction method.

Size–position of openings: Open spaces: Because of well condition of climate, open areas in this place use for social patterns especially in spring and summer.

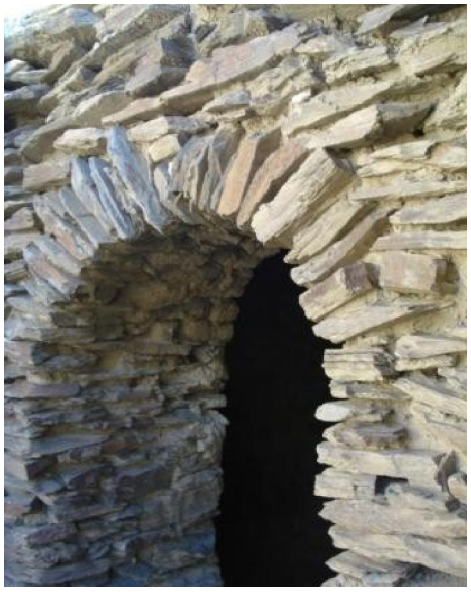


Fig. 5. Openings and their special type.

5.1.4. Building envelope

Buildings specific typologies have centered on the kind of settlement types according their density. It appears to be concept that a useful settlement typology must combine a range of different indicators.

The indicators used to formulate the building envelope predominantly focused on housing structures and settlement pattern, with environmental capacity/sensitivity and socio-demographic and economic characteristics also being included (Flood, 1997). The physical prospect of housings have effected by the environment, culture and using local materials based on the concept of the village typology.

Walls: In rural construction, walls built from adobe and mud, stone, wood or bricks and concrete blocks. In the mountainous region Stone walls are very popular in that stone is easily accessible.

Fig. 6. Various stone walls.

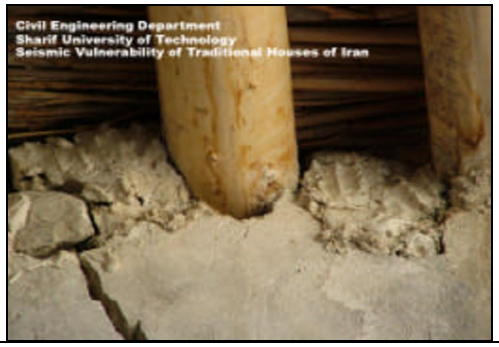
As stones have a high compressive strength, stone walls bear the gravitational loads by far; on the other hand, very weak mortars are usually used in this type of walls, giving it little strength against lateral loads. Table 2 includes the range of dimensions of stone walls (Mousavi et. al 2006).

Table 2: Stone walls.

Specification	**Range**
Thickness	40 to 60 cm
Height	More than 2 m
Weight of unit area	1000 to 1500 kg/m2

Roofs: Roofs of rural settlements in Iran separate in four major groups according to their shapes and materials: arched roofs, wooden flat roofs, inclined roofs and jack-arch roofs. In this village natural environment (Mountainous and cold region) requires to use a kind of wooden flat roofs. These roofs are the traditional format of joist roofs using wooden beams instead of reinforced concrete or steel beams. Gravitational load of the roof is transmitted to the walls through wooden beams, which are embedded in adobe, or stone walls and usually no longitudinal or transverse anchorage is observed. Wooden beams covered with branches of trees, earth and mud and finally coated with mud-straw that works as an insulator. Fig 7 shows the sketch of a wooden flat roof and an example of this type.

Wooden flat roofs are common in cold and mountainous regions such as western Iran, Hamedan and its regions and in general, parts of Iran that construction wood like aspen trees are available. Table 3 shows the range of dimensions of wooden flat roofs observed in different parts of Iran (Mousavi et. al 2006).



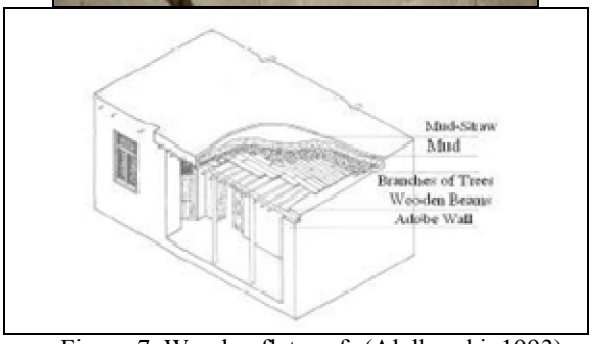


Figure 7. Wooden flat roofs (Alalhesabi, 1993).

Connection, the roof is covered with mud-straw every 2 or 3 years that makes it heavy, weak beam to wall connections, the mortar is mud, gypsum or sometimes no mortar is used, stone and mud mortar are not consistent materials (Mousavi et. al 2006).

5.2. Varkane: a sustainable historic vernacular settlement

During the several changes of lifestyle for more than a hundred years, the fact that Varkane has maintained its strictures show that the techniques of its construction and the building materials employed were well thought professional choices aiming at sustainability. Moreover, traditional architectures always try to prepare comfort without the need of any

mechanical systems and concerned about energy, materials of use, as well as the impact of the human buildings on the environment. This certainly becomes obvious by their use of vernacular and recyclable materials. Therefore, the vernacular architecture of this settlement is a kind of sustainable settlement. The criteria that lead to the creation of such a sustainable vernacular settlement are:

- Holistic consideration of negative environmental impacts that arise in the construction of buildings and their infrastructures,
- Design recommendations, which minimize the adverse environmental effects in building,
- Use of materials with low maintenance and energy efficiency,
- Selection of building materials that provides thermal comfort,
- Use of renewable and natural resources,
- Reduction of energy consumption by maximizing passive thermal comfort,
- Concern for integral quality: economic, social and environmental performance,
- Improvement of environmental quality,
- Provision for comfortable living spaces (Godfaurd et. al 2005).

Table 3: Wooden flat roofs.

Specification	**Range**
Diameter of wooden beam	5 to 20 cm
Beam span	250 to 400 cm
Lateral spacing	20 cm for diameters less than 10 cm and 100 to 200 cm for larger diameters
Thickness of roof excluding joists	20 to 40 cm
Clear story height	270 to 300 cm
Weight of unit area	300 to 600 kg/m2

6- Conclusions

During several changes in the lifestyle in communities and their requests, the additions to the traditional dwellings or new constructions added to this vernacular has been coordinate with consideration of the climate since they never depend heavily on mechanical systems to provide comfort. Varkane is a vernacular historic settlement that takes advantage of its environment through the appropriate application of design elements and building materials for energy preservation as well for ensuring comfortable dwelling conditions. This paper was concerned with constructions of the buildings, the kind of vernacular architect, the spacing, the openings, and the building envelope (walls: construction materials-thickness, roof construction detailing). It evaluated specific vernacular dwelling types and their response to climate, based on design principles that could be adapted to current architectural practice in the area, in order to optimize, the relationship between site, building and climate. This paper attempts to evaluate the architectures applied in such durable, compatible, elegant, reliable and eco-efficient buildings in this settlement. This presumed that these vernacular characteristics generate climatic benefits since residents who had lived in them in several generations with several changes in requirements, could find their needs of spaces and building in their vernacular traditional architecture. The dwellings of Varkane demonstrate an economical use of local building resources, and respond to climatic conditions using low-energy design principles that provide human comfort. These design principles are consistent with the form, orientation and materiality of the buildings. Their combination of engineering and architecture reveals an aesthetic quality, which, instead of imposing on the environment it emanates from it. The study of these settlements, helps to understand their traditional development better, and provides examples of a sustainable building tradition, from which many lessons can be learned.

References

1. Moradchelleh. A. Environmental Factors in Iranian Architecture. Journal of American Science 2011;7(6):1-12.
2. Alalhesabi, M. Patterns of rural houses, Housing Foundation of Islamic Revolution, Tehran, Iran. 1993:52-8.
3. Augenbroe, G., Park, C. S. Quantification methods of technical building performance. Building Research and In-formation 2005;33 (2):159-72.
4. Balaras C, Gaglia A, Georgopoulou E, Mirasgedis S, Sarafidis Y, Lalas D. European residential building and empirical assessment of the Hellenic building stock, energy consumption, emissions and potential energy savings. Building and Environment 2007;42(5):1298–314.
5. Coch H. Bioclimatism in vernacular architecture. Renewable and Sustainable Energy Reviews 1996;2(1–2):67–87.
6. Cultural research association. The Iranian Atlas of Vernacular Architecture. Cultural research association Publisher. Tehran, Iran. 2007:160-71.
7. Filippy, F. Sustainable living heritage conservation through community based approaches, forum UNESCO University and Heritage 10th International Seminar. Cultural Landscapes in the 21st Century. Newcastle, 2005;12(1):70-82.

8. Flood, J. Urban and Housing Indicators. Urban Studies 1997;34 (10):1635-1665.
9. Ghobadian, V. Climatic analysis of the traditional Iranian buildings, Tehran University Publications, Tehran, Iran. 1994:150-70.
10. Godfaurd J, Clements-Croome D, Jeronimidis G. Sustainable building solutions: a review of lessons from the natural world. Building and Environment 2005;40(3):319–28.
11. Goh, Daniel P.S. Eyes Turned Towards China: Postcolonial Mimicry, Transcultural Elitism and Singapore Chineseness, in Goh et al (eds.), Race and Multiculturalism in Malaysia and Singapore, London: Routledge 2009;1(1):37-53.
12. Harimi, M., Harimi, Dj., Kurian, V.J., Bolong, N. Evaluation of the Thermal Performance of Metal Roofing under Tropical Climatic Conditions, SBO: World Sustainable Building Conference, Tokyo, Japan. September, 2005;1(1) 709-716.
13. Hartman, R. and Kwon, O.-S. Sustainable growth and the environmental Kuznets curve. Journal of Economic Dynamics & Control 2005;29(2):1701-36.
14. Haweks, D. The technical imagination: thoughts on the relation of technique and design in architecture, Journal of Architecture 1996;1(4):42-56.
15. Hyde, R. Climatic Responsive Design, New York, E & FN SPON publications. 2000:112-97.
16. Kerschner H. Weather-Type climatology of precipitation in the eastern Alps. Croatia Meteorological Journal 2005;40(8):90-93.
17. Kowaltowski, D.C.C.K.; Labaki, L.C.; Pina, S. Mikami G.; Gutierres, G.C.R. and Gomes, V.S. The Challenges of Teaching bioclimatic architectural design. Proceedings of International Conference: Passive and low energy cooling for the built environment. 2005;1(1):327-332.
18. Mason, M. D. and Kingston, T. M. Let's talk about weather, In Proceedings of Building Simulation Conference, Adelaide, Australia 1993;93(1):470-487.
19. Pfafferott, J. U., Herkel, S., Kalz, D. E., Zeuschner, A. Comparison of low-energy office buildings in summer us-ing different thermal comfort criteria, Energy and Buildings 2007;39(7):750-757.
20. Ramin Beedle. Weather types, their frequency and relation with rainfall in west of Iran. Journal of American Science 2011;7(8):760-767.
21. S.E. Mousavi Eshkiki, A. Khosravifar, M.A. Ghannad, A. Bakhshi, A.A. Taheri Behbahani, Y. Bozorgnia. Structural Typology of Traditional Houses in Iran Based on Their Seismic Behavior. Proceedings of the 8th U.S. National Conference on Earthquake Engineering, San Francisco, California, USA Paper 2006;1143(1):156-170.
22. Shearer, W. Forward: Natural Energy and Vernacular Architecture, principles and examples with reference to hot arid climate. The University of Chicago Press, Chicago and London. 1986:90-52.
23. Tol, Richard S. J. Is the Uncertainty about Climate Change Too Large for Expected Cost-Benefit Analysis? Climatic Change 2007;56(2003),265–289.
24. Watson, D. Climatic Design. Tehran University Publications, Tehran, Iran. 1994: 187-45.
25. Wu, S., Clements-Croom, D. Understanding the indoor environment through mining sensory data-A case study. Energy and Buildings 2007;39(11):1183–1191.
26. Yeang, Ken. The Ecological or Green Approach to Design in Szokolay, Steven V. (ed.), Sustaining the Future: Energy Ecology Architecture, Proceedings of the PLEA Brisbane. PLEA and University of Queensland. 1999;99(2):1-6.

6/25/2017